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| xx) | Economics of Production and Marketing of King Chilli in UBVZ of Assam | Saradi Sondhya Baruah |
| xxi) | Estimation of Risk Frontiers in Rice Cultivation under Flood Prone Situation of North Bank Plain Zone of Assam | Shivangee Acharya |
| xxii) | Comparative economics of potato cultivation using tuber and True Potato Seed (TPS) in Tripura | Sonia Das |
| xxiii) | An economic analysis of production and marketing of orange in Kamrup Metro district of Assam | Sunil Pator |
| 7xxiv) | Disaggregated regional growth and disparity analysis of public sector banks in India with special reference to Assam | Swathy Parvathy |

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| xxv) | A study on crop diversification and its impact on agricultural production in Biswanath district | Trailukya Das |
| xxvi) | Assessment of women participation in Assam Agriculture | Trishna Chutia |
| xxvii) | A study on financial management of muktai dairy farm | Vishal Kacharu Kahandal |

4.4.1 Agricultural Economics & FM (MBA)

423-448

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|-------|---|----------------------|
| i) | Performance of Agri-Supply Chains: A study on Fresh Vegetable Distribution System in Jorhat district of Assam | Allah Mohammad Riaz |
| ii) | Impact of the Celebrity Endorsement on the Buying Behaviour of the Consumers in Jorhat District of Assam | Balaganesh T |
| iii) | Consumer preference towards Ayurvedic product in Assam | Debasis Kalita |
| iv) | Business analysis of Community Supported Agriculture (CSA) in Assam | Julfikur Rahman |
| v) | Post-harvest Management of Medicinal Plants in Assam: A Case Study of Assam Prakritik Udyog | Nabajit Barman |
| vi) | Supply chain and value addition in flower marketing – A case study in Sukleshwar Ghat flower market of Guwahati | Nilakhi Sarma |
| vii) | Economic Analysis of Sugarcane Industry in Haridwar District of Uttarakhand | Nishant Choudhary |
| viii) | Organizational structure and management of Dream Dragon Fruit Farm of Nagaland | Pithunglo L Kiron |
| ix) | Impact of organized retailing on consumer buying behaviour for vegetables in Kamrup (Metro) district of Assam | Prabal Pratim Kalita |
| x) | Production and marketing management of flower cultivation in Hajo | Priyanka Bora |
| xi) | Consumer Preference towards Online Shopping in Jorhat District of Assam | Rahmatullah Shahin |

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| xii) | Investment Analysis of Dairy Farming in Assam | Raj Kallol Dutta |
| xiii) | Study on Management of Agribusiness Startups | Sahryar Tehzib Ahmed Choudhury |
| xiv) | Rice Distribution System Through Co-operative Societies and Fair Price Shops in Jorhat district of Assam | Tabarak Hussain |
| xv) | Value Chain Management of Naga King Chilli of Nagaland | Tumei Konyak |
| xvi) | Study on vishaka dairy products and consumers' perception in North Coastal districts of Andhra Pradesh | Yedla Divya Dinkar |

4.5. Agrometeorology

449-465

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|-------|--|----------------------------|
| i) | Growth and yield of tomato crop under modified microclimatic condition in Jorhat | Amlanika Kalita |
| ii) | Effect of weather parameters on growth and yield of Greengram [<i>Vigna radiata</i> (L.)] under the agroclimatic conditions at Jorhat | Mangshatabam Annie |
| iii) | Simulation modelling of Winter Rice (<i>Oryza sativa</i> L) using DSSAT model in Agroclimatic condition of Jorhat | Nikhil Shrishail Paschapur |
| iv) | Effect of elevated CO ₂ and temperature on growth and yield of winter rice under Jorhat condition | Parishmita Das |
| v) | Impact of thermal and radiation regimes on growth and yield of Potato (<i>Solanum tuberosum</i>) under varying microenvironments | Raktim Jyoti Saikia |
| vi) | Dry and Wet spell Analysis for Crop Planning in Upper Brahmaputra Valley Zone (UBVZ) of Assam | Sangeeta Hazarika |
| vii) | Evaluation of Pan Coefficient Methods for Estimating Reference Crop Evapotranspiration at Jorhat | Saurabh Sharma |
| viii) | Quantification of thermal and radiation regimes on growth and yield of aromatic rice in Jorhat district of Assam | Silpa Rajkhowa |

4.6. Agronomy	466-515
i) Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice (<i>Oryza sativa</i> L.)	Abhinandan Chetia
ii) Zinc fortification in maize <i>Zea mays</i> through soil and foliar application	Anupriya Yadav
iii) Nutrient and weed management in buckwheat (<i>Fagopyrum esculentum</i>) after <i>sali</i> rice	Bamon Timung
iv) Conservation irrigation and integrated nutrient management of late sown <i>toria</i> in rice fallows of Assam	Bhakti Priya Dutta
v) Effect of sowing dates and planting geometry on summer baby corn	Dibya Jiban Panda
vi) Effect of fertility levels and mulching on growth and yield of <i>rabi</i> baby corn	Dulla Pushpa
vii) Performance of quality protein maize (<i>Zea mays</i> L.) under different crop management practices	Gargi Kashyap
viii) Estimation of crop water footprint in Jorhat district of Assam	Grefy Morang
ix) Agronomic bio-fortification of fodder maize (<i>Zea mays</i> L.) with boron and zinc	Himangshu Deka
x) Effect of Plant Growth-promoting Rhizobacteria and Weed Management in Direct-seeded Upland Rice	Jimni Phukan
xi) Effect of Phosphate Solubilising Bacteria (PSB) on fodder productivity of cowpea in acid soil	Jishnu Pratim Mudoi
xii) Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation	Keisham Dony Devi
xiii) Irrigation scheduling in rapeseed using Can evaporimeter	Krishna Bharadwaj

xiv)	Effect of date of sowing and row spacing on growth and yield of baby corn(<i>Zea mays L.</i>) during <i>rabi</i> season	Lipika Talukdar
xv)	Crop diversification in organic rice ecosystem	Merajul Hussain
xvi)	Integrated nutrient management in summer maize (<i>Zea mays</i>)	Minakshi Bezboruah
xvii)	Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem	Nayan Jyoti Bordoloi
xviii)	Relative performance of niger varieties to graded levels of fertilizer under rainfed condition	Nikita Kaman
xix)	Performance of late sown toria in rice fallows under integrated nutrient management practices	Priyanki Bora
xx)	Nutrient and weed management in rainfed toria by organic methods	Prostuti Bora
xxi)	Studies on potato crop as affected by planting date and nutrient management	Rajibul Hoque Mullah
xxii)	Response of rainfed late sown toria in rice fallows as influenced by application of sulphur and boron and sulphur	Rekhankona Pegu
xxiii)	Effect of irrigation schedule and sulphur fertilization on productivity of Indian mustard (<i>Brassica juncea L.</i>)	Shantonu Paul
xxiv)	Nutrient management in rapeseed through organic sources	Sonam Lhamu
xxv)	Performance of direct seeded sali rice under two different crop establishment methods and weed management practices	Vigneshwaran M

4.7. Crop Physiology

516-538

i)	Effects of Manganese on some rice genotypes in acid soil of Assam	Aisina Yomso
ii)	Regulation of vase life and quality of gerbera (<i>Gerbera jamesonii</i>) by postharvest chemical application	Anirban Saikia

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| iii) | Tolerance of summer greengram genotypes against water-logging condition | Bhaskar Saikia |
| iv) | Effect of jatropha leaf extract and seed oil on okra (<i>Abelmoschus esculentus</i> L.) | Mr. Jeffrey Malsawmzuala |
| v) | Physiological effect of high temperature stress on some <i>sali</i> rice genotypes | Kabita Saikia |
| vi) | Physiological basis of aluminium tolerance in rice (<i>Oryza sativa</i> L.) | Ms. Ph. Fakiha |
| vii) | Phenotyping of some cultivated and wild banana germplasm of NE India under rainfed and irrigated conditions of Assam | Nishita Pathak |
| viii) | Physiological performance of lentil genotypes under late sown condition in rice fallow as influenced by rhizobacteria (<i>Pseudomonas fluorescens</i>) | Reshme Moirengjam |
| ix) | Effects of some Organic Nutrients on Physiology of Scented Rice (<i>Oryza sativa</i> L.) | Stutipriya Hazarika |
| x) | Impact of high temperature and carbon dioxide on plant growth and beneficial rhizospheric microbes of rice | Supriya Sarma Rajkhowa |
| xi) | Study on growth and yield of green gram (<i>Vigna radiata</i> L. Wilczek) under high level of CO ₂ | Tarique Aziz |

4.8. Entomology

539-580

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|------|--|---------------------------|
| i) | Biology of <i>Callosobruchus chinensis</i> (L.) on Green gram, <i>Vigna radiata</i> (L.) and Black gram, <i>Vigna mungo</i> (L.) in two different seasons | Abhilasa Kousik Borthakur |
| ii) | Loss assessment and prey preference of coccinellid (<i>Coccinella transversalis</i> Fabricius) to different instars of aphids (<i>Aphis gossypii</i>) in tomato (<i>Solanum lycopersicon</i> L.) | Ankita Baruah |
| iii) | Bioassay of some plant extracts against banana pseudo stem weevils <i>Odoiporus longicollis</i> Oliver (Coleoptera: Curculionidae) | Annabhatula Sasidhar |
| iv) | Studies on predator-prey and host-parasitoid relationship involving sucking pests and it's entomophages in mulberry ecosystem | Arindam Khanikar |

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| v) | Bioassay of some plant extracts against banana leaf and fruit scarring beetle (<i>Nodostoma subcostatum</i> Jacoby, Coleoptera: Chrysomelidae) | Baishali Boruah |
| vi) | Avifaunal diversity in Rice Agro ecosystem | Chiranjeeb Sonowal
Borah |
| vii) | Influence of coloured light emitting diodes on specific behaviours of <i>Sitophilus oryzae</i> (L.) and <i>Callosobruchus chinensis</i> (L.) | Jabanika Hazarika |
| viii) | Evaluation of Two Native Entomopathogenic Nematodes against Termite (<i>Odontotermes obesus</i>) and Cutworm (<i>Agrotis ipsilon</i>) | K. Sindhura Bhairavi |
| ix) | Comparative biology of <i>Callosobruchus chinensis</i> (L.) under different colour cues | Komedity Chamua |
| x) | Diversity of insect forager complex and foraging behaviour of honeybee, <i>Apis cerana</i> in ber and papaya | Liza Shyam |
| xi) | Nutritional composition of some commonly available aquatic edible insects of Assam | Mintu Sarma |
| xii) | Methods of Extraction of Mucin from Giant African Snail, <i>Achatina fulica</i> (Stylommatophora: Achatinidae) | Partha Pratim Gyanudoy
Das |
| xiii) | Pests scenario of tea, <i>Camellia sinensis</i> (L.) O. Kuntze, and management of red spider mite, <i>Oligonychus coffeae</i> Nietner by newer acaricidal molecules | Parthiban. M |
| xiv) | Bio efficacy of certain entomopathogenic fungus against major insect pests of <i>Brassica campestris</i> var. <i>toria</i> | Prabhu Prasanna Pradhan |
| xv) | Management of <i>Callosobruchus chinensis</i> (L.) (Coleoptera: Bruchidae) - a stored grain pest of <i>Flemingia macrophylla</i> (Willd.) and <i>Flemingia semialata</i> (Roxb.) | Preetipuja Kashyap |
| xvi) | Botanicals for Tea Insect Pest Management | Ritushree Mahanta |
| xvii) | Brood rearing and foraging activity of stingless bee (<i>Tetragonula iridipennis</i> Smith) in cucumber (<i>Cucumis sativus</i> Linnaeus) under protected condition | Sourav Sen |

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| xviii) | Haemocyte Morphology and Cellular Immune Response in Cabbage butterfly, <i>Pieris brassicae</i> (L.) against <i>Beauveria bassiana</i> (Bals.)Vuill. | Sravanthi Erla |
| xix) | Evaluation of release methods of Trichogrammatids (Hymenoptera: Trichogrammatidae) against lepidopteran pests of cabbage | Tanbir Hazarika |
| xx) | Study on native plants as hosts of Lac insect, <i>Kerria chinensis</i> (Mahdihassan) | Tanjil Rahman |
| xxi) | Effect of gamma irradiated rice seeds against certain insect pests of rice | Uddipana Shandilya |

4.9. Extension Education

581-621

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|-------|--|-----------------------|
| i) | A study on extent of Farm Mechanization in North Bank Plains Zone of Assam | Abhishek Rajkhowa |
| ii) | A study on effectiveness of advisory services rendered by Agro-Input Dealers in Jorhat District, Assam | Adrija Bora |
| iii) | A study on the extent of diversification and level of livelihood security of farmers in the North Bank Plains Zone of Assam | Akhoy Jyoti Bharadwaj |
| iv) | A Study on the Entrepreneurial Behaviour of the Nursery Owners in Kamrup (Metro) and Kamrup Districts of Assam | Arup Bora |
| v) | Resource Integration in <i>bari</i> system farming: A study in Jorhat district of Assam | Ashish Hazarika |
| vi) | A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat | Chiranjeeta Dutta |
| vii) | A Study on the Effectiveness of Skill Training of Rural Youth (STRY) Programme Implemented by KVKs in Assam | Darpan Kr. Das |
| viii) | A Study on the Extent of Adoption of Recommended Muga (<i>Antheraea assamensis</i>) Rearing Practices in Lakhimpur District of Assam | Jagat Jyoti Baruah |

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| ix) | Training need assessment of agricultural input dealers in Upper Brahmaputra Valley Zone (UBVZ) of Assam | Lisha Bordoloi |
| x) | Livelihood diversification of muga and non muga rearers- A comparative study in Majuli district of Assam | Manash Jyoti Borah |
| xi) | Livelihood diversification of muga and non muga rearers- A comparative study in Majuli district of Assam | Manash Jyoti Borah |
| xii) | A Study on the factors influencing entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production | Manisha Barman |
| xiii) | Paddy Farmers' Perspective Towards Sustainable Practices in Agriculture: A Study in Tinsukia District of Assam | Moukham Wakhet |
| xiv) | An Evaluative Study of Selected Training Programmes Conducted by KVKs of Upper Brahmaputra Valley Zone of Assam | Niberto Sangma |
| xv) | Preference of farm women towards sericulture as income generating activity- a study in Sivasagar district of Assam | Rekamoni Gogoi |
| xvi) | Extent of Gender Participation in Paddy cultivation- A Study in West Godavari district of Andhra Pradesh | Sakku Bala Jasmine Muthabathula |
| xvii) | Perceived assessment of utilization pattern of remittance – A study on interstate migration from Assam to Kerala | Shinu Thomas |
| xviii) | An appraisal of Farmer Producer Organisation operating in Assam And Karnataka | Somesh Hiremath |
| xix) | A study on vulnerability and adaptability of farmers to climate change in North Bank Plains Zone of Assam | Trilochan Karki Chetri |

4.10. Horticulture

622-676

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|----|--|-------------|
| i) | Nutrient budgeting of NPK doses for sweet pepper (<i>Capsicum annuum</i> ssp. <i>grossum</i> var. <i>Swarna</i>) under protected condition | Anjela Deka |
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| ii) Effect of planting depth and spacing on yield and quality of upland taro (var.Ahina kachu) | Arjun Loying |
| iii) Combination of Micronutrient and Pesticide Application for Enhancing Yield and Quality of Guava (<i>Psidium guajava</i> L.) | Arunabh Gogoi |
| iv) Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding dahlia (<i>Dahlia variabilis</i>) | Biprajit Datta Choudhury |
| v) Nutrient management in Thailand ber (<i>Zizyphus mauritiana</i>) | Bipul Das |
| vi) Studies on effect of different mulches on growth and yield of chilli (<i>Capsicum annum</i> L.) | Chayanika Das |
| vii) Standardization of propagation of jackfruit (<i>Artocarpus heterophyllus</i> Lam.) by grafting | Debashree Baruah |
| viii) Fruit and seed production of Bhut Jolokia (<i>Capsicum chinense</i> Jacq.) as influenced by growing condition and canopy management | Deepak Ranjan Pradhan |
| ix) Suitability Studies of <i>Dracaena</i> as Cut Foliage | Dikshita Baruah |
| x) Response of chinese cabbage (<i>Brassica campestris</i> ssp. <i>Pekinensis</i>) to organic amendments | Dilsha Chandran |
| xi) Integrated Nutrient Management in Lemon var. Assam lemon (<i>Citrus limon</i> L. Burm.) | Eleza Baro |
| xii) Studies on physico-chemical characters of Thai Apple ber (<i>Zizyphus mauritiana</i> Lamk.) grown in Assam | Haribhakta Khanikar |
| xiii) Standardization of propagation method of custard apple (<i>Annona reticulata</i>) by air layering and stem cuttings | Jahnabi Hazarika |
| xiv) Impact of sprout management on growth and yield of pointed gourd (<i>Trichosanthes dioica</i> Roxb.) | Kanchan Kumari Gupta |
| xv) Morpho-biochemical characterization of custard apple (<i>Annona reticulata</i>) grown in Brahmaputra valley of Assam | Karobi Hendique |

xvi)	Response of garden pea (<i>Pisum sativum</i> L.) to foliar application of zinc	Lupita Borah
xvii)	Standardization of growing media and assessment of plant species suitable for Vertical Gardening	Madhushree Ghosh
xviii)	Effect of Indigenous methods of ripening on shelf life and quality of banana fruits	Manuranjan Roy
xix)	Studies on different exotic varieties of Lettuce (<i>Lactuca sativa</i>) in agro-climatic condition of North Bank Plain zone of Assam	Mrutyunjaya Behera
xx)	Performance of radish (<i>Raphanus sativus</i> L) cv Japanese white as influenced by organic inputs and microbial consortium	Nandeesh J
xxi)	Study on the diversity of <i>Colocasia</i> germplasm of Dima Hasao District of Assam	Nehail Hojai
xxii)	Organic amendments on growth, yield and quality of strawberry (<i>Fragaria x ananassa</i> Duch.)	Pooja Rayanna Bastawadkar
xxiii)	Assessment of growth, yield and quality of different types of cluster bearing ridge gourd (<i>Luffa acutangula</i> Roxb.	Priyanka Boruah
xxiv)	Response of Bitter Gourd (<i>Momordica charantia</i> L.) to organic amendments	Raktim Kiran Das
xxv)	Growth performance of some gladiolus cultivars in paired row system	Rocktim Baruah
xxvi)	Effect of dehydration methods on quality parameters of drumstick (<i>Moringa oleifera</i> Lam.) leaves	Sahinur Ahmed
xxvii)	Comparative performance of marigold hybrids (<i>Tagetes erecta</i> L.) in different planting dates	Saptarisha Chetia
xxviii)	Impact of seed priming and priming durations on early season okra [<i>Abelmoschus esculentus</i> (L.) Moench]	Sarath Krishna R
xxix)	Performance of Brinjal (<i>Solanum melongena</i> L.) as influenced by rootstock	Trideep Rajak

xxx)	Effect of growth regulators on Assam Lemon (<i>Citrus limon L</i>)	Wahedullah Bakhtari
4.10.1 Food Science & Technology (Horticulture)		677-694
i)	Preparation and analysis of whey based fruit beverage	Ananya Borah
ii)	Quality of elephant apple (<i>Dillenia indica L.</i>) powder as affected by drying methods	Aradhana Boruah
iii)	Ready-to-reconstitute soup mix from <i>Moringa</i> leaf and <i>Mentha</i> leaf powders	Jadhav Priyanka Yashwant
iv)	Development of tuber crops based composite flour	Kasturi pusty
v)	Quality of Carambola RTS beverage as influenced by preservation methods	Monmayuri Phukan
vi)	Awareness and use of food label information by consumers of Jorhat, Assam	Monosweta Gracy Shaw
vii)	Quality of sweet potato flour as affected by pre-treatment and drying methods	Mriganka Shekhar Borah
viii)	Studies on quality of dried Oyster mushroom (<i>Pleurotus ostreatus</i>) and Milky mushroom (<i>Calocybe indica</i>) as influenced by various pre-treatment and selected drying temperatures	Nastalina Borah
ix)	Development of Vinegar from Rice Varieties of Assam with Herbal Incorporation	Pratikshya Dutta
x)	Formulation of ready-to-use curry powder for ethnic cuisines of North East India	Priyankhi Kalita
xi)	Production of blended tea-fruit wine with efficient yeast culture	Richi Sika
xii)	Development of a beverage powder using Elephant apple (<i>Dillenia indica</i>) and whey	Udangshree Borah
4.11. Nematology		695-709
i)	Survey and management of root-knot nematode, <i>Meloidogyne incognita</i> on tuberose, <i>Polianthes tuberose</i> <i>Polianthes tuberose</i>	Abhijit Chetia

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| ii) Efficacy of entomopathogenic nematodes (EPNs) against major insect pests of tea | Amuri Bharath |
| iii) Bio-management of rice root knot nematode, <i>Meloidogyne graminicola</i> through native fungal bioagent | Indumoni Phukan |
| iv) Mechanism of <i>Lantana camara</i> leaf extracts in the management of <i>Meloidogyne incognita</i> on tomato | Kankana Bordoloi |
| v) Management of root knot nematode (<i>Meloidogyne incognita</i>) in Tomato by Bacterial Bioagent | Karter Nyodu |
| vi) Evaluation of antagonistic potential of certain plants against root-knot nematode <i>Meloidogyne incognita</i> | Kasturi Goswami |
| vii) Characterization and evaluation of Heterorhabditis bacteriophora | Madhumita Goswami |
| viii) Antagonistic crop biomass as a tool for improving carrot yield in root knot nematode (<i>Meloidogyne incognita</i>) infested field | Mirlona Rongpipi |
| ix) Screening and pathogenicity of root-knot nematode, <i>Meloidogyne incognita</i> on bitter melon, <i>Momordica charantia</i> (L.) | Mansi |
| x) Histopathological and biochemical changes in traditional rice cultivars due to rice root-knot nematode <i>Meloidogyne graminicola</i> | Priyanka Gogoi |
| xi) Effect of Silver Nanoparticles on the development of root knot nematode (<i>Meloidogyne incognita</i>) in Green gram | Rishikesh Phukan |
| xii) Morphological and morphometric variations of <i>Hoplolaimus</i> and <i>Helicotylenchus</i> | Venkadesh G |

4.12. Plant Breeding and Genetics

710-747

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|---|----------------------------|
| i) Characterization of rice (<i>Oryza sativa</i> L.) cultivars for traits associated with adaptation under moisture stress | Abu Saleh Nizamuddin Ahmed |
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| ii) | Genetic analysis of adaptive traits and assessment of seed quality in response to high temperature in a diallel cross and molecular diversity in popular varieties of rapeseed (<i>Brassica rapa</i> L.) | Aradhana Phukan |
| iii) | Estimation of heterosis and combining ability studies in Kharif Marigold (<i>Tagetes erecta</i> L.) | Chayanika Lahkar |
| iv) | Genetic Variability and Diversity in Rice (<i>Oryza sativa</i> L.) for Traits Related with Grain Yield and Thermal Indices | Daizi Durba Saharia |
| v) | Evaluation of some rice genotypes under delayed sown condition in sali with low level of fertilizer input | Dalibha Pathak |
| vi) | Morphometric Characterization of Selected Mutants of Mungbean (<i>Vigna radiata</i> L. Wilczek) | Deepshikha Saikia |
| vii) | Assessment of genetic variability for glucosinolate in a set of Indian mustard [<i>Brassica juncea</i> (L.) Czern. & Coss.] genotypes and their relationship with economically important agronomic traits | Devidutta Lenka |
| viii) | Evaluation of inbred progenies of maize (<i>Zea mays</i> L.) for yield and important morphometric traits | Dikshita Gogoi |
| ix) | Interspecific hybridization in the genus <i>Capsicum</i> and Molecular characterization of F1 hybrids | Gayatree Hazarika |
| x) | Study on effect of Mutation on Ranjit Sub-1 for yield and yield attributing characters | Kasturi Shivam |
| xi) | Evaluation of rice varieties for yield and ancillary traits under organic cultivation | Lonishree Dutta |
| xii) | Characterization of Hill Rice (<i>Oryza sativa</i> L.) Germplasm of Assam for Yield and Quality Traits | Manash Protim Nath |
| xiii) | Genetic enhancement in tomato for resistance to bacterial wilt and quality through intra and inter-specific hybridization | S. Yasmin Das |
| xiv) | Genetic variability for traits related to synchronous maturity in Greengram | Nivedita Talukdar |

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| xv) | Genetic variability of root traits of different classes of rice (<i>Oryza sativa</i> L.) in Assam | Priyanka Bairagi |
| xvi) | Assessment of genetic variability and screening of soybean cultivars against major diseases in Assam | Priyankee Dutta |
| xvii) | Evaluation of maize (<i>Zea mays</i> L.) hybrids at high plant density for important yield attributes | Ramesh Kanna M |
| xviii) | Study on genetic variability and character association in rapeseed (<i>Brassica rapa</i> L.) under organic farming | Sentikokla Kechu |
| xix) | Studies on induced mutation in gladiolus (<i>Gladiolus hybrida</i> L.) through gamma rays | Shephali Priya |
| xx) | Evaluation and background selection of Bacterial Blight introgressed lines in Ranjit Sub-1 | Sruthi R |
| xxi) | Assessment of genetic variability and association analysis for morpho-physiological attributes in Sesame (<i>Sesamum indicum</i> L.) | Subrat Das |
| xxii) | Genetic variability in Rice bean (<i>Vigna umbellata</i> Thunb.) for important quantitative characteristics and their relationship with grain and forage yield | Suchitra Balmiki |
| xxiii) | Performance evaluation and character relationship in a set of genotypes of Yellow Sarson (<i>Brassica rapa</i> L.) | Supriya Kaushik |
| xxiv) | Evaluation of selected F3-4 lines of Tomato crosses (<i>Solanum lycopersicum</i> x <i>Solanum pimpinellifolium</i>) for morpho-metric traits | Upasana Bordoloi |

4.12.1. Plant Breeding and Genetics (SST)

748-763

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|------|---|--------------------------|
| i) | Effect of Seed Enhancement on Seed Establishment, Seed Yield and Quality of Direct Seeded Rice | Himashri Baishya |
| ii) | Effect of different storage structures on the seed quality of green gram (<i>Vigna radiata</i>) | Madhurima Bezboruah |
| iii) | Identification of morpho-chemical characters for genetic purity testing of rice varieties | Madhuryya Mohan Khanikar |

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| iv) | Varietal characteristics and divergence of rice varieties for genetic identity | Mannem Niveditha |
| v) | Influence of seed priming on aged seeds | Pratha Pratim Bora |
| vi) | Nutrient management for broccoli quality seed production in Assam | Pratiksha Gogoi |
| vii) | Application of bio priming for seed invigouration and early seedling establishment | Prithviraj Pegu |
| viii) | Evaluation of a few botanicals and bioagents in seed transmission of brown spot of rice caused by <i>Bipolaris oryzae</i> | Priyanku Mazumder |
| ix) | Evaluation of some indigenous rice varieties for seed morphology and cooking quality characteristics | Rajasree Rajkhowa |
| x) | Performance evaluation of pre-sowing seed treatments using bio agents in transplanted aromatic rice for organic condition | Shamima Nashrin |

4.13. Plant Pathology

764-794

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| i) | Molecular screening of Citrus germplasm for simultaneous detection of <i>Candidatus Liberibacter</i> species associated with citrus greening disease | Amitha Paul |
| ii) | Bioassay of toxicity of green synthesized silver nanoparticles on biocontrol agents and mammalian cells | Arti Kumari |
| iii) | Enhancing biocontrol potential of <i>Trichoderma viride</i> with micronutrients against <i>Colletotrichum capsici</i> | Bhanusree Doley |
| iv) | Study on fungal diseases of Gerbera (<i>Gerbera jamesonii</i> Bolus ex. Hook F) in Assam | Bishal Saikia |
| v) | Study on incidence, detection and characterization of Brinjal Little Leaf (BLL) disease in Assam | Dibya Sree Dutta |

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| vi) | Enhancement of microbial load in <i>Bhut chilli</i> (<i>Capsicum chinense</i> Jacq.) rhizosphere by bioformulation application and management of bacterial wilt disease (<i>Ralstonia solanacearum</i>) | Dipankar Das |
| vii) | Management of fruit rot of brinjal with fungal bioformulations | Fahnaz Sultan |
| viii) | Effect of bioprimering and nanopriming on seed storage, plant vigour and wilt suppression of chickpea | Gitashree Das |
| ix) | Assessment of microbial diversity of tomato plants and their relationship with bacterial wilt disease caused by <i>Ralstonia solanacearum</i> | Gurpreet Kaur Bhamra |
| x) | Biological management of bacterial diseases of few ornamental crops in Assam | Hrishikesh Hazarika |
| xi) | Exploring Actinomycetes and endophytes of rice ecosystem for management of Bacterial blight of rice | Kakumoni Saikia |
| xii) | Increasing the yield attributing character of different species of pleurotus through hybridization | Karishmi Riba |
| xiii) | Incidence, detection and molecular characterization of <i>Papaya ringspot virus</i> (PRSV) | Lonmow Gohain |
| xiv) | Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (<i>Pleurotus</i> spp.) | Lunisha Pegu |
| xv) | Comparative efficacy of different microbe based biopesticides on major pathogens | Mehjabin Rahman |
| xvi) | Fungus nematode interaction and management of root rot of Patchouli | Moyurtrisna Rajkhowa |
| xvii) | Identification and characterization of bacterial pathogens in fruits and plantation crops of Assam | Rajashree Chetia |
| xviii) | Studies on occurrence and organic management of anthracnose of black pepper in nursery | Rajshree Verma |

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| xix) | Bioformulation of Organophosphate Degrading Bacteria and Plant Growth Promoting Microbes for pesticide degradation <i>vis-à-vis</i> management of bacterial wilt pathogen <i>R. solanacearum</i> | Shenaz Sultana Ahmed |
| xx) | Assay of volatile organic compounds in citrus greening disease infected Khasi mandarin (<i>Citrus reticulata</i>) | Subrata Bora |
| xxi) | Evaluation of antifungal activity of essential oil against grey mould of tomato caused by <i>Botrytis cinerea</i> | Sudharshan K. R. |
| xxii) | Management of fruit rot of <i>Capsicum chinense</i> Jacq. with fungal bio-formulations | Sunita Dutta |
| xxiii) | Management of seed-borne mycoflora of greengram through botanicals | Suveta T. S. |
| xxiv) | Microbial consortia for management of citrus canker and regulation of defence related plant chemicals | Swagata Saikia |

4.14. Sericulture

795-817

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|------|---|-------------------------------|
| i) | Economics of Sericulture with special reference to Jorhat district of Assam | Barsha Das |
| ii) | A study on the ericulture based livelihood opportunities of the Kachari tribe in Jorhat district of Assam | Chowcin Borsali
Buragohain |
| iii) | Study on constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam | Dipankar Hatibaruah |
| iv) | Effect of zinc chloride (ZnCl ₂) supplementation on larval growth and economic cocoon characters of eri silkworm, <i>Samia ricini</i> Boisd. (Lepidoptera: Saturniidae) | Nanita Bora |
| v) | A study on livelihood opportunities of muga silkworms rearers of Sivasagar district of Assam | Nawaab Tasmin Hussain |
| vi) | Sucking pests and their natural enemies in mulberry ecosystem in Jorhat district of Assam | Nilutpal Saikia |

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| vii) Effect of botanical and chemical bed disinfectants on larval growth and economic cocoon characters of mulberry silkworm, <i>Bombyx mori</i> L. (Lepidoptera: Bombycidae) rearing | Pompi Kowar |
| viii) Effect of fortification of host leaves with silver nanoparticles (AgNPs) on larval growth and economic characters of eri silkworm (<i>Samia ricini</i> Boisd.) | Pranab Boro |
| ix) A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam | Pulak Rabha |
| x) Seasonal variation on larval, cocoon and yarn parameters of eri silkworm (<i>Samia ricini</i> Boisd.) reared on <i>Ailanthus</i> species | Raktim Ranjan Borah |
| xi) Study on regional variations on cocoon and yarn characteristics of muga silkworm during commercial seasons | Shilpa Saikia |
| xii) Nutritional ability and economic characters of eri silkworm (<i>Samia ricini</i> Donovan) eco-races on different food plants | Shilpi Devi Borah |
| xiii) Phenology and cocoon characters of Eri silkworm (<i>Samia ricini</i>) as affected by temperature and humidity under Jorhat conditions | Sudipta Kumar Das |

4.15. Soil Science

818-861

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|--|---------------------|
| i) Nutrient availability in soil and yield of tomato as influenced by manure sources and rice stubble management | Anupama Das |
| ii) Effect of Nutrient Management on Phosphorus Transformation and its influence on yield of Bell Pepper (<i>Capsicum annum</i>) under protected cultivation | Arindam Kumar Dutta |
| iii) Soil Available Phosphorus Pedotransfer Function for Acidic Soils of Central Brahmaputra Valley Zone of Assam | Bishnu Jyoti Saikia |
| v) Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice | Dipankar Sonowal |

vi)	Formulation of consortia using Plant Growth Promoting Rhizobacteria	Himadri Gogoi
vii)	Distribution of micronutrients under different land uses in soils of Golaghat district of Assam	Jatiprasad Barala
viii)	Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam	Jemima Ahmed
ix)	Symbiotic Effectiveness of Common Bean (<i>Phaseolus vulgaris</i> L.) <i>Rhizobium</i> grown in Soils of Assam	Jyotirupa Kalita
x)	Morphometric evaluation and soil loss estimation of a transect of Subansiri watershed in Lakhimpur district of Assam	Kamal Kishor
xi)	Profile distribution of potassium in some soils of Sarupathar block of Golaghat district, Assam	Karabi Das
xii)	Effect of liming on soil acidity components and available nutrients in Upper Brahmaputra Valley Zone of Assam	Manoharmayum Devi
xiii)	Distribution of plant nutrients in soil profiles under different land use systems	Meghna Saikia
xiv)	Targeted Yield based Fertilizer Prescription Model for Scented Rice	Momin Dloey
xv)	Phosphate adsorption in soils of Assam in relation to physico-chemical properties and plant uptake	Montrishna Rajkhowa
xvi)	Enrichment of Maize Grains with Zinc through Agronomic Biofortification	Narendra Kumar Yadav
xvii)	Nutrient availability, soil acidity and tomato yield as influenced by FYM-lime-wood ash mixture and rice stubble management	Prantika Kakati
xviii)	Effects of conservation tillage and herbicide application on soil microbial activity in rice-mustard sequence	Rajat Kumar Parit

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| xix) | Ecological Occurrences of Methyloproths in Phyllosphere of crops | Sanghamitra Phukan |
| xx) | Distribution of micronutrients in soils under Horticultural crops of Assam | Srinivasulu Kumbha |
| xxi) | Carbon and Nitrogen Mineralization in an Inceptisol with and without stubble addition | Suravi Nandi |
| xxii) | Soil properties in termite mounds under different land uses | Sushmita Konwar |
| xxiii) | Morphometry and Soil Erodibility of a transect of Ranganadi Watershed in Lakhimpur district of Assam | Tilak Prasad Panika |

4.16. Tea Husbandry & Technology

862-884

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|------|--|---------------------|
| i) | Scope of augmenting farmers' income in small tea plantations – a case study in Golaghat sub division of Golaghat district | Anganjyoti Swarup |
| ii) | Scope of augmenting farmers' income in small tea plantations – A case study in Bokakhat subdivision of Golaghat district | Angshuman Bezbaruah |
| iii) | Impact of gas flaring on soil health and growth of tea plants adjacent to oil field in merbil Majuli OCS 6 (west) in Dibrugarh district of Assam | Anubrat Borah |
| iv) | Scope of Augmenting Farmers' Income in Small Tea Plantations – A case study in Dhansiri Sub Division of Golaghat district | Dipankar Handique |
| v) | Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam | Eimon Bharadwaj |
| vi) | Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1 (North), Dibrugarh district of Assam | Jayshree Konwar |
| vii) | Impact of gas flaring on soil health and growth of tea plants adjacent to merbil Majuli, OCS-6 (south) in Dibrugarh district of Assam | Kalparanjan Bhuyan |

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| viii) Impact of oil field effluent on soil health and growth of tea in small tea farms in proximity of OCS-2 in the Digholia area of Dibrugarh district of Assam | Preetisha Dutta |
| ix) Impact of oil field effluent on some physico- chemical properties of soil and growth of tea in the plantation of small growers of Dibrugarh district of Assam | Pubali Neog |
| x) Impact of Gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS North in Dibrugarh district of Assam | Rashmi Kalita |
| xi) Impact of gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS south in Dibrugarh district of Assam | Ripsita Phukan |
| xii) Scope of Augmenting Farmers' Income in Small Tea Plantations - A case study in Titabor sub-division of Jorhat district | Shyamal Kishore Bordoloi |

5. Master of Fishery Science

5.1. Aquaculture

886-904

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|--|----------------------|
| i) Extraction of fibre from <i>Ricinus communis</i> and evaluation of its physical and chemical properties | Ashim Kumar Bora |
| ii) Effect of Diet on Growth, Haematology and Disease Resistance of Amur Carp (<i>Cyprinus Carpio Haematopterus</i>) through Replacement of Rice Polish with Rice Beer Waste | Astrica Phukan |
| iii) Development of Multiplex PCR Assay for Simultaneous Detection of Three Major Fish Pathogenic Genera <i>Aeromonas</i> , <i>Pseudomonas</i> and <i>Edwardsiella</i> | Ganesh Borah |
| iv) Effect of stocking densities on growth performance and survivability of Amur Carp (<i>Cyprinus carpiohaematopterus</i>) in floating cage environment of a floodplain wetland of Morigaon District | Homen Saikia |
| v) Effect of <i>Streblus asper</i> Lour. as periphyton substrate on growth performance of jayanti rohu (<i>Labeo rohita</i> Hamilton) and amur carp (<i>Cyprinus carpio haematopterus</i> Temminck & Schlegel) | Kongkon Jyoti Bhuyan |

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| vi) | Comparative Growth Assessment Of 9generation Jayanti Rohu with Non-Jayanti Rohu Cultured Together with <i>Catlacatla</i> and <i>Cirrhinus mrigala</i> | Lucy Ingtipi |
| vii) | Effect of Different Stocking Densities of Mola, <i>Amblypharyngodon Mola</i> (Hamilton, 1822) on Growth of Indian Major Carps | Preetam Kala |
| viii) | Effect of Dietary Selenium on Haematological Parameters, Antioxidant Enzymes and Growth in <i>Cirrhinus Mrigala</i> (Hamilton, 1822) | Parishmita Handique |
| ix) | Prevalent Fish Diseases with Reference to Motile Aeromonas Septicaemia in the Central Brahmaputra Valley Zone of Assam | Pabitra Kumar Saharia |
| x) | Effect of probiotic bacteria identified and characterized from gut of freshwater fish on growth performance of <i>Labeo rohita</i> | Rubina Yasmin |
| xi) | Evaluation of some non conventional animal protein sources in the practical diet formulation of fresh water cat fish <i>Clarias Magur</i> and its effect on growth and biochemical composition | Shah Mustahid Hussain |
| xii) | Effect of Natural and Artificial Carotenoid for Colour Enhancement in Tiger Barb, <i>Puntigrus tetrazona</i> (Bleeker, 1855) | Shilparani Hazarika |

5.2. Aquatic Environment Management

905-926

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|------|---|----------------------|
| i) | Reproductive Biology of Indian River Shad <i>Gudusia Chapra</i> (Hamilton-Buchanan-1822) | Abdul Malik Ahmed |
| ii) | Effect of Profenofos Toxicity on Fingerlings of <i>Labeo gonius</i> (Hamilton, 1822) | Abhijit Choudhury |
| iii) | Evaluation of Length-Weight Relationshp, Age and Growth Parameters Andreproductive Biology of <i>Mystuscavasius</i> (Hamilton-Buchanan, 1822) | Bhargav Bhushan Nath |
| iv) | Hydrobiological Profile of River Kolong in Nagaon, Central Brahmaputra Valley Zone | Dibya Jyoti Dev Nath |

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| v) | Acute Toxicity Study of Silica Nanoparticles (SiO ₂ -NPs) on <i>Cyprinus carpio</i> (Linnaeus, 1758) | Habiba Jahan Ahmed |
| vi) | <i>In Vivo</i> Evaluation of Toxicity effects of a Neonicotinoid Insecticide Imidacloprid on Freshwater Cypriniform <i>Cyprinus carpio</i> var. <i>communis</i> | Hemanta Pokhrel |
| vii) | Evaluation of Ichthyofaunal Diversity and Habitat Ecology of the Namchik River, Changlang District of Arunachal Pradesh, North East India | Jayanta Dutta |
| viii) | Evaluation of Length-Weight Relationship and Reproductive Biology of Vulnerable Carp <i>Cirrhinus reba</i> (Hamilton, 1822) | Jyotirmoyee Das |
| ix) | Assessment of Productivity and Fish Diversity of Dzii River of Kohima, Nagaland | Kedolhouse Kuotsu |
| x) | Acute Toxicity and Behavioural Changes in Zebra Fish <i>Danio rerio</i> (Hamilton, 1822) Exposed to a Neonicotinoid Pesticide “Thiamethoxam” | Lawonu Prasad Mudoi |
| xi) | Study of Productivity and Ichthyofaunal Diversity of Kharungpat Lake, Manipur | Md. Abdul Salam |
| xii) | Effect of pH on Acute Toxicity of Synthetic Antioxidant Butylated Hydroxytoluene in Embryo of Zebrafish <i>Danio rerio</i> (Hamilton, 1822) | Nikimoni Borah |
| xiii) | Assessment of Environmental Integrity of Northern Plain Region of the River Umtrew (Digaru) in Meghalaya and Assam with special reference to its pollution status | Nishi Sarmah |
| xiv) | Hydrobiological Studies of Morakolong Beel, Morigaon District, Central Brahmaputra Valley Zone | Priyanky Tamuli |
| xv) | Experimental Breeding Of <i>Channa striatus</i> (Bloch, 1793) Using Different Hormones under the Agro-Climatic Condition of Assam | Rikki Bagra |
| xvi) | Assessment of Acute Toxicity in Fresh Water Cypriniform <i>Cyprinus carpio</i> (Linnaeus, 1758) Exposed to a Commercial Neem based Biopesticide | Rituparna Borah |

xvii)	Acute Toxicity of Synthetic Pyrethroid Pesticide Cypermethrin in Developing Zebrafish (<i>Danio rerio</i>) (Hamilton-Buchanan, 1822) Embryo	Ruhul Amin
xviii)	An Assessment of Carbon Sequestration of a Floodplain Wetland (48 No. Thekera <i>beel</i> , Morigaon District) of Central Brahmaputra Valley Zone, Assam	Rupam Jyoti Nath
5.3. Fish Processing Technology		927-929
i)	Effect of Garlic Extract on Quality of Dried <i>Puntius Sophe</i> During Storage at Ambient Temperature	Ipsita Jamatia
ii)	Effect of Ginger Extract on Quality of Dried <i>Amblypharyngodon Mola</i> During Storage at Ambient Temperature	Misan Debbarma
5.4. Fisheries Resource Management		930-933
i)	Study on Ichthyofaunal Diversity and Physicochemical Parameters Downstream of Hydroelectric Power Project Dam of Subansiri River, Assam	Imran Hussain
ii)	Study on Ichthyofaunal Diversity and Physico-Chemical Parameters of a Floodplain Wetland (Jaluguti <i>Beel</i> , Morigaon District, Assam) of Central Brahmaputra Valley Zone	Sheetala Chintey
6. Master of Veterinary Science		
6.1. Animal Biotechnology		935-936
i)	Dna Polymorphism in Mitochondrial Genes Encoding Nd1, Co1 and Cytb in Canine Malignant Tumours	Dr. Shakeel-Ul-Rehman
6.2. Animal Genetics Breeding		937-942
i)	Production Performance of Daothigir Chicken under Field Condition	Dr. Banani Talukdar
ii)	Growth and Reproductive Performance of Hampshire x Desi Half- Bred Pigs	Dr. Toshimongla Aier
iii)	Characterization of Indigenous Ducks of Manipur	Dr. Y. Sovarani Devi

6.3. Animal Nutrition	943-952
i) Effect of Supplementation of Certain Anti-oxidants (Vitamin E, Vitamin C and Selenium) on the Growth Performance of Broiler Chicken During Heat Stress	Dr. Chanra Deep Singh
ii) Evaluation of Banana Stem and Urea Treated Paddy Straw Based Complete Rations for Growing Crossbred Calves	Dr. Keruulenuo Yhome
iii) Effect of Supplementation of Garlic and Multi-Strain Probiotics on the Performance of Broiler Chicken	Dr. Reema Shrestha
iv) Effect of Feeding Total Mixed Ration and Complete Feed Block on Productive Performance of Crossbred Cows	Dr. Sikhamoni Haloi
v) Effect of Mannan-Oligosaccharide and Pomegranate (<i>Punica granatum</i>) Peel Powder on the Performance of Broiler Chicken	Dr. Sudhanya Nath
6.4. Animal Reproduction, Gynaecology and Obstetrics	953-957
i) Seroprevalence of Leptospirosis in Dairy Cows With Reproductive Disorders and Therapeutic Management of Endometritis	Dr. Alapa Baba Ikpe
ii) Addressing Postpartum Anoestrus in Crossbred Cows	Dr. Chandra Prakash Dixit
iii) A Study on Centrifugation Regime and Commercial Extender on Quality of Frozen Beetal Buck Semen	Himsikha Chakravarty
6.5. Livestock Reproduction and Management	958-970
i) Effects of Split-Weaning on the Performance and Behavioural Traits of Hampshire Piglets	Dr. Arunima Kalita
ii) Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor	Dr. Ibasani Sawian
iii) Physicochemical and Microbiological Quality of Drinking Water for Livestock under Organized and Unorganized Sectors in the Brahmaputra Valley of Assam	Dr. Jiaur Rahman

iv) Effect of Dietary Supplementation of Satomul (<i>Asparagus racemosus</i>) on Certain Production Performances of Crossbred Dairy Cows	Dr. Parteek Kumar Khera
v) Performance of Crossbred Cows under Farm Conditions	Dr. Venus Das
vi) Carcass and Meat Quality Characteristics of <i>Kamrupa</i> Chicken	Dr. Jameel Ahmad
vii) Effects of Starter Culture and Types of Bamboo on Quality Attributes of <i>Banhor Chunga Doi</i>	Dr. Sumi Roy
6.8. Veterinary Anatomy and Histology	971-972
i) Influence of Zinc Oxide Nanoparticle on the Growth of Intestinal Epithelium and Microflora in Broiler Chicken (<i>Gallus gallus domesticus</i>)	Dr. Alline Josph Pathil
6.9. Veterinary Clinical Medicine, Ethics and Jurisprudence	973-975
i) Prevalence of Eye Diseases in Dog with Special Reference to Bacterial Infection	Dr. Dibyajyoti Das
ii) Management of Hypovitaminosis-D for the Prevention of Periparturient Hypocalcaemia in Dairy Cows	Dr. Patel Nisha Manish
iii) Canine Pyoderma : Diagnosis and Therapeutic Management	Dr. Sabetini S. Marak
6.10. Veterinary Extension Education	976-980
i) Empowerment of Women Through Milk Cooperative Societies on Selected Districts of Assam	Dr. (Ms) Banani Das
ii) Empowerment of Women of Selected Tribes in Tripura Through Livestock Enterprises	Dr. Keshab Jamatia
6.11 Veterinary Epidemiology and Preventive Medicine	981-982
i) Prevalence of Newcastle Disease Virus in Backyard and Commercial Poultry in Assam	Dr. Pubaleem Deka

6.12. Veterinary Microbiology	983-989
i) Immune Response of Pigs Vaccinated with Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine	Dr. Nouloungunuo Suokhrie
ii) Isolation of Foot-and-Mouth Disease Virus Type 'O' of Bovine and Porcine Origin in Different Cell Lines and Molecular Characterization of the Adapted Virus	Dr. Ray Kayaga
iii) Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate From Assam	Dr. Shyama Prasad Panda
iv) Characterization of Methicillin Resistant <i>Staphylococcus aureus</i> Isolated From Raw Meat	Dr. Leons Mathew Abraham
6.13. Veterinary Parasitology	990-991
i) Trematode Parasites of Asian Elephant (<i>Elephas maximus</i>) with Special Reference of Liver Fluke	Dr. Bandanpreet Kour Raisim
6.14. Veterinary Pathology	992-993
i) Clinico Pathological Studies of Canine Parvoviral Infection	Dr. Ginah Maria Binny
6.15. Veterinary Pharmacology and Toxicology	994-997
i) <i>In Vitro</i> Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent	Dr. Monoshree Sarma
ii) Evaluation of <i>In-Vitro</i> Antiviral Effect of Nanocurcumin and Nanoeugenol against Goat Pox	Dr. Namitha. A
6.16. Veterinary Physiology	998-999
i) Physio-Biochemical Studies of Adult Pati Ducks Reared under Semi-Intensive System	Dr. Tenzing Lopsang Lachenpa
6.17. Veterinary Public Health	1000-1003
i) Sero-Prevalence and Risk Factor Analysis of Leptospirosis among Cattle Population in West District of Tripura State	Dr. Banitya Mohan Tripura

ii) Prevalence of Cysticercosis in Jorhat District of Assam	Dr. Mrinmoyee Sarma
6.18. Veterinary Surgery and Radiology	1004-1009
i) Intraoperative Assessment of Intestinal Viability In Rabbits	Dr. Evakordor Hynniewta
ii) Tiletamine-Zolazepam Anaesthesia in Cat	Dr. Monalisa Ahmed
iii) Sevoflurane Anaesthesia in Butorphanol-Midazolam Premedicated Dogs Induced with Propofol and Ketamine	Dr. Sarahna Taufiq
7. Master of Science (Home Science)	
7.1. Extension and Communication Management	1011-1022
i) Entrepreneurial behaviour of members of Self Help Groups of Jorhat district of Assam	Dhruba Jyoti Mudoj
ii) Food habit of tribal community of Assam with special reference to Shyam tribe	Manash Pratim Konwar
iii) Management practices of fast food street vendors of Jorhat district of Assam	Parsha jyoti Bharadwaj
iv) Problems faced by undergraduate students of Assam Agricultural University in obtaining scholarships	Santosh
v) Knowledge of Anganwadi workers (AWWs) for rendering Nutrition and Health Education service under ICDS scheme in Karbi-anglong district of Assam	Semson Engleng
vi) Status of Women Tea Plantation Workers in Jorhat District of Assam	Toko Jumi
7.2. Family Resource Management	1023-1028
i) School backpack weight and prevalence of musculoskeletal discomfort among adolescent students	Bristi Angkita Saikia
ii) Application of Vastu Shastra for house design in Jorhat City	Khumukcham Jenita

- iii) Effect of advertisement on buying habits of college students of Jorhat city with special reference to cosmetic products Pallavi Singh

7.3. Food Science and Nutrition

1029-1045

- i) Quality evaluation of beetroot powder incorporated cakes Jula Sarma
- ii) Impact of high protein high energy formulation on exercise performance in relation to strength and endurance capacity Jyotishmita Konwar
- iii) Effect of processing on *in-vitro* starch digestibility and glycemic index of selected rice varieties of Assam Laishram Maria Devi
- iv) Development and evaluation of fish powder incorporated ready to cook snacks Mansi Tiwari
- v) Awareness and use of food label information by consumers of Jorhat, Assam Monosweta Gracy Shaw
- vi) Assessment of vitamin d status in women of reproductive age: a case study among tea plantation workers of Assam Priyanka Bhattacharyya
- vii) Effect of Processing on Nutrient Composition and Bioactive Components of Selected Rice Varieties of Assam Senorita Gogoi

7.4. Human Development and Family Studies

1046-1063

- i) Wellness of Elderly: A comparative study of socially engaged and unengaged retired people Huidrom Rinky Devi
- ii) Prevalence of bullying among adolescents Irin Das
- iii) Enhancing Number Concepts of Preschool Children Through Musical Intervention Jyotika Boruah
- iv) Parent-adolescent disagreement in the use of social media Kshiptimayee Patra
- v) A study on social maturity of adolescents in Manipur Leishon Shangjam

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| vi) | Selfie taking behaviour of college students | Pallavi |
| vii) | Academic procrastination among students of Assam Agricultural University of Jorhat- An Explorative Study | Rashmi Rekha Gohain |
| viii) | Academic stress of boarding and non-boarding high school students in Dima Hasao district of Assam | Shalu Swati Agarwal |
| ix) | Parental stress in raising children with special needs – A study in Prerona, Jorhat | Sushmita Borah |
| x) | Emotional Maturity of Adolescents in Intact Family and Single Parent Family | Tasso Puniya |

7.6. Textiles and Apparel Designing

1064-1075

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|-------|---|-------------------------|
| i) | Extraction of fiber from gossypium arborium and evaluation of fiber for various end uses | Rikamchi Ch. Marak |
| ii) | Designing and construction of functional dresses for persons with special needs | Anakshree Borah |
| iii) | Designing and construction of skirts for teenage girls | Anchie Maliva A. Sangma |
| iv) | Extraction of sugarcane bagasse fibre for different end uses | Dilowar Hussain |
| v) | Exploration of non-conventional fibre bhindi (<i>Abelmoschus esculentus</i>) for textile application | Manashree Saikia |
| vi) | A study on extraction of underutilized plant fibre from pendulous sleeping hibiscus and evaluation of its physico-chemical properties | Mintu Hazarika |
| vii) | Softening of roselle blended fabric for quality improvement | Nicky Ayekpam |
| viii) | Impact of enzymatic treatment on dyeing of kenaf yarn with natural dye | Runa Laila Parvin |
| ix) | Development of Lac Dye from Lac Insect <i>Kerria chinensis</i> , (Hemiptera:Kerriidae) | Saswati Rajkhowa |
| x) | Extraction of fibre from <i>Ricinus communis</i> and evaluation of its physical and chemical properties | Trideep Bor Saikia |

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Ph.D (Agriculture)

- **Agricultural Biochemistry**
- **Agricultural Biotechnology**
- **Agricultural Economics and Farm Management**
 - **Agronomy**
 - **Crop Physiology**
 - **Entomology**
 - **Extension Education**
 - **Horticulture**
 - **Nematology**
- **Plant Breeding and Genetics**
 - **Plant Pathology**
 - **Sericulture**
 - **Soil Science**
- **Tea Husbandry and Technology**

Functional proteomics of rice bran lipase(s)/esterase(s) in *Ranjit*, a major high yielding rice variety of Assam

Udit Nandan Mishra

On milling, the paddy produces brown rice and hulls. Brown rice upon polishing results in the production of white rice and byproducts such as head rice, broken rice, polish and bran. Rice bran, the byproduct of rice milling has been gaining a commercial importance in the world due to the fact that it contains nutritionally superior oil and a number of health beneficial compounds. Although rice bran is a good nutritional food source, rapid rancidity from the activity of lipolytic enzymes such as lipase, esterase and lipoxygenase deteriorate the nutritional values in rice bran and limits the wide usage of rice bran as a food ingredient. The effective utilization of rice bran is possible only by deactivating the lipolytic enzymes responsible for the hydrolytic rancidity which otherwise severely affects the nutritive value and palatability of rice. Lipases are carboxyesterases acting on long chain acylglycerides and classified as serine hydrolase class due to their catalytic triad mechanism of serine protease. In the past few decades lipases gained a significant choice for scientists from the research point of view due to their ubiquitous nature and wide range of distribution across different kingdoms. Currently lipases from microbial sources are exploited commercially.

Present research work was undertaken to study the functional proteomics of rice bran lipase (RBL) in a major high yielding variety (HYV) '*Ranjit*', a popular high yielding variety of Assam. The objective of the present investigation was to extract and purify the major lipolytic enzyme in the bran, study the enzyme kinetics along with inhibition study and immobilization of the enzyme for subsequent industrial use. Some aspects of functional proteomics of enzyme responsible for rancidity were studied. To have an idea about how rancidity affects the products obtained after the milling process, both white refined rice and bran powder were stored for one week at room temperature after which the visible physical change in the color of the product was evident. Subsequently, chemical constituents like moisture (9.83%), ash (10.31%), reducing sugar (4.91%), total carbohydrate (52.31%), crude protein (14.07%), total soluble protein

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(4.33%), crude fiber (8.18%), mineral composition such as Fe (22.43 mg/100g), P (1090.07 mg/100g), Na (20.39 mg/100g), K (1512.22 mg/100g), Ca (69.10 mg/100g), Zn (5.09 mg/100g), Mg (786.61 mg/100g) on dry weight basis were determined in defatted rice bran. Rice bran yielded 16.04% of oil and the chemical characteristics for the oil such as acid value (1.11 mg/g oil), saponification value (155.40 mg/g oil) and iodine value (88.83 mg/g oil) were determined. Phytochemical compositions like total phenol (513.38 mg/100g), phytate 'P' (542.01 mg/100g) and tannin (32.66 mg/100g) were also analyzed. Lipase was extracted from bran following alkaline extraction method. Preliminary assay of crude lipase with the substrate 4-nitrophenyl palmitate showed specific activity of 0.04 U/mg. Subsequently a 9.45-fold purification was obtained with a specific activity of 0.378 U/mg by following ammonium sulfate precipitation, FPLC and RP-HPLC sequentially. The purified rice bran lipase (RBL) was shown to have an approximate molecular weight of 33 kDa in SDS-PAGE by silver staining and a separate fluorescent staining with 4-methylumbelliferyl butyrate. Further, purified RBL showed a preference for natural oils of long chain unsaturated fatty acids with a maximum specific activity (0.452 U/mg) in case of rice bran oil.

The purified lipase was immobilized in calcium alginate beads with an efficiency of 65% to that of free lipase activity. Kinetic study revealed both immobilized lipase (IL) and free lipase (FL) had a pH and temperature optima of 7.5 and 300C, respectively, with a maximum catalytic activity at a substrate (4-nitrophenyl palmitate) concentration of 200 μ M. Non-polar organic solvents like petroleum ether, hexane and surfactant like SDS reduced the activity of both free (FL) and immobilized lipase (IL). On the other hand in presence of lower concentration of metal ions such as Ca²⁺, Mg²⁺ and Na⁺, both FL and IL showed increased activity. Both synthetic (PBA; IC₅₀ 0.92mg PBA/mg of lipase) and natural (mango leaf extract; IC₅₀ 0.89mg extract/mg of lipase, ground nut shell extract; IC₅₀ 0.88mg extract/mg of lipase) inhibitors caused decrease in lipase activity at optimum reaction condition. In order to check the viability of immobilized lipase for commercial exploitation blending of fish oil free fatty acids (FFA) with sunflower oil (SO) was done at different ratios with 12h, 24h and 36h of incubation during the acidolysis reaction. A highly desirable n-6/n-3 ratio of (5.6:1) was observed in the novel structured triglyceride using pure RBL with 1:1 ratio of SO:FFA with 12h incubation during acidolysis reaction. This was followed by another novel triglyceride synthesized from 1:4 ratio of SO:FFA with 36h of incubation during acidolysis reaction which had a desired n-6/n-3 ratio of 3.6:1. Thus immobilized lipase could be used to optimize the fatty acid profile of existing commercial sunflower oil by either replacing or incorporating n-3 fatty acids from marine source to impart better nutritional desirability.

Molecular and physiological analysis of transgenic rice harbouring chimeric *PDH47* gene against abiotic stress tolerance

Dimple Boro

Abiotic stress especially drought can severely affect the physiological status of any plants; thereby impart significant negative impact on growth, development, and metabolism. The major emphasis of most of the recent studies was identification of stress-regulated genes and transcription factors which play important role in governing tolerance/resistance against abiotic stresses. DEAD-box helicases (Asp-Glu-Ala-Asp amino acid) are one of the important genes which confer tolerance to various abiotic stresses. They are involved in unwinding of nucleic acids by utilizing the energy from ATP hydrolysis. *PDH47* (Pea DNA Helicase 47kDa) gene, one of the DEAD-box helicases is known to impart various abiotic stress tolerance. In the present study rice transgenic line cv. IR64 was developed through *Agrobacterium* mediated genetic transformation using immature embryos as explants. The putative transgenic lines showed presence of transgene when subjected to PCR analysis using gene specific primers. Three previously developed transgenic rice lines in our laboratory namely ASD16-46/1, ASD16-66/1 and ASD16-68/1 expressing *PDH47* gene were selected for drought stress tolerance study. Quantitative Real Time PCR analysis showed varied level of expression of *PDH47* gene both in the root and leaf tissues of transgenic line before and after drought stress. The expression of *PDH47* gene induced during drought stress in the transgenic lines, showed varied level of drought tolerance in the vegetative stage without any negative effects on the morphological and agronomical traits. The physiological and biochemical analyses confirmed that the expression of *PDH47* gene in the transgenic lines was associated with increased leaf relative water content, water retention capacity, maintenance of chlorophyll, stomatal conductance, net photosynthetic rate, transpiration rate and water use efficiency. These transgenic lines also showed an increased accumulation of the osmolytes like proline, glycine betaine and decreased electrolyte leakage, lipid peroxidation, less accumulation of H₂O₂ during drought stress. These transgenic lines showed better root architecture system such as root length, root

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number, root thickness, root biomass, shoot biomass and root to shoot ratio as compared to control untransformed plants during drought stress. The western blot analysis confirmed that the expression of RUBISCO large subunit (55kDa) protein was more in the transgenic rice lines as compared to untransformed control plants during drought stress treatment.

Study on Acid Stress Response in *Bacillus amyloliquefaciens*

Naimisha Chowdhury

Soil bacteria have evolved various mechanisms to adapt to stress environmental conditions such as temperature, salinity, drought and low pH condition of soil. Among the several environmental stress conditions, soil acidity an important factor influencing physicochemical and biological properties of soil along with microbial diversity and crop production is an emerging issue of immense concern due to its wide spread distribution across the globe. Although low soil pH restricts the number and diversity of bacteria, it is known that some soil bacteria are able to thrive in such conditions having evolved various mechanisms. The isolate *Bacillus amyloliquefaciens* MBNC can survive in low pH condition (upto pH 4.0). Moreover it can retain its antagonistic and plant growth promotion attributes under acidic condition. Early log phase cells of *B. amyloliquefaciens* MBNC were more susceptible to extreme pH than the late log phase cells. In addition, pre-exposed *B. amyloliquefaciens* MBNC cells to moderate acid condition had higher survival rate in extreme acid. In-vitro production of indole-3-acetic acid and gibberellic acid by *B. amyloliquefaciens* MBNC at neutral condition was higher (12.82 ± 0.12 $\mu\text{g/ml}$ and 35.15 ± 0.005 $\mu\text{g/ml}$ respectively) than at acidic condition (07.27 ± 0.06 $\mu\text{g/ml}$ and 26.66 ± 0.003 $\mu\text{g/ml}$). Maximum antagonistic effect against fungal pathogens were shown 3 days post inoculation under acidic condition. High Resolution Mass Spectroscopy results shows the presence of surfactin C13 (exact mol.mass 1007.651836 g/mol) and surfactin C14 (exact mol.mass 1021.6677486 g/mol) in chloroform-methanol extract of both pH 7.0 and pH 4.5. Surfactin (exact mol.mass 1035.683136 g/mol) and iturinD was detected only in the extract of pH 4.5 and pH 7.0 respectively. For differential expression analysis a total of 22 genes were selected. Genes relating to maintenance of cell integrity (membrane integrity) showed increase expression under acid stress with an exception of *spoA*, *flotilin* and *pdaA*. Acid stress induce the environmental and energy stress regulon *SigB*, general stress protein *gspA* and the major molecular chaperones *DnaK* and *GroES*. pH-responsive gene, *atpB* (coding for the beta sub-unit of the F1F0-ATPase enzyme), cytochrome bd oxidase

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(*cydA*) and gene for nitrate reductase was upregulated. Cadmium, cobalt, and zinc/H/K antiporter (*czcD*), Iron-uptake system responsive genes (*feuABC*) and osmotic stress related gene pyrroline-5-carboxylate reductase (*proC*) was upregulated. Acidic pH upregulated acetoin production (*alsDS*), a pathway known to shunt fermentation into neutral products, minimizing acid production. Acid also upregulated a large number of NAD(P)-dependent dehydrogenases: alcohol dehydrogenase (*eutG*), formate dehydrogenases (*fdhA*), malate dehydrogenase (*mdh*). These enzymes are capable of removing acidity through NAD(P)H which transfers electrons to the electron transport system (ETS) and pumps protons out of the cell. The cupin gene (cupin superfamily of proteins) involved in the modification of cell wall carbohydrates showed manifold upregulation under acid stress. To further validate this, targeted mutagenesis of cupin in *B.amyloliquefaciens* MBNC was performed using pMUTIN4 integration vector. The transformation efficiency was very low with 32 transformants/ μg pmutcupin DNA. The integration of pmutcupin into the chromosome of *B.amyloliquefaciens* MBNC was confirmed by PCR amplification of *ermAM* and *bla* gene using the genomic DNA of the transformed *B.amyloliquefaciens* MBNC. The mutant isolate, Δcupin failed to grow in nutrient broth at pH 4.5 which confirms the role of cupin gene in acid stress. Inability to form biofilm and scanning electron microscopy (SEM) of *B.amyloliquefaciens* MBNC wild type and its cupin mutant (Δcupin) at neutral pH confirms the targeted mutagenesis of cupin gene.

Cloning, Characterization and RNAi mediated silencing of gene encoding 1-deoxy-D-xylulose 5-phosphate reductoisomerase (DXR) in *Centella asiatica*

Richa Sharma

Centella asiatica (L.) is one of the most valuable medicinal plants which belong to the family Apiaceae. The medicinal importance of this green leafy vegetable is known since prehistoric times. The pharmaceutical importance of this herb is due to the accumulation of large quantities of pentacyclic triterpenoid saponins, collectively known as centelloids synthesized by the isoprenoid biosynthesis pathway. Biosynthesis of triterpenoid in the plants proceeds via either of the two pathways, viz. Mevalonate (MVA) pathway (in the cytosol) or 2-C-methyl-Derythritol 4-phosphate (MEP) pathway (in plastid). In *Centella*, the pathway leading to the accumulation of triterpenoid is still not known. Thus, to know whether the MVA or MEP pathway or contribution of both has a role in the biosynthesis of triterpenoid, silencing the key regulatory enzyme gene using RNAi tool, of each of the pathway and then to analyze a metabolite is an efficient approach. In our lab, HMGR (a key enzyme of MVA pathway) RNAi construct has already been designed, confirmed by RT-PCR and validated by Agro-infiltration. 1-deoxy-D-xylulose-5-phosphate reductoisomerase (DXR) play a role in catalyzing the first committed step of the MEP pathway. The present study is the first step aimed to delineate the MEP pathway using RNAi silencing approach to knock down rate limiting 1-deoxy-D-xylulose-5-phosphate reductoisomerase (DXR) enzyme. The full-length DXR gene sequence (JQ965955) of *Centella* has been characterized using *in silico* approach. CaDXR is a 1425bp ORF encoding a peptide of 474 amino acids and of molecular weight of 51.5 KDa. Multiple sequence comparison using MEGA tool showed the presence of two NADPH binding motif, two substrates binding motif, and one cleavage site motif. In this study, the 3-D structure of CaDXR was identified and validated along with this molecular dynamics simulation and finally docking with cofactor NADPH was done. The expression analysis suggests that CaDXR is differentially expressed in different

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tissues (with maximal expression in node and lowest in the roots). Our result suggests that nodes may be crucial to terpenoid biosynthesis in *Centella asiatica*. The RNAi-DXR construct was designed using the pHANNIBAL vector and subsequently cloned into a binary vector pART27. The binary vector pART27 containing RNAi-CaDXR construct was transformed into *Agrobacterium* strain AGL1. The transient analysis of the RNAi-CaDXR using semiquantitative RT-PCR confirmed the silencing of the endogenous DXR gene in *Nicotiana* and further confirmed in *Centella asiatica*. Thus, further incorporation of both the RNAi construct (HMGR and DXR) in transformed *Centella* shall shed light into the pathway that leads to the synthesis of principal secondary metabolites i.e centelloids.

Genetic studies for improving yield under drought stress environments in rice of Assam

Rouf Ahmad Parray

Drought is a major limiting factor for rice under rainfed ecosystem in Assam. In this context, thirteen rice cultivars with varied level of drought tolerance were chosen from a set of 272 different rice genotypes based on a field experiment conducted during 2014-15 season under drought. The thirty days old seedlings of 13 cultivars were tested for extensive morpho-physiological, biochemical parameters, relative transcript accumulation and global gene expression using next generation sequencing (NGS) method, and data were recorded at fifth, tenth and fifteenth day of withholding water (DWW) in order to obtain detail trait based gene architecture and to improve high yielding variety of Assam using transcript dynamics. Among the physiological traits studied, stomatal conductance decreased as the dehydration stress increased but the effect was minimum in Apo, Dumai and Tepi Dumai compared to others. Photosynthetic rate decreased with increasing water deficit, but the effect was less pronounced in Apo, Dumai and Tepi Dumai. The rate of transpiration decreased upto 5DWW but gradual increase was observed in later stage. Moreover, the fall in transpiration rate was less in Apo. Water use efficiency (WUE) of rice plants was enhanced significantly under moisture stress at all the three periods of stress (5DWW, 10DWW, 15DWW) in Apo, Tepi Dumai and Dumai. Reduction in RWC was experienced across all genotypes but the decrease was less prominent in Apo, Dumai and Tepi Dumai. Drought stress condition led to increased proline content across genotypes as compared to irrigated condition. Apo, Tepi Dumai, Dumai and Kali Murali showed rapid increase compared to others. Increase in root length was observed across all cultivars with Apo being the longest followed by Dumai and Ranjit. Then, five drought responsive pathway genes (*OsDREB2*, *OsNAC1*, *bZIP16*, *OsZIP23*, *OsZIP72*) were chosen to check the differential expression pattern in the cultivars at the same data point as mentioned above. Expression profiling of *OsDREB2* showed significant increase in gene expression with increase in drought stress in the case of Apo and Dumai. Significant expression of the *OsNAC1* was found in Apo, Dumai at different

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time points of dehydration stress whereas expression of ARC 10372 was prominent in 15DWW. Apo showed significant difference in expression of *bZIP16* under all the three stages of water stress whereas Dumai and Ranjit showed enhanced expression compared to other cultivars. Expression profile of *OsZIP23* showed significant accumulation of transcripts in Apo in all stages followed by Dumai. Significant expression of *OsZIP72* was observed in Apo at 10DWW and 15DWW followed by Ranjit and Dumai. Based on the results of morpho-physiological, biochemical and expression analysis, three cultivars, viz., Ranjit, Apo and Dumai were chosen to study the detailed transcriptome at only 10DWW. Transcriptome profile revealed highest mapped genes in Dumai followed by Ranjit and Apo, however, only 14.5% genes were in common. Ranjit was found to be more responsive to abiotic stimulus including water stress. Gene ontology (GO) suggested no significant change of pathway genes upto 10 DWW among the three cultivars. The transcriptome data were validated using five differentially expressed genes in these three cultivars along with a F₄ mapping population. It revealed similar trend, suggesting the present transcriptome data set was in good fit. However, detail transcriptome study in vital plant parts at different stages under drought stress will throw more light about the interaction of pathway genes to address the problem better.

Molecular characterization and nutritional equivalence evaluation of transgenic chickpea expressing either a *cry1Ac* or *cry2Aa* gene

Rubi Gupta

Biosafety assessment of transgenic chickpeas having *B. thuringiensis* genes for resistance to pod borers is a regulatory requirement and mandatory to document before releasing in the field. Therefore, Bt chickpea lines harbouring either a *cry1Ac* or *cry2Aa* gene were characterized for the presence and expression of the transgene in their advanced generations, biosafety assessments and transcript profile were studied. The homozygous lines were selected for comparative nutritional equivalence assay. Biochemical estimations of major nutritional components such as proximates, vitamins, minerals, fatty acids and anti nutrients confirmed that the Bt chickpeas lines are nutritionally equivalent to their non-transgenic counterparts and the seed composition is similar or within the range reported, previously. Seed protein quality was investigated by separating the proteins in PAGE and eluted proteins after mass spectrometry (MS) showed expected fractions of 11S legumin, 7S vicilin, and 2S albumin of chickpea storage proteins in the transgenic lines. The protein digestibility was assayed using the multi-enzyme system and transient pepsin hydrolysis to mimic simulated gastric fluid followed by trypsin hydrolysis to mimic simulated intestinal fluid. Total seed proteins of both the transgenic and non-transgenic lines were digested at a similar rate and enzyme-resistant peptides were not observed in transgenic Bt chickpea lines. The unintended changes in the whole transcriptome profile of Bt chickpeas were surveyed using a homozygous transgenic line expressing a *cry1Ac* gene. The differentially expressed genes (DEGs) profiling confirmed a low (0.69%, \log_2 fold change ≥ 2) frequency of differentially expressed in the transgenic chickpea line. Only a small (34 up-regulated) proportion of genes showed > 2 fold (P-value of 0.05, FDR of 0.05) change in their expression, while only 23 genes down-regulated by >2 fold. Furthermore, no transcripts for potential allergenic proteins were represented in the DEGs. Most of these genes appeared to be developmentally regulated or stress-related

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which was expected because absolute synchronous growth and development even under a controlled environment are challenging. A few upregulated (AT-hook motif nuclear-localized protein 17-like, probable inactive 2-oxoglutarate-dependent dioxygenase AOP2, protein EXORDIUM-like) and down-regulated (histone H2B, gonadal, embryonic abundant protein VF30.1- like, fasciclin-like arabinogalactan protein 12) genes were subjected to qPCR. The qPCR data validated the fold change of the up-regulated (>2) and down-regulated (<-2) genes. Thus, the above data revealed no potential alterations in the nutritional equivalence or transcript profile of transgenic Bt chickpeas like, fasciclin-like arabinogalactan protein 12) genes were subjected to qPCR. The qPCR data validated the fold change of the up-regulated (>2) and down-regulated (<-2) genes. Thus, the above data revealed no potential alterations in the nutritional equivalence or transcript profile of transgenic Bt chickpeas.

Use of Agro-Chemicals and their Effect on Commercial Vegetable Production in Assam

Ghana Kanta Sarma

During the production of vegetables farmers generally use different agrochemicals. It has numerous benefits, but over utilization may cause health hazardous to human beings, animals, soil and to the environment. Scientific cultivation of vegetables is a profitable venture from the economic point of view. There are number of vegetables that farmers grow. This study was confined to five rabi vegetable namely; cabbage, cauliflower, potato, brinjal and tomato considering the time constraint.

The present study was carried out with the objectives to examine the economics of commercial vegetable production in different categories of farms, to study the extent of use of agro-chemicals in commercial vegetables production, to explore the factors affecting the use of agro-chemicals in commercial vegetable production and to examine the nature and extent of agro-chemicals residue in consumption ready vegetables.

Out of six agro-climatic zones of Assam, three agro-climatic zones namely; Lower Brahmaputra Valley Zone (LBVZ), North Bank Plain Zone (NBPZ), and Central Brahmaputra Valley Zone (CBVZ) were selected based on the area under vegetable cultivation. From each zone, one district such as Barpeta district from Lower Brahmaputra Valley Zone, Darrang district from North Bank Plain Zone and Nagaon district from Central Brahmaputra Valley Zone was selected purposively. Two ADO circles from each district were selected based on the area coverage under vegetable cultivation and its production. From each ADO circle, 5 (five) numbers of village were selected for the study. From each village, 15 (fifteen) number of vegetable growing farm families were selected randomly. Thus, the total number of respondent farm families in each district was 150 and the total number of farm families covered for the study was 450. For construction of strata, the Cumulative Square Root frequency method was followed (Singh and Mangat, 1996). The cost of production of the selected vegetables was calculated as per the standard cost concepts. The determinants of use of plant protection chemicals and chemical fertilizers in vegetable production are evaluated

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using multiple regression analysis. The purity of the samples was confirmed by HPLC analysis.

The results of the study revealed that out of 2856 populations of the 450 farm families under study, 51.37 per cent (1467 numbers) populations were male and 48.63 per cent (1389 numbers) were female. The average size of household was calculated as 6.65 in all the three zones under study. Out of the total populations, 37.57 per cent populations were considered as children who had not yet attained the age of 18 years. 36.41 per cent populations attained the age range 18 – below 40 years and 18.77 per cent populations were under the age group of 40 – below 60 years. Only the 7.25 per cent of the populations attained the age more than 60 years. Amongst the respondents, 28.22 per cent respondents were higher secondary passed followed by high school passed (23.78 per cent), ME passed (18.00 per cent), degree passed and above (11.78 per cent) and LP passed (10.44 per cent). Only 7.78 per cent respondents are found illiterate.

Out of the total respondents of 450, the percentage of farmers growing potato was found the highest (62.00 per cent) followed by cabbage (60.00 per cent) and cauliflower (52.67 per cent) and the lowest percentage was calculated for tomato (31.33 per cent). 32.44 per cent respondents had 10 - 15 years vegetable farming experience.

In case of cabbage, the highest all farm net return was received by the farmers of Lower Brahmaputra Valley zone amounting to Rs. 1,38,103 followed by the farmers of North Bank Plain zone (Rs. 1,33,295) and Central Brahmaputra Valley zone (Rs. 1,15,127). In case of cauliflower, the highest was received by the farmers of Lower Brahmaputra Valley zone amounting to Rs. 1,00,879 followed by the farmers of North Bank Plain zone (Rs. 97,021) and Central Brahmaputra Valley zone (Rs. 77,478). For potato, the highest was received by the farmers of North Bank Plain zone amounting to Rs. 79,823 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 77,032) and Central Brahmaputra Valley zone (Rs. 63,126). In case of brinjal, the highest net return was received by the farmers of North Bank Plain zone amounting to Rs. 2,12,650 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 1,79,520) and Central Brahmaputra Valley zone (Rs. 1,75,136). In case of tomato, the highest all farm net return was received by the farmers of North Bank Plain zone amounting to Rs. 1,40,455 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 1,33,641) and Central Brahmaputra Valley zone (Rs. 1,15,142).

The highest return over cost for cabbage was calculated in Lower Brahmaputra Valley zone (2.03) followed by North Bank Plain zone (1.98) and Central Brahmaputra Valley zone (1.86). For cauliflower, the highest return over cost was recorded for Lower Brahmaputra Valley zone (2.06), the second and the third rank was occupied by North Bank Plain zone (1.93) and Central Brahmaputra Valley zone (1.68) respectively. In case of potato cultivation, in terms of return over cost, the first rank was occupied by North Bank Plain zone (1.51) followed by Lower Brahmaputra Valley zone (1.48) and Central Brahmaputra Valley zone (1.40). The return over cost for brinjal was calculated the highest for North Bank Plain zone (2.92) followed by Central Brahmaputra Valley zone (2.73) and Lower Brahmaputra Valley zone (2.59). In case of tomato, the return

over cost was found the highest for North Bank Plain zone (2.23) followed by Lower Brahmaputra Valley zone (2.04) and Central Brahmaputra Valley zone (1.82).

The major chemical fertilizers used by the respondent farmers were urea, single super phosphate (SSP), murate of potash (MOP), diammonium phosphate (DAP), borax, some chemical micronutrients. The insecticides used by the farmers in vegetables cultivation were Dimethoate 30 EC, Malathion 50 EC, Chloropyriphos 20 EC, Endosulphan 35 EC, Monocrotophos 36 WSC, Cypermethrin 25 EC, Carbofuran 3G. The fungicides used by the farmers were Carbendazim, Carboxin, Mancozeb, Zineb, Captan, Copper Oxychloride, Metalaxyl 8% + Mancozeb 64% and Carbendazim 12% + Mancozeb 63%. All the farmers used insecticides and fungicides at a higher concentration as compared to the recommended dose. Farmers sprayed the plant protection chemicals at different time and as per their convenience. All zones average revealed that the highest percentage of farmers (49.33 per cent) sprayed the chemicals at 4 - 7 days before harvesting of the crops followed by 1 - 3 days before harvesting (35.11 per cent) of crops. In case of insecticides, the farmers made lesser number of sprays in potato and tomato crops than cabbage, cauliflower and brinjal but they made more number of fungicide sprays in potato and tomato crops than the other three crops. On an average 10.00 per cent farmers took full protective measures during the application of pesticides, 45.56 per cent farmers took partial protective measures and 44.44 per cent of the total respondent farmers did not take any protective measures.

Out of different factors responsible for use of plant protection chemicals vegetable farming experience (years) showed a significant relationship at 0.1 level in group II and group III. The use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level in all farmers' groups of LBVZ. In NBPZ, educational qualification and vegetable farming experience showed a significant relationship with the use of plant protection chemicals at 0.1 level in group I and group III respectively. Distance from home to inputs dealer showed a significant relationship at 0.1 level in group I. Area under rabi vegetables showed a significant relationship at 0.1 level in group I and group III. Use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level. In CBVZ only the use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level. In case of use of chemical fertilizers, age (yr) of the head of the households showed a significant relationship at 0.01 level in group I and at 0.5 level in group III in LBVZ and use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups. In NBPZ, use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups. In CBVZ, use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups and type of seeds used a significant relationship with the use of chemical fertilizers at 0.1 level.

The residue test analysis of the insecticides Endosulfan 35 EC, Chlorpyrifos 20 EC, Cypermethrin 25 EC and Carbofuran 3G available in vegetables ready for consumption revealed that except a few all the vegetables contained the residues of the above chemicals above the Maximum Residue Level (MRL) as compared to the report made by Agnihotri (1999) and the Food Safety and Standard Authority of India (FSSAI).

Economic analysis of production and marketing of milk and milk products in Assam

Pinky Pathok

Livestock happens to be an integral component of Indian economy since time immemorial. Though, Assam possesses comparatively large number of Bovine population, it continues to remain a deficit state in terms of total milk production and per capita milk availability. The availability of milk in the state was around 35.00 per cent of the total requirement during 2016-17. However, there is enough potential of making dairy a lucrative proposition in Assam in mitigating the problem of unemployment in one hand, and income generation, on the other. Therefore, the present study was undertaken to have an insight into the dairy sector in Assam and to examine the livelihood pattern of dairy farmers in the context of Dairy Cooperative Societies and also to suggest ameliorative measures through field investigation.

The study was conducted in Jorhat and Morigaon district of Assam. Two Dairy Co-operative Society (DCS) from each district were selected and from each DCS, 30 registered members with DCS and 15 non-members were selected, thereby making the total sample size for the entire study at 180 households. Also, the trade-related information was collected from 25 milk traders and the sampled DCSs.

Dairy continued to be a major occupation for a large chunk of population in both the districts, contributing significantly to the total income, and for that matter, to the livelihood pattern. For Morigaon district, the DCS were more organized as compared to that of Jorhat district and hence, dairy, as a livelihood option, yielded more income. Dairy contributed more than 50.00 per cent of the total annual income earned by the DCS-members. Also, parameters like age, experience, area under fodder crops, herd size and milk productivity were found to be positively related to the income generated from dairy enterprise.

The B: C ratio shows that, dairy, as a means of livelihood, was successful in the study area. Commercialization of dairy farming in Morigaon district had resulted in increase in income through increased milk production. Majority of the non-members in Jorhat district had dairy as their main occupation while the DCS-members of the district

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Department : Agricultural Economics & Farm Management

Major Advisor : Dr. A. K. Das

had dairy as their subsidiary occupation. However, in case of Morigaon district, majority of the members had dairy as their main occupation while it was a secondary occupation for majority of the non-members of the district. The overall net return per litre of milk was higher in Morigaon district (Rs.7.01) as against Rs. 5.05 6 in Jorhat district. Among the various cost components, feed cost accounted for highest share (60-70 per cent) to the total cost. Growth and development of dairying has not only increased the income of the dairy farmers, but also stimulated the growth of agriculture through increased demand for feed and fodder.

Apart from paying higher price to the DCS members in Morigaon district, the cooperative provided easy, stable and lucrative price for milk which helped the farmers to plan for better dairy farming. Traditional marketing system dominated the study area but more so in Jorhat district (55.64 per cent). Non-members involved in milk marketing had to face the problems of high marketing cost, unstable milk price, time consuming nature of home delivery, high production cost and were deprived of other benefits as availed by the Cooperative society members. Cooperative provided all modern marketing facilities which lacking in Jorhat district. Further, the conversion of milk to milk products was found to be more profitable. Milk marketing through the DCS can reduce the transportation cost due to collective marketing, can get benefits from the Government and can avail available infrastructure and marketing facilities. Therefore, synergy among the Governments and other agencies is the need of the hour to strengthen the dairy sector in Assam through promotion of cross-bred cows, making adequate provision of animal health support, motivation of dairy farmers to go for fodder cultivation, aiding and assisting in obtaining banking and technical support. At the same time, there is need to promote the DCS among the dairy farmers to stimulate them to go for it on a mission mode which can ultimately raise their living standard besides creating additional opportunities for others.

An Assessment of Food and Nutritional Security Status of Rural Households in Assam

Upama Hazarika

India is an agricultural country and agriculture plays an important role in the economic life of India. Food and nutritional security continues to be the strong foundation of India's food policy despite its tremendous achievement on food production. Household food security is an important measure of wellbeing. Despite the increasing global concern of improving food security, the nature and extent of food security at the household level in rural areas is not well documented.

The present study has been undertaken to examine the present level of food and nutritional security status of rural households in Assam State. An attempt has been made to examine the status of temporal agricultural food production and variability across the state of Assam. An analysis to the various factors that affect existing food security of the sample farmers and their coping strategies during food shortages were done. Finally, an alternative plan for attaining food security of sample households was given. For evaluating the specific objectives of the study, both primary and secondary data were collected. Appropriate analytical and statistical procedure was followed for each objectives such as compound growth analysis and coefficient of variation of area, production, yields of major food crops in Assam, regression analysis, linear programming, percentage and ranking method etc. for the period of 1998-99 to 2014-15. A multi stage random sampling design was used for the present study. Altogether, 240 sample households were taken from Upper Brahmaputra Valley Zone and Lower Brahmaputra Valley Zone of Assam zones.

The results of the study revealed that positive and highly significant growth in production (2.37%) in food grains which was mainly due to highly significant growth rate of yield (2.72%). But negative growth rate was also observed in case of area of food grains (0.34%) during the study period of 1998-99 to 2014-15. Semi-log quadratic equation estimated for food grains production, area and yield revealed significant acceleration during the period in the state of Assam. An analysis of instability measured by coefficient of variation of production of total food grains revealed that in the entire

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period it was 17.35 per cent with major contribution of yield variability which was 16.57 per cent. Again, the analysis of per capita availability of different food grains revealed that the per capita availability of cereals remained more than normative requirement during all the periods. Per capita availability of pulses, though remained more than normative requirement, it was in a declining trend up to 2008-13 and increased during 2013-15 but per capita availability of total food grains was more than normative requirement during all the periods. It was found that the per capita availability of oilseeds produced in the state was far below the normative requirement, although its area, production as well as productivity increased over the years.

It was found that in Lower Brahmaputra Valley Zone, 30 per cent of sample households were food secure while 70 per cent households were food insecure. Moreover, the food secure percentages of marginal, small, semi medium and medium farmers of Lower Brahmaputra Valley Zone were 22.22 per cent, 17.07 per cent, 33.33 per cent and 76.92 per cent, respectively. In Upper Brahmaputra Valley Zone, 36.67 per cent of sample households were food secure while 63.33 per cent of households were food insecure. The food secure percentages of marginal, small, semi medium and medium farmers of Upper Brahmaputra Valley Zone were 7.50 per cent, 28.57 per cent, 66.67 per cent and 72.22 per cent, respectively. It indicated that the farm size could be a significant factor to the food security status of farming households.

Different socioeconomic, personnel and natural factors were analyzed in order to study the factors affecting food security of sample households. The regression analysis revealed there were important factors such as total land (ha), farm size, rice area (ha), monthly income, age of household head, education of household head, household member, age of wife, education of wife and access to finance that affected food security status of sample households. The findings revealed that the most important way of obtaining food when stocks run out was to purchase food on credit from the market followed by selling productive assets like land or livestock during the food shortages. Other options like reduce quantity, consume seed stock held for next season, take money from money lenders etc. were also adopted by rural households during shortage period.

A linear programming was used mathematical technique designed to assist managers in decision making and resource allocation among the food insecure households of Lower Brahmaputra Valley Zone and Upper Brahmaputra Valley Zone. The optimal farm plan for food insecure households that recommended that there was scope for reorganizing the resources in order to increase the net farm returns to the extent of 24.70 per cent of marginal farms, 40.57 per cent of small farms 62.01 per cent of semi-medium farms and 73.16 per cent of medium farms of Lower Brahmaputra Valley Zone which were shown through optimum plan. In the same way, in Upper Brahmaputra Valley Zone, there was scope for reorganizing the resources which would result in increasing the net farm returns to the extent of 24.02 per cent of marginal farms, 37.20 per cent of small farms 73.41 per cent of semi-medium farms and 85.90 per cent of medium farms under the limited capital situations which were shown through

optimum plan. The results showed that majority of the food insecure farming households would improve the food security status from the production of crop enterprises based on an efficient allocation of resources as recommended by the optimal farm plan.

Therefore, it could be concluded that appropriate policy measures should be taken up to facilitate equitable growth of all major food crops in the state. Again, policy effective community participation in the design of concepts and messages aimed at imparting knowledge about family measures directed towards the provision of better family planning, increased awareness and access to family planning facilities should be given adequate attention and priority by the government.

Organic nutrient management in aromatic rice-linseed cropping sequence under rainfed situation

Anjan Krishna Sarmah

A field experiment entitled “Organic nutrient management in aromatic ricelinseed cropping sequence under rainfed situation” was conducted at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat during *kharif* and *rabi* seasons, 2018-19 and 2019-20 to evaluate the direct effects of organic nutrient management on growth, yield attributes, yield and quality of aromatic rice varieties and residual effects on succeeding relay sown linseed under rainfed situation taking into account the system’s cumulative effects on soil health. The experiment consisted of three aromatic rice varieties *viz.*, *Kola joha* (V1), *Keteki joha* (V2) and *Chakhao poireiton* (V3) and five organic nutrient management practices *viz.*, control (N0), vermicompost @ 40 kg N ha⁻¹ (N1), vermicompost @ 30 kg N ha⁻¹ + *in situ* green manuring with *Sesbania aculeata* (N2), vermicompost @ 30 kg N ha⁻¹ + *in situ* green manuring with *Sesbania aculeata* + seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha⁻¹ each (N3) and vermicompost @ 20 kg N ha⁻¹ + *in situ* green manuring with *Sesbania aculeata* + seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha⁻¹ each (N4). The experiment was laid out in factorial RBD with three replications. The soil of the experimental site was sandy loam in texture with pH 5.3, low in available N (242.50 kg ha⁻¹), low in available P₂O₅ (18.60 kg ha⁻¹), medium in available K₂O (140.60 kg ha⁻¹) and medium in organic carbon (0.58 %). The total rainfall received was 1544.3 mm with 86 rainy days in 2018-19 and 1691.30 mm with 80 rainy days in 2019-20 during the total cropping period. The growth, yield attributes and yield of aromatic rice was significantly influenced by the varieties and different organic nutrient management treatments. Among the varieties tested, most of the growth parameters *viz.*, plant height, LAI, root dry weight, root length and root volume, dry matter production at different stages were observed to be significantly higher in *Chakhao poireiton*. However, the highest leaf number and panicle number m⁻² was recorded in *Keteki joha*. The length of panicle, weight of panicle and test weight was found highest in *Chakhao poireiton*. The filled grain panicle-1 was highest in *Kola joha*

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and unfilled grain panicle-1 was lowest in *Keteki joha*. The highest grain yield was recorded in *Keteki joha* which was found to be statistically at par with *Chakhao poireiton* during both the years of experimentation. The highest pooled grain (27.46 q ha⁻¹) and the straw (78.80 q ha⁻¹) yield were recorded with *Keteki joha* and *Chakhao poireiton*, respectively. Different organic nutrient management practices significantly influenced most of the growth, yield attributing parameters and yield of aromatic rice as compared to the control. The highest panicle numbers viz., 264.93 m⁻² in 2018 and 271.40 m⁻² in 2019 were recorded in *Keteki joha* with the N3 treatment. The N3 treatment was found superior in respect of almost all the studied parameters which was found statistically at par with the N2 treatment for most of the parameters. The N3 treatment registered the highest pooled grain (31.42 q ha⁻¹) and straw (67.48 q ha⁻¹) yield. The interaction effects between the varieties and organic nutrient management practices were found not significant except for the panicle numbers. N, P and K contents and their uptake by grain and straw were significantly influenced by the varieties and the highest uptake of N (92.7 kg ha⁻¹), P (20.78 kg ha⁻¹) and K (91.98 kg ha⁻¹) were recorded in *Chakhao poireiton*. All the organic nutrient management practices recorded significantly higher nutrient content and uptake as compared to the control and the highest values were recorded with N3 treatment. All the three rice varieties showed significant variations in their quality traits and *Kola joha* was found superior in respect of Fe, Zn and Mn content and aroma, *Keteki joha* was found superior in respect of crude protein, Ca and Mg content and milling quality whereas the *Chakhao poireiton* registered the lowest amylose content (6.23%). Most of the studied quality traits did not differ significantly due to organic nutrient management practices.

All the studied parameters on growth, yield attributes and yield of succeeding relay sown linseed (var.T-397) were not significantly influenced by the aromatic rice varieties but significantly influenced by the organic nutrient management practices applied to the preceding rice crop. The highest values of growth, yield attributes and yield were recorded with the treatment N3 and the highest pooled seed yield (405.74 kg ha⁻¹) and stover yield (893.36 kg ha⁻¹) were recorded with this treatment. The effect of organic nutrient management practices on available N, P₂O₅ and K₂O in soil after the sequence was found significant. The highest available N, P₂O₅ and K₂O in soil after harvest of linseed were recorded with the N3 treatment. The difference in organic C due to organic nutrient management practices was found significant and the N3 treatment recorded the highest build up of organic C. The comparative economic study of the aromatic rice-linseed (relay) sequence revealed that the highest net return and B:C ratio was achieved with the N3 treatment in *Keteki joha*-linseed, *Chakhao poireiton*-linseed and *Kola joha*-linseed sequence as a whole during both the years. However, the highest B:C ratio (1.63) was achieved with the N4 treatment in *Kola joha*-linseed sequence during the second year of experimentation. The *Keteki joha*-linseed was found to be the most profitable sequence which was closely followed by the *Chakhao poireiton*-linseed sequence. Based on the findings of two years study on organic nutrient management in

aromatic rice-linseed cropping sequence, it may be concluded that among the varieties tested *Keteki joha* and *Chakhao poireiton* were found to be at par in respect of their yield potential under organic nutrient management in rainfed situation. Among the organic nutrient management practices, application of 30 kg N ha⁻¹ through vermicompost along with green manuring with *Sesbania aculeata* and seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha⁻¹ each (N3) was found to be most effective in regard to their direct effect on rice, carryover effect on the succeeding relayed linseed and sustenance of soil health.

Integrated Nutrient Management in rice (*Oryza sativa*) - toria (*Brassica campestris* var. toria)-greengram (*Vigna radiata*) cropping sequence under different rice establishment techniques

Barshi Baro

A field experiment on “Integrated Nutrient Management in rice (*Oryza sativa*) - toria (*Brassica campestris* var. toria) - greengram (*Vigna radiata*) cropping sequence under different rice establishment techniques” was carried out at Instructional-cum-Research Farm of Assam Agricultural University, Jorhat during 2016-17 and 2017-18. The experiment was laid out in split-plot design with three replications. The treatments consisted of two different establishment techniques of rice viz., Transplanted rice (M1) and Direct seeded rice (M2) in main plot and five different nutrient management practices viz., Control(N1), 100% RDF (N2), 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer (N3), 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer (N4) and 100% N as vermi-compost + bio-fertilizer (N5) in sub-plots. The soil of the experimental plot was sandy loam, acidic in reaction (pH 5.8), medium in organic carbon content (0.61%), available N (299.67kg ha⁻¹), available K₂O (139.71 kg ha⁻¹) and low in available P₂O₅ (21.59kg ha⁻¹).The total rainfall received during the experimental period was 138.4 mm and 220.6 mm during 2016 and 2017 respectively.

The results of the experiment revealed that the establishment techniques of rice brought significant effect on growth characters in terms of plant height, dry matter accumulation, post flowering photosynthetic contribution (PFPC), yield attributing characters, grain and straw yield and NPK-uptake of rice during both the years. Transplanted technique of rice establishment recorded the higher value for all those growth characters except for CGR, RGR and LAI in first crop rice. Yield attributing characters, grain and straw yield, NPK-uptake was also higher under transplanted technique of rice as compared to direct seeded rice. In second crop toria, growth attributing characters viz., plant height, dry matter accumulation, post flowering

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photosynthetic contribution (PFPC) and yield attributing characters, seed and stover yield, sink capacity, oil content and oil yield were found higher when grown following transplanted technique of rice establishment. The NPK- uptake in seed and stover registered the higher value grown following transplanted techniques of rice establishment over direct seeded rice establishment technique. The growth attributing characters, in terms of plant height, number of leaves per branch, dry matter accumulation, CGR, LAI and post flowering photosynthetic contribution (PFPC) recorded the higher values under transplanted technique of rice establishment in third crop greengram. Yield attributing characters and yield were also higher under transplanted technique of rice establishment. NPK- uptake in seed and stover, available soil NPK- status after harvest of crop, nutrient harvest index were also higher in transplanted rice establishment technique as compared to direct seeded rice establishment technique.

Different nutrient management brought about significant differences in growth attributes, yield attributing characters, grain and straw yield, NPK-uptake, physiological nitrogen use efficiency, NPK - status in soil during both the years. Among all the nutrient management, 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer recorded the highest value of growth and yield attributing characters, grain and straw yield, NPK-uptake, physiological nitrogen use efficiency in rice. The treatment was followed by 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer. The increase in grain yield under the treatment was 9.19% and 9.34% higher than 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer in first year and second year respectively. Nutrient management with 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer registered the highest value of growth and yield attributing characters in second crop toria. The percent increase in seed yield was 18.43% and 53.42% higher than 100% RDF and 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer respectively. The lowest seed yield (2.99q/ha and 3.31 q/ha) was observed under the control in both the years. The highest oil content and oil yield, NPK- uptake in seed and stover were found in 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer. Similarly, in third crop greengram, nutrient management with 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer registered the highest value in growth and yield attributing characters. The treatment was closely followed by 100% RDF, 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer and 100% N as vermi-compost + bio-fertilizer. The increase in seed yield under the treatment was 15.73% and 18.77% and 19.97% and 23.58% higher than 100% RDF and 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer in first year and second year respectively. Nutrient management with 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer also reported the highest NPK-status in soil after harvest and nutrient harvest index in greengram.

Transplanted technique of rice establishment with nutrient management package of 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer recorded the

highest values of total equivalent yield and production efficiency of the system as a whole. Similarly, in terms of soil health also, transplanted technique of rice with nutrient management package of 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer registered the highest value. In terms of economics, transplanted techniques of rice with 100% RDF gave the highest net return of Rs.1, 19,365.12 and Rs.1,24,099.40, benefit - cost ratio of 2.20 and 2.28 during both years, respectively.

Integrated nutrient management in yellow sarson - greengram cropping system under rainfed condition

Bebi Gogoi

A field experiment entitled “Integrated nutrient management in yellow sarson - greengram cropping system under rainfed condition” was carried out at the Instructional-cum-Research farm of Assam Agricultural University, Jorhat during two consecutive *rabi* (Oct-Feb) followed by summer (Feb-May) seasons of the year 2017-2018 and 2018-2019. The experiment was laid out in randomized block design for first crop and split plot design for second crop with three replications. The eight INM practices *viz.*, 100% RDF (60-30-30 kg/ha N-P₂O₅-K₂O) (Y1), 100% RDF + biofertilizer consortium (Y2), 75% RDF + 25% N through vermicompost (Y3), 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4), 50% RDF + 50% N through vermicompost (Y5), 50% RDF + 50% N through vermicompost + biofertilizer consortium (Y6), 25% RDF + 75% N through vermicompost (Y7) and 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8) were applied to yellow sarson crop. In greengram crop the residual effect of the treatments applied to yellow sarson were allotted in main plots and two different integrated nutrient management practices *viz.*, 100% RDF + biofertilizer consortium (G1) and 50% RDF + biofertilizer consortium (G2) in the sub plots. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.40 and 5.56), medium in organic carbon (0.69 and 0.72%), available N (274.86 and 290.75 kg/ha), available K₂O (138.16 and 140.89 kg/ha) and low in available P₂O₅ (17.90 and 20.30 kg/ha) in the year 2017-18 and 2018-19, respectively. Experimental findings revealed that application of 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4) resulted in significantly higher growth as well as yield attributing characters like plant height, number of branches per plant, dry matter accumulation, crop growth rate, relative growth rate, number of siliquae per plant, length of siliqua, number of seeds per siliqua in both the years. The highest seed yield of 998.34, 1026.22 and 1012.28 kg/ha, stover yield of

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2393.97, 2420.65 and 2407.31 kg/ha during 2017-18, 2018-19 and in pooled analysis, respectively, were recorded with treatment having 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4). The seed oil content of 36.40 and 36.97% and seed protein content of 13.27 and 13.44% were also recorded in Y4 in 1st and 2nd year, respectively. Similar effects of this treatment were also observed in respect of N, P and K content and uptake by both seed and stover. However, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of yellow sarson were significantly higher in treatment having 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8). The crop recorded the highest gross return (₹ 56105 in 2017-18 and ₹ 57652 in 2018-19), net return (₹ 35407 during 2017-18 and ₹ 36954 during 2018-19) and benefit-cost ratio (2.71 during 2017-18 and 2.79 during 2018-19) with the treatment containing 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4).

In case of greengram, residual effect of 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8) resulted in significantly higher growth as well as yield attributing characters like plant height, number of branches per plant, dry matter accumulation, crop growth rate, number of pods per plant and number of seeds per pod in both the years. The effect of these was reflected in higher seed yield (849.56, 806.56 and 828.06 kg/ha in the year 2018, 2019 and in pooled analysis, respectively) and stover yield (2012.68, 1935.58 and 1974.13 kg/ha in 2018, 2019 and in pooled analysis, respectively) under the same integrated nutrient management practices. The maximum values of N, P and K uptake by seed and stover, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of greengram were also observed under this treatment (Y8). However, direct application of 100% RDF + biofertilizer consortium (G1) brought about higher values in growth parameters, yield attributes, yield of seed (804.21, 724.68 and 764.45 kg/ha during 2018, 2019 and in pooled analysis, respectively) and stover yield (1830.89, 1763.80 and 1797.35 kg/ha during 2018, 2019 and in pooled analysis, respectively), protein content in seed (22.39 and 22.26% in 2018 and 2019 respectively), content and uptake of N, P and K by both seed and stover, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of greengram over 50% RDF + biofertilizer consortium (G2). The highest gross return (₹ 50726 in 2018 and ₹ 48922 in 2019), net return (₹ 33611 during 2018 and ₹ 31807 during 2019) and benefit-cost ratio (2.96 during 2018 and 2.86 during 2019) were observed under treatment Y8G1 containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y8 (25% RDF + 75% N through vermicompost + biofertilizer consortium). In regards to yellow sarson-greengram cropping system the highest yellow sarson equivalent yield (1678.57 and 1614.02 kg/ha in 2018 and 2019, respectively) were obtained by treatment Y4G1 containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y4 (75% RDF + 25% N

through vermicompost + biofertilizer consortium). The highest gross return (₹ 93518 in 2017-18 and ₹ 89981 in 2018-19), net return (₹ 55705 during 2017-18 and ₹ 52168 during 2018-19) and benefit-cost ratio (2.47 during 2017-18 and 2.37 during 2018-19) of yellow sarson greengram cropping system were observed under treatment Y4G1, containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y4 (75% RDF + 25% N through vermicompost + biofertilizer consortium). The performance of yellow sarson greengram cropping system was assessed on the basis of yellow sarson equivalent yield, net monetary returns and B-C ratio. The application of 75% RDF + 25% N through vermicompost + biofertilizer consortium to yellow sarson and 100% RDF + biofertilizer consortium to greengram was the most beneficial combination compared to rest of the treatments.

Effect of irrigation and nutrient management in Indian mustard (*Brassica juncea*) – direct seeded autumn rice (*Oryza sativa*) cropping system in Assam

Bollaveni Sathish Kumar

A field experiment entitled “Effect of irrigation and nutrient management in Indian mustard (*Brassica juncea*) – direct seeded autumn rice (*Oryza sativa*) cropping system in Assam” was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during two consecutive *rabi* (Oct- Feb) followed by summer (Feb-June) seasons of 2016 - 2017 and 2017-2018 to evaluate the optimum irrigation and nutrient management practices on growth and yield of the crops. The treatments consisted of four levels of irrigation viz., I0-Rain-fed, I1-IW:CPE=1.20, I2-IW:CPE=1.40 and I3-IW:CPE=1.60 and five levels of nutrient management practices viz., N1- Recommended dose of fertilizers (RDF), N2 – RDF + FYM @ 5t/ha, N3 -75% RDF (N) + 25% N through FYM, N4- 50% RDF (N) + 50% N through FYM and N5- 50% RDF (N) + 50% N through FYM + Bio-fertilizers (Consortium of *Azotobacter* and PSB), laid out in a split-plot design with irrigations in the main plots and nutrient management practices in the sub-plots and were replicated thrice. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.6), medium in organic carbon (0.65%), low in available N (226.63 kg/ha), available P₂O₅ (21.18 kg/ha) and available K₂O (127.71 kg/ha). The bulk density, field capacity, permanent wilting point and water holding capacity of the soil were 1.38 g/cc, 26.60%, 10.25% and 41.28%, respectively.

Results revealed that irrigations at IW:CPE=1.60 followed by IW:CPE=1.40 resulted in higher growth in terms of plant height, dry matter accumulation, crop growth rate and branches per plant as well as yield attributes like number and weight of siliques per plant and number of seeds per silique. The effect of these was reflected in higher yield of seed, stover and oil yield under the same irrigation regimes. The maximum values of N, P and K uptake, weed biomass, microbial population, evapotranspiration

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and total water use were also observed under these treatments. The higher gross and net returns with higher B:C ratio were found under the irrigation regime IW:CPE=1.60. Pooled over two years also showed similar trend on seed yield of Indian mustard.

In regards to nutrient management practices, application of 50% RDF (N) + 50% N through FYM + Bio-fertilizers followed by RDF + FYM @ 5t/ha brought about higher values in growth parameters, yield attributes, yield of seed and stover and oil yield and uptake of N, P and K by both seed and stover over rest of the treatments. Pooled data of two years on seed yield of mustard also showed similar trend. The evapotranspiration and total water use and water use efficiency of the crop were also higher under these treatments. However, comparatively higher gross and net returns and B:C ratio associated with the treatment 50% RDF (N) + 50% N through FYM + Bio-fertilizers.

In case of direct seeded autumn rice, application of irrigations at IW:CPE=1.60 and IW:CPE=1.40 resulted in statistically similar values in most of the cases of growth parameters viz., plant height, number of tillers, dry matter accumulation and crop growth rate as well as yield attributing characters like number and weight of panicles/m² and grains per panicle and were higher over lower irrigation regime and rainfed. These led to produce higher yields of grain and straw and thereby resulted in higher uptake of N, P and K by the crop under the said treatments. The favourable influence of the irrigation regime IW:CPE=1.60 was observed on weed biomass, microbial population, evapotranspiration and total water use by the crop in which it recorded higher values over rest of the treatments. Though the cost of cultivation was considerably more with IW:CPE=1.60, it produced higher gross and net returns with higher B:C ratio.

Application of 50% RDF (N) + 50% N through FYM + Bio-fertilizers followed by RDF + FYM @ 5t/ha resulted in higher growth parameters, yield attributing characters, grain and straw yields, uptake of N, P and K by the crop and evapotranspiration, total water use and water use efficiency over rest of the treatments. Pooled over two years data also showed at par effect on grain yield of rice due to these treatments. The highest gross and net returns and B: C ratio were observed under 50% RDF (N) + 50% N through FYM + Bio-fertilizers.

In regards to Indian mustard-direct seeded autumn rice cropping system, the irrigation regime IW:CPE ratio 1.60 or IW:CPE ratio 1.40 along with the application of 50% RDF (N) + 50% N through FYM + Bio-fertilizers or RDF + FYM @ 5 t/ha found to produce higher rice equivalent yield of the crops as well as gross and net returns and B: C ratio over other practices.

Organic Nutrient Management in winter rice (*Oryza sativa L.*) Under different methods of crop establishment and its effect on summer rice

Gayatree Goswami

An experiment entitled “**Organic nutrient management in winter rice (*Oryza sativa L.*) under different methods of crop establishment and its effect on summer rice**” was carried out at the instructional cum research farm of AAU, Jorhat during 2016-17 and 2017-18 to study the effect of organic nutrients on winter rice, to assess the performance of winter rice under different methods of crop establishment, to study the effect of nutrient management in winter rice on summer rice and to assess the soil physico-chemical properties as influenced by the organic nutrient management. The experiment was laid out in factorial Randomized Block Design (RBD) with three replications. The treatments consisted of three crop establishment (E) methods viz., transplanting (E1), wet seeding (E2) and SRI (E3) and five nutrient management (N) practices viz., control (N0), application of vermicompost either @ 2.5 t/ha (N1) or @ 5.0 t/ha (N2) and application of enriched compost either @ 2.5 t/ha (N3) or @ 5.0 t/ha (N4). *Satyaranjan* (winter rice) and *Kanaklata* (summer rice) were the crop varieties. The soil of the experimental field initially was sandy loam in texture, acidic in reaction (5.21), medium in organic carbon (0.63%), medium in available nitrogen (302.85 kg/ha), high in available phosphorous (32.04 kg/ha) and medium in available potassium (167.78 kg/ha). The main weeds in the experimental field were; *Echinochloa crusgalli*, *Digitaria violescens*, *Cyperus iria*, *Cyperus rotundas*, *Scirpus juncoides*, *Monochoria vaginalis*, *Marsilea minuta*, *Alternanthera philoxeroides*, *Cynodon dactylon*, *Eleusine indica* and *Ageratum conyzoides*. The crop establishment method significantly increased plant height, dry matter accumulation/plant, leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), number of tillers/m² and root dry weight/plant in winter rice. Transplanting increased days to 50% flowering and maturity in winter rice followed by SRI and wet seeding. The yield attributing characteristics, viz., number of effective tillers/m², number of grains/panicle, number of filled grains/panicle, percent

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unfilled grains/panicle, 1000-grain weight, grain yield and straw yield of winter rice were found to be significantly increased due to crop establishment method. SRI was the best treatment in respect of growth and yield attributing characteristics of winter rice followed by transplanting and wet seeding. SRI also significantly increased the yield of winter rice (30.83 q/ha in 2016 and 31.49 q/ha in 2017) by 32.77% and 30.23% over wet seeding in 2016 and 2017, respectively. During both the years, density and dry weight of weeds in winter rice were found to be significantly higher in case of wet seeding (E2). Application of 5.0 t/ha enriched compost (N4) resulted in significant improvement of the aforesaid growth and yield attributing characteristics in winter rice. Application of 2.5 t/ha of enriched compost (N3) was the second best treatment. The interaction effect was significant in respect of LAI at 90 DAS, dry matter accumulation/plant at 90, 120 DAS and harvest and CGR at 90-120 DAS during both the years of experiment. SRI (E3) alongwith application of 5.0 t/ha of enriched compost (N4) was the best combination in this regard followed by the treatment combination E3N3 *i.e.* SRI (E3) alongwith application of 2.5 t/ha of enriched compost (N3). SRI resulted in significantly higher nitrogen, phosphorous and potassium uptake at 60 DAS of winter rice plants and also of rice grain and straw and thus the total uptake followed by transplanting (E1) and wet seeding (E2). Application of 5.0 t/ha enriched compost (N4) significantly increased nitrogen, phosphorous and potassium content and uptake in plants at 60 DAS and of rice grain and straw and in its total uptake. There was no significant influence of crop establishment method on pH and organic carbon. However, available nitrogen, available phosphorous and available potassium in soil was significantly higher in wet seeding followed by transplanting method. Application of 5.0 t/ha of enriched compost (N4) resulted in significantly higher organic carbon, available nitrogen, available phosphorous and available potassium in soil followed by application of 2.5 t/ha of enriched compost (N3).

There was no significant carryover effect of crop establishment method of winter rice on summer rice. However, nutrient management of winter rice seemed to significantly improve growth and yield of summer rice and the best treatment was application of 5.0 t/ha enriched compost in winter rice with grain yield of 31.61 q/ha in 2016 and 33.44 q/ha in 2017, respectively. Organic carbon and available nitrogen, available phosphorous and available potassium in soil were found to be significantly higher due to the residual effect of application of 5.0 t/ha enriched compost in winter rice. The nitrogen, phosphorous and potassium content, uptake and total uptake were significantly higher in summer rice due to the residual effect of nutrient management in winter rice. Although SRI combined with application of 5.0 t/ha enriched compost resulted in highest gross, the comparative economics of the sequence revealed that SRI coupled with application of 2.5 t/ha enriched compost was better in terms of Benefit:Cost ratio (2.96 in 2016 and 2.86 in 2017) compared with that in case of association of SRI and application of 5.0 t/ha enriched compost (2.35 in 2016 and 1.93 in 2017).

Intensive food-forage cropping system under medium land situation as influenced by integrated nutrient management

Joshila Enghipi

A field investigation entitled “Intensive food-forage cropping system under medium land situation as influenced by integrated nutrient management” was conducted at the Instructional-cum-Research farm, Assam Agricultural University, Jorhat during the year 2016-2017 and 2017-18 with a view to study the performance of food-forage cropping system under different integrated nutrient management and their effect on succeeding rice in *kharif* and thereafter rapeseed as relay crop during *rabi* season. The experiment was laid out in split-plot design with three replications for the teosinte+ricebean intercropping system during summer season and a split- split plot design for the treatments in rice crop during *kharif* season and relay crop rapeseed during *rabi* season. During summer the treatments comprised of four different cropping system in main plots *viz.*, C1= Sole teosinte, C2= Sole ricebean, C3=3:2 row proportion of teosinte+ ricebean and C4 =3:3 row proportion of teosinte + ricebean intercropping and four integrated nutrient management in sub plots *viz.*, M1 =RDF(inorganic), M2 =50% N of RDF + 50% N through FYM, M3 =50% N of RDF + 50% N through vermicompost and M4 =100% organic (50% N through vermicompost + 50% N through FYM). During *kharif* two treatments were superimposed in rice crop in sub-sub plot *i.e.* I1= Recommended INM packages and I2= Recommended INM package with 50% OM in rice. During *rabi* season rapeseed crop was grown as relay crop succeeding rice on residual fertility without application of fertilizer. The soils of the experimental site was sandy loam in texture, acidic in reaction, medium in organic carbon and available N, P2O5 and low in available K2O.

In intercropping system the highest green forage yield (163.74 and 170.74 q/ha) and dry matter yield (37.21and 39.83 q/ha) of teosinte was recorded with 3:2 row proportion of teosinte + ricebean during 2016 and 2017, respectively. Higher green forage yield of ricebean was recorded in sole ricebean and among the intercropping

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system 3:3 row proportion of teosinte + ricebean recorded the highest green forage yield (127.75 and 136.50 q/ha) and dry matter yield (31.18 and 33.48 q/ha) in both the year. The effect of integrated nutrient management on green forage yield and dry matter yield were significantly higher in 50% N of RDF + 50% N through vermicompost than other treatments in both the years. *Kharif* rice grown after sole ricebean and application of 50% N of RDF + 50% N through vermicompost resulted in significantly higher values in respect of plant height, LAI, CGR, RGR, panicles/m², filled grains/panicle, grain yield (47.24 and 49.62 q/ha) and harvest index as compared to other cropping systems and other integrated nutrient management treatments. Recommended INM packages increased the rice yield in both the years as compared to recommended INM package with 50% OM. In respect of relay crop of rapeseed the higher values of all the growth and yield attributes, seed yield, harvest index and oil content were found under sole ricebean-rice-rapeseed sequence where 50% N of RDF + 50% N through vermicompost were applied to sole ricebean followed by recommended INM package in rice as compared to other cropping systems/treatments. The highest green forage equivalent yield of the cropping system as a whole was observed in teosinte + ricebean at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages followed by rapeseed as relay cropping in both the years. Economics of the cropping system as a whole revealed that sole ricebean with (50% N of RDF + 50% N through vermicompost) - rice with recommended INM package followed by succeeding crop of relay rapeseed on residual fertility recorded the highest net return of Rs. 73896 and Rs. 80312 and benefit-cost ratio of 1.41 and 1.53 in both the years, respectively. Among the intercropping system the highest net return and benefit-cost ratio was observed in 3:3 row proportion in both the years. The energy use efficiency was found to be the highest in sole ricebean-rice-rapeseed cropping system where 50% N of RDF + 50% N through vermicompost was applied to ricebean and recommended INM packages to rice. Among the intercropping system the highest energy use efficiency was found in teosinte+ricebean intercropped at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages in the two successive years. The highest energy productivity ratio of 0.377 and 0.400 kg/MJ were recorded in teosinte+ricebean intercropping at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with INM packages followed by rapeseed in both the years of experimentation.

In a nutshell, based on the finding of the two years of experimentation teosinte+ricebean intercropping at 3:3 row proportion along with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages succeeded by rapeseed relay cropping may be a suitable cropping sequence for medium land situation of Assam from the view point of improving and sustaining higher food and forage productivity, economic feasibility and maintenance of soil health.

Evaluation of weed management practices under organic production in Rice (A) – Rice (W) – Toria cropping sequence

Jyoti Rekha Hazarika

An experiment entitled “Evaluation of weed management practices under organic production in autumn rice-winter rice-toria cropping sequence” was conducted for two consecutive years during 2018-19 and 2019-20 at Instructional-Cum-Research Farm of Assam Agricultural University, Jorhat. This study forms a part of the long-term experiment under All India Coordinated Research Project on Integrated Farming System with a view to evaluate the efficiency of cultural and mechanical weed management practices under organic production system. The experiment was laid out in Randomized Block Design replicating thrice with seven treatments *viz.*, T1: two hand weeding (HW) in rice and 1 HW in toria, T2: one mechanical weeding (MW) + one HW in rice and one HW in toria, T3: intercropping (dhaincha in autumn and winter rice and french bean in toria, at 2:1 ratio in replacement series, T4: stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 HW (in all the three crops), T5: locally available dry weed mulch (3 *inch* thick) + 1 hand pulling (in all the three crops), T6: incorporation of oilcake (5 t/ha) + 1 HW (in all the three crops) and T7: deep ploughing during summer + 1 HW (in all the three crops). Recommended doses of N were applied as 1/3 rd N through FYM + 1/3 rd N through vermicompost + 1/3 rd N through mustard oil cake to each crop of the sequence. The soil texture of the experimental site was sandy loam with acidic in soil reaction (pH 5.40). The initial soil status was medium in organic carbon (6.82 mg/kg) and available nitrogen (340.50 kg/ha), low in available phosphorus (8.80 kg/ha), available potash (95.23 kg/ha) and in soil available sulphur content (6.50 kg/ha). The results revealed that plant height and other yield attributing parameters as well as grain (30.90 q/ha in autumn rice and 33.51 q/ha in winter rice) and straw (42.37 q/ha in autumn rice and 43.17 q/ha in winter rice) yield of rice were recorded to be the highest in the treatment with stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 hand weeding (HW) *i.e.* treatment T4, while the

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lowest values were recorded under the treatment receiving 1 mechanical weeding + 1 hand weeding in rice and 1 HW in toria (T2). The yield attributing parameters as well as seed (5.92 q/ha) and stover yield (18.82 q/ha) of toria was the highest in T6 treatment. The highest REY of rice-rice-toria sequence was recorded in T4 (75.39 q/ha) and the lowest (66.03 q/ha) was under T2 treatment. The highest total weed density and dry weight of the sequence were found in T2 at 30 DAP/DAS (34.53 no./m² and 14.567 g/m²), 60 DAP/DAS (35.40 no./m² and 21.02 g/m²) and at harvest (48.69 no./m² and 22.78 g/m²), whereas the lowest was observed in T4 treatment. The total N, P and K uptake by the crops were the highest in T4 treatment with values of 147.6, 49.9 and 154.6 Kg/ha respectively and the highest total N, P and K uptake while that by weeds were recorded in T2 treatment with 102.09, 19.93 and 170.21 Kg/ha in rice-rice-toria cropping sequence. Soil available N, P, K and S content as well as soil microbial parameters after completion of the sequence were recorded to be the highest in T3 treatment.

In the present investigation, the gross return (₹178974.00), net return (₹27877.00) and B:C ratio (1.18) were found to be the highest under T4 treatment [stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 HW (in all the three crops)] and the lowest were recorded under T6 treatment [receiving mustard oilcake (@5 t/ha) + 1 HW (in all the three crops)]. Thus, considering the system productivity, and economic feasibility, the practice of stale seedbed + reduced spacing by 25% + mulching with previous crop mulch + 1 HW in all the three crops (T4) could be considered as the best organic weed management practice in case of rice- rice- toria cropping sequence under the prevailing climatic condition of Assam. However, this practice needs multi-locational trials in all the agro-climatic conditions to derive valid conclusion before putting forwarded for recommendation to the farmer's. There is also need for further study on long term effect of these organic weed management practices on soil physical, chemical and biological properties.

Effect of integrated nutrient management (INM) in rice-sesame-pea cropping system

Kangujam Bokadu

A field experiment was conducted in Instructional cum Research Farm, Assam Agricultural University, Jorhat for two years i.e, 2016-17 and 2018-19 to study the effect of integrated nutrient management (INM) on growth, yield and quality of Rice-Sesame-Pea cropping system and also to find out the requirement of Sulphur in sesame. The treatment consisted of four levels of INM viz., F₁: 100% N from Inorganic, F₂: 25% N from FYM + 75 % N from Inorganic, F₃: 50% N from FYM + 50 % N from Inorganic and F₄: 75% N from FYM + 25 % N from Inorganic for rice. For sesame and pea, the treatment consisted of four levels of INM (F₁, F₂, F₃ and F₄) and four Sulphur levels which include S₀: 0 kg ha⁻¹, S₁: 10 kg ha⁻¹, S₂: 20 kg ha⁻¹ and S₃: 30 kg ha⁻¹. The experiment consisted of 16 treatments replicated thrice in a split-plot design. The initial soil status of the experimental site was sandy clay loam in texture, acidic in reaction, medium in organic carbon, low in available nitrogen, low in available phosphorus, medium in available potassium and low in available sulphur. Growth and yield components of rice were influenced by INM. Plant height, number of tillers per running metre, plant dry weight (g hill⁻¹), crop growth rate (g m⁻² day⁻¹), number of effective tillers m⁻², panicle length (cm), number of grains panicle⁻¹, test weight (g), grain yield (t ha⁻¹), straw yield (t ha⁻¹), harvest index (%) and benefit-cost ratio, protein content (%), carbohydrate content (%) in grain, total nitrogen, phosphorus and potassium uptake was observed to be maximum at 100% N from inorganic. INM and sulphur levels influenced growth and yield components of sesame significantly. Plant height, number of branches plant⁻¹, plant dry weight (g hill⁻¹), crop growth rate (g m⁻² day⁻¹), number of capsule plant⁻¹, number of seeds capsule⁻¹, grain yield (t ha⁻¹), stover yield (t ha⁻¹), harvest index (%), protein content (%), oil content (%) in grain, total nitrogen, phosphorus, potassium and sulphur uptake was observed to be maximum at 75% N from FYM + 25% N from inorganic+ 30 kg ha⁻¹. The effect of INM and sulphur on growth and yield components of succeeding pea were significantly influenced by nitrogen levels and sulphur levels.

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Plant height, number of branches plant⁻¹, plant dry weight (g hill⁻¹), crop growth rate (g m⁻² day⁻¹), number of pods plant⁻¹, Number of seeds pod⁻¹, pod yield (t ha⁻¹), stover yield (t ha⁻¹), harvest index (%), protein content (%), oil content (%) in seed, total nitrogen, phosphorus, potassium and sulphur uptake was observed to be maximum at 75% N from FYM + 25% N from inorganic+ 30 kg ha⁻¹.

Integrated Nutrient Management in Rice - buckwheat cropping sequence

Mahadev Uzir Basumatary

A field experiment entitled “Integrated Nutrient Management in Rice - buckwheat cropping sequence” was conducted during *kharif* of 2016 and 2017 and *rabi* of 2016-17 and 2017-18 at Krishi Vigyan Kendra (KVK) farm of Kokrajhar district under Lower Brahmaputra Valley Zone (LBVZ) of Assam. The treatment consisted of Integrated Nutrient Management (INM) viz., T1 (control), T2 (100% RDF), T3 (100% RDF + FYM @ 10 t ha⁻¹), T4 (75% RDF + 25% N through FYM), T5 (75% RDF + 25% N through vermicompost), T6 (50% RDF + 50% N through FYM), T7 (50% RDF + 50% N through vermicompost) and T8 (FYM @ 1 t ha⁻¹ + mixture of *Azospirillum amazonens* A-10 and *Bacillus megaterium* P-5 @ 4 kg ha⁻¹, + Rock phosphate @ 10 kg, MOP @ 40 kg ha⁻¹) applied to *kharif* rice (as main-plot treatment in *rabi* season) in randomised block design and replicated three times. In succeeding *rabi* season, each main- plot treatment was splitted into three sub plot treatments with three levels of recommended dose of fertilizers viz., B1 (0% RDF *i.e.* control), B2 (50 % RDF) and B3 (100% RDF) to buckwheat resulting into twenty four treatment combinations and replicated three times in split plot design. The result revealed that the highest grain yield (54.13 and 52.71 q ha⁻¹) and straw yield (64.23 and 64.18 q ha⁻¹) of rice were recorded with the application of treatment T3 (100% RDF + FYM @10t ha⁻¹) during *kharif*, 2016 and 2017, respectively. Most of the growth and yield attributes, nutrient content and their uptake by the crop, organic carbon and available NPK status of soil after harvest of the *kharif* rice were maximum under application of T3 (100% RDF + FYM @ 10 t ha⁻¹) followed by treatment T5 (75% RDF + 25% N through vermicompost) during both the years of experimentation. The highest net return (Rs.36417 ha⁻¹) and B: C ratio (1.99) were obtained with the treatment T3 (100% RDF + 10 t FYM ha⁻¹) followed by T5 (75% RDF + 25% N through vermicompost) having net return of Rs.32534 ha⁻¹ and B:C ratio of 1.92 to *kharif* rice. During *rabi* season, the residual effect of treatment T3 (100% RDF + FYM @10 t FYM ha⁻¹) showed higher growth, yield attributes, seed and stover yields of buckwheat as well as nutrient content and their uptake by the crop

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during both the years of experimentation. The highest seed yield (12.76 and 13.65 q ha⁻¹) and stover yield (23.52 and 25.47 q ha⁻¹) were recorded with the residual effect of the treatment T3 (100% RDF + FYM @10 t FYM ha⁻¹) in *rabi* 2016-17 and 2017-18, respectively. Lower bulk density and higher organic carbon value and improvement in status of available NPK in soil after harvest of buckwheat (end of the rice – buckwheat sequence) were also recorded with the residual effect of T3 (100% RDF + FYM @ 10 t ha⁻¹) applied to the preceding *kharif* rice. In terms of monetary return, the highest net return (Rs. 19070 ha⁻¹) and B: C ratio (2.26) were recorded with the residual effect of T3 (100% RDF + FYM @ 10 t ha⁻¹) followed by T5 (75% RDF + 25% N through vermicompost) with net return (Rs. 15630 ha⁻¹) with B: C ratio (2.03) to buckwheat on the basis of average of two year (2016-17 and 2017-18) data. The result further revealed that the treatment B3 (100% RDF) resulted in higher values of growth, yield attributes, seed and stover yields, harvest index of *rabi* buckwheat as well as nutrient content and its uptake by crop, organic carbon and available NPK status with lower bulk density of soil after harvest of crop among the different levels of RDF (NPK) directly applied to buckwheat crop during both the years of investigation. Among RDF levels to buckwheat, maximum net return (Rs.14894 ha⁻¹) with B: C ratio (1.89) was obtained with B3 (100% RDF). The treatment combination of T3B3 *i.e.* 100% RDF + FYM @10 t ha⁻¹ with 100% RDF calculated highest net return (Rs.26674 ha⁻¹) and B:C ratio (2.60) followed by treatment combination of T5B3 (75% RDF + 25% N through vermicompost with 100% RDF) with net returns of Rs. 19758 per hectare with B:C ratio of 2.18. The performance of rice-buckwheat cropping sequence was assessed on the basis of rice equivalent yield, net monetary returns and B:C ratio. In respect of all the above assessment, the application of 100% RDF + FYM @ 10 t ha⁻¹ to *kharif* rice and 100% RDF to buckwheat was the most beneficial combination compared to rest of the treatments. However, the interaction differences were not up to the significant extent.

Performance of bud chip seedlings under integrated nutrient management in autumn planted sugarcane (*Saccharum officinarum* L.)

Mahima Begum

A field experiment entitled “Performance of bud chip seedlings under different integrated nutrient management practices in autumn planted sugarcane (*Saccharum officinarum* L.)” was conducted at Sugarcane Research Station, Buralikson, Assam for two consecutive years 2017-18 and 2018-19. The experiment consisted of three crop establishment techniques in main plot *viz.*, M1: Conventional method of planting M2: Planting of bud chip seedling at 90 cm x 60 cm, M3: Planting of bud chip seedling at 120 cm x 60 cm and five integrated nutrient management practices under sub plot *viz.*, F1: 100 % RDF, F2: 100 % RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ F3: 100 % RDF + enriched compost @ 1 t ha⁻¹ + green manuring (cowpea incorporation), N4: 75 % RDF + FYM @ 5 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ and F5: 75% RDF + FYM @ 5 t ha⁻¹ + enriched compost @ 1 t ha⁻¹ + green manuring (cowpea incorporation). The treatments were laid out in split plot design and replicated thrice. The soil of experimental plot was clay loam in texture, acidic in reaction (pH 5.46 and 5.48) and medium in organic carbon content (0.71 and 0.68%) and available K₂O (194.33 and 187.66 kg ha⁻¹), low in available N (231.42 and 226.77 kg ha⁻¹) and P₂O₅ (19.28 and 18.64 kg ha⁻¹) during 2017-18 and 2018-19, respectively. Experimental findings revealed that the most of the plant growth parameters were significantly affected by crop establishment techniques. The planting of bud chip seedling at 120 cm x 60 cm (M3) recorded significantly higher values of plant growth parameters *viz.*, total number of shoots ha⁻¹, number of shoots plant⁻¹, plant height, root growth, above ground biomass, LAI, LAD and CGR throughout the crop growing period, but was *at par* with planting of bud chip seedling at 90 cm x 60 cm (M2) in respect of physiologically active leaves plant⁻¹ and leaf area stalk⁻¹ during both the years. However, in case of few growth parameters such as chlorophyll content, green

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seeker NDVI, crop canopy temperature and RGR, no significant variation was observed among the crop establishment techniques.

The planting of bud chip seedling at 120 cm x 60 cm (M3) also revealed significantly higher values of most of the yield attributing parameters such as length of millable cane, number of millable canes, number of internodes millable cane-1, length of internodes, average cane weight and eventually the cane yield of both individual years 7 as well as in pooled analysis. Results revealed that planting of bud chip seedling at 120 cm x 60 cm (M3) produced significantly higher cane yield for both the individual years (123.20 t ha⁻¹ during 2017-18 and 118.64 t ha⁻¹ during 2018-19) as well as in pooled analysis (120.92 t ha⁻¹). Similarly, significantly higher values of green top, trash as well as total biological yield were also obtained under the planting of bud chip seedling at 120 cm x 60 cm (M3). The same crop establishment technique (M3) also registered significantly higher CCS as well as jaggery yield during both the years, but did not exert any significant effect on juice quality parameters over other crop establishment techniques.

Likewise, significantly higher uptake of nutrients by different plant parts as well as the whole plant was obtained under the planting of bud chip seedling at 120 cm x 60 cm (M3). However, no significant differences were observed in case of soil physico-chemical characteristics *viz.*, soil pH and organic carbon during both the years.

All the integrated nutrient management treatments produced significantly higher plant growth, root growth and physiological parameters over 100% RDF (F1). Application of 100 % RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (F2) produced significantly higher values in case of all the plant growth such as total number of shoots ha⁻¹, number of shoots plant⁻¹, plant height, leaf area stalk⁻¹, dry weight of above ground biomass, root growth and other physiological parameters like LAI, LAD, CGR, and RGR. But in few parameters such as number of physiologically active leaves plant⁻¹, chlorophyll content, canopy temperature and green seeker NDVI all the treatments were at par with each other except 100% RDF.

The integrated supply of 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (F2) also recorded significantly higher results in case of yield attributing characters *viz.*, length of millable cane, number of millable canes, number of internodes millable cane-1, length of internodes, average cane weight and finally resulted in higher cane, green top as well as trash yield. Results revealed that the integrated application of 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ produced the highest cane yield for both individual years (115.46 t ha⁻¹ in 2017-18 and 111.11 t ha⁻¹ in 2018-19) as well as in pooled analysis (113.28 t ha⁻¹) which was at par with all other treatments, but superior over 100% RDF. Similarly, significantly 8 higher green top as well as trash were also obtained under the treatment

receiving 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (F2) for both individual years as well as in pooled analysis. The same treatment (F2) also recorded the significantly higher biological yield (142.08 and 136.78 t ha⁻¹), commercial cane sugar (14.62 and 13.95 t ha⁻¹) and jaggery yield (10.67 and 10.13 t ha⁻¹) during both the years. But except CCS%, the integrated nutrient management treatments failed to exert any significant effect on other juice quality parameters like field brix content, juice recovery and purity %.

The N in content in all the plant parts *viz.*, cane stalk, green top, trash and K content in cane stalk was significantly influenced by integrated management practices and maximum values were obtained due to application of 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring of cowpea + biofertilizers @ 10 kg ha⁻¹ (F2). Significantly higher N, P and K uptake by cane stalk, green top, trash as well as whole plant were also obtained under integrated application of 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring of cowpea + biofertilizers @ 10 kg ha⁻¹ (F2). All the integrated nutrient management practices significantly influenced the soil physico-chemical and biological characteristics over 100% RDF. The application of 75% RDF + FYM @ 5 t ha⁻¹ + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (F4) produced the highest soil organic carbon (0.85 and 0.84%), fungal (5.44×10^4 cfu g⁻¹ and 5.38×10^4 cfu g⁻¹) and bacterial population (6.51×10^6 cfu g⁻¹ and 6.45×10^6 cfu g⁻¹) as well as available N and P₂O₅ in soil during both the years. The interaction effect was found to be significant in few growth parameters like total number of shoots, number of shoots plant⁻¹ and leaf area duration. The planting of bud chip seedling at 120 cm x 60 cm along with 100 % RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (M3F2) recorded the highest values in the above parameters. In case of economics the higher gross return (₹ 3, 82,906 ha⁻¹ and ₹ 3,67,546 ha⁻¹), net return (₹ 2,62,388 ha⁻¹ and ₹ 2,45,628 ha⁻¹) as well as B-C ratio (3.18 and 3.01) was also recorded under the planting of bud chip seedling at 120 cm x 60 cm along with 100% RDF + vermicompost @ 1 t ha⁻¹ + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha⁻¹ (M3F2) during both the years.

Real time nitrogen application in winter rice under different crop establishment techniques

Milon Jyoti Konwar

A field experiment entitled “Real time nitrogen application in winter rice under different crop establishment techniques” was carried out in the year 2017 and 2018 in the Instructional-Cum-Research (ICR) farm, Assam Agricultural University, Jorhat to study the relative performance of *winter* rice varieties with LCC- based N application under different crop establishment techniques. The experiment was comprising of 45 treatment combinations with three varieties *viz.*, V1: Ranjit, V2: Bahadur, V3: Gitesh; three crop establishment techniques *viz.*, M1: Transplanting, M2: System of Rice Intensification, M3: Direct seeding by drum seeder and five nitrogen application techniques *viz.*, N0 : Recommended dose of N (60 kg ha⁻¹); N1 : 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 2; N2 : 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 3; N3 : 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 4; N4 : 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 5, laid out in a split-plot (split-split) design with varieties in the main plots, crop establishment techniques in the sub-plots and nitrogen application techniques in the sub-sub plots and were replicated thrice. The soil of the experimental site was sandy loam, acidic in reaction, medium in organic carbon and available N, low in available P₂O₅ and K₂O. Among the different growth and physiological parameters *viz.*, plant height, tillers m⁻², dry matter accumulation, CGR, RGR and NAR, the highest values recorded in the variety Ranjit followed by Bahadur and Gitesh. Similarly, in case of crop establishment techniques and nitrogen application techniques, SRI and 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 5 recorded the highest values in different growth and physiological parameters *viz.*, plant height, tillers m⁻², dry matter accumulation, CGR, RGR, NAR during 2017 and 2018, respectively. Root volume was also significantly affected by different varieties and was found to be the highest in Ranjit followed by Bahadur and Gitesh. Similarly, in case of crop establishment techniques, the root volume was recorded highest in SRI method followed by transplanting and direct seeding by drum seeder whereas the root volume was found to be highest in application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC ≤ 5 as compared to recommended dose

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of nitrogen in different nitrogen application techniques. The results from the pooled data revealed that the variety Ranjit recorded significantly the highest yield attributing characters and grain as well as straw yields of 47.22 q ha⁻¹ and 87.12 q ha⁻¹ during 2017 and 2018. In case of methods of crop establishment, SRI recorded significantly higher grain and straw yields of 46.54 q ha⁻¹ and 85.86 q ha⁻¹ as compared to sowing by drum seeder. Application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 recorded significantly the highest grain as well as straw yields of 53.65 q ha⁻¹ and 94.48 q ha⁻¹, respectively as compared to other treatments. Pooled data of the treatment combinations showed that application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 with Ranjit establishing with SRI method registered significantly higher grain and straw yields over other treatment combinations. The highest grain and straw yields of rice from the pooled data was recorded with the application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 in Ranjit when SRI method of crop establishment was followed. The uptake of N, P, K and total uptake had been significantly affected by different varietal treatments. The highest uptake was found in case of Ranjit followed by Bahadur and Gitesh. In different crop establishment techniques N, P, K and total uptake was found to be the highest in case of SRI method followed by transplanting and direct seeding by drum seeder. Highest uptake was also found in application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 in comparison to other treatments. Results from the apparent nitrogen balance sheet indicated that the highest net gain in available N in soil was recorded in application of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 in Ranjit when SRI method was followed during 2017 and 2018, respectively, as compared to other treatment combinations. In case of economics, the higher net returns and B:C ratio (1.65 and 1.62) was recorded under treatment combinations of 30 kg N as basal + 15 kg ha⁻¹ N when LCC \leq 5 with Ranjit and drum seeder method of crop establishment in 2017 and 2018, respectively.

Direct seeded upland rice based cropping system as influenced by different moisture conservation practices under *rainfed* ecosystem

Nikhilesh Baruah

A field experiment was conducted during 2016–17 and 2017–18 at the Research field of All India Coordinated Research Project on Dryland Agriculture, Biswanath College of Agriculture, AAU, Biswanath Chariali to study the efficacy of moisture conservation practices along with crop residue incorporation for sustainable productivity of upland direct-seeded rice-based cropping sequences as well as on physico-chemical properties of the soil under *rainfed* ecosystem. Treatments comprised of six moisture conservation practices *viz*; flat bed with crop residue (M1), flat bed without crop residue (M2), BBF 60-30cm with crop residue (M3), BBF 60-30cm without crop residue (M4), BBF 120-30cm with crop residue (M5), and BBF 120-30cm without crop residue (M6) and four rice-based crop sequences *viz*; direct seeded rice-greengram-toria (S1), direct seeded rice-greengram-linseed (S2), direct seeded rice-greengram-niger (S3), and direct seeded rice-greengram-buckwheat (S4). The experiment was laid out in a split-plot design with four replications taking the moisture conservation practices in the main plots and crop sequences in the sub-plots. The cropping systems parameters were analysed in split plot design, however, the effect of moisture conservation practices on *summer*, *kharif* and *rabi* crops was evaluated in a randomized block design. The soil of the experimental site was acidic (pH 5.4), sandy loam in texture, medium in organic carbon (0.59%), low in available N (259.10 kg ha⁻¹), medium in available P₂O₅ (25.65 kg ha⁻¹) and low in available K₂O (112.30 kg ha⁻¹).

The moisture conservation practice BBF 60-30cm with residue incorporation recorded higher growth, yield attributes and yields of different summer-*kharif* and *rabi* crops (rice-greengram-toria/linseed/niger/buckwheat) grown as rice-based cropping systems. The uptake of nutrients N, P and K, water use and water use efficiencies of these crops and soil physico-chemical properties after the crop harvest were also favorably influenced by the treatment. This was followed by the treatments BBF 60-30cm without residue and BBF 120-30cm with residue incorporation, which was also

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equally effective and showed better crop performance over the flatbed methods of sowing. However, the effects of the crop sequences on growth yield as well as uptake of nutrients, water use and water use efficiencies of direct seeded *ahu* rice and *kharif* greengram and soil physico-chemical properties after the crop harvest were not significant. The integrated effect of the moisture conservation practices and rice-based cropping systems were also evaluated in terms of some important biometrics of the cropping, physico-chemical properties of the soil and economics of the practices. The treatment BBF 60-30cm with residue recorded the highest rice equivalent yield of the crops which was being at par with BBF 60-30cm without residue and BBF 120-30cm with residue but significantly higher over the flatbed methods. The increase in yield due to BBF 60-30cm with residue, BBF 60-30cm without residue and BBF 120-30cm with residue over the flatbeds were 29.67%, 22.24% and 21.24% , respectively. The total crop duration and land utilization index of the cropping did not differ due to moisture conservation practices. But, BBF 60-30cm with residue recorded significantly higher production efficiency and rain water productivity of the system over the BBF 120-30cm without residue and flatbeds. Improvement in soil physico-chemical properties in terms of reduced bulk density, increased water-soluble aggregates, water holding capacity and available N and K₂O due to BBF 60-30cm with residue was also observed. The highest cost of cultivation, gross and net return with equivalent B:C ratio as well as higher employment and economic efficiency was also recorded under the said treatment.

The crop sequences, direct seeded *ahu* rice-greengram-toria, direct seeded *ahu* rice - greengram-linseed and direct seeded *ahu* rice-greengram-niger resulted in statistically similar rice equivalent yield and BBF 60-30cm with residue produced significantly higher value over the direct seeded *ahu* rice-greengram-buckwheat. The crop sequence direct seeded *ahu* rice-greengram-toria recorded the lowest cropping duration and land utilization index and considerably higher production efficiency and rain water productivity over other systems. However, it failed to register any positive impact on soil physico-chemical properties. The direct seeded *ahu* rice-greengram-toria also recorded the highest cost of cultivation, gross return, net return, employment generation and economic efficiency over rest of the sequences.

Climate smart Irrigation Schedule and Nutrient Management Practice for Yield and Methane flux of Transplanted Autumn Rice (*Oryza sativa*)

Pompy Deka

A field experiment was conducted at Instructional cum Research Farm, AAU, Jorhat (26°71'N, 94°18'E, 91.0 m above MSL) during the years 2017 and 2018 to study the effect of irrigation schedules and nutrient management practices on growth, yield of transplanted autumn rice (Variety: Dishang) and methane flux from rice field. The experiment consisted of four different irrigation schedules viz., Continuous submergence (I1), 5 cm irrigation at 3 days after disappearance of ponded water (DADPW) [I2], 5 cm irrigation at 5 DADPW (I3), 5 cm irrigation at 7 DADPW (I4) in main plot and four different fertilizers levels viz., F1: Control plots (no fertilizer and manures), F2: Compost @ 5t/ha, F3: INM package (compost @ 1 t/ha along with mixture of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 @ 4 kg/ha + rock phosphate @ 56 kg/ha + MOP @ 67 kg/ha + Urea @ 10 kg/ha) and F4: Recommended fertilizer dose (compost @ 5t/ha + N-P2O5-K2O @ 40-20-20 kg/ha) in sub plot. The experiment was laid out in a split plot design with three replications. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.80 in 2017 and 5.82 in 2018), medium in organic C (0.68% in 2017 and 0.70% in 2018), medium in available N (316.53 kg/ha in 2017 and 348.43 kg/ha in 2018), medium in available P2O5 (25.70 kg/ha in 2017 and 27.31 kg/ha in 2018) and medium in available K2O (137.64 kg/ha in 2017 and 139.56 kg/ha). The rainfall received during the crop season was 767.2 mm in 2017 and 536.60 mm in 2018. The weekly average maximum temperature ranged from 25.6°C to 32.9°C and 23.73°C to 34.51°C during 2017 and 2018, respectively and minimum temperature ranged from 11.34°C to 25.3°C and 11.57°C to 25.06°C during 2017 and 2018, respectively. The weekly average RH during the crop season was ranged from 91% to 97% in the morning hours and 44% to 82% in the evening hours in 2017. During 2018, weekly average RH ranged from 85% to 97% in the morning hours and 55% to 79% in the evening hours. The mean weekly bright sunshine hours varied from 1.6 to 7.4 hours and 1.5 to 7.3 hours during 2017 and 2018, respectively. The results revealed that

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irrigation schedules influenced growth parameter of rice in terms of plant height, shoot and root dry weight, root volume, leaf area index and crop growth rate. Application of 5 cm irrigation at 3 DADPW (I2) recorded the highest values for all growth characters like plant height (56.13 cm, 70.28 cm and 94.24 cm at panicle initiation, flowering and harvesting stage, respectively), shoot dry weight (3.43 to 30.13 g/hill at different phenological stages), root dry weight (1.13 to 10.42 g/hill) and root volume. The maximum values for yield attributing characters, grain yield (4.08 t/ha in 2017 and 4.13 t/ha in 2018) and straw yield (6.26 t/ha in 2017 and 6.45 t/ha in 2018), N, P, K-uptake and Irrigation Water Use Efficiency (22.21 kg/ha-cm in 2017 and 22.26 kg/ha-cm in 2018) were recorded under 5 cm irrigation at 3 DADPW (I2). On the other hand, the highest irrigation water used (229.63 cm in 2017 and 231.68 cm in 2018) and soil pH were observed under continuous submergence (I1). The highest methane flux (7.00 and 7.02 mg/m²/hr in 2017 and 2018, respectively) and cumulative methane flux values of 275.70 mg/m² in 2017 and 278.81 mg/m² in 2018 were recorded by continuous submergence (I1) followed by the 5 cm irrigation at 3 DADPW (I2). Different nutrient management practices brought about significant differences in plant height, shoot and root dry weight, root volume, leaf area index and crop growth rate. For these parameters, the highest values were recorded under application of recommended fertilizer dose (RDF). The highest yield attributing characters like number of effective tiller/hill and number of grains/panicle, grain and straw yield were observed under RDF (F4) which was *at par* with INM (F3). The INM treatment recorded the highest WUE and soil pH. RDF (F4) recorded the highest methane flux and CME followed by the INM treatment (F3). The treatment combination of 5 cm irrigation at 3 DADPW with RDF (I2F4) recorded the highest plant height, root and shoot weight. The highest grain (4.70 t/ha in 2017 and 4.80 t/ha in 2018) and straw yield (6.71 t/ha in 2017 and 7.07 t/ha in 2018) were recorded by 5 cm irrigation at 3 DADPW with RDF (I2F4) which was statistically *at par* with 5 cm irrigation at 3 DADPW with INM (I2F3). Continuous submergence with RDF (I1F4) recorded the highest seasonal methane flux followed by the treatment 5 cm irrigation at 3 DADPW with RDF (I2F4). In term of economics, the highest gross return (Rs. 1,07,138.00/ha in 2017 and Rs.1,09,287.00/ha in 2018) was obtained by treatment combination 5 cm irrigation at 3 DADPW with RDF (I2F4) and net return (Rs. 70,553/ha in 2017 and Rs. 70,114/ha in 2018) was obtained by treatment combination of 5 cm irrigation at 3 DADPW with INM (I2F3). The highest B:C (2.19 in 2017 and 2.18 in 2018) was obtained by the treatment combination of 5 cm irrigation at 3 DADPW with INM (I2F3). Thus, from the present investigation, 5 cm irrigation at 3 DADPW with INM can be concluded to be the best management practice in minimizing the methane flux from the transplanted autumn rice field and without any effect on grain yield of the crop.

Resource use efficiency in winter rice [*Oryza sativa* L.] under SRI concept as influenced by microclimate

Rekhashree Kalita

A field experiment entitled “**Resource use efficiency in winter rice (*Oryza sativa* L.) under SRI concept as influenced by microclimate**” was carried out during the year 2016 and 2017 at the farmer’s field located at *Nepalikhuti* Village (Lat. 26066’99” N, Long. 93068’26”E) in Bokakhat sub-division of Golaghat district, Assam to study the performance of winter rice with respect to production maximization, resource use efficiency and economic return under varied microclimatic regime imposed by methods of crop establishment, dates of transplanting and hill densities. The experiment was comprised of 24 treatment combinations with two crop establishments viz. C1: System of Rice Intensification (SRI), C2 : Conventional; three dates of transplanting viz. D1 : 26th June, D2 : 10th July, D3 : 25th July and four hill densities viz. H1 : 20 cm x 15 cm (*i.e.* 33 hills m⁻²); H2 : 20 cm x 20 cm (*i.e.* 25 hills m⁻²); H3: 20 cm x 25 cm (*i.e.* 20 hills m⁻²); H4 : 25 cm x 25 cm (*i.e.* 16 hills m⁻²), laid out in a factorial split-plot design with crop establishment methods and dates of transplanting in the main plots and hill densities in the sub plots and were replicated thrice. The soil of the experimental site was sandy loam; acidic in reaction; medium in organic carbon and available N; low in available P₂O₅ and K₂O. The phenological study revealed that SRI crops required significantly lesser days to attain various phenophases viz. MTS, panicle emergence, flowering and physiological maturity as compared to the conventional crops in both the years of investigation. On the other hand, both early transplantation (26th June) and lower hill density (16 hills m⁻²) took more days for attainment of different phenophases. Among the different growth and physiological parameters viz. plant height, tillers m⁻², leaf area, dry matter production, LAI, chlorophyll content, CGR, RGR and NAR; the highest had been recorded by SRI with an exception of lower magnitude of leaf area, LAI and chlorophyll content at the tillering stage. Similar results were also observed in case of lower hill density showing better growth and physiological

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parameters. The early transplanting showed significant improvement in growth parameters, however, failed to show any significance with respect to physiological parameters *viz.* CGR, RGR and NAR. SRI portrayed lower magnitude of microclimatic parameters such as light intensity, light transmission ratio (LTR), AGDD throughout the crop growth, and AIPAR, AHTU and APTU at maturity. However, comparatively higher RUE (1.37 g MJ⁻¹) and HUE (2.48 kg ha⁻¹ 0d) was recorded under SRI method. Throughout the crop growth, early crops recorded highest value of AGDD, and lowest value of light intensity and LTR. In both the years, superior values of AIPAR and APTU were found in early 29 crops; however, improved HUE of 2.16 kg ha⁻¹ 0d and RUE of 1.22 g MJ⁻¹ were noticed in 2016 and 2017, respectively. In case of hill density, increased value of light intensity and LTR were recorded with increase in hill density and highest were observed at higher hill density of 33 hills m⁻², whereas higher AGDD, AIPAR, AHTU, APTU, RUE and HUE were found in lower density (16 hills m⁻²). Marked variation with respect to yield attributes was observed due to methods of crop establishment. Significantly higher numbers of panicles m⁻², longer panicle length, more filled grains panicle⁻¹ and heavier test weight were registered in SRI. Improvement in yield attributes was also observed in early transplantation as well as under reduced hill density. The results from the pooled data revealed that SRI recorded significantly the higher grain yield, straw yield and harvest index of 57.13 q ha⁻¹, 61.43 q ha⁻¹ and 48.15 per cent, respectively, compared to conventional method. In case of date of transplanting, higher grain yield of 56.51 q ha⁻¹ along with 62.00 q ha⁻¹ of straw yield and 47.60 per cent of harvest index was documented in early date of 26th June. Further, crops raised under lower hill density of 16 hills m⁻² showed significant improvement in terms of grain yield (56.75 q ha⁻¹), straw yield (61.83 q ha⁻¹) and harvest index (48.01%). The water use studies revealed comparatively higher magnitude of consumptive use (CU) of water (535.43 to 543.76 mm) and WUE (10.20 to 10.95 kg ha⁻¹mm⁻¹) in SRI than that of conventional method during transplanting to maturity stage. It was observed that the quantum of CU coupled with WUE were maximum in early transplanting (26th June) which got reduced with delaying of dates. Further, the lowest hill density (16 hills m⁻²) recorded the maximum quantum of CU and an increased magnitude of WUE in 2016 and 2017 as well. Results showed more quantum of CO₂ efflux of 5935.42 to 6082.47 mg CO₂ m⁻² d⁻¹ in 2016 and 2017, respectively in SRI whereas conventional establishment recorded 5481.31 and 5626.03 mg CO₂ m⁻² d⁻¹ during the respective years of investigation. In 2016, highest efflux (5816.50 mg CO₂ m⁻²d⁻¹) was recorded in 10th July planting, which was comparable to late planting (25th July) and significantly superior to the early one. However, in 2017, maximum emission of (5972.25 mg CO₂ m⁻²d⁻¹) was registered in late planting which was followed by 10th July and lastly by 26th June planting. Moreover, CO₂ emission was found to be increasing significantly with the increase of hill density the maximum release of 6102.28 to 6247.78 mg CO₂ m⁻²d⁻¹ was recorded at highest density *i.e.* 33 hills m⁻². The N, P, K and total uptake was found to be significantly more under SRI.

The crop transplanted early showed comparatively better result in respect of NPK uptake barring the K- uptake by straw. In the case of hill density, the higher density 30 recorded significantly lower uptake of nutrient, and with the reduction of density, uptake increased and reached the maximum at the lowest density *i.e.* 16 hills m⁻². There were no such significant variations in available N, P and K status at harvest barring N (289.59 kg ha⁻¹) and P₂O₅ (28.37 kg ha⁻¹) in 2017, where SRI as a crop establishment method observed to be better. Correlation study on pooled data showed that grain yield was strongly correlated with LAI, chlorophyll content in all the stages, and RUE and HUE at harvest. On the other hand, significant but negative relationship was noticed with LTR in MTS and AHTU at harvest. Similar correlation pattern was also recorded in cases of straw yield, panicles m⁻², filled grains panicle⁻¹, test weight and harvest index. The seven models of significant linear relationship for yield and yield attributes with microclimatic parameters showed that the value of high determining factors (R²) for combination of microclimatic parameters to explain the variability in grain yield, straw yield, panicles m⁻², panicle length, filled grains panicle⁻¹, test weight and harvest index were 0.987, 0.995, 0.947, 0.954, 0.991, 0.874 and 0.926, respectively. A magnitude of 98.7 per cent variation in grain yield was found to be predicted collectively by chlorophyll content and LTR at MTS, and AGDD and RUE at maturity. At MTS, chlorophyll content, LTR and AGDD was found to be critical influencer whereas at maturity, AGDD and HUE were significant predictive factors of yield determining parameters and yield. Amongst all, RUE was found to be outstanding as the most determining factor for predicting yield attributes and yield followed by chlorophyll content and LTR at MTS and, AGDD and HUE at maturity. On the economic analysis of different treatments, maximum net return (₹ 90,703.73) along with the highest net return per rupee invested (2.06) was obtained by the crop transplanted on 26th June with a spacing of 25cm x 25cm (16 hills m⁻²) under SRI establishment method.

Integrated Nutrient Management in potato-baby corn cropping sequence and its residual effect on succeeding sesamum

Roji Chutia

A field experiment entitled “Integrated nutrient management in potato-baby corn cropping sequence and its residual effect on succeeding sesamum” was conducted during *rabi*, summer and *kharif* seasons of 2016-17 and 2017-18 at the instructional cum research farm of Assam Agricultural University, Jorhat, Assam. The experiment consisting of sixteen treatments *viz.*, 100% RD of N (T1), 75% RD of N+ 25% N through FYM (T2), 75% RD of N+ 25% N through Poultry manure (T3), 75% RD of N+ 25% N through vermicompost (T4), 75% RD of N + 25% N through enriched compost (T5), 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6), 50% RD of N + 25% N through Poultry manure + 25% N through enriched compost (T7), 50% RD of N + 25% N through FYM + 25% N through Poultry manure (T8), 50% RD of N + 50% N through FYM (T9), 50% RD of N + 50% N through Poultry manure (T10), 50% RD of N + 50% N through vermicompost (T11), 50% RD of N + 50% N through enriched compost (T12), 50% RD of N + 25% N through FYM (T13), 50% RD of N + 25% N through poultry manure (T14), 50% RD of N + 25% N through vermicompost (T15), 50% RD of N + 25% N through enriched compost (T16) was laid out in randomized block design with three replications. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.57), medium in organic carbon (0.75%), available N (292kg/ha), P₂O₅ (25.80kg/ha) and K₂O (272.18kg/ha). The total rainfall received during the cropping sequence was 2336.40 mm in 2016-17 and 2107.10 mm in 2017-18 and max and min temperature ranged from 24.3 °C to 35.1 °C and 8.0°C to 26.1°C and 22.5 °C to 35.1 °C and 8.9 °C to 27.2 °C during 2016-17 and 2017-18, respectively.

The experimental findings revealed that application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) recorded the highest values for most of the growth as well as yield attributing characters *viz.*, number of shoots per plant,

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grade wise tuber yield, total tuber yield, dry matter yield of haulm, dry matter yield of tuber, per cent dry matter content of haulm and tuber and nutrient uptake by potato crop, respectively. The highest tuber yield pooled over two years (27.77t/ha) was also observed in T6. In case of baby corn grown in sequence, the highest response in terms of growth as well as yield attributing characters *viz.*, No. of leaves per plant, No. of cobs per plant, length of cobs with husk and without husk, yield of cobs with husk and without husk, stover yield and dry matter yield were observed in integrated nutrient management (INM) practices with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6). This treatment also gave the highest cob yield with husk of 23.09 and 24.83 t/ha during both the years. Similar trend was observed in case of cob yield without husk during both the years. In case of succeeding sesamum crop, the highest response in growth, yield and yield attributing characters *viz.*, no. of branches per plant, no. of capsules per plant, no. of seeds per capsule, 1000 seed weight were also found with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6). The highest seed yield of sesamum pooled over two years (542.72 kg/ha) was also registered at T6.

The effect of INM on N, P and K uptake by haulm and tuber was also found to be significant under different treatments. The highest N uptake of 92.55 and 90.37 kg/ha was registered at T6 followed by 78.51 and 74.27 kg/ha in the INM practice with 50% RD of N + 25% N through FYM + 25% N through poultry manure (T8). Similar trend was observed in case of baby corn and sesamum during both the years.

Integrated nutrient management had significant influence on soil physico-chemical parameters and highest values for all the soil parameters *viz.*, organic carbon (0.98 and 1.02%), available N (391.33 and 423.33kg/ha), P (28.88 and 29.50kg/ha) and K (336.55 and 347.90kg/ha) after completion of sequence were recorded at T6 during both the years of experimentation. This INM practice with combination of 50% RD of N + 25% N through FYM + 25% N through vermi compost (T6) improved soil biological characters with statistically higher microbial biomass carbon (364.44 and 372.18 μ g g⁻¹ soil), dehydrogenase activity (193.19 and 202.65 μ g TPFg⁻¹24hr⁻¹), phosphomonoesterase activity (351.82 and 371.36 μ g *p*-nitrophenol g⁻¹ hr⁻¹), fluorescein di-acetate hydrolysis activity (8.11 and 8.48 μ g fluorescein g⁻¹ hr⁻¹), bacterial population (8.77 and 9.01 No. X 10⁻⁶ cfu g⁻¹) and fungal population (6.57 and 6.80 No. X 10⁻⁴ cfu g⁻¹) followed by the INM practices with 50% RD of N + 25% N through FYM + 25% N through poultry manure (T8). The total tuber yield established strong correlation with MBC (0.655*) and dehydrogenase enzyme (r=0.687*). Similarly the OC showed strong correlation with MBC (r=0.806**) and enzyme phosphomonoesterase established significant correlation with available P₂O₅ (r=0.781*) indicating the role of enzyme in releasing the P from organic sources.

In terms of economics, the highest net return of Rs 6,38,200.00 per ha and benefit – cost ratio (B:C) of 4.82 were obtained in the INM practices with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) in potato-

baby corn-sesamum cropping sequence. This was followed by T8 with net return of Rs 4, 85,600.00 per ha with B- C ratio of 4.21. Thus, application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) was found to be the best INM practice for better crop growth, economic yield, system productivity and sustained soil health in potato – baby corn - sesamum cropping sequence.

Resource conservation practices in winter rice (*Oryza sativa* L.)-mustard [*Brassica juncea* (L.) Czern and Coss.] cropping sequence

Sontara Kalita

A field experiment entitled “**Resource conservation practices in winter rice (*Oryza sativa* L.)-mustard [*Brassica juncea* (L.) Czern and Coss.] cropping sequence**” was carried out during 2017-18 and 2018-19 at the Instructional-Cum-Research (ICR) Farm, Assam Agricultural University, Jorhat to evaluate the effect of different tillage and weed management practices on soil properties, weed growth, crop growth and yield of winter rice and Indian mustard with *Sesbania aculeata* as the preceding crop.

The experiment comprising 20 treatment combinations with 5 tillage practices viz., T1: CT (*Sesbania*)-CT (transplanted rice)-CT (Indian mustard), T2: MT (*Sesbania*)-CT (transplanted rice)-MT (Indian mustard), T3: MT (*Sesbania*)-CT (direct seeded rice)-CT (Indian mustard), T4: MT (*Sesbania*)-MT (direct seeded rice)-MT+R/rice residue (Indian mustard), T5: MT (*Sesbania*)-MT (direct seeded rice)-MT (Indian mustard) and 4 weed management practices viz., W1: recommended herbicides (*Sesbania*: pendimethalin 0.75 kg/ha pre-emergence; rice: pretilachlor 0.75 kg/ha pre-emergence; Indian mustard: pendimethalin 0.75 kg/ha pre-emergence) W2: IWM: integrated weed management (*Sesbania*: pendimethalin 0.75 kg/ha pre-emergence + manual weeding; rice: pretilachlor 0.75 kg/ha pre-emergence + manual weeding; Indian mustard: pendimethalin 0.75 kg/ha pre-emergence + manual weeding), W3: manual weeding/hoeing, W4: weedy check, laid out in a split-plot design with tillage practices in the main plots and weed management practices in the sub-plots replicated thrice. The soil of the experimental site was sandy loam, acidic in reaction (pH 5.59), medium in organic carbon (0.62 %), medium in available N (290.60 kg/ha), low in available P₂O₅ (21.70 kg/ha) and available K₂O (128.90 kg/ha). The initial bulk density, total porosity as well as water holding capacity of the 0-15 and 15-30 cm soil were 1.42 and 1.50 g/cc, 44.96 and 42.31 % and 43.10 and 41.02 %, respectively. The mean weight diameter, macro-aggregates (>0.25mm) and micro-aggregates (<0.25mm) were 1.31 mm, 61.22 % and 38.78 %, respectively.

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Department : Agronomy

Major Advisor : Dr. Jayanta Deka

Tillage practices did not influence growth of weeds and *Sesbania aculeata*, but all weed management practices significantly affected weed growth, fresh biomass and plant dry matter of the green manuring crop as compared to weedy check.

Tillage practices viz., CT(S)-CT(TR)-CT(IM), MT(S)-CT(TR)-MT(IM), MT(S)-MT(DSR)-MT+R(IM) and MT(S)-MT(DSR)-MT(IM) resulted in the lower weed growth throughout the crop growth period and the higher crop growth characteristics as well as yield parameters of winter rice as compared to MT(S)-CT(DSR)-CT(IM) which ultimately resulted into the higher grain and straw yields as well as nutrient uptake. The per cent increase in grain yield of winter rice under CT(S)-CT(TR)-CT(IM), MT(S)-CT(TR)-MT(IM), MT(S)-MT(DSR)-MT+R(IM) and MT(S)-MT(DSR)-MT(IM) over MT(S)-CT(DSR)-CT(IM) were to the tune of 25.59, 40.22, 33.33 and 30.12, respectively in 2017 and 16.86, 26.26, 22.12 and 18.59, respectively in 7 2018. Among different weed management treatments, IWM and manual weeding 20 and 40 DAS/DAT recorded the lower weed growth and nutrient uptake with higher WCE and WCI during active growth period of the crop which resulted into the higher crop growth characteristics and yield parameters, ultimately reflected in the higher grain and straw yields with the higher nutrient uptake by the winter rice. The corresponding per cent increase in grain yield of rice in IWM and manual weeding as compared to weedy check was 83.82 and 80.78 in 2017 and 93.29 and 98.83 in 2018. Treatment combinations, MT(S)-CT(TR)-MT(IM) with IWM and manual weeding; MT(S)-MT(DSR)-MT+R(IM) with IWM and manual weeding recorded the higher grain and straw yields as compared to other treatment combinations. The higher B-C ratio of 2.00 and 2.24 was recorded under treatment combination MT(S)-MT(DSR)-MT+R(IM) and recommended herbicide and MT(S)-MT(DSR)-MT+R(IM) and IWM in 2017 and 2018, respectively.

In case of Indian mustard, MT(S)-MT(DSR)-MT+R(IM) noted the lower weed growth and nutrient removal by weeds and the higher values of crop growth characteristics and yield parameters leading to the higher seed, stover and oil yields as well as nutrient uptake. Among the weed management treatments, IWM and manual weeding 25 DAS controlled weeds efficiently with higher values of WCE and WCI and lower nutrient removal by weeds during critical crop growth period which resulted into the higher crop growth characteristics and yield parameters. The effect was reflected in higher seed, stover and oil yields as well as uptake of nutrients by the crop. Treatment combinations, MT(S)-MT(DSR)-MT+R(IM) with IWM and manual weeding registered higher seed yield in both the years of study. The higher B-C ratio was recorded under treatment combinations MT(S)-MT(DSR)-MT(IM) and manual weeding (2.78) very closely followed by MT(S)-MT(DSR)-MT+R(IM) and manual weeding (2.77) in 2017-18 and MT(S)-MT(DSR)-MT(IM) and manual weeding (3.23) very closely followed by MT(S)-MT(DSR)-MT+R(IM) and IWM (3.20) in 2018-19.

Soil physico-chemical and biological properties like bulk density, total porosity, water holding capacity, carbon stock of soil at 0-15 and 15-30 cm depth, water stable

aggregates, mean weight diameter, available N, P₂O₅ and K₂O, bacterial and fungal population, microbial biomass carbon, activity of soil enzyme such as dehydrogenase, phosphomonoesterase and fluorescein di-acetate at 0-30 cm soil depth were improved under MT(S)-MT(DSR)-MT+R(IM) as compared to other tillage treatments in both the years of study.

In case of economics of winter rice-Indian mustard cropping sequence with *Sesbania aculeata* as the preceding crop, the higher B-C ratio was recorded under treatment combinations MT(S)-MT(DSR)-MT+R(IM) and IWM (1.68 and 2.14) and MT(S)-MT(DSR)-MT(IM) and manual weeding (1.78 and 1.93) in 2017-18 and 2018-19, respectively.

Performance of some banana germplasm under moisture stress condition and its amelioration through chemical intervention

Amarjit Sakia

A study was conducted at the Experimental Farm, Department of Horticulture and laboratories of Department of Crop Physiology, Assam Agricultural University, Jorhat during the period 2017-2019 with twenty nine germplasm of banana *viz.*, Athiya (BB), Manohar (ABB), Dwarf Jahaji (AAA), Barjahaji (AAA), Ketchulepa (ABB), Jatikal (ABB), Kachkal (white) (ABB), Kachkal (green) (ABB), Honda (AAB), Gobin Tulchi (AAB), Doodhsagar (AAB), Digjowa (AAB), Chenichampa (AAB), Malbhog (AAB), Amrit Sagar (AAA), Man Jahaji (AAA), Agnisagar (AAA), Bhimkal (BB), Lesari Manohar (ABB), Simolu Manohar (ABB), Suti Jahaji (AAA), Bhat Manohar (ABB), Sahabhal (AAA), Fesa manohar (ABB), Dwarf Cavendish (AAA), Grand Naine (AAA), Bogimonohar (ABB), Odil (AAA) and Thengransu (ABB) to assess their performance under moisture deficit condition that prevails naturally during November to January every year in Assam due to lack of rainfall. The germplasm were also evaluated for any change in their tolerance level towards soil moisture deficit after receiving certain chemicals *viz.* maltose and trehalose through foliar spray. The experiment was laid out in Randomized Block Design (RBD) with twenty nine germplasm. The number of replications was five. The observations on various parameters were recorded on 3rd, 5th, 7th and 9th MAP in the main crop and one month after application of chemicals in the case of ratoon crop. The mean monthly temperature during the crop growing season ranged from 10.8°C to 29.8°C, the rainfall ranged from 0.0-42.7 mm and the relative humidity ranged between 55-97 per cent. The soil of the experimental field was acidic, well drained and sandy loam in texture with low available N and K and medium available P content. Moisture stress progressively reduced the values of relative leaf water content, leaf area, leaf area index, chlorophyll content (a, b, & total) from 3rd to 9th months after planting; while the contents of proline, total soluble protein, free amino acid and level of lipid peroxidation in leaf tissue increased with increase in the magnitude of moisture deficit during that period. Germplasm *viz.*,

Abstract of Ph.D. Thesis

Department : Crop Physiology

Major Advisor : Dr. Prakash Kalita

Barjahaji, Bhimkal, Athiya etc. recorded higher values for various physiological and biochemical parameters namely relative leaf water content, proline content, total soluble protein content, free amino acid content, leaf area, leaf area index, leaf chlorophyll content, number of functional leaves etc. especially during the period when the soil moisture content was very low. Observed higher efficiency in terms of physiological and biochemical parameters in these germplasm might have contributed immensely towards realisation of better yield attributing characters like fruit length, girth of finger, volume of finger weight of finger, weight of second hand, number of hands per bunch, number of fingers per hand and bunch weight under Assam condition which faces severe shortage in soil moisture (soil moisture content was only 33.70 per cent of the field capacity at 7th MAP) under rainfed situation during the months of winter mostly coinciding the reproductive stage of the crop. The germplasm Barjahaji was found to be the highest yielder followed by the germplasm Bhimkal and Athiya, whereas Gobin Tulchi was found to be the lowest performers. It may be concluded that the germplasm Barjahaji, Bhimkal and Athiya are physiologically more tolerant to moisture shortage. Application of chemicals (trehalose and maltose) could positively influenced various adaptive mechanism during water deficit condition. The characters like relative leaf water content, proline content, total soluble protein content, free amino acid content, chlorophyll content, leaf area, leaf area index etc. did show positive and significant correlation with bunch yield per plant. On an average with foliar application of maltose (60 mM), trehalose (60 mM) and maltose (60 mM) + trehalose (60 mM) during December, increased the yield by 1.18, 1.76 and 2.44 per cent, respectively over control (spray with distilled water). The highest benefit: cost ratio in case of dwarf germplasm, medium tall germplasm and tall germplasm were found to be 4.66 (Dwarf Jahaji), 4.39 (Barjahaji) and 4.41 (Athiya) respectively all with distilled water spray.

Impact of elevated night temperature on some rice genotypes

Ujjal Baruah

The present investigation was carried out under fully automated bioreactors with temperature control facilities in the stress physiology laboratory, Department of Crop Physiology, AAU, Jorhat. The main objectives of the study were to characterize the responses of upland rice genotypes to high night temperature (HNT) and to elucidate the mechanism of such responses. The investigation was carried out during the month of March to July, in 2018 and 2019. The results of the studies revealed variability in various morpho physiological, biochemical and anatomical studies under HNT. A significant variation in photosynthesis and its related parameters (*viz.* stomatal conductance, internal CO₂, transpiration) affected the photosynthates production and their partitioning to root, shoot and reproductive organ under HNT. In some genotypes, maximal fluorescence (F_v/F_m), electron transfer rate, photochemical quenching, quantum yield of PSII showed less deviation from normal range whereas non photochemical quenching showed the maximum; indicating their adaptation under this stress condition. These factors ultimately affected growth efficiency and yield of the plant. Treatment III (TIII) consisting of HNT (+5OC above ambient) have higher detrimental effects as compared to Treatment I (Control). Nitrogen status of leaf, grain and nitrate reductase activity was altered by HNT. However under treatment II (TII) i.e. HNT (+2OC above ambient), some genotypes *viz.* Banglami and Inglongkiri showed some tolerance as compared to N22 (check variety). Amongst the HNT treatments, significant increase of H₂O₂, MDA content was recorded in TIII as compared to TII. Banglami and Inglongkiri also recorded higher SOD activity and lowest H₂O₂ and MDA when compared to other local genotypes. Hence these two genotypes could maintain their plant water status as evidenced by their higher MSI under both the HNT treatments. The maintenance of higher plant water status in Banglami and Inglongkiri could be ascertained by higher RLWC and increased compatible solutes *viz.* proline content and non structural carbohydrate content. Moreover, tolerance efficiency studies indicated that amongst the tested local genotypes, Banglami and Inglongkiri were

Abstract of Ph.D. Thesis

Department : Crop Physiology

Major Advisor : Dr. Ranjan Das

tolerant whereas Maibee and Haringa were found to be most susceptible one under imposed HNT. The present study recorded a non significant effect on vegetative growth *viz.* plant height, leaf numbers and tiller numbers when HNT was imposed at later stages of growth. But both the HNT treatments recorded a significant reduction in leaf area, LAI, SLW. Under both the HNT treatment, a significant reduction in root volume and biomass accumulation was recorded which might be due to improper biomass partitioning. This might be due to a significant reduction in root xylem and phloem size thereby affecting diversion of water and photosynthates toward the sink region as evidenced in the present study. A significant reduction in pollen viability was also observed in the genotypes *viz.* Maibee, Haringa, Dishang, Ronga Ahu. There was a significant variation in yield and yield attributing characters such as numbers of filled grain per panicle, spike per panicle, grain yield, panicle length, grain per panicle, test weight under HNT treatments. Amongst the genotypes tested, under HNT, Banglami and Inlongkiri recorded minimum percent reduction in these parameters when compared to other genotypes. Hence Banglami and Inlongkiri can be considered as adaptable genotypes under HNT.

Bioecology and development of IPM module against fruit flies in cucurbits

Abhilisha Mudoi

Fruit flies are the excellent candidates for studies of biodiversity, adaptability in changing climatic conditions and invasion to new areas because of their polyphagous nature, high reproductive potential, wide range of distribution and great economic importance as pests. Therefore, an extensive elaboration of fruit flies was carried out in five different districts under Upper, Central and Lower Brahmaputra Valley Zones of Assam to know the prevalence and diversity pattern of different fruit fly species of cucurbits. Five species of fruit flies viz., *Bactrocera cucurbitae* Coquillett, *B. tau* Walker, *B. dorsalis* Hendel, along with two new species viz., *B. scutellaris* Bezzi and *Dacus longicornis* Wiedemann were recorded from different districts of Assam. Out of the five districts, maximum number of 2492 individuals were observed to be trapped in cue lure in Darrang district. The species diversity index (1.285) and richness indices (0.393) of fruit fly was found to be highest in Michajan village of Sibsagar district, whereas the lowest species diversity index, (0.656) was in Dhepor village of Sibsagar district but the lowest richness indices (0.132) was observed in Khataniapara village of Darrang district. In respect of distribution pattern, the fruit flies had clumped distribution in all the five different districts under the present investigation. The morphometric parameters of fruit flies showed that the mean body length was the highest (11.846 ± 0.027 mm) in female *D. longicornis* and lowest (5.631 ± 0.053 mm) in male of *B. cucurbitae*. In general, adult males were short-lived as compared to females, however, the adult longevity of female fruit fly in different cucurbits varied from 63.91 ± 1.16 , 60.37 ± 0.41 , 49.82 ± 0.50 mm in respect of *B. dorsalis*, *B. tau* and *B. cucurbitae* against bitter gourd, bitter gourd and bottle gourd, respectively. Morphometrics of immatures stages revealed that the egg ($1.26 \pm 0.02 \times 0.43 \pm 0.02$), larval ($9.59 \pm 0.07 \times 1.85 \pm 0.01$) and pupal ($5.82 \pm 0.01 \times 2.46 \pm 0.02$) size was highest in *B. tau* followed by *B. cucurbitae* with $0.88 \pm 0.01 \times 0.18 \pm 0.01$, $8.07 \pm 0.07 \times 1.12 \pm 0.01$, $5.21 \pm 0.03 \times 2.22 \pm 0.02$ mm, respectively.

Abstract of Ph.D. Thesis

Department : Entomology

Major Advisor : Dr. D. K. Saikia

It is imperative to obtain a baseline data on the seasonal occurrence pattern of fruit flies and the influence of abiotic factors on their activities in a particular ecosystem. Therefore, an experiment was carried out under field conditions at the Horticultural orchard, Department of Horticulture, Assam Agricultural University, Jorhat during 2017-18 and 2018-19 to find out a suitable eco-friendly management module against fruit flies of bitter gourd. Insect pests encountered with the crop revealed altogether seven species under three orders with four families viz., *B. cucurbitae*, *B. dorsalis*, *B. tau*, *Aphis gossypii* Glover, *Epilachna vigintioctopunctata* F., *Aulacophora foevicollis* Lucas and *Monolepta signata* Olivier which were registered as major pests of bitter gourd. Among the natural enemies, a total of sixteen species belonging to three orders and seven families were recorded. Twelve different pollinator species were also recorded during the study period associated with the crop. The seasonal incidence of fruit flies indicated a maximum of 189.90 and 179.60 number of fruit flies were trapped during April, 2017-18 and 2018-19, respectively. Among the different insect pests, the relative abundance of fruit fly, *B. dorsalis* was the highest with 73.65 in 2017-18 and 69.41 per cent in 2018-19 and the lowest was in case of *A. foevicollis* and *A. gossypii*, respectively with 1.69 and 2.65 per cent during the respective years. The correlation study with population build up of fruit fly showed a significant positive correlation with maximum and minimum temperature.

As regards to fruit fly management strategies, module IV comprised of good agricultural practices, installation of cue lure @ 10/ ha, destruction of damage fruits, spray of neem based insecticides and spray of spinosad 45 SC @ 0.3 ml/L was found to be the best with 0.90 damaged fruits / m², followed by module III (2.28 damaged fruits / m²) and module II (3.23 damaged fruits / m²). Similarly, module IV (1.36/ m²) and module III (2.46/ m²) was also found to be superior in suppressing the population of phytophagous beetle, *E. vigintioctopunctata*. In case of *M. signata* and *A. foevocolis*, module III (2.30,2.25) and module IV (1.00,1.18) was almost at par in reducing the population. The maximum yield of 97.43 q/ha with a benefit cost ratio of 2.26 was recorded in module IV, followed by next effective module III (83.93 q/ha) with a benefit cost ratio of 2.08. However, the cue lure barrix fly trap showed maximum efficacy related to trap index of 28.76 and the lowest was recorded in molasses trap with trap index of 21.79.

Efficacy of certain biopesticides against mustard aphid (*Lipaphis erysimi*) and their toxicity on honey bees (*Apis cerana* F.) (Hymenoptera: Apidae)

Abhinandan Yadav

Studies on efficacy of certain biopesticides against mustard aphid (*Lipaphis erysimi* Kalt.) and their toxicity on honey bees (*Apis cerana* F.) (Hymenoptera: Apidae) were carried out under both laboratory and field conditions in the Apiculture Laboratory and in the Apiary of AICRP on honey bees, Department of Entomology, Assam Agricultural University, Jorhat during 2017 to 2019. Laboratory bioassays were carried out to determine the LC50 values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil against honey bee and *Lipaphis erysimi*. For calculation of relative toxicity, neem seed oil was considered as standard check. The LC50 values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil were found to be 1.91, 2.04 and 3.07 when observed after 24 hours; 1.25, 1.35 and 1.30 as observed after 48 hours and 1.15, 1.25 and 1.24 when observed after 72 hours of treatment. The order of toxicity of the selected biopesticides in respect to LC50 values was *Beauveria bassiana* > *Verticillium lecanii* > neem seed oil when applied against *Lipaphis erysimi* Kalt. in varying exposure period (24, 48 and 72 hours). The LC50 and relative toxicity values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil were found to be 5.00, 6.55 and 6.18 at 24 hours; 2.43, 3.88 and 4.28 at 48 hours and 2.18, 2.70 and 2.46 at 72 hours when used against *Apis cerana* F. The order of toxicity in respect to LC50 values was observed as *Beauveria bassiana* > neem seed oil > *Verticillium lecanii* for exposure periods of 24 and 48 hours respectively. However, at 72 hours the order of toxicity was found to be as neem seed oil > *Beauveria bassiana* > *Verticillium lecanii* when *Apis cerana* F. was treated to those biopesticides. The highest population reduction of aphid (*Lipaphis erysimi* Kalt.) was recorded when plots were treated with *Beauveria bassiana* @ 3 ml/lit (10.92, 16.95, 28.46, 47.01 and 72.03%) at one, three, five, seven and ten days after spraying in both the years whereas the lowest population reduction was recorded at *Verticillium lecanii* @ 1 ml/lit (6.41, 13.23, 23.92, 35.47 and 47.12%) at one, three, five, seven and ten days after spraying during 2017-19. The highest yield was obtained from

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Department : Entomology

Major Advisor : Dr. Ataur Rahman

Beauveria bassiana @ 3 ml/lit treated plots (6.23 q/ha) followed by neem seed oil @ 3 ml/lit (5.86 q/ha), *Beauveria bassiana* @ 2 ml/lit (5.78 q/ha), *Verticillium lecanii* @ 2 ml/lit (5.72 q/ha), *Verticillium lecanii* @ 1.5, ml/lit (5.55 q/ha) and *Beauveria bassiana* @ 1 ml/lit (5.39 q/ha) whereas the lowest yield was recorded in *Verticillium lecanii* @ 1 ml/lit treated plots (5.32 q/ha). Though *Beauveria bassiana* @ 3 ml/lit gave highest mortality (72.03% population reduction) there was no significant difference with the treatment *Verticillium lecanii* @ 2 ml/lit after 10 days of treatment (64.76% population reduction). The highest benefit cost ratio (4.90:1) was found in *Beauveria bassiana* @ 3 ml/lit treated plots as the treatment of *Beauveria bassiana* @ 3 ml/lit successfully reduced the aphid population. The highest value of persistent toxicity (PT) and relative persistent of toxicity (RPT) were recorded in the treatment *Beauveria bassiana* @ 3 ml/lit (799.98 and 1.06 respectively) whereas the lowest value were recorded in the treatment *Verticillium lecanii* @ 1 ml/lit (613.28 and 0.81) respectively. All the biopesticidal treatments viz., *Beauveria bassiana* @ 1, 2, 3 ml/lit, *Verticillium lecanii* @ 1, 1.5, 2 ml/lit and neem seed oil @ 3 ml/lit were observed to be significantly superior over control (untreated). The highest population mortality of honey bee was obtained with neem seed oil when applied @ 3 ml/lit (10.00, 15.00, 25.00, 28.33 and 31.16%) whereas the lowest population reduction was found with *Verticillium lecanii* 1 ml/lit (3.33, 6.66, 1.00, 1.33 and 1.66%) at one, three, five, seven and ten days after spraying during 2017-19. Enzyme assay was done to determine the activities of detoxifying enzyme acetylcholine esterase on *Apis cerana* due to these biopesticidal treatments. In the present study, *Apis cerana* was treated with the selected biopesticides viz., *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil. Results pertaining to the study suggested a non-significant effect on *Apis cerana* and no reduction was found in the activity of acetylcholine esterase (AchE) after 24 hours and 48 hours. Therefore, *Beauveria bassiana* 3 ml/lit or *Verticillium lecanii* @ 2 ml/lit might be used to manage *Lipaphis erysimi* in rapeseed crop without affecting the activity of pollinator, *Apis cerana* in IPM.

Efficacy of certain botanicals on *Tribolium castaneum* (Herbst) and *Sitophilus oryzae* (L.) and their effect on detoxifying enzyme activities of these insects

Awaneesh Kumar

“Efficacy of certain botanicals on *Tribolium castaneum* (Herbst) and *Sitophilus oryzae* (L.) and their effects on detoxifying enzyme activities of these insects” was carried out during 2017-2020. The all experimental works were done at Toxicology Laboratory, Department of Entomology and the biochemical analysis was done at the PG laboratory Department of Biochemistry and Agricultural Chemistry Assam Agricultural University Jorhat- 13. Twelve botanicals viz. *Aegle marmelos* (L.), *Annona reticulata* (L.), *Artemisia nilagirica* (L.), *Azadirachta indica* (A. Juss.), *Catharanthus roseus* (L.), *Clausena heptaphylla* (Roxb.), *Datura stramonium* (L.), *Eucalyptus tereticornis* (Sm.), *Heteropanax fragrans* (Roxb.), *Lawsonia inermis* (L.), *Matteuccia struthiopteris* (L.) and *Vitex negundo* (L.) were tested to know the efficacy against *T. castaneum* and *S. oryzae*.

The LD50 (wt/wt g) values of dry leaves powder of *A. indica* (2.09%), showed lowest against *T. castaneum* after 24hrs followed by *E. tereticornis* (2.81%), *D. stramonium* (2.97%), *A. nilagirica* (3.85%) which were comparatively more effective than other botanicals and lowest in *M. struthiopteris* (19.40%) during 2018 experiment. Similarly, after 48 hrs and 72 hrs also *A. indica* (1.71% and 1.49%, respectively) registered minimum LD50 value followed by *D. stramonium* (2.01% and 1.52%), *E. tereticornis* (2.49%, 2.02 %) and *A. nilagirica* (2.95%, 1.80%). The maximum LD50 was observed in case of *M. struthiopteris* (14.64%) and *H. fragrans* (4.58%) at 48 and 72 hrs, respectively. Similar trend of results were also found during 2019 with lowest LD50 (wt/wt g) on *A. indica* followed by *E. tereticornis*, *D. stramonium* and *A. nilagirica* after 24, 48 and 72 hrs. During 2018, when dry leaves powder was used against *S. oryzae* the LD50 was lowest in *A. indica* (1.94%, 1.84% and 1.70%) after 24, 48 and 72 hrs. *E. tereticornis* (2.98%, 2.49% and 2.02%), *D. stramonium* (3.05%, 2.36%

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Department : Entomology

Major Advisor : Dr. Anjumoni Devec

and 1.97%) and *A. nilagirica* (3.75%, 2.62% and 2.14%) which were comparatively lower LD50 than other botanicals at 24, 48 and 72 hrs of treatment. *M. struthiopteris* showed highest LD50 values (30.66%, 15.22% and 4.27%) with XII toxicity rank after 24, 48 and 72 hrs of treatment. Same trend of results was also observed in 2019 against *S. oryzae* where *A. indica* (2.21%, 1.89% and 1.73%), *D. stramonium* (2.86%, 1.83% and 1.68%), *E. tereticornis* (3.36%, 2.29% and 1.93%) and *A. nilagirica* (3.77%, 2.54% and 1.86%) gave lowest LD50 in comparison to other botanicals after 24, 48 and 72 hrs of treatment.

When leaf aqueous extracts were tested against *T. castaneum*, during 2018 and 2019 *A. indica* (2.20%) recorded lowest LC50 values after 24, 48 and 72hrs. In case of *S. oryzae* also, leaf aqueous extracts *A. indica* recorded lowest LC50 (1.93%, 1.70% and 1.42%) in 2018 and 2019 (2.05%, 1.55% and 1.43%), after 24, 48 and 72hrs of treatment.

From the repellency experiment of plant dry powder, it was found that *A. indica* showed highest mean repellency percent against *T. castaneum* (82.21%, 83.61%) and *S. oryzae* (78.19%, 77.03%) in 2018 and 2019 experiment. Similarly, in case of aqueous extract also *A. indica* registered highest repellency rate against *T. castaneum* (86.84%, 85.25%) and *S. oryzae* (81.69%, 78.51%) in both the year.

Based on LD50 and LC50 experiment of both the years, *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* were observed best among all the botanicals against *T. castaneum* and *S. oryzae*. Therefore, to observe the mortality in stored wheat grains, these four botanicals were used and found that *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* recorded hundred per cent mortality after 35 days of treatment in case of *T. castaneum* and 45 days after treatment for *S. oryzae*. The lowest grain weight loss was found in *A. indica* (5.27%, 8.64%) followed by *D. stramonium* (12.05%, 9.87%), *E. tereticornis* (12.05%, 17.38%) and *A. nilagirica* (15.19%, 13.97%) during 2018 and 2019 against *T. castaneum*, when the dry powders were applied. Similarly, the lowest grain weight loss was recorded in aqueous extract of *A. indica* followed by *D. stramonium*, *E. tereticornis* and *A. nilagirica* during 2018 and 2019 against *T. castaneum* and *S. oryzae*. *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* had no significant effect on quality parameters of wheat grains viz., crude protein, soluble protein, gluten, reducing sugar, starch and moisture, after 6 months of storage. Enzyme assay was done to find out the detoxifying enzyme viz. acetylcholinesterase and glutathione-s-transferases activities on *T. castaneum* and *S. oryzae* after treatment of *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica*. It was found that all the botanicals significantly reduced the activity of acetylcholinesterase (AChE) in comparison to control. *E. tereticornis* showed significantly highest reduction in the AChE activity in both the year. *A. nilagirica* and *D. stramonium* also showed more reduction of AChE activity which was significantly higher than *A. indica* against *T. castaneum*. In case of *S. oryzae*, *D. stramonium* and *A. indica* showed maximum reduction of AChE activity, which were statistically atpar and

significantly different from *E. tereticornis* and *A. nilagirica*. No reduction of AChE activity was observed in control treatment during 2018 and 2019.

The activity of glutathione-s-transferase was significantly lowest in *A. indica* followed by *A. nilagirica*, *D. stramonium* and *E. tereticornis* which were statistically different from each other, while in control activity of GST was significantly high in both the years against *T. castaneum*. In case of *S. oryzae*, significantly less activity of GST was observed in *E. tereticornis* followed by *A. nilagirica*, *D. stramonium* and *A. indica* in 2018 and 2019. Activity of GST was significantly low in all these treatments than the control. *A. indica* and *D. stramonium* showed statistically similar activity of GST with each other and significantly different from *A. nilagirica* and *E. tereticornis*. Based on LD50, LC50, mortality, repellency and enzyme assay experiment *A. indica*, *A. nilagirica*, *D. stramonium* and *E. tereticornis* were found equally effective botanicals against *T. castaneum* and *S. oryzae* and can be used for storing of wheat grains up to 6 months without affecting the quality of wheat.

Food- web interaction and community structure of cabbage ecosystem

Daizy Sarma

Field experiment were carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during *rabi* 2017-18 and 2018-19 to study the food web interaction and community structure of cabbage ecosystem.

Major insect pests recorded during both the crop season from 20 DAP, were cabbage aphid, *Brevicoryne brassicae* (L.), diamondback moth, *Plutella xylostella* (L.), cabbage butterfly, *Pieris canidia* (L.), cutworm, *Agrotis ipsilon* (Hfn.), cabbage looper *Trichoplusia ni* (Hubner) and flea beetle, *Monolepta signata* Oliv with minor pests viz., sawfly, *Athalia proxima*, cabbage head borer, *Hellula undalis* (L.), handmaiden moth, *Syntomoides imacon* (L.), epilachna beetle, *Epilachna* spp. (L.) and green stink bug, *Nezara viridula* (L) were also persisted on the crop right from the seedling stage to harvesting of the crop. Six numbers of predators viz., *Coccinella transversalis* (F.), *Maenochilus sexmaculatus* C. *septempunctata* (L.), *Micraspis discolor* (F), *Harmonia dimidiata* (F), *Episyrphus belteotus* (L.) and one number of predatory spider, *Oxyopes* spp. were recorded from cabbage ecosystem. In the present investigation, among different insect pests encountered in the field, *B. brassicae* showed the highest relative abundance (28.78%) on HYV and 29.65% for hybrid variety followed by *A. ipsilon* (20.45% for HYV and 17.65% on hybrid) during 2017-18 and same trend also found during 2018-19. Different weather parameters related to the correlation study indicated that the minimum temperature had negative significant impact with the population build up of *B. brassicae* ($r = -0.652$), *P. canidia* ($r = -0.638$), *T. ni* ($r = -0.627$) and *M. signata* ($r = -0.596$), whereas, BSSH showed positive significant effect with *A. ipsilon* ($r = 0.620$) in HYV variety. In case of hybrid variety, all major insect pests and predators showed negative significant effect with minimum temperature except *T. ni* during 2017-18. During 2018-19, a negative significant correlation was observed in between insect pests and predators associated to local and hybrid variety. The correlation of *B. brassicae* and coccinellid predators for both varieties showed a significant positive impact for 2017-18 and 2018-19. The different physiomorphic, biochemical parameters and the number of

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insect pests and predators for both the varieties were at par with each other during 2017-18 and 2018-19. Glucosinolate, phenol and Flavonoid content showed a negative association with major insect pests and predators for both the varieties during the investigation of 2017-19. The diversity study of insect pests in different phenological stages of cabbage indicated highest species diversity and evenness during the pre heading stage of cabbage followed by heading stage whereas, highest species richness was recorded during seedling stage for both the varieties during 2017-18 and 2018-19. In case of distribution pattern, a contagious distribution (both HYV and hybrid variety) was assessed for insect pests and their natural enemies during the present investigation. The consumption of aphids by *C. transversalis*, when applied individually and in different combination showed that highest consumption rate of 133.40 ± 2.25 was observed in *C. transversalis* (Adult) x *C. transversalis* (Adult) followed by *C. transversalis* (Adult) x *C. transversalis* (4th) and *C. transversalis* (Adult) x *C. transversalis* (3rd) with 104.90 ± 2.25 and 99.10 ± 2.25 , respectively. In case of Consumption of aphids by *M. sexmaculatus*, highest result was observed in *M. sexmaculatus* (Adult) x *M. sexmaculatus* (Adult) combination with 96.26 ± 3.60 . Consumption of aphids when applied *C. transversalis* and *M. sexmaculatus* in different combination, highest consumption rate of 109.10 ± 2.37 was found in *C. transversalis* (Adult) x *M. sexmaculatus* (Adult). Intraspecific cannibalism among different instars and adult of *C. transversalis* and *M. sexmaculatus* in absence of prey was the highest in *C. transversalis* (Adult) x *C. transversalis* (3rd) combination where as, *C. transversalis* (Adult) consumed only 33.30%. In case of Interspecific predation among different instars and adult of *C. transversalis* and *M. sexmaculatus* in absence of prey, *C. transversalis* (Adult) showed highest consumption rate of 40.00% followed by *C. transversalis* (4th) with 33.30%.

Plant mediated synthesis of silver nanoparticles and their efficacy against certain sucking pests

Della Thomas

Experiments were carried out in the Department of Entomology and Plant Pathology, Assam Agricultural University, Jorhat during 2017-18 and 2018-19 to study the efficacy of plant mediated synthesized silver nanoparticles against certain sucking pests. The silver nanoparticles were successfully synthesized by using plant extracts such as Tulsi (*Ocimum sanctum*), Bakul (*Mimusops elengi*), Garlic (*Allium sativum*) and Posotia (*Vitex negundo*). The synthesized silver nanoparticles were characterized by UV-Vis spectrophotometer, Zeta sizer, Fourier Transform Infrared Spectroscopy (FTIR) and Transmission Electron Microscopy (TEM). The UV-Vis spectra recorded peak at 425 nm, 427nm, 420 nm and 430 nm for Tulsi, Bakul, Garlic and Posotia AgNPs, respectively. FT-IR analysis for Tulsi, Bakul, Garlic and Posotia AgNPs showed strong peaks at ranges of 400-4000 cm^{-1} which exhibited different types of functional groups viz., (O-H, C-H, N-H, H-H and C-C). Zeta potential was determined and recorded the charge of green synthesized silver nanoparticles as -24.2, -24.1, -16.7 and -33.0 mV for Tulsi, Bakul, Garlic and Posotia, respectively. TEM study revealed that the synthesized silver nanoparticles from different plant extracts were spherical and circular in morphology and the average size of 8 to 25 nm.

The efficacy of plant mediated synthesized silver nanoparticles against mustard aphid (*Lipaphis erysimi*), papaya mealybug (*Paracoccus marginatus*), rugose spiralling whitefly (*Aleurodicus rugioperculatus*) and two spotted spider mite (*Tetranychus urticae*) was investigated in the dilutions of 100, 200, 300, 400 and 500 ppm. Nanoparticles obtained from Tulsi were found to be effective against *L. erysimi* and *A. rugioperculatus* for both the years 2017-18 and 2018-19 with nymphal mortality of *L. erysimi* (88.89% and 84.44%) and *A. rugioperculatus* (86.67% and 84.44%) after the fifth day of treatment. Nanoparticles extracted from Garlic were found to be effective against *P. marginatus* with 84.44% and 82.22% nymphal mortality for the year 2017-18 and 2018-19. In case of *T. urticae*, nanoparticles extracted from Garlic showed the highest mortality of 73.33% and 77.78% for the year 2017-18 and 2018-19, respectively.

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The LC₅₀ was estimated for all the tested sucking pests against all the synthesized AgNPs in 2017-18 and 2018-19. For *L. erysimi* the lowest value was calculated from Tulsi AgNPs after the fifth day of treatment for both the years 2017-18 and 2018-19, recorded 119.12 ppm and 109.76 ppm, respectively. For *P. marginatus*, lowest LC₅₀ of 109.21 ppm was recorded from Garlic AgNPs after the fifth day of the treatment during 2017-18. In 2018-19 also the lowest LC₅₀ value 116.33 ppm was obtained from Garlic AgNPs. For *A. rugioperculatus*, the lowest LC₅₀ from Tulsi AgNPs was found to be 123.12 ppm during 2017-18 and in 2018-19 also Tulsi AgNPs showed the lowest LC₅₀ value of 139.27 ppm. For *T. urticae* the lowest value was calculated from Garlic AgNPs after the fifth day of treatment for both the years 2017-18 and 2018-19, recorded 142.57 ppm and 130.39 ppm, respectively.

Behavioural changes in selected pests have also been noticed after treating with synthesized silver nanoparticles for both the years 2017-18 and 2018-19. For *L. erysimi*, the movement became slower, decreased feeding activity and colour changed to brown-black, paralysed, body contents became dry and subsequently death. After application of AgNPs on the eggs of *P. marginatus*, the colour changed to light orange to dark brown and did not hatch. The neonate crawlers die within 2-3 days after spray, survival was zero in some replicated plates, deformed and swelled body, sluggish if touched brown liquid ooze out. The cream colour changed to dark brown which was often died. For *A. rugioperculatus* the viability of eggs reduced and nymphs changed their colour from light cream to dark brown and die soon. While incase of *T. urticae*, legs became folded, move only when it disturbed, body contents come out and dry on the 5th day of post spray.

In the pot experiments with biosynthesized AgNPs against *L. erysimi* showed the highest per cent reduction by Tulsi AgNPs (79.40%) and the least per cent reduction was observed with Posotia AgNPs (61.55%). For *P. marginatus*, Garlic AgNPs was highly toxic as this caused 58.40% reduction at one day after spraying which was increased to 75.17% after 5 days of spraying. Among different biosynthesized AgNPs, Garlic AgNPs was found to be most effective against *T. urticae* population which resulted in 69.33% reduction in 5 days after application in potted plants.

Impact of elevated temperature and carbon dioxide on foraging behaviour of *Apis cerana* F. in oilseed ecosystem

Jaya Gogoi

Climate change associated with rise in concentration of atmospheric carbon dioxide and temperature is expected to affect the activity of pollinator and crop production. Oilseeds are an important component of the agricultural produce, next to food grains. The impact of elevated temperature and carbon dioxide on foraging behaviour of *Apis cerana* F. in oilseed (rapeseed var. TS-38 and sesamum var. ST-1683) ecosystem was studied separately in two experiments using Carbon Dioxide Temperature Gradient Tunnel (CTGT) and Open Top Chamber (OTC) established at Department of Crop Physiology and Department of Entomology, Assam Agricultural University, Jorhat during 2016-2019. In the first experiment four levels of CO₂ (2 ambient at 400 ppm each and elevated of 550 ppm and 650 ppm) and 4 levels of temperature (2 ambient, +2°C and +4°C) and in the second experiment 4 levels of CO₂ (2 ambient at 400 ppm each and elevated of 550 ppm and 650 ppm) and 4 levels of temperature (2 ambient, +3°C and +3°C) were used to assess the impacts of elevated temperature and CO₂ levels on foraging behaviour of *Apis cerana* F. in rapeseed and sesamum ecosystem. No anesthetic effect was found on *Apis cerana* when exposed to different concentrations of CO₂ viz., 0.04%, 0.05% and 0.065% for 3 minutes, 15 minutes and 30 minutes. The interactive effect of elevated temperature and CO₂ on maximum frequency of flower (rapeseed) visit by *Apis cerana* was recorded in CTGT III (13.92±0.23) at 0800-0900 hours of the day whereas time spent per flower (6.12±0.17 seconds) at 1000-1100 hours of the day, time taken per trip (47.37±0.47 minutes) and pollen load per trip (7.87±0.12 mg) was recorded in field condition (ambient condition) compared to CTGT III (650 ppm CO₂, +4°C). The time taken per trip (F=44.1000, *P* < 0.0001) and pollen load per trip (F=189.5555, *P* < 0.0001) varied significantly. Similar results were observed in sesamum also with maximum frequency of flower visit by *Apis cerana* (9.08±0.13) at 0800-0900 hours of the day, time spent per flower (7.20±0.10 seconds) at 0900-1000 hours of the day, time taken per trip (28.91

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± 0.51 minutes) and pollen load per trip (6.11 ± 0.11 mg) was recorded in field condition (ambient condition) compared to OTC III (650 ppm CO₂, +3°C). The highest bee mortality rate of 9.46% was recorded in CTGT III followed by 6.57% (CTGT II) and 3% (CTGT I) during the investigation period. The plant height increased with elevated temperature and CO₂ whereas the yield attributing parameters like number of siliqua and capsules per plant, number of seeds per siliqua and capsules and 1000 seed weight of rapeseed and sesamum decreased with elevated temperature and CO₂ condition. However, with elevated temperature and CO₂ level, the stover yield of rapeseed and sesamum were increased whereas harvest index (HI) decreased significantly. The yield was reduced significantly (F= 61.9680, $P < 0.0001$ and F= 16.2102, $P < 0.0001$) with elevated temperature and CO₂ condition and the highest yield of rapeseed and sesamum was recorded in field condition (10.05 ± 0.23 q/ha and 7.58 ± 0.27 q/ha) compared to CTGT III (6.03 ± 0.23 q/ha and 5.06 ± 0.27 q/ha). Reduction in crop yield at increased temperature and CO₂ was mainly attributed to reduction in foraging activity of *A. cerana*, number of siliqua and capsules per plant, number of seeds per siliqua and capsules, 1000 seed weight and harvest index. The present study revealed that elevated temperature and CO₂ level could decrease the foraging activity of pollinator and crop yield.

Diversity and foraging behaviour of syrphid flies on *Brassica campestris* L. and *Mangifera indica* L.

Madhumita Sonowal Bora

Investigation on the diversity and foraging behaviour of syrphid flies on *Brassica campestris* L. and *Mangifera indica* L. was carried out in the ICR Farm; Horticulture Orchard, Department of Horticulture and Apiculture laboratory, Department of Entomology, Assam Agricultural University, Jorhat during 2017-2018 and 2018-2019. The insects forager complex of rapeseed consisted of 27 species namely *Apis cerana*, *A. dorsata*, *Nomia* sp., *Stomorhina discolour*, *Episyrphus balteatus*, *Betasyrphus aeneifrons*, *Syrphus* sp., *Eristalinus arvorum*, *E. polychromata*, *E. quinquestriatus*, *E. megacephalus*, *E. paria*, *Mesembrius quadrivittatus*, *Eristalis tenax*, *Phytomia errans*, *Melonstoma orientale*, *Asarkina ericetorum*, *Sphaerophoria* sp., *Dideopsis aegrota*, *Delias pasithoe*, *Micraspis discolor*, *Coccinella transversalis*, *Chrysomya meghacephala*, *Musa domestica*, *Coccinella septempunctata*, *Syntomoides imaoon* and *Pieris rapae*. Out of these *Stomorhina discolour* was recorded to be maximum (9.37%). Whereas, in mango all total 15 species namely *Apis cerana*, *A. dorsata*, *A. florea*, *Stomorhina discolour*, *Eristalinus arvorum*, *E. polychromata*, *E. quinquestriatus*, *E. megacephalus*, *E. paria*, *Mesembrius quadrivittatus*, *Asarkina ericetorum*, *Chrysomya meghacephala*, *Musa domestica*, *Neptis cartica* and *Oecophylla smargdina* were recorded. Out of these *Eristalinus arvorum* was recorded to be maximum (12.05%). The highest species diversity index of 2.59 was recorded from rapeseed crop as compared to 2.03 from mango crop. The maximum total body length in *Eristalinus arvorum* (10.00 ± 0.52 mm) which was followed by *E. polychromata* (8.64 ± 0.51 mm) and minimum *Mesembrius quadrivittatus* (2.19 ± 0.60 mm), respectively. The principal component analysis of 15 morphometric characters obtained from 15 species of syrphids which explained 84.84 per cent variation among the species of syrphids. Whereas, in the principal component 1, 15 morphometric characters were influencing parameters with components loading from 0.985 to 0.280 that accounting for 76.32 per cent of the variation observed.

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Major Advisor : Dr. M. K. Deka

The length and width of eggs of *E. balteatus*, *B. aeneifrons* and *Syrphus* sp. were 0.70 ± 0.01 mm and 0.26 ± 0.00 mm; 0.70 ± 0.01 mm and 0.26 ± 0.00 mm; 0.71 ± 0.01 mm and 0.27 ± 0.00 mm, respectively. The incubation periods were 3.20 ± 0.45 , 2.80 ± 0.45 and 3.40 ± 0.55 days, respectively. The maximum hatching percentage of eggs was 89.30 per cent of *E. balteatus*. The larvae passed through three instars. The maximum length and width of first instar larvae were 2.14 ± 0.03 mm and 0.70 ± 0.02 mm of *E. balteatus* followed by second instar larvae were 4.86 ± 0.05 mm and 0.90 ± 0.05 mm of *Syrphus* sp., respectively. The minimum duration of first instar larvae of *B. aeneifrons* was recorded (2.40 ± 0.55 days) followed by second instar larvae of *B. aeneifrons* and *Syrphus* sp. were recorded (3.40 ± 0.55 days), respectively. The total life period of male and female of *E. balteatus* were (37.60 ± 1.52 days and 38.60 ± 1.52 days) recorded.

The number of *Eristalinus* and *Syrphini* per sq. m per minute on rapeseed was recorded to be maximum (7.89 ± 0.09 and 7.90 ± 0.93) at 1100-1200 and minimum (1.26 ± 0.07 and 1.53 ± 0.18) at 0700-0800 hours of the day. Maximum time spent per flower by *Eristalinus* and *Syrphini* also recorded to be 29.04 ± 2.03 seconds and 7.18 ± 0.18 seconds at 0700-0800 hours and minimum was 19.24 ± 3.09 and 5.03 ± 0.05 seconds at 1000-1100 hours of the day. The number of flower visit per minute was recorded to be maximum (3.90 ± 0.22 and 7.82 ± 0.32) at 1000-1100 hours and minimum (2.59 ± 0.21 and 2.95 ± 0.24) at 0700-0800 hours of the day. The number of *Eristalinus* and *Syrphini* per sq.m per minute on mango was recorded to maximum (8.04 ± 0.14 and 6.84 ± 0.13) at 1100-1200 and minimum (1.45 ± 0.07 and 1.38 ± 0.10) at 0700-0800 hours of the day. Maximum time spent per flower by *Eristalinus* and *Syrphini* also recorded to be 26.85 ± 0.92 and 7.45 ± 0.14 seconds at 0700-0800 hours and minimum was 20.76 ± 1.49 and 5.52 ± 0.09 at 1000-1100 and 1200-1300 hours of the day. The number of flower visit per minute was recorded to be maximum (3.68 ± 0.11 and 6.53 ± 0.10) at 1300-1400 and 1100-1200 hours and minimum (2.54 ± 0.24 and 2.74 ± 0.05) at 1500-1600 and 1400-1500 hours of the day.

Various meteorological parameters affected the different foraging activities of *Eristalinus* and *Syrphini* viz., number of *Eristalinus/Syrphini* per sq.m per minute, number of flower visit per minute and time spent per flower per second. Temperature and bright sunshine hours showed positive correlation whereas rainfall and relative humidity showed negative correlation with the different foraging activities of *Eristalinus* and *Syrphini*.

The relative abundance of *Eristalinus* and *Syrphini* was recorded to be maximum (9.52 ± 0.69 nos. /5min) at 1100-1200 hours and (7.41 ± 0.38 nos. /5min) at 1200-1300 hours and minimum (1.66 ± 0.33 and 1.98 ± 0.11 nos. /5min) at 0700-0800 hours of the day. The number of loose pollen grain adhering to the bodies of *Eristalinus* and *Syrphini* was recorded to be 1333.2 ± 50.48 nos. and 1294.6 ± 65.10 nos. per forager. The maximum pollination index of 7.40 was recorded from *Eristalinus* as compared to 7.21 of *Syrphini* on rapeseed. The relative abundance of *Eristalinus* and

Syrphini was recorded to be maximum (8.90 ± 0.22 nos. /5min) at 1100-1200 hours and (7.07 ± 0.51 nos. /5min) at 1200-1300 hours and minimum (2.40 ± 0.17 and 2.49 ± 0.09 nos. /5min) at 0700-0800 hours of the day. The number of loose pollen grain adhering to the bodies of *Eristalinus* and *Syrphini* was recorded to be 1415.80 ± 110.80 nos. and 1294.80 ± 60.82 nos. per forager. The maximum pollination index of 9.63 was recorded from *Eristalinus* as compared to 7.14 of *Syrphini* on mango.

Ecology of Aphid Vectors of Citrus Tristeza Virus

Maongkar T. Changkiri

A field survey was conducted to study the incidence of citrus tristeza virus (CTV) and its aphid vectors, in different citrus growing locations of Assam and Nagaland. 190 samples were collected from four districts of Assam (Jorhat, Tinsukia, Sivasagar and Golaghat) and two districts of Nagaland (Mokokchung and Wokha). Citrus leaf samples were used for detection of CTV infection by double antibody sandwich-enzyme linked immuno-sorbent assay (DAS-ELISA) and RT-PCR. According to the results, 75 per cent CTV disease incidence was detected in surveyed areas of Assam and 24.55 per cent CTV disease incidence was detected in Nagaland. District wise, the highest CTV disease incidence (96.67 %) was detected in Tinsukia district of Assam and the lowest (21.43 %) was detected in Mokokchung district of Nagaland. RT-PCR confirmed the results of DAS-ELISA. The survey result also indicated the presence of the vector *Toxoptera citricida* in all the locations. The elevations of the different location surveyed ranged from 79-1130 m AMSL.

The study on population dynamics of *T. citricida*, revealed that the aphid reached its highest peak population of 416.68 on the 4th of June, during 2017 and 431.28 on 15th May, during 2018. *T. citricida* was observed to have two population peaks per year. The minimum temperature was the most dominant factor which showed positive and significant correlation, for mean population of *T. citricida*. 15 species of coccinellid predators and one species of syrphid were observed in the field plot of Assam Lemon and *Micraspis discolor*, *Cheilomenes sexmaculata*, *Coelophora bisellata* and *Coelophora saucia*, were the most abundant and they were found actively feeding on *T. citricida*. The population of *T. citricida*, showed positive and significant correlation, with all four coccinellid beetles, indicating that the populations of the predators, increased or decreased with the abundance or scarcity of *T. citricida*. The data on the two year study of the biology of the four coccinellid beetles revealed that the longest incubation period (3.43 ± 0.07 days) was recorded on *C. sexmaculata*. The longest total larval period (11.52 ± 0.26 days) was recorded on *C. sexmaculata*. The longest pupal period (3.90 ± 0.08 days) was recorded on *C. sexmaculata*. The longest total developmental (egg to adult emergence) period was recorded on *C. sexmaculata*, with

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Major Advisor : Dr. P. Patgiri

an average duration of 18.85 ± 0.31 days. *C. sexmaculata* had the longest adult longevity with an average of 50.90 ± 1.16 days and the longest total life cycle (69.75 ± 1.17 days) was recorded on *C. sexmaculata*. Pooled data analysis of the two year study of predatory efficiency of the four coccinellid beetles reared on *T. citricida*, indicated that there was significant difference among the different predators. It was observed that the feeding potential of all the beetles increased gradually through each larval stage with the fourth being the most voracious. The predatory efficiency of the larval stages of the four coccinellid beetles from highest to lowest was recorded in the following order. *C. Sexmaculata* (27.04 ± 0.32) > *C. bissellata* (24.63 ± 0.23) > *C. saucia* (23.44 ± 0.26) > *M. discolor* (20.13 ± 0.17). The predatory efficiency of the adult stages of the four coccinellid beetles from highest to lowest was recorded in the following order. *C. saucia* (82.66 ± 0.69) > *C. bissellata* (78.94 ± 0.81) > *C. sexmaculata* (66.36 ± 0.83) > *M. discolor* (53.01 ± 0.59).

Diversity of mites in promising flower crops and their management in Gerbera, *Gerbera jamesonii*, Bolus

Nilofar Altaf

Mites are among the most diverse arachnid group in terrestrial ecosystem. Therefore, a survey was carried out during the year 2018-2020 on “Diversity of mites in promising flower crops and their management in gerbera, *Gerbera jamesonii* Bolus in five different districts under Upper, Central and Lower Brahmaputra Valley Zones of Assam to know the diversity of phytophagous mites attacking flower crops. A random survey was carried out at different locations covering five different districts of Assam. The infested leaves were brought to the Acarology Laboratory, Dept of Entomology, AAU, Jorhat for the identification of different mite species collected from different flower crops like rose, gerbera, hibiscus, anthurium, orchid and marigold. A total of five different mite species belonging to the family Tetranychidae viz., *Tetranychus pacificus* McGregor, *T. truncatus* Ehara, *T. okinawanus* Ehara, *T. bunda* Flechtmann and *T. piercei* McGregor and five species under the family Tenuipalpidae viz., *Brevipalpus californicus* Banks, *B. chilensis* Baker, *B. yothersi* Baker, *B. lewisi* McGregor and *B. obovatus* Donnadieu were recorded. However, *B. yothersi*, *T. bunda*, *T. pacificus* and *T. piercei* are supposed to be new record from our country. Out of five districts, maximum number of 5463 individuals was collected from Kamrup district. The species diversity index (1.582) and richness indices (0.587) of mite species was found to be highest in Experimental Farm, Dept of Horticulture, Assam Agricultural University of Jorhat district, whereas the lowest species diversity index (0.342) and richness indices (0.133) were observed in Changamari Habigaon of Dibrugarh district. In case of Pielou’s evenness index for phytophagous mites, highest value of 0.892 was recorded from Potia gaon of Jorhat district and lowest value of 0.494 was recorded from Changamari Habigaon of Dibrugarh district.

The major mite species collected from different locations during survey were brought to the Acarology laboratory, Dept of Entomology, AAU, Jorhat for morphometric study. The body measurements were taken under labovision phase

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contrast microscope. The study revealed that the male of *T. pacificus* possessed highest body length of $371.207 \pm 0.001 \mu\text{m}$ compared to the females with body length of $289.625 \pm 0.003 \mu\text{m}$ whereas lowest body length of $338.354 \pm 0.001 \mu\text{m}$ was observed in the male of *T. okinawanus*. The morphometric study of the major false spider mite species revealed that the *B. obovatus* showed the highest body length of $287.392 \pm 0.001 \mu\text{m}$ whereas the lowest body length of $269.257 \pm 0.400 \mu\text{m}$ was observed in *B. yothersi*. The principal component analysis was done under SPSS 20.0 Statistical package which showed that in case of adult false spider mite species among 25 morphometric characters used for analysis of variance two parameters, viz., length of body and width of body significantly contributed towards variation among them. The Principal Component Analysis of two different morphometric characters indicates two Eigen values which were greater than one that explained 81.977 per cent variation amongst the false spider mite species. In case of adult male and female of spider mite species among 22 morphometric parameters used for analysis of variance, four parameters viz., body length, body width, length of gnathosoma and length of leg I significantly contributed towards variation among them. The principal component analysis of four different morphometric characters indicates four Eigen values which were greater than one that explained 93.590 per cent variation amongst the male and female spider mite species.

Selective Breeding of *Apis cerana* F. and *Apis mellifera* L.

Pooja Borah

Selective breeding of *Apis cerana* F. and *Apis mellifera* L. was carried out in the apiary and under laboratory condition of Department of Entomology, Assam Agricultural University, Jorhat from September, 2015 to March, 2018. The selection studies were carried out from April, 2015 to January, 2016 from 99 colonies of *Apis mellifera* and 20 colonies of *Apis cerana* in the apiary of the Department of Entomology. Ten viable colonies were selected based on parameters viz. colony strength, brood area, pollen area, nectar area, pollen load carrying efficiency, honey yield, pest and disease resistance, swarming and absconding behaviour, gentleness and aggressiveness and hygienic behaviour. After selection of the ten viable colonies both in *Apis mellifera* and *A. cerana*, they were used for preparation of queen and collection of drones.

Comparative performance between artificially inseminated (AI) and naturally inseminated (NI) colonies of *A. mellifera* in the year 2016-17 revealed that brood area, pollen area and nectar area have significant difference between AI and NI colonies in all the months. The pollen load carrying efficiency has significant difference between AI and NI colonies in all the months except for May, December, January and February. Honey yield has significant difference between AI and NI colonies in April, May, June, December, January and February. Again in 2017-18, brood area, pollen area and nectar area were found to have significant difference in all the months between AI and NI colonies. The pollen load carrying efficiency has significant difference in all the months except for October and March. The honey yield revealed significant difference between AI and NI colonies in May, June, December, January and February. And in both 2016-17 and 2017-18, the performance of AI colonies was found to be significantly higher than NI colonies. Comparative performance was also studied in *Apis cerana* between AI and NI colonies from April, 2017 to March, 2018 where brood area, pollen area and nectar area were found to have significant difference in all the months between AI and NI colonies. Pollen load carrying efficiency revealed significant difference between AI and NI colonies in April, May, June, October, December, February, and March.

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Major Advisor : Dr. A. Rahman

Honey yield revealed significant difference between AI and NI colonies in May, July, December, January, February and March. The comparative performance in *A. cerana* between AI and NI colonies also revealed that performance of AI queens was significantly better than the NI queens.

In *A. mellifera*, during the year 2016-17, the correlation study revealed significant negative correlation of brood area ($r = -0.57$ in both AI and NI colonies) and nectar area ($r = -0.71$ in AI and $r = -0.70$ in NI colonies) with maximum temperature and maximum relative humidity, respectively. Whereas, pollen area was found to have significant positive correlation with bright sunshine hours (0.83 in AI and 0.84 in NI colonies) and significant negative correlation with maximum temperature ($r = -0.89$ in AI and $r = -0.88$ in NI colonies) and total rainfall ($r = -0.57$ in AI and $r = -0.60$ in NI colonies). Again in 2017-18, pollen area showed positive significant correlation with maximum relative humidity ($r = 0.57$ in AI and $r = 0.60$ in NI colonies) and negatively significant correlation with maximum temperature ($r = -0.87$ in AI and $r = -0.90$ in NI colonies) and total rainfall ($r = -0.74$ in AI and $r = -0.76$ in NI colonies). Nectar area was found to have negatively significant correlation with maximum relative humidity ($r = -0.74$ in AI and $r = -0.77$ in NI colonies). The correlation study of *A. cerana* with weather parameters in the year 2017-18, revealed significant negative correlation of brood area ($r = -0.58$ in AI and $r = -0.60$ in NI colonies) and nectar area ($r = -0.66$ in AI and $r = -0.70$ in NI colonies) with maximum relative humidity.

The comparative performance of AI queen and NI queen indicated better performance of the artificially inseminated queens of *A. mellifera* and *A. cerana* with respect to brood area, pollen area, nectar area and pollen load carrying efficiency which directly influences honey production. In view of this, it can be concluded that to sustain the vigour and vitality of the honey bee species, artificial insemination is a reliable method on which bee breeders and beekeepers can rely on.

Developing and validation of an integrated pest management (IPM) strategy for invasive South American tomato leaf miner, *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)

Priyakshi Buragohain

Extensive exploration for *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) was carried throughout Andhra Pradesh and Telangana with special emphasis to areas of natural distribution of the insects. A total of 32 fields were studied at monthly intervals during September 2017 to August 2018. The average leaf and fruit infestation percentage was observed from 3.71 to 15.01 per cent and 0.22 to 3.80 per cent in different mandals of Chittoor district, Andhra Pradesh, while, in Telangana, it ranged from 3.50 to 15.15 per cent and 0.08 to 4.45 per cent, respectively.

Efficacy studies on three commercially available pheromone lures *viz.*, SPLAT TUTA, Pheromone Chemicals and TLM lure, along with an untreated control against *T. absoluta* in three different locations in Andhra Pradesh during September 2017 to July 2018 indicated that the weekly trapped male moths of *T. absoluta* (28.14-33.38) differed significantly from the untreated control (1.95 moths/trap) across the locations and seasons ($p < 0.0001$). However, the trapping did not have any significant impact on reducing the larval damage in the leaves (10.29-11.88%) ($p = 0.062$) and the fruits (30.55-32.38%) ($p = 0.80$). The marketable yield was significantly higher ($p < 0.0001$) in pheromone treated plots in Kurbalakota (14.71-14.90 t/ha), Nimmanapalle (12.33-19.63 t/ha) and Palmaneru (15.06-17.01 t/ha) compared to untreated control plots with 4.85, 2.99 and 5.55 t/ha, respectively.

Bioassay experiment (The leaf dip method) against *T. absoluta* to selected bio-pesticides *viz.*, *Bacillus thuringiensis* var. *kurstaki*, Azadirachtin, *Beauveria bassiana* resulted in the LC_{50} values of 4.10×10^9 cfu/ml and 8.06×10^6 spores/mg whereas, it was 91.866 and 212.676 ppm, respectively for Azadirachtin. Similarly, the LC_{50} value for *B. bassiana* was 1.367×10^7 cfu/ gm and 4.473×10^7 spores/ml, respectively.

With regard to efficacy of bio pesticides against *T. absoluta* in three different locations in Andhra Pradesh during May 2018 to December 2018, the average per cent leaf infestation (3.68-14.07%) differed significantly from the untreated control (20.89-25.69%) in the first season. Same trend was also observed in the next season and it

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ranged from 4.23-15.42 per cent, which differed significantly from the untreated control (23.82-28.40%) across the locations and seasons ($p < 0.01$). Similarly, in fruits, the average percent fruit infestation ranged from 1.27-6.44% and 2.19-6.30%, which differed significantly from the untreated control (3.27-10.70% and 9.57-14.21%) in the first and second seasons, respectively across the locations and seasons ($p < 0.01$). The average yield was high in all the treatments, recording 13.92-37.40 t/ha and 23.45-39.73 t/ha in the first and second seasons, respectively and differed significantly from the untreated control with 6.47-23.09 t/ha and 12.50-18.90 t/ha.

The IPM package against *T. absoluta*, which was evaluated during 2018-2019, confirmed that the effect of the IPM package in reducing the infestation of the insect was quite promising in all the trials. The cost benefit ratio in IPM package was nearly two times higher over the control plot and the performance of the IPM package was on par with the Farmers' practice (calendar based chemical application). Hence, IPM strategy could be considered as one of the fundamental and vital components against *T. absoluta*.

The phylogeographical structure in mitochondrial DNA of *T. absoluta* in Telangana and Andhra Pradesh (AP) was studied to assess the genetic diversity. The pairwise F_{ST} values (Distance method) comparing populations of *T. absoluta* (region based analysis) between Telangana and AP were found to be non significant (0.02878). The haplotype diversity (h) and nucleotide diversity (π), from Telangana, AP and Telangana+AP, were 0.248, 0.067, 0.127 and 0.00036, 0.00010 and 0.00022, respectively. The Tajima's D and Fu's F_s tests for *T. absoluta* populations from Telangana, AP and Telangana+AP, were -0.39, -1.14, 0.61 and 0.13, -1.2 and 0.324, respectively. Maximum likelihood (ML) phylogenetic analyses identified one major clade and confirmed the haplotypes of the *cox1* sequences to be genetically similar.

Development of integrated pest management modules against insect pests of *Bhut Jolokia* (*Capsicum chinense* Jacq.)

Sasanka Sekhar Bora

Experiments were carried out under field conditions at the Experimental Farm, Department of Horticulture as well as in the Department of Entomology and Department of Plant Pathology, Assam Agricultural University, Jorhat during 2017-18 and 2018-19 to study the major sucking and chewing pests of *Bhut Jolokia* causing substantial losses in fruit yield. At present, IPM has been attaining immense importance in the agricultural scenario of India and abroad. Therefore, evaluation of sustainable IPM modules was felt very much necessary in *Bhut Jolokia*. The result revealed that altogether twenty three numbers of insect pests were associated with the crop and among them aphid (*Aphis gossypii* Glover/*Myzus persicae* Sulzar), Whitefly (*Bemisia tabaci* Gennadius), thrips (*Scirtothrips dorsalis* Hood), yellow mite [*Polyphagotarsonemus latus* (Banks)], Cutworm (*Agrotis ipsilon* Hufuagel) and fruit fly [*Bactrocera dorsalis* (Hendel)] were considered as the key pests of *Bhut Jolokia*. Highest incidence of major pests was obtained in the 1st fortnight of April during 2018 as against 2nd fortnight of April during 2019, respectively. A new invasive pest, spiraling whitefly (*Aleyrodicus dispersus* Russel, Aleyrodidae:Hemiptera) was also reported for the first time in *Bhut Jolokia* from Assam.

Five IPM modules were evaluated against insect pests of *Bhut Jolokia*, of which module I comprised of recommended dose of fertilizer and farm yard manure+ application of microbial consortium + growth promoter viz., Tricontanol + weeding at 30, 60 and 90 Days after transplanting (DAT) + imidacloprid 17.8 SL 0.4 ml per lt @ 40 days interval was found to be the most effective module in respect of B: C ratio (3.02: 1) followed by module III (Vermicompost 1.25t/ha+ neem cake 500 kg/ha + application of microbial consortium + black polythene mulching + garlic extract @ 10% at 20 and 70 DAT +NSKE 5% at 35 and 100 DAT + installation of sticky trap @ 25 traps /ha) where the B:C ratio was 2.96 with maximum yield of 740.74 gm per plant with next higher yield of 712.13 gm per plant in module I. Hence, module III in comparison to module I

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seems to be quite promising strategy as it did not require any insecticidal interference keeping natural enemies and ecosystem undisturbed.

Out of eight cultivars collected cv. Assam 1 (*King*) contributed maximum yield of 719.85 gm per plant followed by Assam 4 with 626.67 gm per plant with minimum susceptibility towards pests and diseases. Correlation studies between sucking pests and phenotypic characters indicated that only number of leaves and leaf area index had negative significant impact while other parameters *viz.*, plant height and branches showed no effect.

Result of different shade level, 75 per cent shade showed highest plant height and leaf area index of 90.01 cm and 1.81 as against open condition where it was only 53.18 cm and 1.46. The number of leaves and branches of Assam 1 cultivar were to be highest 220.51 cm and 8.75 in open condition, while they were 80.75 cm and 5.13 in 75 per cent shade level. Likewise, for flowering, 116.75 days required in case of 75 per cent shade level, whereas it was only 93.25 days in case of open condition. Similarly, fruit numbers also reduced in case of 75 per cent shade level which was only 27.0 while 92.13 was in case of open condition. Yield per plant was also around 718.13 gm per plant in open condition, whereas it was only 223.63 gm per plant in 75 per cent shade level. The major sucking pests and coccinellid predator population found to be in higher side in open condition also. In 75 per cent shaded area the pooled infestation of aphid, whitefly, thrips and mite was 0.62, 0.35, 0.26 and 0.54 numbers per three leaves whereas, it was 1.69, 1.58, 1.25 and 2.58 numbers per three leaves in open condition. Predatory spider population found highest with 0.34 numbers per plant while coccinellid population was lowest with 0.15 numbers per plant at 75 per cent shade level. But coccinellid population was highest with 0.40 numbers per plant in open condition while 0.18 numbers per plant spider also found at open condition, respectively. RT PCR method confirmed the presence of Cucumber mosaic virus (CMV) on whole seed and seed coat, which indicates that CMV transmitted through seed.

Ecological and biochemical basis of resistance against stem borer and leaf folder of aromatic rice

Shabrin Sultana Ahmed

The present investigation was carried out at Instructional Cum Research farm, Assam Agricultural University, Jorhat during *kharif* 2017 and 2018, respectively to generate a comprehensive information about screening of different aromatic rice varieties along with to determine the relationship between physio-morphic as well as biochemical properties of aromatic rice varieties against the incidence of stem borer and leaf folder and also to study diversity of major insect pests and their natural enemies in rice ecosystem.

Varietal screening of eleven aromatic rice varieties revealed that during *kharif* 2017 and 2018, none of the varieties showed resistance to stem borer in active tillering stage, whereas Kola Joha (12.33%), Sofguti Joha (12.75%), Boga Joha (13.37%), Maniki Joha (13.70%), Keteki Joha (15.67%), Ronga Joha (17.60%) Kon Joha (18.38%), and Krishna Joha (20.37%) showed moderately resistance during vegetative stage. The variety Kon Joha (4.79%) and Maniki Joha (2.40%), however showed resistance during reproductive stage. In case of damaged leaf due to leaf folder infestation, almost all the aromatic rice varieties were proved to be resistant during the study period except check variety "Jaya". Different physio-morphic characters of rice plant against leaf folder damage recorded significant positive correlation with width of leaf blade ($r = 0.821^{**}$ and $r = 0.865^{**}$), whereas significant negative impact was with plant height ($r = -0.939^{**}$ and $r = -0.778^{**}$). The per cent dead heart (DH) caused by stem borer exhibited significant positive correlation with stem diameter ($r = 0.829^{**}$ and $r = 0.816^{**}$), but it showed significant negative correlation with plant height ($r = -0.732^{**}$ and $r = -0.784^{**}$), number of leaves ($r = -0.962^{**}$ and $r = -0.891^{**}$), number of trichomes ($r = -0.860^{**}$ and $r = -0.870^{**}$), number of tillers ($r = -0.806^{**}$ and $r = -0.739^{**}$), number of grains per panicle ($r = -0.688^*$ and $r = -0.771^*$) and thousand grain weight ($r = -0.650^*$ and $r = -0.570^{NS}$), respectively. In case of per cent WEH, width of leaf blade ($r = 0.608^*$ and $r = 0.678$) had positive impact, but plant height ($r = -0.606^*$ and $r = -0.598^*$) and number of leaves ($r = -0.655^*$ and $r = -0.577^*$) showed significant negative relationship.

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Total of 6 species of odonates, 5 species of spider, 2 species of coccinellids, 3 species of lepidopteran, 1(one) species of each hemipteran, homopteran and coleopteran insect were recorded during the investigation period. As regards to diversity index, Sofguti Joha (1.59) showed the highest diversity index and Kola Joha (0.90) showed the highest species richness at vegetative stage, whereas the highest evenness (0.99) was found in Boga Joha at harvesting stage. In case of natural enemy complex, the highest diversity index of 2.50 and species richness (3.05) were recorded in Boga Joha at vegetative stage and the highest species evenness (0.99) was observed in Kola Joha at harvesting stage.

Different sampling methods revealed the highest abundance of *S. innotata* (16.47%) in Boga Joha, *Cnaphalocrocis medinalis* (12.50%) and *Di cladispa armigera* (7.66%) in Sofguti Joha, whereas *Leptocorisa acuta* (24.61%) was appeared as the highest in Maniki Joha and *Nephotettix nigropictus* (50.0%) in Sofguti Joha.

A total of 5 species of spider were recorded during the investigation period. The variety Maniki Joha supported more abundance of *Oxyopes javanus* (11.04%), *Pardosa pseudoannulata* (14.93%) and *Tetragnatha maxillosa* (9.74%), whereas *Argiope anasuja* (7.56%) in Boga Joha and *Neoscona theisi* (6.38%) in Sofguti Joha, respectively. The sub-order of odonata, viz., Zygoptera and Anisoptera had equal numbers of species (3 species each) during 2018. Data collected through different sampling methods showed the highest abundance of *Brachythemis contaminata* (14.89%), *Crocothemis Servilia Servilia* (10.11%) in Sofguti Joha, *Diplacodes nebulosa* (7.30%) in Kola Joha, *Aciagrion hisopa* (12.98%) and *Agriocnemis pygmaea* (11.68%) in Maniki Joha and *Agriocnemis pieris* (10.27%) in Boga Joha. Two species of predators under order coleoptera viz., *Coccinella transversalis* (F.), *Micraspis discolor* (F.) were found to be observed during the period of investigation. However, the highest abundance of *C. transversalis* was found in Kola Joha with 9.44 per cent and *M. discolor* with 8.10 per cent in Boga Joha.

Among the tested biochemical parameters, Phenol ($r = -0.985^{**}$ and $r = -0.834^{**}$), Ortho-dihydroxy phenol ($r = -0.963^{**}$ and $r = -0.829^{**}$), Tannin ($r = -0.837^{**}$ and $r = 0.621^{*}$), Peroxidase ($r = -0.937^{**}$ and $r = 0.871^{**}$) and Phenylalanine Ammonia Lyase ($r = -0.972^{**}$ and $r = -0.622^{*}$) exhibited negative significant impact with stem borer and leaf folder infestation. However, protein ($r = 0.946^{**}$) showed positive significant correlation only with stem borer infestation. In terms of aroma, both Kola Joha and Koni Joha performed excellent in aroma having a score of 5 followed by Maniki Joha, Boga Joha and Bokul Joha with a score of 3.5-4. However, Keteki Joha, Krishna Joha, Kon Joha and Sofguti Joha produced medium aroma with a score of 2.5-3 and Ronga Joha produced very low aroma (score 2). As regards to yield, the highest yield was attributed by Kon Joha (2535.35 kg/ha) and the lowest yield of 1366.31kg/ha was obtained in Tulsi Bhog Joha.

Evaluation of insecticidal materials against some soil insect pests of potato

Saurabh Sarma

Laboratory and field experiments were carried out in the Soil Arthropod Pests Laboratory, Department of Entomology; Soil Microbiology Laboratory, Department of Soil Science; Laboratory of Integrated Farming System and Instructional Cum Research Farm of Assam Agricultural University, Jorhat during 2017-20 to evaluate the effectiveness of different insecticidal materials against some soil insect pests of potato. Fourteen (14) numbers of locally and naturally available eco-friendly insecticidal materials were collected and grouped into four groups (Group I-Physical poisons, Group II-Biopesticides and bio-enhancers, Group III-Botanicals and Group IV-Minerals) based on their different properties. Individual screening of these materials was carried out under laboratory conditions against cutworm (*Agrotis ipsilon*), white grub (*Lepidiota mansueta*) and red ant (*Dorylus orientalis*). Out of the 14 insecticidal materials tested, a total of 11 were selected based on their efficacy and finally 15 numbers of insecticidal mixtures were prepared through trial and error method. From 15 insecticidal mixtures, 5 numbers of mixtures (Mixture-II: mustard oil cake + cow urine + wood ash + neem leaf powder + saw dust; Mixture-IV: mustard oil cake + cow urine + wood ash + tobacco leaf powder + fine sand; Mixture-VIII: mustard oil cake + cow urine + wood ash + jatropha leaf powder + saw dust; Mixture-XI: mustard oil cake + cow urine + wood ash + pongamia seed powder + saw dust and Mixture-XIII: mustard oil cake + cow urine + wood ash + king chili powder + fine sand) were recorded to be superior over the other mixtures in causing mortality of *A. ipsilon* larvae, *L. mansueta* grubs and *D. orientalis*.

Based on superiority, the aforementioned 5 mixtures along with two insecticidal checks (malathion 5% dust and chlorpyrifos 20 EC) were considered to investigate their possible effects on soil physico-chemical properties under laboratory conditions. Highest available N (278.2, 270.9 and 260.9 kg ha⁻¹ on 30, 60 and 90 DAT, respectively) was recorded in soil treated with Mixture-XI which was significantly superior over other mixtures except for the Mixture-II. Maximum (33.34, 33.24 and 33.16 kg ha⁻¹ on 30, 60 and 90 DAT, respectively) available P was estimated in soil

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treated with Mixture-II and found *at par* with all other mixtures except for Mixture-IV. Soil amended with Mixtures IV and XI registered significantly highest available K (210.61, 213.87 and 214.39 kg ha⁻¹ on 30, 60 and 90 DAT, respectively) and CEC [5.63, 5.60 and 5.58 cmol (p+) kg⁻¹ on 30, 60 and 90 DAT, respectively] as compared to the other mixtures tested. However, the pH content was varied from 5.10 to 5.17 in the soil treated with the 5 individual mixtures and found nonsignificant. Mixture-XI registered the highest (0.79, 0.72 and 0.69%) organic carbon content followed by Mixture-II (0.74, 0.69 and 0.67%) and Mixture-IV (0.71, 0.67 and 0.65%) at 30, 60 and 90 DAT, respectively. Minimum (1.31, 1.31 and 1.32 Mg cm⁻³ on 30, 60 and 90 DAT, respectively) bulk density was recorded in soil treated with Mixture-XI which showed statistical parity with other mixtures. The Soil Microbial Biomass Carbon content was found maximum (147.6, 136.9 and 124.9 µg g⁻¹ on 30, 60 and 90 DAT, respectively) in soil treated with Mixture-XI and was found statistically *at par* with Mixtures II, IV and VIII, but significantly higher than Mixture-XIII. No change in the soil textural class was registered during the course of study.

Activity of five key soil enzymes *viz.*, fluorescein di-acetate hydrolysis (FDA), Dehydrogenase, Phosphomonoesterase (PMEase), β-glucosidase and Urease of the treated soils with the individual mixtures as well as insecticidal checks were assessed by raising French bean as the test crop. FDA activity was significantly the highest (6.51 µg fluorescein g⁻¹ soil h⁻¹) in the soil treated with Mixture-XI over other mixtures except Mixture-II which was found nonsignificant. Enzyme activities in respect of dehydrogenase (94.20 µg TTF g⁻¹ soil 24 h⁻¹), urease (119.17 µg NH₄-N g⁻¹ soil 2 h⁻¹) and β-glucosidase (125.50 µg *p*-nitrophenol g⁻¹ dry soil 2 h⁻¹) were also recorded as the highest in the soils mixed with Mixture-XI and was significantly superior over rest of the mixtures. Highest PMEase activity (196.39 µg *p*-nitrophenol g⁻¹ soil h⁻¹) was observed in the soil treated with Mixture-II which showed statistical parity with Mixture-XI (189.54 µg *p*-nitrophenol g⁻¹ soil h⁻¹) but significantly superior over rest of the mixtures. As regards to per cent increase in enzymatic activities, the insecticidal Mixture-XI recorded 125.43, 169.55, 124.9, 155.49 and 200.02 per cent of FDA, dehydrogenase, PMEase, β-glucosidase and urease activities, respectively as compared to their initial enzymatic activity status. A declining trend of enzyme activities was observed in the soils treated with chlorpyrifos 20 EC and malathion 5 per cent dust as compared to the untreated control.

Perusal of data in respect of both soil physico-chemical properties and soil enzyme activities, Mixture-XI @ 250 kg/ha was considered for field evaluation along with two insecticidal checks against various soil insect pests of potato. Experimental results indicated that all the treatments were significantly superior in suppressing infestation inflicted by various soil insect pests as compared to the untreated control. Mixture-XI recorded tuber damage (9.86 and 10.43% on weight and number basis, respectively) which was statistically *at par* with malathion 5 per cent dust @ 40 kg/ha (9.11 and 9.27% tuber damage on weight and number basis, respectively) but

significantly higher than chlorpyrifos 20 EC @ 300 g *a.i./ha* (6.06 and 6.40% tuber damage, respectively). As regards to tuber yield, Mixture-XI resistered 168.29 q/ha which was found to be *at par* with malathion 5 per cent dust (169.77 q/ha) and chlorpyrifos 20 EC (178.63 q/ha) treated plots.

The Scanning Electron Microscope (SEM) of the Mixture-XI was carried out which showed clear heterogeneous nature of the particles present in the mixture under different magnifications. Energy Dispersive X-ray (EDX) analysis revealed the presence of 2 numbers of macro elements and 7 numbers of microelements in the mixture sample. Gas Chromatography-Mass Spectrometry (GC-MS) analysis detected 12 numbers of volatile compounds having possible role in insect pests and disease management and host plants resistance.

A Study on Farmers' Perspective towards Agriculture in the last five decades in the state of Assam

Bhargab Baruah

A lack of approach towards agricultural activities can be observed in the rural areas of Assam despite having economic crisis at the household level. While the notion of disenchantment of farmers towards the profession and the likelihood of many farmers willing to leave agriculture has caught steam in the country, considering how important agriculture is to the lives and livelihood of rural population in Assam the present study was taken up to develop insights into the reasons behind decline in preference of the farmers in Assam to continue performing agriculture as their primary livelihood activity. This study proposes that farmers' psychologically constituted attitude, values and goals towards life domains shall help us understand the foundational basis of preferences and choices of farmers to engage in agriculture as a profession and for fulfillment lifestyle goals under changed circumstances to perform agriculture as a livelihood. The present study was conducted in five districts across Assam, viz., Jorhat, Morigaon, Barpeta, North Lakhimpur, and Cachar. Data was mainly collected through personal interview channels, and employing psychometric assessment techniques - Likert-scale and Q-methodology. Multi-stage purposive and random sampling techniques was used to draw out a sample of 400 respondents proportionately from three strata based on age categories. A purposively drawn sub-sample of respondents was used for Q-study. Cluster analysis and factor analysis were used for interpretation of the data. Other appropriate analytical tools were also used for analysis of data.

The study revealed that although food production was simply seen as a means to meet a minimum level of subsistence through collective action of family members during phase 1, the farmers did not face economic crisis at household level. Farming was more about maintenance of traditional rural/agricultural values, than economic rationality and modern technological innovations had very little importance in farming. Farming was mainly constrained by damage due to floods, lack of policies to safeguard farm household economy against crop loss and access to for credit channels.

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Department : Extension Education

Major Advisor : Dr. Hemanga Kr. Kalita

While there was shift in preferences among *expanders*, *contended believers* and *potential escapees* during phase 2 to utilize their farm holdings for earning a real income from farming most others preferred to farm at subsistence level. Family remained central to the management of farms and farmers drew comfort from being part of his private social world, while many started to see farmers being viewed as inferior section of the society. Farmers became aware that the resources that were accessible and affordable to them would not be enough for a settled life in farming. Farmers were unhappy with the prices of farm produce and the smaller farmers felt that they were relegated to poorer section of the society. Although there was increase in use of modern technologies in farming, the quality planting materials were costly and the situation in marketing did not allow farmers to get a remunerative price. Access to irrigation and credit was also limited. Role of extension was passive and improvements in mechanization was not achieved. Damage to crops due to floods remained a primary concern for the farmers.

Economic rationality in food production took over the idealistic values of being a farmer embedded in the traditionalist rural/agricultural culture during phase 3. Leaving aside the *potential escapees*, it appeared that the others view their farm household enterprise to be of considerable importance for their livelihood, although their livelihood strategies differed. For the *expanders* maintenance of traditional and cultural values in farming and opportunity of self-expression in farming occupation was as important as economic rationality in farming. They enjoyed better wellbeing and status and saw prospects of expansion of their farm business. Otherwise oriented towards commercial cultivation, some of the *contended believers* have been quite selective in making changes to their farming systems during phase 3. Although some *contended conservators* prefer to be commercially oriented, for most of them food production at subsistence or semi-subsistence level seems quite the preferable choice. Being oriented towards farming at subsistence level, the *continuing bottomliners* believed that farming must be carried out with collective action of family members. The symbolic status of owning agricultural land and performance of work tasks, preserving their lands for the future generation and working hard in the land to grow a good crop no longer ensures economic rewards in farming. Change in the institutional life-world within which the farmers are embedded, threatened the traditional values in farming and forced the farmers to question their self-worth. Unsatisfactory performance of extension service, credit and insurance, non-existence of storage facilities, intuitional support in marketing constrained progress of farmers. Irrigation and mechanization improved, while modern quality inputs were easily available. The growth in non-farm employment, within and outside rural areas, made family farming more attractive.

While only 8.95 per cent farm households reported to have off-farm source of livelihood during phase 1, 72.50 per cent of households indicated that they had off-farm sources of income during phase 3. While *potential escapees* had at least one off-farm source of income during phase 3, the *contended believers* less frequently had an off-

farm source of income in their household (56.25%). While 93.68 per cent farmers reported that they were highly dependent on agriculture for livelihood during phase 1, only 49.75 per cent reported that their dependence on agriculture was high during phase 3. While majority of *potential escapees* (69.64%) reported to have very low dependence on agriculture; majority of *expanders* (67.05%) and *contended believers* (65.18%) reported that they were highly dependent on agriculture during phase 3. Although there are fewer households in phase 3 that get their principal income from cultivation than in phase 1 and phase 2, majority of farmers (68.75%) still get their principal income from cultivation. Other off-farm enterprises (10.25%) was the most utilized form of employment for principal income by the farmers during phase 3 next to cultivation, followed by salaried employment (9.50%), and other wage employment (7.5%). Other off-farm enterprises (37.50%), salaried income (25%), and other wage employment (21.42%) were the most prominent principal sources of income for the *potential escapees*. Only as few as 5.50 per cent of the farmers reported that they were dependent on single source of income for livelihood during phase 3. As many as 38.50 per cent of farmers reported that they depended on three sources of income, while another 16.50 per cent farmers depended on four or more sources of income during phase 3. Other sources category of income was frequently utilized by the *expanders*, *potential escapees* and *contended believers*. Salaried income was an important source of income for *potential escapees*, *expanders* and *contended believers*. The *contended conservators* can be frequently found to be either a wage labour in non-farm or operating a petty business while the *continuing bottomliners* are more likely to be involved in wage labour - nonfarm or in blue collar jobs.

Study on impact of “Bringing Green Revolution to Eastern India” (BGREI) programme in UBVZ of Assam in promotion of farm mechanization

Moromi Buragohain

Agricultural mechanization technology plays a key role in improving agricultural production in developing countries, and should be considered as an essential input to agriculture. In Assam most of the farm operations are done using animal power, hence, there is great scope of selective mechanizing in Assam where, small hand tools are used involving drudgery. In order to bring about a change, a programme under Farm Asset Building Activity has also been proposed under BGREI programme. The major component of the BGREI programme is farm mechanization, and promotion of farm mechanization has been recognized as one of the essential requirement and need of the hour for agricultural development in Assam especially in rice cultivation. Keeping this in view primarily, the present study entitled- “A study on impact of Bringing Green Revolution to Eastern India (BGREI) programme in UBVZ of Assam in promotion of farm mechanization” was carried out in three district of Assam namely Golaghat, Johan and Sivasagar. The objectives of the study are as follows:

OBJECTIVES:-

1. To assess the extent of utilization of farm machineries by the beneficiary and neighbouring farmers
2. To determine the level of knowledge on operation of different farm machineries and extent of adoption on scientific practices of applying farm machineries and tools in selected crops
3. To analyze the factors influencing the extent of utilization of farm machineries and tools.
4. To study the change in farming in terms of cropping intensity, cropping pattern, crop, diversification, intensification, productivity and profitability as a result of using farm machineries.
5. To identify the constraints face by the beneficiary and non beneficiary farmers in utilization and application of farm machineries and to pool suggestions thereof.

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Department : Extension Education

Major Advisor : Dr. P. K. Neog

A multistage purposive cum random sampling design was used for selecting 300 farmers as respondents. Appropriate statistical methods were used for analysis and interpretation of data.

The findings reveal that majority (57.33%) and (49.33%) of the BGREI beneficiary farmers and non-beneficiary farmers had medium and low level of utilization for farm machineries and tools respectively. Majority (68.67%) and (55.33%) of the beneficiary farmers and non-beneficiary farmers had medium and low level of knowledge on different farm machineries and tools respectively. Majority (60.00%) and (53.33 %) of the BGREI beneficiary farmers and non-beneficiary farmers belong to medium and low adoption category towards scientific practices of farm machineries and tools respectively.

Paired “t” test was applied to compare between the BGREI beneficiaries’ farmers and non-beneficiaries farmers related to their extent of utilization of farm machineries and tools and it revealed that the beneficiary’s farmers had significantly higher utilization as compared to non-beneficiaries farmers. Likewise, beneficiary’s farmers had significantly higher level of knowledge on operation of farm machineries and tools as well as higher adoption on scientific practices of applying farm machineries and tools as compared to non-beneficiaries farmers.

For extent of utilization of farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between annual income, information source utilization, credit orientation, mass media and social media use and attitude towards farm mechanization. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between social participation and labour availability. For level of knowledge on operation of different farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between information source utilization, credit orientation, scientific orientation and attitude toward farm mechanization. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between age, annual income, scientific orientation, extension contact and mass media and social media use. For extent of adoption on scientific practices of applying farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between age, size of operational land holdings, annual income, information source utilization, mass media and social media use, and participation in farm machineries related training. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between size of operational land holdings, annual income, labour availability, mass media and social media use, participation in farm machineries related training and attitude towards farm mechanization.

Among economic factors, social factors, personal factors and organizational factors subsidies availability, after seeing neighbours development, self-reliance or

independence and guidance from ADO respectively were the major factors influencing the extent of utilization of farm machineries and tools for majority of the BGREI beneficiary farmers and non-beneficiary farmers. The changes has taken place for more than 50 per cent of the beneficiary farmers in terms of cropping intensity, cropping pattern, crop diversification, productivity and profitability. The constraints face by the beneficiary and non-beneficiary farmers in utilization and application of farm machineries and tools are as follows: Economic constraints includes high initial cost of implements (Rank I), Infrastructural constraints includes non availability of spare parts in nearby places (Rank I), Information constraints includes farmers faced lack of skilled labour to operate farm machineries and tools (Rank I), The major situational constraint faced by the respondents was most of the farm machines and tools were not suitable for women farmer (Rank I) and frequent repairing (Rank I) was the most felt technological constraint by the BGREI beneficiary and non-beneficiary farmers.

A study on determinants of different stages of adoption process of post-harvest management practices of potato in Meghalaya

Nisha. V. Kharjana

The study entitled “A study on determinants of different stages of adoption process of post-harvest management practices of potato in Meghalaya.” was carried out to identify the most relevant factors affecting the different stages of adoption process and along with it to also analyse the extent of adoption of post-harvest management practices of potato in East Khasi Hills and West Khasi Hills of Meghalaya. The present study has been undertaken with the following specific objectives.

1. To identify the factors influencing stages of adoption process of post- harvest management practices of potato.
2. To assess the extent of adoption of post-harvest management practices of potato by the growers.
3. To analyse the relationship of socio-personal and economic variables with the extent of adoption of post-harvest management practices of potato.
4. To identify constraints faced by potato growers and to find out the measures suggested by them.

The study was conducted in East Khasi Hills and West Khasi Hills district of Meghalaya which were selected purposively. East Khasi Hills is a district which has 11 (eleven) community and rural development blocks and West Khasi Hills is a district which has 6 (six) community and rural development blocks. Amongst all these blocks, a total of four blocks were selected randomly for the study. Two blocks namely, Mawphlang Block and Myllem Block, from East Khasi Hills while the other two blocks namely, Mairang and Mawthadraishan were selected randomly from the West Khasi Hills. From each of the selected blocks, 5(five) villages were randomly selected for the investigation. Thus, a total of 20 villages were selected for the present study. For selection of respondents, simple random sampling technique was used and a total of fifteen numbers of respondents were selected from each of the selected villages making

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Department : Extension Education

Major Advisor : Dr. P. K. Neog

it a total of 300 number of respondents. Altogether fifteen independent variables viz., age, educational level, farm experience, size of operational land holding, annual income, availability of family labour, availability of hired labour, training exposure, extension contact, social participation, scientific orientation, marketing orientation, risk preference, economic motivation and knowledge level and one dependent variable i.e., extent of adoption were included in the study. As for descriptive variables, we have factors influencing different stages of adoption process and problems cum suggestions given by respondents. Data collection was carried out by personal interview technique administering a structured schedule. Statistics like frequency, mean, percentage, standard deviation, coefficient of variation, Karl Pearson's correlation coefficient, multiple regression and ranking were used for analysis of data. The study revealed that majority of the respondents were of middle age group (51.33%) and had literacy up to middle school (26.34%). Majority of the respondents (52.34%) were found to have medium farm experience. In case of size of operational land holding, it was found that majority (50.67%) had marginal land holdings. Most of the respondents (86.00%) had medium annual income followed by (53.66%) respondents who had 1-2 members, in terms of availability of family labour. And about (49.67%) respondents who could not avail hired labour as and when required. In regards to social participation, majority of the respondents (53.00%) had no membership in any organization. With respect to training exposure, it was found that about (39.00%) of the respondents were not exposed to any training related to post harvest management of potato. Extension contact was also found to be medium in majority (60.67%) of the respondents. Scientific orientation and marketing orientation were found to be medium with (71.67%) and (78.00%) respectively. The risk preference of the respondents, majority (92.00%) were found to be medium and (84.00%) of the respondents were found to be medium in economic motivation. Lastly, regarding the knowledge level, it was found that majority (65.67%) of the respondents had medium level of knowledge. The study revealed that that more than, 50 per cent of the respondents had perceived high level of influence on six factors which include agriculture pamphlets (51.00%), friends or neighbours (55.00%), opinion leaders (61.33%), ATMA functionaries (59.00%) market intermediaries (52.33%), and market demand (52.67%) on the 'Awareness stage' of adoption process. The study also revealed that majority of the respondents, above 50 per cent had perceived high level of influence of five factors which include agriculture pamphlets (54.00%), friends or neighbours (53.33%), ATMA functionaries (54.00%) market intermediaries (50.67%), and market demand (53.33%) on the 'Interest stage' of adoption process. This table indicates that majority of the respondents, above 50 per cent had perceived high level of influence of four factors which include, agriculture pamphlets (55.00%), availability of family labour (54.00%), market demand (52.00%) and availability of input (53.00%) on the 'Evaluation stage' of adoption process. The study also revealed that majority of the respondents, above 50 per cent had perceived high level of influence of five factors which agriculture pamphlets (56.67%), availability of family labour (52.33%), market

demand (50.00%), size of land holding (53.00%) and availability of inputs (58.33%) on the 'Trial stage' of adoption process. The study also revealed that majority of the respondents, above 50.00 percent had perceived high level of influence of seven factors which include agriculture pamphlets (51.00%), market intermediaries (54.67%), availability of storage (57.00%), availability of family labour (51.33%), market demand (52.33%), size of land holding (50.33%) and availability of inputs (56.67%) on the 'Adoption stage' of the adoption process. The study also revealed that majority (65.33%) of the respondents had medium level of adoption in terms of overall extent of adoption of post-harvest management practices of potato followed by 23.00 per cent of the respondents who had high level of adoption and only 11.67 per cent of the respondents were found to be low in the adoption category.

The study revealed that more than 50 per cent of the respondents, fully adopted 10 (ten) of the practices which include timely (78.33%), harvesting under good weather conditions (73.33%), washing of potato tubers after harvesting (70.00%), drying of potatoes under the shade (curing) (69.00%), sorting and grading of harvested potatoes (66.00%), grading of potato according to different sizes (55.00%), storing of potatoes after they are properly dried (72.33%), maintenance of proper aeration while storing (67.33%), proper storage method (77.33%), and use of recommended packaging material (68.33%). Reasons for their full adoption was because level of knowledge of these respondents was also high for these practices. Correlation coefficient revealed a positive and significant relationship between the extent of adoption and the variables namely educational level, farm experience, annual income, availability of family labour, availability of hired labour, training exposure, extension contact, scientific orientation, economic motivation and knowledge level. Whereas, for multiple regression analysis the variables which were found to have significant relationship with the dependent variable were considered. The multiple regression analysis with all the ten predictors produced $R^2=0.831$. Thus, this signifies that ten variables taken together could explain 83.1 per cent of the total variation in respondent's extent of adoption. The most important constraints faced by majority of the respondents was the unavailability of cold storage facilities in and around the area and this was ranked as first amongst the other major constraints. The respondents have also suggested a number of measures regarding solving of the problems they were facing but the most important measure suggested by majority of the respondents were that the development of cold storage facilities by the concerning authorities and this was ranked first amongst other measures.

Evaluation of small and marginal farmers' livelihood strategies, changing trends and preferences for income-generating activities for future in Assam

Pallabi Phukon

Rural livelihood in India is complex, involving multiple activities and strategies. Agriculture is an integral part of daily life on the Indian subcontinent, with 82 per cent of farmers being small. Despite occupying only 44% of arable land, small farms are the country's primary food and nutritional security providers. Even so, they lack access to markets and technology. Small and marginal families are contributing more to the national food supply and agricultural GDP; they account for more than half of the hungry and poor. Small and marginal farmers lack access to capital and inputs. This has hampered their competitiveness in both domestic and international markets. The high-value segment of the agricultural sector is expected to benefit smallholders more than cereals because it requires more labour and yields more than cereals.

Assam's agriculture is a mix of peasant and tenant farming, with most farmers being marginal (62.2%) or small (20.9%). Various economic factors (e.g., fragmented land) contribute to the state's lagging agricultural sector. Small and marginal farmers earn between Rs. 35,000/- and 40,000/- per year. Many farmers in Assam lacked collateral due to a lack of proper land inheritance documentation and inadequate land (due to land fragmentation). Already Assamese farmers are reluctant to adopt farming as a source of livelihood for small and marginal farmers. Rural youth are no longer interested in farming as a source of livelihood. In reality, most farmers in Assam own less than two acres of land. Therefore, the present study has been proposed to be undertaken to find out the small and marginal farmers' livelihood options and perceived profitable agricultural activities in future; thereby, one can prepare the right strategy to strengthen the livelihood of small and marginal farmers with following objectives:

1. To assess livelihood strategies pursued by small and marginal farmers in the study area.
2. To describe changing trends of livelihood strategies among small and marginal farmers in the study area.
3. To determine the choice of income-generating activities for future livelihood strategies.

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Department : Extension Education

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4. To identify the determinants of small and marginal farmers' choices of livelihood strategies.

The respondents were initially chosen using a random sampling technique. However, due to the lockdown and pandemic situation surrounding Covid-19, the survey could not begin on time or as planned. Data collection was conducted using a flexible sampling strategy in which final respondents from the villages were randomly selected. However, during the pandemic, various international organisations such as the World Bank, the Food and Agriculture Organization (FAO), and the International Food Policy Research Institute conducted surveys without a sampling plan. They note that it is impossible to follow a proper sampling design during pandemic situations. It surveyed a total of 300 farmers and collected data using a personal interview technique with a structured schedule. Data analysis was conducted using appropriate statistical tools.

About 40.00 per cent of the respondents were under the age group 44-53 years. In the case of marital status, family type, Job card, BPL card, holding of bank account, access to market, access to credit, member of social organisation, and SHGs, there was a significant association between 2010 and 2020. As the income was increasing in 2020 as compared to 2010, but price index was 95.63%. Result of the study also evidenced that marginal farmers were more in positive trend in respect of all independent variables as compared to the small farmers. It was observed that the non-farm sector contributed more to the annual income than the farm sector. The majority (17.33%) of the respondents preferred 'field crops+ vegetable cultivation+ piggery' as their current livelihood strategy. Though livelihood diversification had occurred, there was no prominent/ dominant livelihood strategy, and most of them were moderately diversified. The study also asserted a significant association of education, job card, and BPL card with the extent of livelihood diversification.

In the case of annual income and operational land holding, there was a significant relationship with the extent of diversification. Likewise, in changing trends of small and marginal farmers' livelihood diversification, mostly in marginal farmers, there was an increasingly positive trend concerning all independent variables. It was also noticed that livelihood diversification occurred but at an almost equal level. All the respondents (100%) wanted alternate livelihood options if they got a second chance. About 14.33 per cent of respondents preferred 'paddy+ fishery+ vegetable cultivation' as their livelihood option and ranked I. However, it was indicated from the study that the livestock sector was selected as their livelihood option, where 80.00 per cent of respondents preferred fishery as their livelihood option. Pareto chart analysis identified the determinants that were responsible for selection of fishery, vegetable cultivation, piggery, and paddy as their livelihood options. Mostly 5-6 determinants like 47 years, Rs 40,000/-, up to primary passed and up to HSLC passed, 0.01-0.04 ha, 1.00-2.00 ha, access to credit, migration, were responsible in selection livelihood option. The study discovered that land size is almost similar in both the year i.e., 2010 and 2020 and they realized that fragmented land would not increase their income. In last ten years farmers were living in a joint family to intake their land holding and making it as a livelihood

strategy. Although the income was increasing but according to the price index income is less in true sense. The findings also reported that livelihood diversification had occurred but there was no prominent strategy was followed till date. The study was conducted in micro level which had identified significant outcomes and some differences in livelihood activities among marginal and small farmers were found. As a result, the research suggests that policymakers of government further would go for more micro level study would help to develop different policies for small and marginal farmers. The result asserted that most of the farmers preferred livestock sector along with the farm sector, so emphasis should be given to livestock so that it can improve the livelihood of small and marginal farmers of Assam.

Factors Impinging Adoption of Integrated Pest Management Practices by the paddy growers of Upper Brahmaputra Valley Zone of Assam

Patrika Sharma

Rice forms the staple food crop of India and Assam is one of the ten most rice producing states in the country. One way to achieve more benefits and have low input cost in agriculture finds its way in sustainable agriculture that aims to reduce input costs into crop production. Integrated Pest Management is the approach to achieve sustainable agriculture as it integrates all the crop production practices mainly cultural, mechanical, biological and chemical practices for pest management rather than sole reliance on chemical pesticides. In order to reduce the use of hazardous chemical pesticides and to manage the insect/pest/disease attack as well as to increase the crop productivity, Govt of India, Ministry of agriculture, department of Agriculture and Co-operation launched a scheme Strengthening and Modernization of Pest Management (IPM) approach in India in 1991-92. CIPMC, KVKs, District Agricultural Office from DoA, Assam has conducted enormous programmes on Integrated Pest Management for paddy crop throughout the state. However, dependence on synthetic pesticides has not been eliminated from the farmer's field. Therefore, this study was conducted in Upper Brahmaputra Valley Zone of Assam with a view to identify the factors impinging adoption of IPM practices by the paddy growers, their knowledge level in IPM practices, extent of adoption of IPM practices, effect of innovation characteristics of IPM in its adoption and to analyze obstacles faced by the paddy growers in adoption of IPM practices. A multi-stage sampling design was followed for selection of 280 respondents from 20 villages. Data were collected administering a structured schedule. Relevant statistical tools viz. frequency, percentage, mean, standard deviation, C.V., C.D., Karl Pearson product moment co-efficient of correlation, Multiple regression analysis, ANOVA test were used. The study revealed that majority of the respondents aged between 41-53years (56.43%), studied upto High School (46.07%) and had membership of at least one organization (70.72%). Most of the farmers had family size

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Department : Extension Education

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of 5-7 members (62.50%), agricultural experience between 16-23 years (62.85%), and in between 4-9.6 years involved in pesticide application (60.71%). A majority of the respondents were semi medium land holders (50.71%) having 2 to 4 ha of land, had annual income of Rs. 95,720-2, 03,280 (58.57%) and 60.00 per cent used to spend Rs 100-390 for pesticides in a year. Attitude towards IPM practices was moderate for 49.28percent and majority of the respondents (63.92 %) had moderate level of economic motivation. 57.5 per cent had moderate level of scientific orientation and more than half (55.35%) of the respondents had moderate level of innovativeness. Majority (95.71%) of the respondents utilised information sources like progressive farmers, neighbours/local farmers and sometimes family members mostly, rather than utilising modern sources of information mobile phones and internets (32.5%). 40.00 per cent of the total respondents attend training regularly whereas field visit was attended occasionally by 69.64 per cent 53.57 per cent had never attended group discussion. The study further revealed that overall knowledge level of paddy growers in IPM practices is medium (52.85%) for most of the respondents. They had great extent of knowledge on the practice of 'Proper summer ploughing, Trimming of bunds and Destruction of crop residues before transplanting of rice to minimize the insect pest & disease intensity' (100.00%) followed by 'Use bird perches for predatory birds against insect pests of rice' (90.00%) whereas, majority of the respondents (76.78%) did not know about 'spraying of Trichogramma in 6 different times at 10 days interval starting from 30-35 DAT' followed by 'application of Trichogramma as a biocontrol agent against rice stem borer and rice leaf folder' (69.28%). Extent of adoption of IPM practices was medium (69.28%) and cultural practices were mostly adopted where as biological practices were least adopted. The correlation analysis showed that operational land holding ($r = 0.1979^{**}$), annual income ($r = 0.1979^{**}$), attitude towards IPM practices ($r = 0.1979^{**}$), innovativeness ($r = 0.4151^{**}$), extension participation ($r = 0.2159^{**}$) and knowledge level ($r = 0.8710^{**}$) had positive and significant correlation with extent of adoption of IPM practices. Data pertaining to multiple regression analysis between farmer's characteristics and adoption of IPM practices showed that Operational land holding ($b = 0.080^*$), Attitude towards IPM practices ($b = 0.150^*$), Economic motivation ($b = 0.089^*$), Scientific orientation ($b = 0.029^*$), Innovativeness ($b = 0.044^{**}$), Information source utilization ($b = 0.373^{**}$), Extension participation ($b = 0.759^*$) and Knowledge level ($b = 1.652E-05^{**}$) of the respondents jointly contributes 59 percent towards variation in extent of adoption of IPM practices. The study also reveals that a huge majority (72.14%) of the respondents perceived IPM as a technology to a moderate level. 57.85 per cent considered it as profitable, 48.21 per cent of the respondents found IPM practices as highly compatible to the culture of the community, another highest percentage of respondent (37.85%) mentioned it as complex system, but 27.85 percent of the respondents found it simple. Further the study shows that 38.21 percent of the respondents felt trying IPM in their paddy may involve some risk as results are only sometimes visible in the field. Limited access to biological inputs, like

pheromone traps, bio-pesticides, tricho-cards etc was ranked top among the obstacles faced in adoption of IPM practices as reported by 100.00percent of farmers followed by inability to control / restrict pest for a limited area and lack of collective action within farming community (98.92%) and Insufficient training ranks third as reported by 96.42 per cent of the respondents. Strategies such as strengthening Community Based Approach for collective pest control, developing farmers friendly educational method/appropriate extension approaches, Ensuring the availability of Biological control agents and IPM devices by KVKs, District Agriculture Offices and other non govt organization etc. can be taken up to promote IPM among paddy growers in a effective way.

Adoption of tea cultivation practices by trained and untrained small tea growers- An evaluative study in Upper Brahmaputra Valley Zone of Assam

Purnima Saikia

The study entitled “Adoption of tea cultivation practices by trained and untrained small tea growers- An evaluative study in Upper Brahmaputra Valley Zone of Assam” was carried out during 2020-21. Multistage purposive cum random sampling design was used for selection of respondents. A total of 400 (200 trained and 200 untrained) respondents constituted the sample of the study. Data collection was done by adopting the personal interview technique administering a structured schedule. Frequency, percentage, mean, standard deviation, coefficient of variation, ‘t’ test, weighted mean score, rank analysis, two sample ‘t’ test for comparing two means, correlation and multiple regression were the statistical techniques used for the analysis of data.

The study revealed that majority of the trained respondents (50.00%) were belonged to young age group. On the other hand majority of the untrained respondents (49.50%) were belonged to young age group. Majority of the trained respondents (25.00%) and untrained respondents (26.50%) were middle school level and primary school level, respectively. Moreover, majority of the trained respondents (78.50%) and untrained respondents (73.50%) had nuclear type of family. In case of operational land holding, majority of the trained respondents (52.00%) and untrained respondents (58.50%) were small farmers. It was found that majority of the trained (55.00%) and untrained (59.00%) respondents had medium level of annual income. It was observed that majority of the trained respondents (54.50%) and untrained respondents (63.00%) had only cultivation as occupation. In case of experience of tea growers 58.50 per cent of the trained respondents and 57.50 per cent of the untrained respondents had average experience (5-10 years). It was found that majority (40.50%) of the respondents had attended 2 days training programme. Majority of the trained (67.50%) and untrained

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Department : Extension Education

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(76.50%) respondents had medium level of mass media exposure. It was also observed that majority of the trained (60.50%) and untrained (72.00%) respondents had medium level of extension contact. Majority of the trained (77.00%) and untrained (90.50%) respondents had medium level of social participation. Majority (57.50%) and (57.00%) of the trained and untrained small tea growers possessed medium level of achievement motivation, respectively. In case of marketing orientation, it was found that majority (69.50%) and (74.50%) of the trained and untrained small tea growers possessed medium level of marketing orientation, respectively.

It has been also observed that majority of the trained (64.50 %) and untrained (69.50 %) small tea growers possessed medium level of economic motivation. Moreover, majority of the trained (71.00%) and untrained (75.50%) respondents had medium level of risk preference ability. The findings of the study revealed that majority of the trained (70.50%) and untrained (68.50%) respondents had medium level of scientific orientation. Regarding decision making ability majority of the trained (81.00%) and untrained (85.00%) respondents had medium level of decision making ability.

The study further revealed that majority of the trained (64.50%) and untrained (70.00%) respondents had medium level of extent of adoption, followed by 18.00 per cent of the trained and 16.50 per cent of the untrained respondents having low level of extent of adoption of recommended tea cultivation practices. Moreover, 17.50 per cent of the trained and 13.50 per cent of the untrained respondents had high level of extent of adoption of recommended tea cultivation practices.

A positive and significant relationship was found between extent of adoption and annual income, mass media exposure, extension contact, achievement motivation and scientific orientation of the trained small tea growers. On the other hand, size of operational land holding had a negative and significant relationship with the extent of adoption.

A positive and significant relationship was found between extent of adoption and mass media exposure and achievement motivation of the untrained small tea growers.

The two sample 't' test between independent variables result revealed that there was positive and significant difference between trained and untrained small tea growers with respect to type of family, mass media exposure and extension contact.

The two sample 't' test between dependent variable result revealed that there was positive and significant difference between trained and untrained small tea growers with respect to extent of adoption of recommended tea cultivation practices. It has been observed that trained small tea growers were good adopter of recommended tea cultivation practices than the untrained small tea growers.

The major problem faced by the small tea growers in adopting recommended cultivation practices as perceived by them were high cost of planting materials,

inadequate knowledge regarding infilling, high cost of some fungicides and fertilizer, inadequate knowledge in the use of pesticides, inadequate knowledge on soil pH and its management, lack of awareness about the method of propagation and advantages of mulching, non availability of pruning machine, lack of courage in taking risk, lack of proper guidance from linkage organisations, inadequate availability of land as per the activity to be carried out, poor economic status of STGs hamper mobilization of labour, lack of knowledge about proper techniques of marketing, high rate of interest of loan/credit, lack of proper transportation facilities and adequate training for skill development.

Farmers' Adoption Behaviour and factors affecting their 'Willingness to Pay' (WTP) for Climate Smart Agriculture (CSA) in Assam

Sundar Barman

Agriculture has become a high-risk profession towards climate change and weather variability, which have direct impact on farmers' socio-economic condition, and at the same time has to face challenge to provide food security for ever increasing population. So, there is a need to study the different aspects of climate smart agriculture. Keeping this in view primarily, the present study entitled 'Farmers' Adoption Behaviour and factors affecting their 'Willingness to Pay' (WTP) for Climate Smart Agriculture (CSA) in Assam' was carried out in four districts of Assam namely Dibrugarh, Sonitpur, Dhubri and Cachar in which NICRA programme has been implemented since 2011. The objectives of the study are as follows:

1. To study the degree of farmers' knowledge and adoption of CSA practices
2. To assess the farmers' preferences and their 'Willingness to Pay (WTP) for CSA practices and factors likely to influence thereon
3. To determine farmers' attitude towards 'Fee Based Extension Services' (FBES)
4. To document farmers coping strategies for mitigating effect of climate change and variability.

A purposive and proportionate random sampling method was used for selecting 400 farmers as respondents from four NICRA villages of respective districts. Appropriate statistical methods were used for analysis and interpretation of data.

The profile analysis of respondents showed that majority of respondents (60%) belonged to age group of 35-50 years with formal educational experiences 6 to 10 years having family size more than 7 members with agriculture as main occupation. The dependency ratio of family was found 64.90 to 304.18 % with average size of land holding as 3.79 ha out of which more than 66 per cent was lowland with average cropping intensity of 135.20 %. The average annual income was Rs.1, 05,000 of which 54 % income came from farm activities. Major proportion of respondents (68 %) had training exposure of 1-3 days with medium level of farm information source relevancy

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(60 %), market accessibility (55.50%), degree of commercialization (70 %) and degree of innovative proneness (68.75%) with 12-24 years of farm experiences.

The findings reveal that overall knowledge on selected CSA practices was of medium level for majority of respondents (69%). The adopters of overall selected practices were 79.85 per cent. The adoption consistency for overall selected CSA practices was of medium level for majority of respondents (58.25%). STVs, INM and IPM were found to be the most preferred and high degree of WTP while low degree of WTP was found for VC and MT. The LMR model showed that adoption consistency, degree of preference and WTP were expressed variation by selected explanatory variables with 23% ($R^2=0.23$), 51% ($R^2=0.51$) and 74% ($R^2=0.74$) respectively. 'Age' (X_1), 'dependency ratio of family' (X_3), 'proportion of low land' (X_4), 'market accessibility' (X_7) and 'cropping intensity' (X_9) were found to have positive and significant influence on adoption consistency while dependency ratio of family (X_3), 'proportion of low land' (X_4), institutional contact (X_6), 'market accessibility' (X_7) degree of commercialization' (X_{10}) and 'adoption consistency' (X_{13}) recorded to have positive but age (X_1), annual farm income (X_5) and 'farm experience' (X_8) have negative and significant influence on farmers' degree of preferences. In case of WTP, educational experience' (X_2), 'market accessibility' (X_7) 'cropping intensity' (X_9), 'adoption consistency' (X_{13}) and 'degree of preferences to CSA practices' (X_{14}) were found to have positive while variable 'age' (X_1) and 'institutional contact' (X_6) have negative and significant influence on WTP. Perception of farmers about climate change was found complementary with realities as most of the farmers disagree with change of temperature, rainfall over last 20 years. Majority of respondents (54.75 per cent) had unfavorable attitude towards FBES while middle age group with occupation agriculture, agriculture +service and agriculture + wage earner had favourable attitude but medium and large farmers had unfavourable attitude towards FBES. Farmers with low and high institutional contact had favourable attitude but high income group farmers had unfavourable attitude. Farmers' coping strategies such as 'transplanting of *Bao* paddy during May-June instead of normal practice *i.e.* direct sowing during March-April', 'erecting solar electrical wire with low voltage in the boundary of crop cultivation area' 'selling of livestock before onset of summer season' change of cropping sequence rice - *rabi* vegetables to rice-maize, staggered sowing of seed with high rate, Community seed bank for paddy crop were followed for mitigating adverse effect of climate change.

Extension agencies, both public and private should put forward strategic effort to make farmers aware of climate change and its impact on food production, popularizing these technologies need to be taken care of in other similar areas, systematic assessment of other CSA practices available in the research front, different stakeholders (both public and private) in input and output chains should work in convergence mode as a common entity so that farmers get necessary environment for adoption of technologies.

Determinants of adoption in regard to recommended cultivation practices of rice (*Oryza sativa*) and maize (*Zea mays*) in the state of Nagaland

Zujanbemo Khuvung

Agriculture is considered as the backbone of Nagaland's economy where the majority of the population depends on agriculture. Major variants of cereals produced in Nagaland are rice, maize and millet. The two methods of cultivation among the Naga tribes are jhum and terrace cultivation which makes about 86 per cent of the total cultivable area in Nagaland. Emphasis on improving the production and productivity of agriculture is crucial to bridge the gap between the demand and supply of food grains. The present study on Determinants of adoption in regard to recommended cultivation practices of rice (*Oryza sativa*) and maize (*Zea mays*) in Nagaland was carried out in the state of Nagaland. The objectives of the study were measure the extent of adoption in regard to recommended cultivation practices of rice and maize in Nagaland, find out determinants of adoption of rice & maize production technology, identify the constraints faced by the farmers while adopting recommended cultivation practices, solicit suggestions from the research scientists, development workers and policy makers on measures for enhancing the production and productivity of rice and maize in Nagaland and develop a strategy to increase the rate of adoption of recommended rice and maize production technology. The study was taken up in six districts of Nagaland with a sample size of 300 farmers. Eighteen independent variables viz., age, gender, education, family type, family size, occupation, operational land holding, annual income, farming experience, social participation, information sources utilization, extension contact, cosmopolitaness, innovativeness, economic motivation, scientific orientation, achievement motivation and attitude towards shifting cultivation with extent of adoption as dependent variables were studied. The respondents were interviewed personally with the help of structured interview schedule. The data collected were coded, tabulated and analyzed using frequency, percentage, mean, standard deviation, co-efficient of variance, Karl Pearson's co-efficient of correlation and multiple linear regression analysis. The

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Department : Extension Education

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profile of the farmers revealed that more than half (59.7%) of the respondents were medium aged and were males (65.7%), less than one-third of them were illiterates (31.7%), majority belonged to nuclear family type (86%) and more than half (51.7%) of them had family size of 3-5 members. A little more than two-third (67.7%) of the farmers did cultivation as occupation, majority (46%) had marginal operational land holding, 80.67 per cent had medium (<Rs. 12009->Rs. 80905) income level, more than half (57.7%) of them had 13-32 years of farming experience, less than half (49.3%) of the farmers had no membership in any organization, 47.67 per cent of them had medium level of information sources utilization and 51.67 per cent had medium level of extension contact. Majority (23.66%) of them had contact with ATMA officials, 67 per cent of them visited town for agriculture purpose. More than half (69.67%) of the respondents had medium level of innovativeness, 45.67 per cent had medium level of economic motivation, 62 per cent having medium level of scientific orientation, 56.67 per cent having medium level of achievement motivation while 63.7 per cent of them had moderate level of attitude towards shifting cultivation. Majority (60.67%) of the farmers had medium level of adoption of recommended cultivation practices of irrigated rice, 60 per cent had medium level of adoption of recommended cultivation practices of upland rice and 69 per cent had medium level of adoption of recommended cultivation practices of maize.

The computed correlation coefficient value of family size ($r=0.946^*$) showed a positive significant relationship with extent of adoption of recommended cultivation practices of irrigated rice, while sixteen independent variables with the extent of adoption of recommended practices of irrigated rice taken on multiple linear regression analysis gave the co-efficient of multiple determination (R^2) value of 0.913. The variables namely family size ($b=2.209^*$), social participation ($b=0.377^*$) and economic motivation ($b=1.121^*$) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of irrigated rice. The computed correlation coefficient values of family size ($r=0.944^*$) and annual income ($r=0.160^*$) were positively and significantly correlated with the extent of adoption of recommended cultivation practices of upland rice, while sixteen independent variables with the extent of adoption of recommended practices of upland rice by the farmers taken on multiple linear regression analysis gave the co-efficient of multiple determination (R^2) value of 0.905. The variables namely age ($b=0.103^*$), family size ($b=3.449^*$) and scientific orientation ($b=0.121^*$) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of upland rice. The computed correlation coefficient values of operational land holding ($r=0.197^*$), information sources utilization ($r=0.931^*$), extension contact ($r=0.905^*$), innovativeness ($r=0.958^*$), economic motivation ($r=0.941^*$) and achievement motivation ($r=0.945^*$) were positively and significantly correlated with the extent of adoption of recommended cultivation practices of maize.

and annual income ($r=-0.263^*$) was found to be negatively significant. Sixteen independent variables with the extent of adoption of recommended practices of maize by the farmers taken on multiple linear regression analysis gave the co-efficient of multiple determination (R^2) value of 0.954. Variables namely family size ($b=0.097^*$), information sources utilization ($b=2.050^*$) and innovativeness ($b=1.067^*$) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of maize. Whereas annual income ($b=-4.685^*$) and extension contact ($b=-0.452^*$) were found to be negatively significant with extent of adoption of recommended cultivation practices of maize. Non-availability of quality seeds, lack of proper financial assistance and subsidies, non-availability of timely farm inputs and machineries, pest and disease incidence, lack of storage facilities and processing units, low market value for crops, lack of marketing facilities and channels, lack of proper interactions between farmers and extension service providers, lack of result-oriented trainings and demonstrations, weather uncertainty, high cost of fertilizers and lack of knowledge of government schemes and incentives and proper irrigation and drainage facilities were some of the major constraints highlighted by the farmers while adopting recommended cultivation practices of rice and maize. Some of the strategy proposed to increase the production of rice and maize in Nagaland were timely supply and use of high yielding varieties and hybrid seeds, System of Rice Intensification, Crop Diversification in maize crop, Integrated Nutrient Management (INM), Integrated Pest & Disease Management (IP&DM), Water Resource Management, Improved farm mechanization, Integrated Farming System (IFS) Approach and Participatory Research and Development.

Performance of Strawberry (*Fragaria × ananassa* Duch.) cultivars under open and protected conditions

Bhoirab Gogoi

An experiment was carried out in the Experimental Farm, Department of Horticulture, College of Agriculture, AAU, Jorhat during 2016-17 and 2017-18 to study the performance of Strawberry (*Fragaria x ananassa*) cultivars under open and protected conditions in subtropical climatic condition of Assam. Twenty eight combinations were laid out in the field in Split Plot Design with three replications and four planting time. The treatments comprised of seven varieties namely, Subrina (T₁), Winter Dawn (T₂), Chandler (T₃), Sweet Charlie (T₄), Cristal (T₅), Selva (T₆) and Camarosa (T₇) and planting time of 1st November (S₁), 15th November (S₂), 1st December (S₃), 15th December (S₄), respectively.

All the varieties were planted in open condition and net house. All the varieties were planted in three replications in each situation. All together 28 treatment combinations were laid out in Split Plot Design with three replications. The variety Subrina recorded maximum plant height (16.17 cm) in open condition while it recorded (17 cm) in 50 per cent shade net house condition. Again in planting time maximum Plant height was achieved in 15th November (S₂) in both open condition and net house. The Variety Winter Dawn recorded maximum number of leaf at flowering (14.25) in open and (11.50) in 50 per cent shade net house condition. In both the growing conditions the maximum number of leaves were recorded in 15th November (S₂) of (13.33) in open condition and (11.52) in 50 per cent shade net house condition respectively. Again the variety Winter Dawn recorded the maximum leaf area of (64.67 cm²) and (62.33 cm²) respectively in open condition and net house conditions respectively. In both the growing conditions maximum leaf area was recorded at 15th November (S₂) of (58.05 cm²) in the open condition while it recorded (56.29 cm²) in the 50 per cent shade net house. The plant spread recorded maximum in Sabrina (22.23 cm) in open condition and in 50 per cent shade net house it recorded (24.17 cm). In both the planting condition maximum plant spread is recorded in 15th November (S₂) with (20.05

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cm) and (21.17 cm) respectively. In terms of Number of Crowns per plant (3) and (3.25) were recorded by Sabrina in open condition and (11.52) in 50 per cent shade net house condition respectively. In days to flowering the minimum days were recorded in Winter Dawn of (22.25 days) in open condition and (27.75 days) in 50 per cent shade net house.

In Days from flowering to maturity of fruits the minimum days were recorded in winter dawn of (26.00 days) in open condition and (27.08 days) in 50 per cent shade net house respectively. The maximum numbers of fruits per plants were recorded in Winter Dawn of (12.92) in open condition and (11.25) in 50 per cent shade net house. Winter Dawn recorded the height fruit weight of (14.69 g) in open condition and (13.49 g) in 50 per cent shade net house respectively. In both the planting condition the maximum fruit weight were recorded (12.40g) and (11.55g) at 15th November (S₂). The variety Winter Dawn recorded maximum fruit length and fruit diameter of (3.82 cm) in open condition, (3.68 cm) in 50 per cent shade net house and (3.57 cm) in open and (3.45 cm) in 50 per cent shade net house respectively. In both the parameters of fruit length and fruit diameter 15th November (S₂) recorded the maximum fruit length and fruit diameter of (3.33 cm), (3.33) cm and (2.88 cm), (2.98 cm) in open condition and 50 per cent shade net house respectively. In fruit production, Winter Dawn recorded the highest of (231.33 g per plant) in open condition while it recorded (207.83 g per plant) in 50 per cent shade net house. In both the planting condition maximum fruit production was recorded in 15th November (S₂) of (182.62 g per plant) and (171.14 g per plant) respectively.

Qualitative characters of fruits in terms of Anthocyanin content and Total Soluble Solids the variety Sweet Charlie recorded (21.07 mg/100g) and (7.62⁰ Brix) in open condition and (18.71 mg/100g) and (6.88⁰ Brix) in 50 per cent shade net house respectively. In both the parameters the highest Anthocyanin content and Total Soluble Solid was recorded in 15th November (S₂) of (20.30 mg/100g), (6.64⁰ Brix) in open condition and (17.56 mg/100g), (6.39⁰ Brix) in 50 per cent shade net house respectively. Again the variety Sweet Charlie recorded the height Titratable acidity of (0.62%) in Open condition while Winter Dawn received the highest Titratable acidity (0.62%) in 50 per cent shade net house. In Ascorbic Acid Content the variety Cristal recorded (30.29 mg/100g) in Open condition and in 50 per cent shade net house it recorded (26.19 mg/100g). In Total Sugars, Non Reducing Sugar and Reducing sugar the variety Sweet Charlie recorded (6.07%), (3.26%) and (3.28%) in open condition respectively where as it recorded (4.60%), (2.41%) and (2.17%) in 50 per cent shade net house respectively. In all the planting conditions the planting time 15th November (S₂) recorded the maximum Total Sugars, Non Reducing Sugar and Reducing sugar of (6.32%), (3.23%) and (3.20%) in the open condition respectively and (4.55%), (2.36%) and (2.18%) in 50 per cent shade net house respectively. Maximum Calcium and Phosphorus content was recorded in Sabrina of (9.35 mg/100g) and (1.15 mg/100g) respectively in open condition and (9.41 mg/100g) and (1.09 mg/100g) in 50 per cent shade net house respectively. In all the planting conditions the planting time 15th November (S₂) recorded the maximum Calcium and Phosphorus content of (8.60 mg/100g) and (0.93

mg/100g) in open condition and (8.50 mg/100g) and (0.83 mg/100g) in 50 per cent shade net house respectively. In open condition the highest B:C ratio (2.67) was recorded in Winter Dawn (V_2). The variety Winter Dawn (V_2) recorded the highest B:C ratio (2.52). There were significant differences in B:C ratio with respect to the Planting time. In the open condition maximum B:C ratio (2.50) was recorded in S_2 (15th of November) and in 50% Shade Net house condition there were also significant differences in B:C ratio among the planting time. The highest B:C ratio (2.34) was recorded in S_2 (15th of November).

Organic cultivation of Papaya (*Carica papaya* L.) under varied growing conditions

Bikash Hazarika

Investigations on “Organic cultivation of Papaya (*Carica papaya* L.) under varied growing conditions” have been conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period 2015-2018. The field experiment was laid out in Factorial Randomised Block Design (RBD) with four treatments replicated three times under three different growing conditions with spacing of 2m × 1.5m. The three different growing conditions were rain shelter with insect proof net (S1) (top covered with 200 micron UV film and side wall of 40 mesh net), rain shelter without insect proof net (S2) and Open condition. Treatment were FYM @ 5kg/plant (T1), Vermicompost @ 3kg/plant + Microbial consortium @ 20 g/plant (T2), Enriched compost @ 3kg/plant + Microbial consortium @ 20 g/plant (T3) and Compost @ 3 kg/plant + Microbial consortium @ 20 g/plant. The results revealed that most of the morphological characteristics were significantly influenced by combination of treatment and growing conditions. Among the combinations of treatment and growing conditions, T3S1 was the best in increasing growth characteristics *viz.*, plant height (203.30 cm), collar girth (15.50 cm), number of leaves (42.17), number of lobes in leaf (14), petiole length (54.67 cm), number of flowers (24.50) at 240 DAP and also initiated earliness in flowering. Number of fruit per plant (27.83), average fruit weight (1.45 kg), fruit yield (40.22 kg/plant) was also found to be significantly higher in T3S1 in both the years. The study on nutrient status of the soil revealed that the available N (285.89 kg/ha), P (66.35 kg/ha) and K (146.34 kg/ha) content, Organic carbon (0.92%), soil pH (5.69), microbial population *viz.*, bacteria (7.22 log cfu g⁻¹ soil) and fungi (5.63 log cfu g⁻¹ soil) and activity of soil enzyme *i.e.*, Phosphomonoesterase (410.94 µg *p*-nitrophenol g⁻¹ soil hour⁻¹) were found to be significantly higher for both the year in treatment combination T3S1. On the basis of results obtained in present investigation, it can be concluded that Papaya plant grown under rain shelter with insect proof net (S1) (top covered with 200 micron UV film and side wall of 40 mesh net) and treated with soil application of Enriched compost @ 3kg/plant + microbial consortium 20 g/plant (T3) *i.e.*, T3S1 resulted in higher economic return (2.13) during 2017-18, with improvement in fruit quality of papaya *cv.* Sinta.

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Department : Horticulture

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Morpho-biochemical characterization of Jackfruit (*Artocarpus heterophyllus* Lam.) types of Assam

Biswajit Dey

Jackfruit (*Artocarpus heterophyllus* Lam) is an underutilized fruit of Assam. It is mostly grown as backyard crop in homestead garden. The fruit is a good source of energy, vitamins, minerals, flavonoids, etc. Jackfruit is indigenous to the rain forests of the Western Ghats of India. Most jackfruit plants are of seedling origin in the region and thus tend to exhibit a wide range of variability in terms of morphological and biochemical parameters. Therefore, an investigation was undertaken during 2016-2018 on 'Morpho-biochemical characterization of jackfruits (*Artocarpus heterophyllus* Lam) of Assam to study the existing variability. One district in each of the six agro climatic zones was chosen and four plants were selected in each district, comprising of twenty four plants. Wide variability was observed among the selected jackfruit accessions for morphological characters. Variability in crown shapes like irregular, elliptical, oblong and spherical were observed. Wide variations in leaf blade shape i.e. elliptic, obovate, oblong, broadly elliptic and narrowly elliptic were recorded in the selected jackfruits. Different fruit shapes like ellipsoid, spheroid, oblong, clavate, oblong and irregular were recorded in the selected accessions. Flake texture and flake flesh colour also showed wide variation. In seeds, different seed shapes such as ellipsoid, irregular, reniform, spheroid and oblong were recorded. Cluster analysis of 23 qualitative characters using Average Linkage Between Groups resulted in grouping of the jackfruit accessions into eight non-overlapping clusters. Cluster I consisted of 6 accessions, Cluster II consisted of 4 accessions, Cluster III consisted of 5 accessions, Cluster IV consisted of 2 accessions, Cluster V consisted of 2 accessions, Cluster VI consisted of 2 accessions, Cluster VII consisted of 2 accessions and Cluster VIII had only 1 accession. The clusters formed did not comprise of accessions based on geographical location indicating that qualitative traits were largely influenced by genetic factors. The quantitative characters of flower, leaf and fruit showed significant variation among the jackfruit accessions. The highest tree height and trunk circumference recorded was 18 m and 198 cm respectively (SON2) and the lowest recorded was in 7 m and 120 cm respectively (CAC3). The

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number of fruits per tree ranged from 9 to 68 with an average of 26.25. The highest fruit weight among the accessions recorded was 10.89 kg (GLP3) while the highest fruit length was 46.67 cm (SON1). The highest number of flake per kg of fruit recorded was 38.18 (SON4) while the highest weight of flake per kg of fruit recorded was 0.54 kg (SON1). The highest flake seed ratio observed was 7.29 (CAC3) while the highest 100-seed weight recorded was 900g. In terms of biochemical constituents, the highest TSS recorded was 29.70°Brix while the highest TSS: acid ratio recorded was 229.57. The highest total sugar recorded was 26.87% (NAG2) while the highest ascorbic acid content recorded was 14.29 mg/100g (CAC1). The highest crude fibre content recorded was 3.17% and the highest total flavonoid content recorded was 127.45mg QE/100g. The highest antioxidant activity was recorded in accession number CAC1 (80.12%) and the lowest antioxidant activity was recorded in accession number JRT1 (32.46%). The lowest IC₅₀ value was recorded in accession number CAC1 (0.62 mg) indicating high antioxidant potential over all other accessions. The seed biochemical constituents also showed significant variations. The highest seed crude protein content was recorded in accession number SON4 (21.18%), while the highest starch was reported in accession JRT1 (35.30%). The highest total mineral (ash) content was recorded in accession number SON2 (5.18%) and the lowest in accession number KA4 (2.89%). The effect of locations on quantitative characters was found to be non-significant. Fruit length and diameter of jackfruit accessions showed significant positive correlation with fruit weight. A significant positive correlation was also found between fruit weight with number of flakes per kg of fruit and weight of flake per kg of fruit. Among the biochemical parameters, the correlation between ascorbic acid and total antioxidant activity was found to be highly significant.

Post- Harvest Quality Enhancement in Banana cv. Grand Naine

Swosti Debapriya Behera

An experiment on “Post harvest quality enhancement in banana cv. Grand Naine” was conducted in kharif season of 2017-18 and 2018-19 in the Orchard and Quality Control laboratory, Department of Horticulture, Assam Agricultural University, Jorhat to study the effect of various pre and post harvest treatments on post harvest quality and shelf life of banana. Two pre harvest treatments B1 (Bunch spray of sulfate of potash 2% + calcium chloride 2%), B2 (Bunch spray of sulfate of potash 2% + micro nutrient Tracel 2%) and six post harvest treatments H1(Dipping hands in 1% chitosan solution for 2 minutes), H2 (Dipping hands in 30 ppm Benzyl adenine solution for 10 minutes), H3 (Dipping hands in 2% calcium chloride solution for 5 minutes) H4 (Dipping hands in 1% Garlic extract for 4 hours), H5 (Dipping hands in Gibberelic acid 150 ppm solution for 1 minute), H6 (Control or Hands without any treatment) were applied to fruits. Fruits were subjected to post harvest treatments immediately after harvest and kept at ambient conditions (mean temp. 21.8 + 2.3°C; mean RH 85 + 10%). Physicochemical properties and enzyme activities were studied at harvest and across storage at 3 days (S1), 6 days (S2), 9days (S3) and 12 days (S4). The laboratory experiment was laid out in a factorial completely randomized block design with three replications. Among pre harvest treatments, sulfate of potash 2% + micro nutrient (Tracel 2%) proved better in improving fruit qualities. On 12th days after storage, maximum TSS (25%), Reducing sugar (17.83%) , Non reducing sugar (11.13%) and Total sugar (28.97%) were recorded in B1H6 (spray of sulfate of potash 2% + calcium chloride 2% + control) while minimum content was found in B2H5 (sulfate of potash 2% + micro nutrient (Tracel 2%) + GA3 150 ppm i.e. 18.72%, 9.03%, 7.40% and 16.44%, respectively. B2H6 registered the lowest titrable acidity (0.32%) which was followed by B1H6 (.322%) and B2H1 (0.357%). Maximum retention of ascorbic acid (4.71 mg/100g), crude protein (3.25%), crude fibre (0.42%), pectin (2.38%) and the lowest phenol content (25.50 mg/100g) were obtained in B2H5 . Pectin methyl esterase activity in pedicel was the highest i.e. 37.34 units / mg protein on 12th days of storage in

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B1H6 and the lowest activity (20.84 units / mg protein) was found in B2H5. In pedicel, its activity was higher than that of peel. Physiological loss in weight (PLW) and rotting of fruits were increased during storage. B2H5 recorded the lowest PLW (10.39%) on 12th days after storage and absence of rotting of fruits which was followed by B2H3 (10.92%). Organoleptic qualities of fruits were found to decrease with the advancement of storage period. The highest score values in respect of colour (9), flavour (8.67) and overall acceptability (9) were obtained in sulfate of potash (2%) + Tracel 2% + post harvest treatment of Gibberelic acid 150 ppm followed by sulfate of potash (2%) + Calcium chloride (2%) + Post harvest treatment of Gibberelic acid 150 ppm which was having highest taste score (9) and texture value (8.73). Maximum shelf life of 15 days was recorded in sulfate of potash (2%) + Tracel 2% + post harvest treatment of Gibberelic acid 150 ppm while the lowest of 9 days was found in sulfate of potash (2%) + Calcium chloride (2%) + Control. The former treatment is also very cost effective while comparing with other treatments. Thus, it may be suggested that pre harvest treatments with sulfate of potash (2%) + Tracel 2% and post harvest treatment of Gibberelic acid 150 ppm (1 min) appeared to be the best treatment with minimum pectin methyl esterase activity, physiological weight loss, rotting and microbial activities retaining maximum pectin, crude fibre, protein which extended the shelf life up to 15 days at ambient conditions.

Technological improvement of the traditional manufacturing process for development of fruit flavoured rice beer

Francis Dutta

An investigation was carried during 2016-2020; to standardize the production process of fruit flavoured rice beer from bora (glutinous rice) and black rice, and evaluate the quality of the manufactured beers. Contrary to the traditional one, an alternate method of rice beer preparation by using malted rice was undertaken with the focus on developing a product with stable storage life and appreciable quality parameters. It was observed during the discourse that both the rice varieties selected can be effectively malted and individual fruit flavours can be infused in the brewing process. The beers developed from both the malted rice showed similar quality and nutritional parameters. The range of alcohol content of the developed beers from bora and black rice was 4.92-5.42 % (v/v) and 4.67-5.32 % (v/v) respectively. The highest alcohol content was recorded in the jackfruit flavoured bora rice beer (5.42% v/v). Total phenol content was maximum in the jackfruit flavoured bora rice beer (31.97 mg mL⁻¹) and the highest flavonoid was detected in the jackfruit flavoured black rice beer (23.33 mg mL⁻¹). The range of total carbohydrate in the developed beers from bora rice and black rice was 3.13-3.53 g 100 mL⁻¹ and 3.03-3.43 g 100 mL⁻¹ respectively. The microbial load of the developed beverage was highest on 3 days with a decline on 7 days. Owing to clarification and pasteurization of the beverage, there wasn't any visible microbial load on 15 days. The developed beers from both the rice obtained good ratings in sensory evaluation, with the exception of the mixed fruit flavoured ones. No off-flavour was revealed and beer like character was confirmed. Product characterization of the beverages revealed that jackfruit and banana flavoured bora rice beers and jackfruit, banana and pineapple flavoured black rice beers scored significantly high scores. The developed products showed remarkable stability across storage at 4 °C, which was one of the most important highlights of the discourse.

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Department : Horticulture

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Characterization and evaluation of sponge gourd [*Luffa cylindrica* (L.) Roem.] germplasm of Assam

Ira Sarma

The present investigation entitled “Characterization and evaluation of sponge gourd [*Luffa cylindrica* (L.) Roem.] germplasm of Assam” was conducted at the farm site of Krishi Vigyan Kendra, Jorhat, Assam Agricultural University (AAU) during 2017 and 2018 and at the Department of Horticulture, AAU, Jorhat during 2019. The experimental material comprised of thirty-three genotypes of sponge gourd collected from different parts of Assam during 2016 and 2017. The experiment was laid out in a Randomized Block Design (RBD) with two replications. For the qualitative traits observed during 2017, it was found that all the genotypes had angular stems, branched tendrils, dentate leaf margins, prostrate growth habit, yellow coloured flowers, monoecious sex type, low dorsal and ventral leaf pubescence, white coloured flesh and black coloured seeds indicating monomorphism of these traits. Leaf lobe with shallow, intermediate or deep types, fruits with elliptical, elongate elliptical, elongate tapered or elongate slim shapes and fruits with green, light green or dark green colour were noticed as polymorphic traits to distinguish the sponge gourd germplasm in to phenotypic classes. Analysis of variance during 2017 and 2018 revealed significant mean square due to genotype for all the quantitative characters under study. The characters studied were primary branches (PB), internode length (IL), petiole length (PL), days to appearance of first male flower (DAFMF), days to appearance of first female flower (DAFFF), internode number (IN), vine length (VL), node number to first female flower appearance (NNFFFA), days to first fruit harvest (DFFH), peduncle length (PDL), fruit length (FL), fruit diameter (FD), female flowers per plant (FFPP), fruits per plant (FPP), fruit weight (FW), male-female flower ratio (MFFR), seeds per fruit (SPF), marketable fruit yield per plant (MFYPP) and marketable fruit yield per hectare (MFYPH). Across the years, SGG29 and SGG30 gave the highest estimates of PB and FL, respectively while SGG30 had the highest FPP. SGG29, SGG26 and SGG32 had the highest FW while SGG29 and SGG26 had the lowest DFFH across the years. SGG29 gave the highest value of MFYPP while the genotypes *viz.*, SGG29, SGG30, SGG33 and SGG7

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gave the highest MFYPH across the years. GCV was high for the characters namely, PB, IL, PDL, FL, FPP, SPF and MFYPP during 2017 while it was high in PB, PDL, FL, SPF and MFYPP during 2018. All the characters except VL in 2017 had high heritability (h^2) coupled with high genetic advance as per cent of mean (GAM%). These traits indicate preponderance of additive genetic effects. Correlation studies revealed that MFYPP had highly significant positive correlation with PB, IN, FFPP, FPP and FW at both genotypic and phenotypic levels in both the years. MFYPP had significant to highly significant negative correlation with IL, DAFMF, DAFFF and DFFH at both genotypic and phenotypic levels. Path analysis studies showed that direct effects of FPP and FW on MFYPP were large at both genotypic and phenotypic levels. FFPP and IN had large and positive indirect effects on MFYPP via FPP in both the years at both genotypic and phenotypic levels. Among the nutritional traits analyzed from the marketable fruits of 2018, the highest protein content was observed in the genotypes *viz.*, SGG7, SGG12, SGG16, SGG15, SGG32 and SGG26. Both the ash as well as iron contents were the highest in SGG10, SGG22, SGG16, SGG27 and SGG12. Highest fat content was observed in five genotypes namely SGG32, SGG20, SGG30, SGG4 and SGG15. Two genotypes exhibited the highest amount of carbohydrates in the investigation and they were SGG7 and SGG29. The genotypes were constellated in to various clusters using unweighted neighbor-joining (UNJ) method based on Euclidean distances as dissimilarity measures for the quantitative characters. Each of cluster I and cluster II was divided into two sub-clusters while the cluster III contained only one and the same genotype during both 2017 and 2018. The cluster mean values suggest that superior performing genotypes of cluster I should be crossed to those of cluster II based on the data of 2017 and superior performing genotypes of cluster II should be crossed to those of cluster I as per data of 2018 to produce productive hybrids.

Characterization and heterotic studies in brinjal (*Solanum melongena* L.) during *kharif* season

Jamini Saikia

Studies on characterization of germplasm, estimation of genetic parameters and determination of heterotic ability in hybrids were performed for various morphological and biochemical traits in thirty genotypes along with four (F_1) progenies of brinjal (*Solanum melongena* L.) in a Randomized Block design with three replications at Assam Agricultural University, Jorhat during *kharif* season, 2017. Among the qualitative traits, the variability among the genotypes was revealed by fourteen traits. The analysis of variance revealed highly significant differences among the genotypes for all the fifteen morphological and six biochemical characters studied. The mean performance of genotypes indicated that the genotypes Kuchia, Brinjal-3, Khoruah-1, Brinjal-6, Brinjal-8, Brinjal-4, Seujia Bengena, Brinjal-1, Brinjal-9, Brinjal-2, Brinjal Long, Green Long, Boga Bengena, Kajala, Sagolishingia, Long Khoruah, Brinjal-7 and Koni Bengena were found to be superior for plant height, plant spread, number of branches per plant, days to first flowering, days to 50% flowering, number of fruits per plant, fruit yield per plant and fruit yield per hectare during *kharif* season and all these genotypes can be use for strengthening of the landraces. Among the F_1 hybrids, JC-1 x Khoruah-1 was found to be the best in respect of plant height, plant spread, fruit weight, fruit yield per plant and fruit yield per hectare while Kuchia x JC-1 recorded the highest value for number of primary branches per plant, leaf blade length, days to first and 50% flowering, fruit pedicel length, fruit length and number of fruit per plant. In biochemical traits, the same hybrids JC-1 x Khoruah-1 and Kuchia x JC-1 showed better performance for most of the characters *viz.*, crude protein content and ascorbic acid content with less solasodine content. The values of GCV and PCV for all the traits except for plant height, plant spread, leaf blade length, leaf blade width, days to first flowering and days to 50% flowering indicating the less influence of environment on the traits. Estimates of high heritability and high genetic advance as per cent of mean were recorded for the characters except days to first flowering and days to 50% flowering indicating that the characters were least influenced by the environmental effects and the

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improvement of these characters would be possible through simple selection methods such as mass selection. All the hybrids namely, Brinjal-1 x PPL followed by JC-1 x Khoruah-1, Brinjal-3 x JC-1 and Kuchia x JC-1 exhibited high positive MP and BP heterosis for yield/plant, yield/hectare and fruit weight. Among the genotypes including the hybrids, Kuchia, Brinjal-3, Khoruah-1, Brinjal-6, Brinjal-8, Brinjal-4, Seujia Bengena, Brinjal-1, Brinjal-9, Brinjal-2, Brinjal Long, Green Long, Boga Bengena, Kajala, Sagolishingia, Long Khoruah, Brinjal-7 and Koni Bengena, JC-1 x Khoruah-1, Brinjal-3 x JC-1, Brinjal-1 x PPL and Kuchia x JC-1 were found to be the most promising genotypes for *kharif* season.

Morphological, bio-chemical and molecular study in some upland taro [*Colocasia esculenta* (L.) Schott] cultivars

Khatemenla

A study entitled “**Morphological, bio-chemical and molecular study in some upland taro [*Colocasia esculenta* (L.) Schott] cultivars**” was carried out to characterize 22 taro cultivars collected from four North Eastern states of India using morphological, bio-chemical and molecular markers. The experiment was carried out in the experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016 and 2017. The experiment was laid out in RBD with three replications. Characters like plant height, plant span, leaf area index, number of suckers, number of inflorescence per leaf axis, corm length, diameter of corm, corm weight, number of cormels, diameter of cormel, yield per plant, starch content, ash content and oxalate content contributed maximum to the variation among the cultivars. The dendrogram developed based on morphological and biochemical data grouped the 22 cultivars into two main clusters i.e. ‘CL-I’ and ‘CL-II’. The first cluster consisted of cultivars like Takali, Muktakesh, Sree Kiran, AAU-Col-32, JCC-31, Damor Dema, Boga Ahina, Kaka, Panch Mukhi, Red Garo, Naga, AAU-Col-39, Ghoti and AAU-Col-5. The second cluster consisted of cultivars like Garo, Makhuti, AAU-Col-46, Arunachal-2, Koni, Ahina, Karbi Anglong and Bor-Kochu. The molecular characterization of the 22 taro cultivars revealed that SSR primers like uq201-302, Ce1 B03 and Ce1 C06 with PIC=0.82, 0.76 and 0.76 respectively were found to be the most informative markers which can be used for future molecular works on taro. There were no true duplicates detected among the cultivars. The dendrogram constructed based on the molecular study categorized the 22 cultivars into two main clusters ‘CL-I’ and ‘CL-II’. Only one cultivar Damor Dema was clustered in CL-I. The second cluster CL-II contained the remaining 21 cultivars. Geographical origin of the cultivars did not bear any relationship with the morphological, bio-chemical and molecular classification. Characterization of taro cultivars using morphological, bio-chemical and molecular markers would contribute to the knowledge of genetic relationships between different taro cultivars, thereby facilitating plant breeding programmes and *ex-situ* conservation of plant genetic resources.

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Major Advisor : Dr. S. Alam

Genetic diversity analysis in tuberose (*Polianthes tuberosa* L.) cultivars and their aromatic variation

Kishalayee Gogoi

An experiment was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016-17 and 2017-18, to study the “Genetic diversity analysis in tuberose (*Polianthes tuberosa* L.) cultivars and their aromatic variation”. The experiment was laid out with eighteen tuberose cultivars in Randomized Block Design (RBD) with three replications. Observations were recorded for growth, flower and physiological characters. Results indicated that morphological traits based on DUS guidelines contributing largely to the variability were those related to leaf colour, leaf variegation, pigmentation at leaf base on abaxial side, bud and flower colour, flower type, rows of tepal, tepal tip, inflorescence, flower shape, flower tube shape, style shape, stigmatic lobes, stigma type, anthers, tepal colour on abaxial side, fruit setting, bud length, flower diameter and days taken for flowering. There were significant variations among the cultivars for quantitative characters. The mean performance of cultivars for quantitative traits revealed that cv. Vaibhav exhibited maximum for most of the flower and bud characters viz., spike length (88.33cm), rachis length (64.50cm), number of florets per spike (39.16), length of floret (6.63cm), diameter of stalk (1.02cm), weight of floret (4.38g), fresh weight of spike (106.25g), diameter of rachis (0.87cm), number of spikes per bulb planted (2.83), duration of single flower (7.83days), duration of spike (30.50days), vase life of floret (6.17days), vase life of spike (16.83days), number of economic bulbs produced per bulb planted (10.67), bulblets weight (35.33g), weight of clump (459.16), size of bulb (4.16cm), yield of floret per spike (169.85g), yield of floret per m² (1358.67g) and yield of floret per ha (13586.63kg). Cv Arka Nirantara exhibited maximum for plant height (104.33cm), leaf length (51.50cm), leaf breadth (2.83cm), leaf area index (299.40) and took minimum days for bulb sprouting (12.17days), spike emergence (74.83 days) and opening of first pair of floret from spike emergence (16.00days).

Based on D² values, the cultivars were grouped into seven clusters. Maximum inter cluster distance was observed between cluster 6 (Phule Rajani) and cluster 3 (Subhasini and Vaibhav). Traits viz., duration of spike, number of spike per bulb planted

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and yield per spike had highest contribution towards genetic divergence. Marker analysis showed two primers UBC814 and UBC 815 resulted 100% polymorphism across all the populations and primer UBC 814 showed highest PIC value of 0.42. Three major clusters were formed using 7 primers.

The estimates of PCV and GCV were very close for yield of floret per spike, yield of floret per m², floret weight, moisture content, fresh weight of spike, diameter of rachis, vase life of spike, vase life of floret, weight of clump, size of bulb, days to spike emergence, days to opening of first pair of floret, which were also reflected in their respective high heritability estimates. That means there is considerably high genetic variation and environment effect is less for these characters. Yield of florets per spike, yield of florets per m² and floret weight exhibited high heritability and high genetic advance. So these characters are predominantly controlled by additive gene.

Correlation studies revealed that at genotypic level significant positive correlation of yield of floret per spike was observed with leaf length, leaf breadth, leaf area index, rachis length, no of florets per spike, length of floret, diameter of spike, number of economic bulbs produced per bulb planted, bulb weight, bulb size, flower weight, vase life of spike, vase life of floret, moisture content, fresh weight of spike, duration of spike, duration of Single flower, diameter of rachis and number of spike per bulb. Path analysis revealed that fresh weight of spike showed the highest and positive direct effect on yield of floret per spike. Highest positive and indirect effect was observed in floret weight via duration of floret. So these traits may be used as selection criteria for the improvement of yield of tuberose cultivars.

Aromatic variation of six cultivars were observed and found that single cultivars contain more concrete % than double cultivars. Cultivar Shringar results highest concrete% among the six cultivars. The chemical composition of the tuberose absolutes were analyzed by gas chromatography-mass spectrometry (GC-MS). Major chemical compound identified benzyl benzoate, geranyl acetate, citral, phenol, alpha-terpineol, fernesol etc. Single petaled cultivars were found more promising for concrete recovery. So these cultivars should be cultivated commercially for industrial purpose.

Integrated nutrient management in papaya (*Carica papaya* L.)

Mingnam Ch Marak

The present investigation on “Integrated nutrient management on papaya (*Carica papaya* L.) ” was carried out at the Horticulture Experimental Farm, Assam Agricultural University, Jorhat during the year 2017-2019. The objectives of the present investigation were to find the effect of different integrated nutrients on growth, development, yield, and post-harvest attributes of papaya and to standardize the integrated nutrient model for sustainable production of papaya. The experiment was laid out in randomized block design (RBD) with ten treatments and three replications. The observations were focused on growth characters, physiological attributes, yield, post-harvest attributes and soil status. The growth parameters *viz.* plant height (186.00cm), stem girth (45.92cm), number of leaf (40.17), total leaf area (10.63m²), number of lobes in leaf (8.50) recorded maximum value when plant were treated with T₉:75% (NPK + Vermicompost + FYM + Consortia/plant) during both the year and in pooled analysis. Whereas, the same treatment showed earliness in the initiation of flowering (104.00days), increased number of flowers (82.00) and the lowest height for the first flower (58.67cm). Number of fruits per plant (79.40), average fruit weight (1.75kg), fruit length (25.25cm), fruit diameter (17.91cm), fruit yield per plant (118.68kg) and per ha (366.29t) were also found to be significantly higher in papaya plants supplied with T₉:75% (NPK + Vermicompost + FYM + Consortia/plant). Regarding soil parameters, *viz.* N, P₂O₅, K₂O, (229.22kg/ha, 50.19kg/ha and 128.89kg/ha) were higher in T₉:75% (NPK + Vermicompost + FYM + Consortia/plant). Minimum physiological loss in weight (11.01%), titratable acidity (0.017%), higher content of total soluble solids (9.77°brix), total sugars (9.94%), reducing sugars (8.72%), ascorbic acid (23.01mg/100g pulp) and shelf life of fruit (10.17days) were also noted in same treatment *i.e.* T₉:75% (NPK + Vermicompost + FYM + Consortia/plant). The data concerning the economics of present investigation revealed that the maximum net returns of Rs. 13326029.49 with a BCR (2.64) per hectare were obtained with application T₉:75% (NPK + Vermicompost + FYM + Consortia/plant). On the basis of results obtained in present investigation, it is concluded that the application of T₉:75% (NPK + Vermicompost + FYM + Consortia/plant) resulted in higher economic returns with improvement in soil and fruit quality of papaya *cv.* Taiwan Red Lady.

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Major Advisor : Dr. P. K. Borthakur

Growth, yield and biochemical composition of garlic (*Allium sativum* L.) varieties under elevated regimes of temperature and carbon dioxide concentration

Naseema Rahman

A study was conducted during 2013-14, 2014-15 and 2015-16 on “**Growth, yield and biochemical composition of garlic (*Allium sativum* L.) varieties under elevated regimes of temperature and carbon dioxide concentration**” in the Department of Horticulture and Crop Physiology, Assam Agricultural University, Jorhat, Assam for screening of nine (9) germplasm/ varieties of garlic (*Allium sativum* L.) (seven germplasm collected from four North Eastern states along with two National varieties from DOGR, Nashik, Maharashtra) in field condition; as well as to optimize the best planting month in terms of yield of selected germplasm/ varieties. The interactive results revealed that planting of garlic cloves in the month of October recorded the highest growth parameters and yield in germplasm/ varieties, viz., Bhima Omkar (V₈) (11.51 t ha⁻¹) followed by Ekfutia Assam (V₁) (10.03 t ha⁻¹), Assam Local (V₂) (9.43 t ha⁻¹) and Bhima Purple (V₉) (8.94 t ha⁻¹). The four (4) screened germplasm/ varieties viz., Ekfutia Assam, Assam Local, Bhima Omkar and Bhima Purple were grown in Carbondioxide Temperature Gradient Tunnels (CTGTs) to assess the interactive effect of elevated CO₂ and temperature and to identify the elite ones for future cultivation. The treatments consisted of T₁ = AMB (Ambient CO₂ condition and temperature condition); T₂ = CTGT I (400 ppm CO₂ + 2⁰C higher than ambient temperature); T₃ = CTGT II (550 ppm CO₂ + 4⁰C higher than ambient); T₄ = CTGT III (700 ppm CO₂ + 6⁰C higher than ambient). The elevation of temperature and carbon-dioxide condition was maintained from planting to harvesting stage. The results revealed that improvement of some of the major morpho-physiological parameters of the germplasm/ varieties in CTGT II as compared to ambient condition viz., plant height (+9.71%), leaf number (+14.53%), LAI (+13.83%), LAD (+12.82%), relative leaf water content (+3.32%), water potential (+7.78%), photosynthesis (+13.43%). However, in CTGT III some

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parameters *viz.* stomatal conductance (-27.48%) and chlorophyll content (-21.97%) were significantly lower over ambient condition. Similarly, the biochemical parameters *viz.* Allicin, Proline, Ascorbic Acid content, TSS *etc.* showed a significantly higher value in CTGT II (Allicin content : Assam Local 5.92 mg g⁻¹; Ekfutia Assam 5.69 mg g⁻¹ and Bhima Omkar 4.99 mg g⁻¹) as compared to ambient condition (Allicin : Assam Local 5.21 mg g⁻¹, Ekfutia Assam 5.14 mg g⁻¹, Bhima Omkar 4.54 mg g⁻¹). A decline in chlorophyll content of leaves observed under both the CTGTs. A better status of membrane was recorded at CTGT II, as compared to CTGT III and ambient condition in terms of lower activity of MDA (Lipid peroxidation) and H₂O₂ content; hence a comparatively lesser reduction in membrane stability index was recorded in CTGT-II over CTGT III. Anatomical studies revealed better stomatal aperture status and anatomical modifications in CTGT II as compared to CTGT III. Better yield attributing parameters were recorded in CTGT II as compared to CTGT III and other treatments, which could be correlated to a higher per cent of reduction in bulb formation in CTGT III. Reduction of the above parameters due to high temperature was ameliorated by CO₂ enrichment under CTGT II. From the above experiment, it is evident that some degree of tolerance exhibited against high temperature stress which could be attributed to higher accumulation of proline content in leaves, adjustment of anatomical features, better water status in germplasms Assam Local and Ekfutia Assam and National variety Bhima Omkar as compared to Bhima Purple under elevated carbon-dioxide and temperature condition. This indicates the differential responses of germplasm/ varieties under future climate change conditions.

Thus, it may be concluded that, the present investigation extends and adds our knowledge of both crop-intrinsic and extrinsic determinants of growth and productivity. The detailed and comprehensive analysis presented in different garlic varieties and under varied and elevated climatic conditions will provide critical insights into optimal strategies for future farming of commercially and medicinally important crops like, garlic. It is anticipated that this information has the potential to benefit researchers, farmers and ultimately the consumer.

Evaluation of moisture stress response of *Cynodon dactylon* (L.) and its recuperative ability by using plant growth regulators

Prarthana Gogoi

An experiment was conducted to study the “Evaluation of moisture stress response of *Cynodon dactylon* (L.) and its recuperative ability by using plant growth regulators” with three different plant growth regulators like Trinexapac-ethyl (TE), Paclobutrazol (PBZ) and Flurprimidol (FD) under nine different concentration levels in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2015-2018. The experiment was laid out in factorial Randomized Block Design. The ten treatments comprised of T₀ - Control, T₁ -100 ppm TE, T₂- 200 ppm TE, T₃-300 ppm TE, T₄– 500 ppm PBZ, T₅– 1000 ppm PBZ, T₆– 1500 ppm PBZ, T₇– 50 ppm FD, F₈ – 100 ppm FD and T₉- 150 ppm FD. These treatments were applied in two methods, viz., during the moisture stress (Method I) and before stress (Method II).

Experimental results revealed that visual characters, plant growth, physiological characters and biochemical parameters were significantly influenced by treatment, method and their interaction effect.

Regarding the treatment effect Treatment T₁ exhibited the highest mean performance for turf quality at before stress, turf quality at 15th day stress, turf quality at 15th day after rewatering, turf color at before stress, turf color at 15th day stress and turf color at 15th day after rewatering , coverage percentage at before stress, coverage percentage at 15th day stress and coverage percentage at 15th day after rewatering, clipping fresh weight at 15th stress and clipping fresh weight at 15th day after rewatering, clipping dry weight at 15th day stress and clipping dry weight at 15th day after rewatering, relative leaf water content at before stress, relative leaf water content at 15th day stress and relative leaf water content at 15th day after rewatering, shoot N content at before stress, shoot N content at 15th day stress and shoot N content at 15th day after rewatering, shoot P content at before stress, shoot P content at 15th day stress and shoot P content at 15th day after rewatering, shoot K content at before stress, shoot K content

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at 15th day stress and shoot K content at 15th day after rewatering, stolon length at before stress, stolon length at 15th day stress, stolon length at 15th day after rewatering and turf density at before stress, turf density at 15th day stress and turf density at 15th day after rewatering. Treatment T₃ exhibited the highest mean performance for root fresh weight at before stress, chlorophyll content at before stress, chlorophyll content at 15th day stress and chlorophyll content at 15th day after rewatering and chlorophyll stability index at before stress, chlorophyll stability index at 15th day stress, chlorophyll stability index at 15th day after rewatering and the lowest mowing frequency. Treatment T₆ exhibited the highest mean performance for root fresh weight at 15th day stress and root fresh weight at 15th day after rewatering, leaf proline content at before stress, leaf proline content at 15th day stress and leaf proline content at 15th day after rewatering and SOD enzyme activity at before stress, SOD enzyme activity at 15th day stress and SOD enzyme activity at 15th day after rewatering and Treatment T₀ exhibited the highest mean values for clipping fresh weight and clipping dry weight at before stress condition and mowing frequency.

It was observed that the treatments applied in method II exhibited the highest mean performance for all the visual, growth, physiological and biochemical characters. From the experiment it was clearly observed that most of the growth characters, physiological characters as well as biochemical characters were influenced by treatments, methods which may be due to positive effect of Plant Growth Regulator during the growth period. The Plant Growth Regulator Trinexapac-ethyl was the most effective PGR to maintain the turf quality and reducing the mowing frequency. The best treatment was found to be T₁ and Method II and their interaction was considered the best for growth characters as well as quality characters, *viz.* colour, resiliency, rigidity and uniformity etc.

Maximizing the productivity of French bean types through optimal nutrient management

Pritikana Basumatary

An experiment titled ‘**Maximizing the productivity of French bean types through optimal nutrient management**’ was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016-17 and 2017-18 to mitigate zinc requirement through foliage feeding for augmenting growth, yield and quality and to optimize the fertilizer doses for two type of french beans. A total of eighteen treatment combinations, including two french bean types (Main treatment: V₁: pole and V₂: dwarf), three levels of NPK (sub treatment: F₁: 30-40-20, F₂: 30-40-30 and F₃: 40-40-40) and three levels of zinc sulphate spray (sub-sub treatment: Z₀: 0ppm, Z₂₅: 25ppm and Z₅₀: 50ppm) were laid out in a split-split plot design with three replications.

Results revealed that most of growth characters, yield attributes, pod yield and quality were significantly influenced by variety, NPK levels, zinc sulphate concentrations and their interactions during both years (2016-17 and 2017-18). As a whole the combined effect of variety (Anandi, pole type) with highest level of fertilizer doses (40-40-40 NPK kg ha⁻¹) along with two zinc sulphate sprays had produced significantly maximum plant height (377.33cm), number of branches/plant (13.23), number of leaves/plant (24.78), number of pod (33.83), number of seed/pod (9.00), seed weight/pod (3.18g), fresh weight of pod (7.20g) and pod yield/plant (243.58g) during 2016-17. Similar trend was followed with slight variation in every aspect of characters during 2017-18. In respect of quality during 2016-17, the crude protein content (20.31%), tryptophan (0.37g), SOD (3.70mg g⁻¹) were recorded as the highest and significant at (40-40-40 NPK kg ha⁻¹) along with two zinc sulphate sprays.

While at the same level of fertilizer management practices i.e. (40-40-40 NPK kg ha⁻¹) along with two zinc sulphate sprays the highest pod yield/ha (12.42t) was recorded by dwarf type (Pant Anupama) with benefit cost ratio of 6.41.

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Major Advisor : Dr. Luchon Saikia

Modelling of low cost growing structure for commercial cultivation of *Dendrobium* orchid

Punam Saikia

An experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, during 2016-2018, to study on “**Modelling of low cost growing structure for commercial cultivation of *Dendrobium* orchid**”. The experiment was laid out in Factorial Completely Randomized Design with 10 treatment combinations replicated five times. The first factor comprised G₁ (Bamboo frame structure covered with fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling), G₂ (Bamboo frame structure with fixed 50% agro shade net as cladding material), G₃ (Bamboo frame structure covered with fixed 200 micron UV film with side removable and 50% agro shade net as ceiling), G₄ (Bamboo frame structure with fixed 50% agro shade net and 200 micron UV film as top covering) and G₅ (Bamboo frame structure with 200 micron UV film side removable and fixed 50% agro shade net as covering). The second factor comprised T₁-1 tier (40 cm above the ground level) and T₂-2 tiers (40 and 100 cm above the ground level). Further, the correlation analysis was done to explore dependency and interdependency of growth, flowering and physiological characters of *Dendrobium* cv. Sonia with microclimatic parameters in different growing structures and develop some growth predictive models of *Dendrobium* cv. Sonia using Regressions analysis and Artificial Neural Networks (ANN) based on microclimatic parameters.

Variation of weather parameters *viz.*, maximum and minimum temperature, morning and afternoon relative humidity, light intensity and accumulated growing degree days were recorded in growing structures as well as open field condition for both the years. It was observed that all the weather parameters of growing structures were found to be lower than the open field condition. The maximum and minimum temperature was highest in G₃ while the morning and afternoon relative humidity was highest in G₂ during 2017 and 2018, respectively. The average light intensity was highest in G₃ for both the years. Moreover, an average accumulated degree day irrespective of the microclimatic regimes was highest in G₃.

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The results revealed that most of the growth characters were significantly influenced by growing structure and tier. Amongst the growing structures, G₁ was the best for increasing the growth characters *viz.*, plant height (45.26 cm), leaves per plant (11.65), leaf area per plant (569.61 cm²), height of pseudobulb (25.67 cm), pseudobulbs per plant (9.67), canes per clump (6.85) and cane girth (3.14 cm). In respect to flower characters, G₁ exhibited minimum days for bud visibility to opening of first floret (19.00 days), days for opening of first floret to full bloom (15.80 days) as well as the highest value for spikes per plant (4.40), spike length (38.317 cm), florets per spike (9.50), floral diameter (9.28 cm), self life (44.60 days), vase life (30.35 days), fresh weight of spike at harvest (19.60 g) and fresh weight of spike at senescence (7.47 g). However, G₃ was the best for increasing the total chlorophyll content (0.30 mg/g) whereas G₁ for crop growth rate (0.15 g/m²/day), relative growth rate (0.07 g/g/day), net assimilation rate (0.21 g/m²/day) and dry matter production (15.85 g/plant).

Similarly, T₂ was found to be superior in respect of the growth characters *viz.*, plant height (42.57 cm), leaves per plant (10.54), leaf area per plant (532.47 cm²) and height of pseudobulb (24.13 cm). Regarding flower characters same results were found, T₂ took minimum days for bud visibility to opening of first floret (21.82 days), days for opening of first floret to full bloom (18.99 days) as well as the highest value for florets per spike (7.60), fresh weight of spike at harvest (15.38 g) and fresh weight of spike at senescence (5.55 g). In case of physiological characters, T₂ was found to be better for total chlorophyll content in leaf (0.28 mg/g FW), crop growth rate (0.13 g/m²/day), relative growth rate (0.06 g/g/day) and dry matter production (13.56 g/plant). There was no significant difference among the interactions except plant height (46.30 cm).

In terms of cost economics it was observed that the highest benefit cost ratio of 3.92 was obtained from G₁T₂ followed by G₄T₂ (3.50).

It was found from the correlation analysis that all the growth characters mostly correlated with maximum temperature, minimum temperature and accumulated growing degree days under G₁ condition. For flower and physiological characters mean microclimatic parameters calculated during 5 different phenophases *viz.*, PP₁ (planting to bud visibility), PP₂ (planting to full bloom), PP₃ (bud visibility to opening of first floret), PP₄ (bud visibility to full bloom) and PP₅ (opening of first floret to full bloom). The results revealed that the highest negative correlation coefficient of most of the flower characters was found at PP₁ and PP₄ in respect of maximum temperature, minimum temperature and accumulated growing degree days. Regarding physiological parameters, total chlorophyll content in leaf was positively correlated with maximum and minimum temperature at PP₂ and negatively correlated with afternoon relative humidity at PP₄. However, crop growth rate negatively correlated with afternoon relative humidity at PP₄ and net assimilation rate with minimum temperature of PP₁. Dry matter production and relative growth rate was negatively correlated with minimum temperature at PP₄.

Results of the regression analysis indicated that minimum temperature in PP₁ phase could predict the spikes per plant to an extent of 87%, light intensity and accumulated growing degree days in PP₅ could together predict florets per spike to an extent of 80%, floret diameter to an extent of 82%. Moreover, light intensity and accumulated growing degree days in PP₅ could together predict floral diameter to an extent of 89%. On the other hand, afternoon relative humidity of PP₄ could predict the vase life of spike to an extent of 84%.

It was revealed from the artificial neural networks analysis that the normalized importance of microclimatic variables (maximum temperature, minimum temperature, morning relative humidity, afternoon relative humidity, light intensity and accumulated growing degree days) was 68, 21, 59, 73, 75 and 100%, respectively in relation to flower yield and quality of *Dendrobium* cv. Sonia. Comparing the results generated using artificial neural networks showed that the root mean square error (RMSE) between the observed data and the predicted data for growing structures were 0.206, 0.256, 0.356, 0.218 and 0.220 in G₁, G₂, G₃, G₄ and G₅, respectively. G₁ showing the least root mean square error (0.206), followed by G₄ (0.218) which provides congenial microclimates for growing of *Dendrobium* orchids.

Morpho-physiological and biochemical characterization of some minor fruits of Assam

Purabi Tamuli Phukan

An investigation was conducted during the period of 2015-2017 to study the “Morpho-physiological and biochemical characterization of some minor fruits of Assam”. The plant selected for the study were viz., *Averrhoa carambola* L. (Rohdoi); *Chrysophyllum roxburghii* (Bl.) D.C. (Bonpitha); *Elaeocarpus floribundus* Bl. (Jalphai); *Phyllanthus acidus* (L.) Skeels (Poramlokhi); *Spondias mangifera* Wild. (Amora); *Terminalia chebula* Retz. (Silikha) belonging to six different families. The morpho-physiological characteristics and biochemical compositions of fruits were studied in five numbers of healthy, uniform aged and size of bearing trees for each species from five different districts and data were recorded in four replications. Data on morphological characters and floral biology were recorded in the selected farmers’ field, whereas, physical parameters and biochemical composition of fruit were recorded in the laboratory. Wide variations were observed for morphological characters among the studied minor fruit plants. Maximum duration of flowering (54.32 days) was observed in *E. floribundus*, while, *P. acidus* exhibited minimum duration of flowering (14.98 days). The highest 176.43 days for duration of fruit maturity was recorded in *C. roxburghii*, while *A. carambola* required only 53.46 days from fruit setting to harvesting. The *A. carambola* exhibited highest (90.40 g) fruit weight whereas *P. acidus* exhibited lowest (3.84 g) fruit weight. With respect to edible portion, *C. roxburghii* recorded the highest amount (82.65 per cent) and *S. mangifera* realized lowest value (63.18 per cent). The moisture content was found to be highest (90.48 per cent) in *A. carambola* and lowest (64.68 per cent) in *T. chebula*. The carbohydrate content was found to be highest (93.69 per cent) and lowest (82.80 per cent) in *P. acidus* and *C. roxburghii*, respectively while, energy content was found to be highest in *C. roxburghii* (406.25 Kcal/100g) and lowest (375.74 Kcal/100g) in *T. chebula*. A wide range of variation was observed for TSS-acidity ratio and sugar-acidity ratio and the highest values were shown by *A. carambola* and the least values by *T. chebula* for both the characters. The pectin content ranged between 0.58 per cent to 2.64 per cent in

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P. acidus and *C. roxburghii* respectively. The highest total phenol content (941.51 mg/100g) was recorded in *P. acidus* while the lowest (27.73 mg/100g) was observed in *S. mangifera*. The flavonoid content ranged between 30.38 mg/100g to 746.35 mg/100g in *S. mangifera* and *C. roxburghii*, respectively. However, the highest DPPH inhibition percentage (93.16 per cent) was recorded in *S. mangifera* and lowest (73.98 per cent) in *A. carambola*. Among the various minerals, the highest value of phosphorous (349.97 mg/100 g), sodium (36.04 mg/100 g) and magnesium (78.48 mg/100 g) was obtained in *S. mangifera*, while highest value of potassium (1288.61 mg/100 g), calcium (378.70 mg/100 g) and iron (870.36 mg/100 g) was recorded in *E. floribundus*. On the other hand, the lowest value of phosphorous (17.66 mg/100 g), calcium (6.11 mg/100 g), magnesium (11.59 mg/100 g) and iron (0.45 mg/100 g) was obtained in *A. carambola*, whereas lowest value of potassium (157.58 mg/100 g) and sodium (1.99 mg/100 g) was observed in *P. acidus*. Among the organic acid, the highest value of oxalic acid (475.78 mg/100 g) was obtained in *A. carambola*, tartaric acid (39.69 mg/100 g) in *S. mangifera*, malic acid (1647.44 mg/100 g) in *P. acidus*, ascorbic acid (220.63 mg/100 g) in *S. mangifera* and citric acid (12.65 mg/100 g) in *T. chebula*.

Morpho-biochemical characterization of rough lemon (*Citrus jambhiri* Lush.) of Assam

Purnima Pathak

Rough lemon (*Citrus jambhiri* Lush.), commonly known as ‘*Gol Nemu*’ is an underutilized citrus fruit of Assam. It is mostly grown as backyard crop in homestead garden. The fruit is a rich source of vitamins, minerals, flavonoids, limonoids *etc.* It is polyembryonic in nature and highly cross pollinated. Most rough lemon plants are of seedling origin in the region and thus tend to exhibit a wide range of variability in terms of morphological and biochemical parameters. Therefore, an investigation was undertaken during 2016-2017 on ‘Morpho-biochemical characterization of rough lemon (*Citrus jambhiri* Lush.) of Assam to study the existing variability. One district in each of the six agro climatic zones was chosen and five plants were selected in each district, comprising of thirty plants. Wide variability was observed among the selected rough lemon accessions for qualitative characters of tree, leaf, flower, fruit and seed. Four different fruit shapes were recorded *viz.* spheroid, obloid, obovoid and ellipsoid. Wide variations in pulp colour *i.e.* ivory white, orange, orange-red, yellow were recorded in the selected rough lemon. Cluster analysis of 45 qualitative and 25 quantitative characters using SPSS resulted in grouping of the rough lemon accessions into three broad groups. Group I consisted of 17 accessions (AR01T1, AR01T2, AR01T3, AR02T1, AR02T2, AR02T3, AR02T4, AR03T2, AR03T3, AR04T4, AR05T1, AR05T2, AR05T3, AR05T4, AR06T2, AR06T3, AR06T5) of all locations. Group II consisted of six accessions (AR01T5, AR03T1, AR03T4, AR03T5, AR04T1, AR06T1). Group III consisted of seven accessions (AR01T4, AR02T5, AR04T2, AR04T3, AR04T5, AR05T5, AR06T4). No groups were formed based on geographical location indicating that qualitative and quantitative traits were largely influenced by genetic factor. The quantitative characters of flower, leaf and fruit showed significant variation among the rough lemon accessions. The maximum fruit weight was recorded in accession number AR02T5 (144.34 g) and the minimum was recorded in AR03T1 (17.36 g). In terms of biochemical constituents, the highest TSS was recorded in accession number AR06T4 (8.87 °B) and the lowest was recorded in AR02T1 (6.13 °B).

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The highest TSS-acid ratio was recorded in accession number AP06T4 (2.12) and the lowest was recorded in AR02T1 (1.00). HPLC quantification of limonin showed significant variations among the rough lemon accessions which ranged from 10.42 to 24.07 mg/100ml. Among the 30 rough lemon accessions, two main groups were recognized based on 12 biochemical constituents with strong genetic similarity within a location. All the morphological quantitative traits *i.e.* fruit length, fruit diameter, rind thickness, seeds per fruit, seed weight, juice content, juice per cent showed significant variation among different locations. Significant differences among the locations were observed with respect to biochemical constituents except essential oil content. The highest TSS, total sugar, TSS-acid ratio were recorded in location L6 (Cachar) and the lowest value was recorded in location L4 (Biswanath). Present study on propagation of rough lemon through seed showed an average germination percentage of 87.67 % and air layering recorded a success percentage of 92.11%. However, propagation through stem cutting was found to be comparatively difficult with moderate success percentage (79.11%).

Three elite types *i.e.* AR03T1, AR06T1 and AP06T4 were identified in terms of high overall acceptability (>8), TSS-acid ratio (>2.00), less seed content (\leq 10 per fruit), low limonin content, high essential oil (>4%), high ascorbic acid and antioxidant activity (>80mg/100ml juice) and thin to medium rind thickness.

Influence of radish as cover crop and vegetable cropping system on crop productivity and soil health of sandy soil of Gossaigaon, Assam

Sanchita Brahma

The present investigation entitled “*Influence of radish as cover crop and vegetable cropping system on crop productivity and soil health of sandy soil of Gossaigaon, Assam*” was carried out during *Rabi* season of 2017-18 and 2018-19 and *Summer* season of 2017-18 and 2018-19 at KrishiVigyan Kendra (KVK) farm of Kokrajhar district under Lower Brahmaputra Valley Zone (LBVZ) of Assam State. The soil of experimental site was sandy loam in texture with strongly acidic soil reaction, with low EC, CEC, high bulk density, particle density, low in organic carbon, low in available nitrogen medium in phosphorus and low in potassium. The treatment details were: cover crop (CC) ,followed by CS-I (okra followed by bitter gourd), CS-II (chilli followed by dolichos bean) and cropping system-III (cowpea followed by amaranthus). The experiment was laid out in randomized block design (RBD). Forage radish CC was sown during 10th October, 2017-18 and 15th October, 2018-19 with seven replications, 100 % CC (30cm x 30cm), 75% CC (45cm x 30cm) and 50 % CC at 60cm x 30cm, respectively. At young, decomposable harvesting maturity (60DAS), the CC was incorporated in the soil manually in all the plots. After one month of CC incorporation vegetable crops viz., Orka, chilli and cowpea were sown/transplanted during January, 2018 & 2019 with five replications. Vegetable crop biomasses were also incorporated in soil after harvest and followed by the second vegetable crops viz., bitter gourd, dolichos bean and amaranthus, respectively in respective vegetable sequence(s). The influence of cover crop and crop biomasses on soil chemical and physical parameters were studied at different sampling depths for both years. Soil chemical and physical parameters after incorporation of forage radish cover crop recorded significant improvements over control. Most of the growth parameters, yield attributes and yield of vegetable crops, soil chemical parameters (EC, CEC, available NPK, organic carbon, organic matter and C/N ratio), soil physical attributes viz., WHC, total porosity and reduction in bulk

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density, particle density of soil after harvest and incorporation of crop biomasses were maximum under cent per cent surface cover (T1) during both the year of experimentation. Significantly, the highest okra yield (17.11 and 18.86 q/ha), chilli yield (31.32 and 32.19 t/ha), cowpea yield (27.59 and 28.92t/ha), bitter gourd yield (18.31 and 19.00 t/ha), dolichos bean yield (18.64 and 19.00 t/ha) and amaranthus yield (25.21 and 26.23t/ha) were obtained with the application of 100 % cover crop (T1) followed by 75 % per cent cover crop (T2) over the control(T0) without surface cover. Among the different levels of cover crop, cent per cent cover crop (T1) resulted in significant EC, CEC, organic carbon (%), organic matter (%), soil available NPK, C/N ratio after crop harvest. Similarly the soil physical parameters also showed improvements in cent per cent cover crop treatment which recorded the highest WHC (%), total porosity (%) lowest bulk density (gmcm-3) and particle density (gmcm-3) over other cover crop treatment as well as control after crop harvest in all the vegetable cropping system. Among the vegetable cropping system, the highest net return (Rs. 7,56,195/ha) with benefit : cost ratio (6.39) were recorded by CS-II (chilli followed by dolichos bean) under 100 % cover crop (T1) followed by the same cropping system under 75 % surface cover (T2) with net returns (Rs. 6,14,595/ha) with B:C ratio (5.38). On the basis of experimental results, it can be concluded that for getting higher returns and improvement of soil health, vegetable crops viz., chilli (spring-summer) followed by dolichos bean (summer) can be grown after cent per cent surface cover with radish cover crop in sequence for sustainable vegetable production in sandy soil of Gossaigaon, under Lower Brahmaputra Valley Zone of Assam.

Characterization of *Rhynchosyilis retusa* (L) genotypes of Assam and their growth and flowering behaviour under different shade conditions

Sanjib Sharma

Investigation on “Characterization of *Rhynchosyilis retusa* (L) genotypes of Assam and their growth and flowering behaviour under different shade conditions” has been carried out in the experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period 2017-2018. Two sets of field experiments were laid out in Completely Randomised Design (CRD) with six treatments each. In one experiment, the treatments were the six different agro-climatic zones of Assam from where the genotypes were collected and in the second experiments the six growing conditions were created with different shade per cent and cladding materials. (T1: Bamboo frame structure covered with a 35% shade net as a roof and on all sides; T2: Same as T1 with a 50% shade net; T3: Same as T1 with a 75% shade net; T4: Bamboo frame structure with a 200 micron UV stabilized polyethylene as a roof with 35% shade net on all sides with a ceiling; T5: Same as T4 with 50% shade net on all sides with a ceiling; T6: Same as T4 with 75% shade net on all sides with a ceiling). The genotypes from Upper Brahmaputra Valley zone exhibited maximum for growth and flower characters, viz., plant height (34.61 cm), Length of leaf (31.46 cm), breadth of leaf (3.10 cm), number of spikes (2.21), number of florets per inflorescence (73.47), self-life (14 days) followed by North Bank Plain zone. The estimates of genotypic and phenotypic coefficient of variation for the characters revealed that the estimates were generally low for the characters. It was also observed that most of the characters exhibited low to moderate heritability (h^2 b.s). Correlation studies revealed that the spike length exhibited positive and significant correlation with florets numbers, days to bud visibility and days to full bloom. Florets number showed positive and significant correlation with days to bud visibility, days to full bloom and self-life of the inflorescence.

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The molecular studies were carried out by following PCR based Random Amplification of DNA Polymorphism (PCR-RAPD) with 13 numbers OPA and OPD markers and six inter simple sequence repeat (ISSR) markers. The present study revealed 92.31% of RAPD markers were polymorphic whereas only 66.67% of ISSR markers were found polymorphic. The DNA analysis and genetic similarity coefficient revealed that the genotypes have a high similarity of DNA character. T7 and T8 share maximum similarity of 0.9166 while T12 and T13 share a similarity which ranges between 0.5 to 0.6 with other variables.

The results of the growing condition revealed that growth and flowering were significantly influenced by different shade conditions. Among the treatments, T2 was found to be the best in respect of growth parameters *viz.*, plant height (38.16 cm), numbers of leaves (7.95), Leaf length (34.16 cm), leaf breadth (3.58 cm) and leaf area (806.94 cm²). T2, also resulted better flower parameters *viz.*, spike length (36.90 cm), number of spike (2.68), number of florets (76.30), flower across (2.35 cm), lip size (1.27 cm), spike length (15.45 days), vase life (10.65 days), fresh weight of the inflorescence at harvest (17.85 gm), fresh weight of the inflorescence at senescence (4.23 gm), dry weight of the inflorescence at harvest (2.50 gm), except days taken from flower bud visibility to first floret opening and blooming where T4 took minimum number of days. Maximum total chlorophyll content was also recorded by T2 (0.43 mg per g of FW). Growing conditions with polyethylene as roofing material recorded early initiation of flower bud but the longest flowering period was recorded by T2. On the basis of the morphology and molecular studies, it may be summarized that the genotypes have a broad similar history of evolution of the species resulting in inherently lower variation, even though growth and flower characters like length of leaf, plant height and flower across showing moderates genetic advance provide scope for genetic improvement. Based on the results of different shade conditions, T2 (Bamboo frame structure covered with a 50% shade net as a roof and on all sides) may be considered as the best for growing *Rhynchosyilis retusa* (L) commercially. The outcome of this study could be considered as a basic work for future line of research with further improving the structure of the green house by incorporating the provision of natural ventilations and nutrient management aspects may provide even better results.

Green synthesis of Copper nanoparticles (CuNPs) and its efficacy in managing leaf spot disease of chrysanthemum (*Dendranthema grandiflora*)

Sewali Saikia

An investigation was carried out during 2015-2018 to study the “Green synthesis of Copper nanoparticles (CuNPs) and its efficacy in managing leaf spot disease of chrysanthemum (*Dendranthema grandiflora*)”. Different plant species used for research purpose were *Nyctanthes arbor-tristis* (Night jasmine), *Gardenia jasminoides* (Cape jasmine), *Tabernaemontana divartica* (Crape jasmine), *Cascabela thevetia* (Yellow oleander), *Clerodendrum inerme* (Glory bower), *Hibiscus rosa-sinensis* (China rose) and *Allamanda cathartica* (Allamanda) for synthesizing CuNPs. The fungal infection was studied in chrysanthemum in pot experiment and the synthesized CuNPs were targeted to the fungus in lab condition. Further, the CuNPs were also tested in vase solution of cut chrysanthemum.

Results showed that out of seven ornamental plant species CuNPs were synthesized from three species viz. *Nyctanthes arbor-tristis* (Night jasmine), *Cascabela thevetia* (Yellow oleander), *Allamanda cathartica* (Allamanda) which were confirmed through UV-VIS spectrophotometer in wavelength 250-450 nm. The SPR peak was recorded at 301.00 nm, 300.50 nm and 300.00 nm for Allamanda, Yellow oleander and Night jasmine respectively that confirmed the formation of CuNPs. FTIR analysis of CuNPs showed different functional groups such as O-H, N-H, S-H, O=C=O, C≡C, C=O, N-O, C-H, M-O for Allamanda, O-H, N≡N, N-H, C-Cl for Yellow oleander and O-H, C-N, -C≡C-, =C-H, N-O for Night jasmine. DLS study revealed the average size of CuNPs as 125 nm, 120 nm and 100 nm for Allamanda, Yellow oleander and Night jasmine respectively. Zeta potential recorded for Allamanda, Yellow oleander and Night jasmine are -13.7 mV, -10.03 mV and -12.6 mV respectively. TEM micrograph clearly indicated that all the green synthesized CuNPs were spherical in morphology and the average size were 14.05 nm, 16.96 nm and 11.58 nm for Allamanda, Yellow oleander and Night Jasmine respectively.

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A novel fungus was isolated from infected leaf of chrysanthemum (*Dendranthema grandiflora*) and was cultured in PDA media. The isolate was identified as *Corynespora dendranthema* that is reported for the first time as foliage pathogen of chrysanthemum. The efficacy of green synthesized CuNPs against the fungus was evaluated using Agar well technique. The result showed that the green synthesized CuNPs exhibited mycelial growth inhibition at 60.52%, 57.13% and 52.44% for Night jasmine, Allamanda and Yellow oleander CuNPs respectively against the mycelial growth inhibition by traditional of fungicide (48.57%).

The CuNPs treatments significantly enhanced the vase life of cut chrysanthemum. Night jasmine mediated CuNPs and Allamanda mediated CuNPs at 75 ppm found to be best among all other treatments that increase vase life of cut chrysanthemum than traditional practice.

From the study inference can be drawn that green synthesis of nanoparticles from ornamental plants *viz.* Night jasmine, Yellow oleander and Allamanda may be superior method for management of leaf spot disease in chrysanthemum and enhancing vase life of cut chrysanthemum.

Marigold as a tool for intervention in improving carrot and french bean production system

Subhashree Dihingia

A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, during 2016-17 & 2017-18 to study the marigold based intercropping with carrot and french bean to find out suitable intercrop treatments and also to study the nematicidal effect of marigold on carrot and french bean. Two separate sets of experiments were laid out with Randomized Block Design with seven different treatments and four replications.

The studies indicated better growth and yield characters in the treatments when both the crops were intercropped with marigold as single row at every inter row, T₁ = C-M-C-M-C and F-M-F-M-F, followed by marigold as single row at every two inter row, T₄ = M-C-C-M-C and M-F-F-M-F. On the other hand yield parameters are found better in T₅ (25.64 t/ha) in carrot and (22.13 t/ha) in french bean when treated with nematicide though it was a chemical control. In T₁ treatment better results in terms of plant height (44.36 cm), leaves per plant (14.94), root length (16.50 cm), root diameter (3.17 cm) and yield (12.68 t/ha) etc. was obtained in carrot plant. Likewise in case of french bean better results in terms of plant height (38.96 cm), leaves per plant (27.12), branch number (8.80) and yield (12.82 t/ha) etc. was obtained in T₁ treatment. The growth and flower parameters of french marigold plant exhibited better results when grown as intercrop than sole crop.

The control of plant parasitic nematode, *Meloidogyne incognita* was positively affected due to intercropping treatments throughout the experiment period. Among the intercropping treatments, the best effective control measure for nematode was observed with alternate arrangement of main crops with marigold plant (T₁) in nematode parameters in both the crops. Although the best effective measure was the chemical control.

The intercrop treatment T₁ for both carrot and french bean with french marigold was maximum in terms of combined yield, gross return, net return, B.C ratio, land equivalent ratio and monetary advantage among other intercropping treatment combinations apart from the chemical control, T₅.

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Though, chemical control T₅ was found best in yield parameters, most comprehensive solution of using eco-friendly approaches of growing crop is the intercropping practices for controlling various pests including nematode and thereby increasing productivity. However, our crop row arrangement (T₁) was very effective which gives almost double the total production compared to sole crops.

Genetic diversity in banana (*Musa* spp.) germplasm of Assam

Sudeshna Baruah

An experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat to evaluate the huge diversity among the banana germplasm commonly available in the state of Assam. The experiment was laid out in Randomized Block Design with five replications the evaluation was done based on agro-biochemical parameters as well as the genetic diversity present within the genotypes using SSR markers. Based on growth, yield and fruit biochemical characters, the genotypes were clustered with respect to Euclidean distance and also by Trocher's method. These clusters showed significant differences as compared to the genomic classification of banana. The genotypes were found to show significant diversity based on all the characters and considering all the variations, there were four major clusters found within the 24 genotypes under this investigation. The diploid *balbisiana* genotypes (Bhimkal and Athiakal) were found to occur in two different solitary clusters, whereas both the culinary genotypes (Kachkal green and white types) consisted a single cluster. The characters like pseudostem height, leaf area, planting to shooting interval, shooting to harvesting interval, crop duration, number of fingers per bunch, fruit weight, fruit volume, number of seeds, pulp: peel ratio, sugar content were found to show high GCV, PCV added with very high heritability and high genetic advance and therefore, these characters were identified to be subjected to improvement by direct selection. After the molecular study using 52 primers, a total of 32 primers were found to produce reproducible bands and 197 alleles were detected by them, of which 170 were polymorphic bands. Percent polymorphism thus obtained was 84.95%. The average polymorphism information content of the primers was 0.437, which was the highest for primer 41(0.913). In the study, a few molecular identities for different genotypes could be identified. A single band sized 400bp, specific to 'Digjowa' genotype was found with the SSR27. For both the red bananas considered in the study (Agnisaga and Gobin Tulsi), another specific band sized 250bp was identified with SSR22. The Jaccard's similarity index was calculated using the molecular marker

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data and the average similarity index was found to be 0.552, which suggested sufficient diversity present within the genotypes. The maximum similarity based on this was found between 'Manjahaji, and 'Barjahaji'. Based on this similarity index, another clustering was done which found two major clusters within the 24 genotypes. In cluster 1, there were two subclusters and in cluster 2, there were three sub-clusters followed by a single genotype ('Fesa Manohar'). This study had revealed that even among the genotypes belonging to same genomic group, there is sufficient differences based on agro-biochemical parameters and genetic information they carry. Moreover, from this study, the promising genotypes for different characters could be identified on the basis of growth, yield and fruit biochemical characters. Further, on the basis of the present study, efforts can be made for inclusion of more number of primers for even better characterization of the genotypic variability, detailed study for pest and disease resistance and more specifically by including gene specific primers.

Morpho-biochemical studies of Tezpur litchi

Sukanya Gogoi

A study was conducted on different varieties of litchi (*Litchi chinensis* Sonn.) at litchi garden, Porua, Tezpur and Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016-2018 to have a “Morpho-biochemical studies of Tezpur litchi”. A total of seven varieties with four replications were laid out in a Completely Randomized Design (CRD). The varieties that were taken for investigation were Bombay, Shahi, Piyaji, China, Bilati and Elaichi from Tezpur and Shahi from Jorhat district.

The canopy spread of cultivar T₂ (TezpurShahi) was the highest (15.80m) and lowest (8.65m) in T₇ (JorhatShahi). Pyramidal, oblong, spherical and elliptical tree shape was observed among the various cultivars of litchi.

During the period of investigation, the cultivar T₁ (Bombay) took the lowest duration of flowering (18 days) and the highest was recorded in cultivar T₅ (Bilati), i.e., 31.50 days. The duration from flowering to harvesting was highest (92.25 days) in T₅ (Bilati) and lowest (81.25 days) in T₁ (Bombay).

The highest fruit weight of 27.79kg was recorded in the cultivar T₅ (Bilati) which is followed by T₄ (China) cultivar (21.88kg) and lowest (13.12kg) was recorded in T₇ (JorhatShahi). The highest fruit length of 3.82cm was recorded in the cultivar T₃ (Piyaji) and the lowest fruit length (2.97cm) was in T₇(JorhatShahi). Fruit circumference showed significant difference among the cultivars where highest (12.40cm) was recorded in T₅ (Bilati) and that of lowest (8.70cm) in T₇ (JorhatShahi). The highest fruit volume (29cc) was recorded in T₅ (Bilati) followed by T₄ China (24.50cc). Round, cordate, oblong and oval shapes were noticed among the cultivars.

The highest aril weight was observed in case of T₅ (18.42g) and the lowest was observed in the cultivar T₇ i.e., 9.40g. The highest peel weight (4.98g) was recorded in case of Bilati. The highest (6.42) and the lowest (3.07) aril-peel ratio of were observed in case of the cultivar T₂ and T₇ respectively. The aril thickness was the highest in case of T₅ (0.97cm) and the lowest was recorded in T₇ (0.47cm). The highest seed weight (3.69g), length (3cm) and diameter (1.27cm) were recorded in T₃ (Piyaji) and the lowest values were recorded in T₆ (Elaichi). The highest specific gravity of 1.091 was recorded

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in the cultivar T₅ (Bilati) and the lowest (1.036) in T₇ (JorhatShahi) though their differences among the varieties were found to be non-significant. The variety T₄ (China) recorded the highest yield per hectare (48.47t/ha), whereas, the lowest yield (13.92t/ha) was recorded in T₇ (JorhatShahi). The data on fruit cracking percentage revealed that, the highest fruit cracking (27.22%) was recorded in cultivars T₂ (TezpurShahi), followed by T₃ (Piyaji) and the lowest (12.56%) was in T₅ (Bilati). The highest skin strength of 3.21kgcm⁻² was recorded in cultivar T₅ (Bilati) and T₂ (TezpurShahi) was found to have the lowest fruit skin strength of 2.48kgcm⁻². The highest fruit skin calcium (5.29mg/100g DW) and highest boron content (0.123mg/100g DW) were found in case of the variety T₅ (Bilati) and lowest values were in T₇ (JorhatShahi).

Regarding juice content, the highest (18.46cc) was recorded in T₅ (Bilati). The cultivar T₅ (Bilati) was recorded to have the highest TSS content of 19.77°Brix and the lowest TSS was in T₇ (JorhatTezpur). The highest titratable acidity (1.65%) was recorded in the cultivar T₇ (JorhatShahi). Highest reducing sugar (9.86%) and total sugar 17.33% were recorded in the cultivar T₅ (Bilati). The cultivar T₅ (Bilati) exhibited the highest Vitamin C content of 63.38mg/100g. The highest potassium content (1270mg/100g) was recorded in T₅ (Bilati) which was followed by T₁ (1105.75mg/100g). The highest anthocyanin content (39.93mg/100g) was recorded in the cultivar T₅ (Bilati), whereas, the highest anthocyanin degradation index (4.07) was recorded in the cultivar T₇ (JorhatShahi). The highest POD (4870.93U/mg protein) and PPO (89.17U/mg protein) specific activity were recorded in T₇ (JorhatShahi) and that of the lowest values was observed in T₅ (Bilati). The highest DPPH inhibition percentage (69.62%) and highest flavonoid content (65.93mg/100g) were recorded in T₅ (Bilati). Physiological loss in weight (4.46%) and browning index (243.77) were lowest in T₅ (Bilati).

Correlation coefficient analysis revealed significant positive correlation of yield with fruit weight, volume, aril weight and canopy spread.

The available soil nutrient content of Tezpur was found to be better than that of Jorhat and from this investigation, it can be concluded that, all the litchi varieties of Tezpur were found superior both in quantitative and qualitative characters.

Heat unit indexing of garden pea in relation to climate shift and nutrient management

Trudy Tengse A. Sangma

An experiment was conducted consecutively during 2016-17 and 2017-18 in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat to study the “Heat unit indexing of garden pea in relation to climate shift and nutrient management”. The experiment consist three treatments viz., variety (main), fertility management level (sub) and sowing date (sub-sub) laid out in split plot design with random allocation and replicated thrice. The main treatment consisted Arkel(V₁), A1(V₂), DS-10(V₃) and GS-10(V₄); sub treatment was comprised of 5t FYM, 10-46-0 kgha⁻¹ (F₁), 10t FYM, 10-46-10 kgha⁻¹ (F₂), 10t FYM, 20-46-20 kgha⁻¹ (F₃) and 10t FYM, 30-46-30 kgha⁻¹ (F₄) and sub-sub treatment was dates of sowing: 10th October (S₁), 24th October (S₂), 7th November (S₃), 21st November (S₄), 5th December (S₅) and 20th December (S₆).

Growth, yield attributes, soil related and quality characters viz., plant height(cm), days to 50% flowering, pod plant⁻¹, pod length (cm), pod diameter (cm), seed pod⁻¹, shelling (%), pod yield (tha⁻¹), duration (days), growing degree days, root nodules plant⁻¹, total plant nitrogen (%), total plant phosphorus(%), total potash (%), TSS (⁰ Brix), crude protein (%), soil organic carbon (%), soil available nitrogen (kgha⁻¹), soil available phosphorus (kgha⁻¹), soil available potash (kgha⁻¹) and soil pH have responded significantly due to treatments as well as their interactions, except pH. Variety evidently produced significant effect on growing degree days (GDD) and results showed V₄>V₃>V₂>V₁ with requirement of 955, 948, 933 and 833 GDD for 2016-17 and similarly 958, 949, 942 and 825 GDD. The maximum duration was reported as 76.00days in V₄F with (1,2,3,4) and S (with 3,4,5). Duration was closely associated with degree days by sowing date had indicated significant duration among varieties, least with V₁(58.73days), to maximum in V₄(72.30days). Fertility level had a range of maturity at 68.08 to 68.29days. Sowing dates showed significance as 911(S₁), 915(S₂), 915(S₃), 915(S₄), 916(S₅) and 918(S₆) during 2016-17 and the GDD was found significant as S₁<S₂=S₄<S₃<S₅<S₆ during 2017-18 with values of GDD 916, 915, 913,

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919, 918, 915, indicating the total accumulated heat was more or less similar irrespective of season but differed by duration. The best performer combination was V₄F₄S₅ (63.59%). Pod yield differed due to variety (6.76 tha⁻¹ to 7.61 tha⁻¹), fertility level (5.60 tha⁻¹ to 8.21 tha⁻¹) and the best combination was V₄F₄S₅ (10.21tha⁻¹). Cost economics indicated the best B:C was 2.08 against V₃F₄S₅ i.e. variety DS-10 at sowing during 21st November and at fertility level of 10t FYM along with 30-46-30 kg NPK ha⁻¹.

It is concluded that sowing of pea should be shifted within 2nd week to 3rd week of November with fertility level of 10tFYM, 30-46-30 NPK ha⁻¹.

Studies on introgression of drought tolerant QTLs in a short duration rice variety through MAS

Amrit Tamuly

Rice is one of the important staple cereals which are consumed as a main part of diet by more than half of world's population. Rice production in India accounts to more than 40% of country's grain production. Rice is a major crop of Assam and it plays a major role in state's economy. A panel of 50 upland diverse rice cultivars collected from different parts of India were genotyped using SSR markers distributed across the 12 chromosomes in rice. The phenotyping using various yield traits were performed in rainout shelter as well as in open field conditions. A significant variation among the genotypes for all the characters under drought stress as well as in irrigated conditions study was obtained indicating the existence of considerable amount of variability among the genotypes selected for study. Grain yield is the most important character for selection under drought stress condition. Mannitol treatment may be an effective tool for selecting genotypes in drought stress. High heritability coupled with high genetic advance over mean was observed for days to 50% flowering, plant height, grain yield and days to maturity in both drought stress and irrigated conditions. Therefore, selection based on these characters may be effective for the improvement of drought tolerance. The log likelihood revealed by Structure showed the optimum subpopulations (K) value as 2 (K= 2), which indicated that the entire population can be grouped into two subgroups. The results clearly indicated that two subgroups were formed due to the different adaptation behaviour of cultivars to drought stress and yield attributes under drought. A total of forty-three cultivars were grouped in cluster I however, remaining seven cultivars were grouped in cluster II. The assessment of genetic diversity among the cultivars is pre requisite for any successful breeding programme. Kolong was selected as a recipient parent and it was crossed with a donor parent IR-64drought during Rabi 2016. Three SSR markers namely RM3825 (*qDTY1.1*), RM279 (*qDTY2.2*) and RM518 (*qDTY4.1*) exhibited polymorphism between the parents and these polymorphic markers were used for foreground selection during BC2F2 and BC2F4. Out of 300 SSR marker screened across the parental cultivars (Kolong and IR-64

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drought), only 86 (28.66%) SSR markers revealed distinct polymorphism and 214 SSR markers (71.33%) were found monomorphic. Eighty six polymorphic SSR markers were used for analyzing background recovery of recurrent parent genome in two best performing BC2F4 lines. The two BC2F4 lines (7 and 8) were selected based on the superior phenotypic performance of cultivars under drought stress conditions and analysed for background genome recovery. It was found that the line number 7 has got 83.07 percent background recovery of recurrent parent genome. Whereas, line number 8 has got only 78.48 percent background recovery of recurrent parent genome. The sixteen advance back cross population raised from the cross between 'Kolong' and 'IR-64 drought' were phenotyped along with the parents under drought stress conditions in rain out shelter and control conditions in the field at RARS, Titabar. Kolong was found to be lower in grain yield per plant as compared to the advanced generation lines. The grain yield per plant for Kolong (2.07 Kg/ha) and IR-64drought (4.07 Kg/ha) under drought stress condition. Kolong x IR-64drought-8 and Kolong x IR-64 drought-11 had 4.13Kg/ha which was 99.05% increases in grain yield per plant as compared to the parent 'Kolong' under drought condition. The duration of the drought introgressed lines *i.e.*, Kolong x IR-64 drought-7 is 100 days and Kolong x IR-64 drought-8 is 106 days which is similar to that of recurrent parent Kolong. Therefore, these drought tolerant lines may be suitable for cultivation during *Ahu* season.

Morphological, biochemical and molecular characterization of aromatic joha rice of Assam and mutation induction for improvement of morpho-agronomic traits

Dibosh Bordoloi

The investigation on "Morphological, biochemical and molecular characterization of aromatic *Joha* rice of Assam and mutation induction for morpho-agronomic traits through M1 to M3" was carried out with 20 indigenous *Joha* rice cultivars. The cultivars' morpho-metric evaluation followed a randomized complete block design with three replications during *Sali*, 2018 and 2019. The radio-sensitivity study standardized the electron beam, X-rays and gamma-rays for the cultivars based on germination/seedling growth. Dry uniform seeds of *Kon Joha-Moran* were exposed to 100-400 Gy of gamma-rays from a ⁶⁰Co source. The M1 generation used a randomized complete block design with four replications during *Sali* 2017. In M2 generation, 5998 M1 plant progenies were evaluated during *Sali* 2018. In M3 generation, 662 morpho-agronomic variants identified in the M2 generation were raised in plant rows during *Sali* 2019, and 66 mutants were confirmed. The seedling traits registered a decreasing trend towards increasing the mutagen doses in all the cultivars, showing differential radio-sensitivities. The LD50 values ranged from 515 to 615 Gy for electron beam and 421 to 537 Gy for X-rays and 414 to 481 Gy for gamma-rays. The GR50 values ranged from 138 to 315 Gy for the electron beam, 192 to 322 Gy for X-rays, and 185 to 291 Gy for gamma-rays. DUS characterization of the cultivars revealed polymorphism in thirty-seven traits. Thus, the phenotypic characterization of the aromatic cultivars established distinctiveness for their utilization in breeding programmes. UNJ clustering based on usual Euclidean distances for the polymorphic traits grouped the cultivars into three multi-genotypic clusters. The *Joha* rice cultivars showed highly significant differences for all the quantitative traits except for panicle length. The GCV and PCV estimates were high for grain yield per ha (24.62 & 24.85%) and filled grains per panicle (23.69 & 25.02%). All the traits except days to flowering and maturity, flag leaf breadth and

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spikelet fertility exhibited high heritability along with high to moderate genetic advance, indicating the most likely role of additive gene action. Mahalanobis D_2 analysis revealed three multi-genotypic and four mono-genotypic clusters of the cultivars. The contribution towards the total variation was the maximum for flag leaf length (72.11%) followed by rice length (13.68%) and grain length (6.84%). The inter-cluster D_2 value was the maximum between clusters IV and VI (7303.31) and hybridization would likely produce a broad spectrum of variability and transgressive segregations with high heterotic effects. The cultivars' average polyunsaturated fatty acids were 37.9% oleic acid, 39.22% linoleic acid and 0.5% linolenic acid. The fatty acid profile of *Local Joha* was better than the other cultivars as it showed a high level of linoleic and linolenic acid and low saturated fatty acid content. Thus, the *Joha* rice cultivars' fatty acid profile qualified for extraction of quality bran oil for consumption. *Kon Joha 4* and *Ronga Joha* contained the highest iron (82.88 mg kg⁻¹) and zinc (47.39 mg kg⁻¹), respectively while protein content of *Kon Joha-1* and amylose content of *Harinarayan* were the highest. *Joha-Bihpuria* showed the highest gel consistency of 140.50 mm. A strong aroma characterized the cultivars viz., *Kalijeera*, *Kunkuni Joha*, *Kon Joha-5*, *Manimuni Joha* and *Kon Joha 2*. The cultivar *Soru Joha-Tinsukia* with the highest yield (3012 kg ha⁻¹), high spikelet fertility (90.9%) and Fe (61.09 mg kg⁻¹) is a worth recommendation in Assam. PCR amplified 174 alleles with a mean value of 2.64 across the 66 polymorphic SSR markers. PIC values ranged from 0.091 to 0.698, with an average of 0.326. The highly informative (PIC>0.50) markers were RM316, RM283, RM585, RM1388, RM3562, RM171, R1M30, RM118, RM11 and RM29 for identification of the twenty aromatic rice cultivars. The UNJ clustering-based on Jaccard's coefficients classified the 20 cultivars into three significant clusters with eight, ten and two entries. The M1 of *Kon Joha* registered a reduction in germination, seedling height, pollen/spikelet fertility and plant survival at 400 Gy. All the traits showed highly significant differences among the doses in M2 generation. The shift in trait means was in both directions as influenced by the genotype and mutagen dose. The 66 mutants exhibited significant differences for all the traits in M3 generation. Fifty mutants were shorter than the parent *Kon Joha*. The GCV and PCV estimates were high (>20%) for grain yield, biological yield, productive tillers, filled grains, and average panicle weight. All the traits except panicle length exhibited high heritability coupled with high genetic advance, suggesting the predominance of additive gene action and the effectiveness of simple selection. Grain yield showed a significant positive correlation with plant height, panicle length, filled grains, spikelet fertility, the average panicle weight and harvest index in the mutant population. Thus, mutation induction in *Kon Joha* proved useful in inducing desirable changes in plant architectural traits. The study further emphasized the short stature high yielding mutants with strong aroma for wide-scale testing in the state.

Genetic characterization and relatedness assessment of maize landraces of North-east India

Hiramani Barman

The present investigation was conducted to study genetic variation and diversity for local maize germplasms, quality analysis, and inbreeding tolerance. The experiment was conducted in the ICR Farm, Assam Agricultural University, Jorhat, during the *rabi* season of 2018-19 and 2019-20. Forty germplasms were evaluated in Augmented Randomized Complete Block Design with four blocks with spacing 60 x 20 cm. Analysis of variance revealed that the entries differed significantly for all the characters except ear leaf width and leaf width. Germplasm namely, ARR1, ASTSY, ASSV2, ASKAR and ASDJ were recorded high grain yield per plant. Moderate to high estimates of GCV and PCV were recorded for all the traits except days to 75% dryhusk, days to maturity and moisture content. Moderate to high estimates of heritability (h^2) and genetic advance percent of mean Gs (%) for all the traits. High estimates of h^2 with high to moderate Gs (%) were observed for all the traits indicating the preponderant role of additive gene action for their inheritance. Grain yield per plant had positive and highly significant correlations with traits namely ear length, ear diameter, kernel rows per ear, kernels per row, kernel length, kernel width and 100 kernel weights. Path analysis revealed that the highest positive direct effects were observed in days to 50% silk followed by 100KW while the highest negative direct effect was observed in days to 50% PS. Morphological diversity studies revealed that genotypes of cluster A showed earliness along with higher values of ear traits, leaf traits, and grain yield while the genotypes of cluster B exhibited the desirable trait short plant. Hence, the genotypes belonging to cluster A and cluster B could be useful in developing early, short and high yielding varieties. Based on phenotypic mean data, maximum dissimilarity was observed between ASKAY and MNY followed by NLY1 and MNY while minimum dissimilarity was recorded between ARY1 and ARW2. The molecular analysis of variance revealed that there was a highly significant variation in all sources. The maximum variance (52%) was due to the variation among the population. The variation within individuals was very low (3%), while among individuals variation was (45%). As

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a result, umc2322, identified on chromosome 6, showed the maximum number of alleles (7) as well as the highest PIC value of 0.80. F-statistics revealed that moderate to high F_{st} values with a range of 0.324 to 0.700 indicated variable genetic differentiation among the populations. The germplasms MZW1 and NLB2 with the maximum Nei's genetic distance were found to be the most dissimilar indicating a high degree of genetic diversity in these two genotypes. The biochemical study indicated that ARR1 exhibited high carbohydrate content, crude protein, and zinc content. The entries namely, ARW1, ARY5, ARR1 and ASKAW1 which showed the minimum level of ID from studies on inbreeding depression, can be used as components for developing high yielding and inbreeding tolerant composite variety in future.

Genetic diversity and combining ability studies in pumpkin (*Cucurbita moschata* L.) landrace of Assam

Khirud Pangng

Thirty diverse landrace of pumpkin comprising from eight districts of Assam viz., four from each district of Sivasager, Dibrugarh, Karbi Anglong, Haflong, Jorhat & Majuli and three from each of Lakhimpur and Kokrajhar. With three objectives, the landraces were subjected to analyses of variance and covariance for estimation of genetic variability parameters, correlation coefficients and causal relationship among the 27 characters. The experiment was carried out at ICR Farm of Assam Agricultural University in a Randomized Block Design with three replications. From analysis of variance it was recorded presence of variation among thirty pumpkin landrace for all characters. The highest coefficient of variation (CV%) was for yield per plant (28.78%), indicating environmental effects for these characters. The highest genotypic coefficient of variability (GCV) was recorded for single fruit weight (51.47%) followed by yield per plant (43.58%) and female: male flower ratio (37.71%). The heritability in broad sense was recorded highest for the hundred seed weight. The GA calculated as per cent of mean was recorded for single fruit weight (99.44%), followed by yield per plant. In character association five traits were positively correlated with fruit yield per plant out of 27 yield correlations genotypic level. Among the characters, single fruit weight exhibited the highest positive direct effect (1.284) on the fruit yield per plant followed by fruits per plant and number of female flower. The highest positive indirect effect was recorded for number of female flower on fruit yield per plant *via* fruit per plant (0.693). The highest negative indirect effect was recorded for fruit per plant on fruit yield per plant *via* single fruit weight (-0.623). Residual effect was found to be 0.0023. From the Tocher's cluster divided into five group of cluster. The cluster I was composited highest (13) number of landraces. The highest intra-cluster distance was recorded for cluster V. Based on the performance of per cent of contribution towards diversity character ascorbic acid was shoed maximum (67.59%). Following the DUS guidelines 9

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qualitative characters were observed, resulted three major clusters for all landraces. For nine qualitative characters, out of 30 landraces 11 were showed angular type and rests were in circular stem shaped type. Regarding the fruit skin colour pattern, uniform type were dominant with 20 landraces (66.67%), only two landraces *Dibrugarh-2* and *Majuli-4* were recorded striped fruit skin colour pattern and remaining landraces observed mottled type. In regards to leaf blade margin 14 landraces were found to very weakly incised margin, 7 landraces for moderately incised margin and rest landraces had weakly incised leaf margin type. The dendrogram revealed the existence of 3 major clusters in 30 pumpkin landraces. The cluster A comprised of 8 landraces, cluster B comprised of 12 landraces and cluster C comprised of 10 landraces. The molecular studies revealed out of 40 SSR primer only 14 primers were showed polymorphic. Within the 14 polymorphic primers, the primer CMTp19 was recorded lowest polymorphism. From the development of diversity tree the 30 landraces were divided into 3 major groups. For combining ability studies selection of 8 parents were taken from 30 landraces on the diversity and consumer preferred typed fruit. The mating design was followed by Line X Tester. 6 Lines and 2 Tester were crossed in 2018-19 *Rabi* season in ICR farm, AAU and the hybrids were studied in next season along with the parents. Analysis of variance revealed the presence of great genetic diversity among the parental lines used in the study. The estimates of *gca* for lines and *sca* for hybrids represent that the line *Dibrugarh-4*, *Haflong-4*, *Majuli-4* and tester *Haflong-1* were best general combiner for most of the traits where as the hybrids *Majuli-4 X Haflong-1*, *Dibrugarh-1 X Haflong-1*, *Majuli-2 X Haflong-1*, *Dibrugarh-1 X Karbi Anglong-1*, *Majuli-4 X Haflong-1* were the best specific combiner for yield and yield contributing characters. The variance due to *sca* was higher then *gca* for most of the character indicating presence of no additive gene action which can be utilized for the development of hybrids. The hybrids of *Haflong-4 X Haflong-1*, *Karbi Anglong-2 X Haflong-1*, *Dibrugarh-4 X Haflong-1*, *Dibrugarh-1 X Karbi Anglong-1* and *Majuli-4 X Haflong-1* showed maximum heterosis for yield and yield attributing characters over mid and better parent. The hybrid M-4 x H-1 (127.88 per cent) exhibited the maximum positive average heterosis for single fruit weight followed by hybrid M-4 x KA-1 (89.88 per cent) whereas the highly significant negative minimum average heterosis was recorded for the hybrid D-1 x KA-1 (-54.28 per cent). The hybrids M-4 x KA-1 and M-4 x H-1 can be well exploited through heterosis breeding to obtain higher yield. Heterobeltiosis for yield per plant ranged from -59.38 per cent (H-4 x KA-1) to 171.56 per cent (M-4 x H-1). Hybrid H-4 x KA-1 can be exploited for early maturity of the fruit. H-4 x H-1 can be useful for the exploited through heterosis breeding to obtain good fruit quality. The outstanding hybrids may utilize for commercialization.

Genetics of drought tolerance in rice (*Oryza sativa* L.)

Laishram Monalisha Devi

The present investigation was carried out at Instructional-Cum-Research Farm of Assam Agricultural University, Jorhat with the objectives - (i) To assess genetic diversity for drought tolerance in rice and (ii) To study the combining ability and gene action. We evaluated 46 rice genotypes in water sufficient non-stress and water-deficit stress conditions during *Ahu* season of 2018 in PVC pipes. Evaluation of the 6-parent diallel crosses was carried out during *Ahu* 2019 in plastic tubs. The phenotypic evaluation revealed significant variation for all the characters. Leaf rolling (LR) and drought recovery (DR) had a significant correlation with root traits only, positive with root length and negative with root dry matter and root-shoot ratio. Based on the lowest average LR plus DR score of unity, *Basantabhar*, *Haru Bengunigootia*, *Lewly*, *Basmati Red*, *Banglami*, *Ikhojoi*, *Dimrou*, *Lachit*, *Disang* and *Inglongkiri* possessed tolerance to drought stress (7-8% soil moisture content) both at vegetative stage up to 3 weeks and reproductive stage up to 1 week. Root-shoot ratio, root dry weight, proline content, root length, productive tillers, grain yield, grains per panicle and biomass yield registered a high magnitude of PCV and GCV estimates. High heritability coupled with high genetic advance for 1000-grain weights, proline content, grains per panicle, root dry weight, days to first panicle emergence, days to 50% flowering, root-shoot ratio, biomass yield per plant, root length, grain yield per plant, productive tillers per plant, harvest index and shoot length implicating the role of additive gene action and scope of simple selection for these traits. D^2 statistics grouped the genotypes into 14 clusters with the highest inter-cluster distance between cluster V-XIII and V-XII. Thousand-grain weights contributed the maximum (74.69%) to the genetic divergence among the genotypes followed by grains per panicle (9.76), proline content (3.29%), root dry weight (3.09%) and grain yield per plant (2.71%). At the molecular level, we detected a total of 86 alleles by using 34 pairs of SSR primers with an average of 2.53 per marker. The Jaccard's coefficient of similarity ranged from 0.200 to 0.944, with an average of 0.360, suggesting diverse nature of the genotypes. The diallel analysis revealed the

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significance of both GCA and SCA variances for all the characters in both non-stress and stress environments, indicating the importance of additive and non-additive gene action in their expression. SCA variance was higher than GCA variance for most of the characters except pollen sterility in both the conditions and harvest index in non-stress condition alone. Simple selection would confer rapid improvement of pollen sterility in both the conditions. Among the parents, the good general combiners were IR 64, IR 36, Tamdao and Inlongkiri for early flowering and early maturity; Banglami and Sahbhagi Dhan for low pollen sterility; IR 64, IR 36 and Sahbhagi Dhan for reduced plant height; Banglami and Sahbhagi Dhan for high productive tillers per plant; Sahbhagi Dhan and Banglami for longer panicle with heavier grain weights; Banglami, Inlongkiri and Tamdao for harvest index in both the conditions; Sahbhagi Dhan, Inlongkiri and Banglami for grains per panicle; IR 64, Sahbhagi Dhan and Banglami for biological yield in stress condition. The cross combinations namely, Sahbhagi Dhan/Inlongkiri and Banglami/IR 64 in non-stress condition and Sahbhagi Dhan/Banglami, Sahbhagi Dhan/IR 64, Banglami/Tamdao, IR 36/IR 64, Inlongkiri/Tamdao in stress condition exhibited significant positive yield-SCA effects along with desirable GCA of parents and SCA for other characters. Hayman's genetic analysis indicated partial to complete adequacy of the additive-dominance model for all the characters in both the conditions. The component of dominance variance was predominant for almost all the characters with mostly overdominance expression of genes demanding a more prudent breeding exercise for genetic manipulation of these traits such as heterosis breeding. The narrow-sense heritability estimates were moderate to high for pollen sterility, plant height, panicle length and harvest index in both the conditions. Partial dominance for pollen sterility in both the conditions suggested its worth for fairly dependable selection. The study also indicated a similar genetic interpretation of the characters with the approaches of Griffing (1956) and Hayman (1954a, 1954b).

Molecular Marker Based Heterotic Grouping of Assam Rice (*Oryza sativa* L.)

Praveen Kumar

In the present investigation, a group of 55 upland rice genotypes along with 5 maintainer lines of wild abortive cytoplasmic male sterility (WA CMS) were characterized using 83 SSR markers. Eleven parents from diverse clusters of SSR based diversity analysis were selected for crossing in a diallel fashion following Model 1 Method II of Griffing (1956). The resultant hybrids were evaluated in RBD under two N-fertilizer doses (40 and 60 kg ha⁻¹) for 19 different traits. Fifty-three polymorphic markers detected a total of 133 alleles across the 60 rice genotypes with an average of 2.5 alleles per polymorphic marker. Polymorphic information content (PIC) values ranged from 0.032 (RM318) to 0.655 (RM293). The marker RM293 having the highest PIC value of 0.655 was adjudged the most appropriate marker to discriminate among the rice genotypes. The genetic divergence study grouped the 60 rice genotypes into 3 major clusters using Unweighted Neighbour-Joining (UNJ) method. Analysis of variance for the parents and their hybrids revealed significant differences for all the traits. The mean squares due to treatment were significant for all the traits. Treatment*Environment mean squares were also highly significant for all the traits except for seedling establishment. Grain yield recorded positive and significant correlations with culm height, productive tillers, biological yield and harvest index, indicating that selection based on these traits would ultimately improve seed yield. The GCA and SCA variances were highly significant for all the traits, suggesting the involvement of both additive as well as non-additive gene action in their inheritance. The SCA variance was higher than the GCA variance for all the traits, suggesting the predominance of non-additive gene action, which was also supported by the low magnitude of $\sigma^2_{gca}/\sigma^2_{sca}$ ratios. Suryamukhi, Lal Aus, Mayamoti, IR 58025B, IR 68888B, IR 68897B, IR 79156B and Lachit were good general combiners for grain yield per plant. The crosses namely IR68888B*Luit, Lal Aus*IR80555B, Suryamukhi*Lachit, Mayamoti*IR79156B, Mayamoti*Lachit, IR58025B*IR6888B, IR58025B*IR68897B, IR58025B*IR79156B, IR58025B*IR80555B, IR68897B*Lachit, Lal Aus*IR68888B, Lal Aus*IR68897B, Lal

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Aus*IR79156B, Lal Aus*Lachit, Lal Aus*Luit, Bor Mekohi Dhan*Mayamoti, Bor Mekohi Dhan *IR58025B, Suryamukhi* Bor Mekohi Dhan, Suryamukhi *IR58025B and Suryamukhi*IR79156B revealed significant desirable SCA effects for grain yield per plant along with other important traits. The crosses viz., IR68888B*Lal Aus, IR68888B*Lachit, IR79197B* Bor Mekohi Dhan, IR79156B*Lal Aus, IR79156B*Lachit, IR80555B*Bor Mekohi Dhan, Suryamukhi*Mayamoti, IR68888B*IR79156B, Lal Aus*Lachit and Bor Mekohi Dhan*Luit were common in both SCA- and SSR diversity based heterotic groups. The genetic distance estimates did not correlate with the SCA effects and heterosis for grain yield. The yield-SCA effects showed positive and significant correlation with grain yield, mid-parent, better-parent and standard-parent heterosis. Thus, prediction of hybrid performance based on SCA-based clustering of the genotypes would enable identification of superior crosses before field testing. The best hybrids viz., Mayamoti*Lachit (G2*G3), IR80555B*Lal Aus (G1*G2) and Luit*IR68888B (G1*G3) belonged to inter-heterotic groups. These heterotic crosses could be exploited in a rice hybrid breeding programme to obtain high-yielding hybrids. The results of the present study, however, provided no concrete evidence to support the effectiveness of random SSR markers for separation of rice genotypes into heterotic groups.

Genetic enhancement in tomato for resistance to bacterial wilt and quality through intra and inter-specific hybridization

S. Yasmin Das

Tomato is the most important solanaceous vegetable crop. To estimate its production under the challenges of bacterial wilt disease, it is important to identify potential genotypes with resistance to bacterial wilt disease of tomato. To achieve this goal an investigation on ‘Genetic enhancement in tomato for resistance to bacterial wilt and quality through intra and inter-specific hybridization’ had been taken up to study the performance of few genotypes, their heterosis and combining ability and nature of gene action. The experiment was carried out at the experimental field of Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati during *rabi* seasons of 2015-16, 2016-17 and 2017-18. Evaluation of six parents, fifteen F₁, fifteen F₂, three BC₁ and three BC₂ generations of tomato revealed existence of sufficient variability and interaction effects in the genotypes. Combining ability analysis in Diallel mating design without reciprocals involving six diverse tomato cultivars/lines, *viz.*, Singimari Local, Megha, Solan Lalima, Arka Abha, Arka Alok and Kon bilahi and their 15 cross combinations in bacterial wilt sick plots revealed importance of both additive and dominance effects. Two parents, Singimari Local and Kon Bilahi were identified as good general combiner. Ten cross combinations out of total fifteen combinations exhibited high estimates of specific combining ability for different desirable traits. Among them the crosses which merit special consideration were Singimari Local x Solan Lalima for yield per plant(g), harvest duration and bacterial wilt survival (%); Singimari Local x Kon Bilahi for number of fruits per plant(g) and bacterial wilt survival (%); Solan Lalima x Kon Bilahi for number of fruits per plant, harvest duration, pH of pulp and bacterial wilt survival (%); Arka Abha x Arka Alok for harvest duration, pH of pulp, fruit weight(g), number of primary branches per plant and yield per plant (g); Megha x Kon Bilahi for days to first picking, days to maturity, pericarp thickness(mm), TSS (° Brix) and bacterial wilt survival (%) could effectively be used to

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exploit heterosis in bringing about desired genetic improvement. Besides, the crosses showing desirable SCA for yield per plant (g) and bacterial wilt survival (%) but without significant heterosis were Arka Alok x Kon Bilahi, Megha x Arka Alok, Singimari Local x Arka Abha and Arka Abha x Kon Bilahi. These crosses could be ideal for further selection to bring them into homozygous genetically improved lines.

Generation mean analysis was carried out in three crosses *viz.* Singimari Local x Megha, Singimari Local x Kon Bilahi and Megha x Kon Bilahi involving six generations (P₁, P₂, F₁, F₂, BC₁ and BC₂). The individual scaling tests were used to test the adequacy of additive dominance model. The gene effects were estimated using three parameter model (Joint Scaling Test) suggested by Cavalli (1952) and six parameter model suggested by Haymen (1958). The analysis of variance among different generations of different crosses revealed significant variation for all the eighteen characters indicating considerable variability in the material studied. All the characters except productive flower retention (%) in cross Singimari Local x Megha recorded significance for at least one of the four individual scaling tests in all the 3 crosses. With respect to interaction effects, all the characters except productive flower retention (%) in cross Singimari Local x Megha, exhibited significant interaction effect for one or more epistatic interactions i.e. [i], [j] or [l] in all the three crosses studied. It is evident that for all the morpho-physiological and yield attributing traits, fruit quality traits and bacterial wilt survival(%) additive, dominance and interaction effects were present indicating the complex inheritance of the traits under study. Further enhancement of the genotypes identified in this study will pave the way for the development of high yielding tomato variety with resistance to bacterial wilt disease.

Characterization of Deepwater rice of Assam for agro-morphological and biochemical traits

Yaster Das

Deep water rice is one of the world's most fascinating as well as challenging climate resilient crop which has elongation, kneeing and nodal tillering ability. They are rich in vital micronutrient like Fe and Zn content, have anti-oxidant property but low yielder about 1.0 to 1.5 tonnes per ha which is mainly due to its plant types, stresses encountered during growth period, low genetic potential and lack of effective breeding techniques. Hence, a study on the morphological, biochemical and biotechnological traits was done to characterize, to understand the extent of diversity and for identification of valuable traits and promising genotypes required for deepwater rice improvement. The experiment was conducted under direct seeded and transplanted conditions during 2017-18 and 25 selected genotypes from both the environment were transplanted during 2018-19. Morphological characterization consisted of 46 qualitative and 16 quantitative traits which consists of 13 monomorphic, 14 dimorphic, 11 trimorphic and 24 polymorphic traits indicating their potential for varietal characterization and distinctiveness. Kneeing ability was observed in 90 genotypes and elongation ability ranged from 3.15 cm to 132.75 cm. Maximum genotypes exhibited procumbent nature, presence of secondary branching, well exerted panicle, phenol reaction of lemma, white stigma colour, short grain length, medium amylose content and chalkiness, high gelatinization temperature, long stem length, medium test weight, red kernel colour, broad grain width and medium grain shape. Though maximum genotypes have semi-erect culm attitude but are lodging susceptible at maturity. The quantitative traits revealed significant difference under both the conditions and for 25 selected genotypes. The mean for the biochemical traits viz., protein content (7.99 %), starch content (71.38 %), amylose content (21.27 %), amylopectin (78.73%), Fe content (16.79 mg kg⁻¹) and Zn content (23.19 mg kg⁻¹) showed rich nutritional status of DWR which may serve as donor for future quality breeding programs. High magnitude of both GCV and PCV was recorded for elongation ability, leaf breadth and EBT per hill under direct seeded condition whereas culm diameter, EBT per hill and KL:KB showed under transplanted condition. High heritability coupled with high estimate of genetic advance

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as percent of mean was recorded for EBT per hill, leaf length, leaf breadth, GL:GB, kernel breadth, KL:KB, culm diameter and for yield per plant under both direct seeded and transplanted condition. Protein, iron and zinc content also showed high heritability coupled with high estimate of genetic advance as percent of mean. Study of correlation coefficients revealed that yield per plant is positively correlated with EBT per hill, leaf length, leaf breadth, panicle length, grains per panicle, 100-grain weight, culm diameter, kernel breadth, protein content, number of filled grain per panicle and harvest index which indicated the importance of these traits in DWR improvement, moreover, zinc content showed positive correlation with iron content. EBT per hill, leaf length, leaf breadth, grains per panicle, 100-grain weight, kernel length, culm diameter and protein content had positive direct effect and significant positive correlation with yield per plant, indicating the true relationship among these traits. D2 analysis grouped 115 germplasms into 14, 5 and 19 clusters under direct seeded, transplanted and for physico-chemical traits respectively. The maximum inter-cluster distance was observed between cluster XI and XIII, cluster II and VI, and cluster XVI and XVIII while highest intra-cluster distance in cluster VIII, Cluster III and cluster XIII under direct seeded, transplanted and for physico- chemical traits respectively. Under both the conditions, days to 50 per cent flowering, 100-grain weight and grain breadth were found the contributor of genetic divergence which prove their importance in DWR breeding programme while Zn and Fe content contributed highest towards genetic divergence for physico- chemical traits. Three markers Sub1BC2, RM 316 and RM 8300 were found to be highly scorable and informative among the thirteen markers used for screening of DWR for submergence tolerance. Three genotypes viz., Badam Bao, Betu Bao-1 and Happy Bao showed the similar banding pattern as to Ranjit-Sub1 on compiling the result of these three markers which showed that these lines are may be the haplotypes of Sub1 QTL which must be validated by sequencing of Sub1 QTL.

Evaluation of protective strains for cross-protection against *Citrus tristeza virus* disease

Borsha Rani Baruah

For *Citrus tristeza virus* strains differentiation and identification, leaf samples were collected from Khasi Mandarin (*Citrus reticulata*) plants expressing differential symptoms from three different locations viz., Tinsukia, Golaghat and Mariani of Upper Brahmaputra Valley Zone of Assam. These were then grouped into three categories, viz. low range, medium range and high range based on ELISA OD₄₀₅ values. Biological indexing with CTV positive samples from these three serological categories on Mexican lime or Kaghzi lime (*Citrus aurantifolia*) seedlings resulted in symptom expression within three months post grafting. Visible symptoms of CTV infection were observed in some of the graft successful indicator plants whereas, in some plants, no visible symptom development took place within this period. Based on the results, the plants were grouped into two groups- mild and severe, and were confirmed through Bi-directional PCR with mild and severe strain specific primers. PCR products for both mild and severe isolates were sequenced. Consensus sequences showed a single nucleotide difference at position 371 for mild and severe isolates, thereby confirming the identity. Two mild isolates and two severe isolates were selected for the cross protection experiment on Khasi mandarin seedlings. Cross protection experiment was carried out in seven treatments with five replications. Real time-PCR analysis of the grafted plants was carried out six months post grafting to determine the virus titre values through absolute quantification by developing an external standard curve with the equation 'y = -3.0543x + 37.018' (R²= 0.9981), using 6 serial dilutions of eluted DNA (10⁻¹ to 10⁻⁶). The average estimated gRNA copies were 1.02 x 10⁵ ± 8.33 x 10³ mol/ng and 9.55 x 10⁴ ± 5.89 x 10³ mol/ng of total RNA in mild inoculated plants, 3.80 x 10⁵ ± 3.05 x 10⁴ mol/ng and 3.94 x 10⁵ ± 3.53 x 10⁴ mol/ng in severe inoculated plants and, 2.20 x 10⁴ ± 2.14 x 10³ mol/ng and 3.44 x 10⁴ ± 3.20 x 10³ mol/ng in mild inoculated plants, later challenged by severe, with no observed amplification in the un-inoculated control. It was observed that the mild inoculated plants, challenged by severe i.e. cross protected plants exhibited the lowest virus copy numbers. Melting curve analysis revealed that the T_m of

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the mild CTV isolates (80.37–80.82⁰C) was lower than that of the severe isolates (81.57–81.97⁰C). In the cross protected plants, T_m in the range of 80.73-80.88⁰C was recorded, indicating the presence of mild isolates.

Biointensive management of Sheath Rot disease of rice caused by *Sarocladium oryzae* (Sawada) Gams and Hawksw

Budha Bora

Sheath rot of rice caused by *Sarocladium oryzae* (Sawada) Gams and Hawksw has emerged as one of the major diseases of rice. The fungus attacks the boot leaf sheath affecting emergence of panicle resulting discoloured and chaffy grains and inflicts considerable yield loss. The pathogen is seed borne and survives in soil on the leftover stubbles, which acts as the sources of primary inoculums. Many effective pesticides have been recommended against this disease, but not considered as a long term solution because of concerns about pesticide residue risk, health and environmental pollution and health hazards, development of resistance, residue persistence and elimination of natural enemies which necessitates an alternative eco-friendly method for its management and sustainable crop production. The present study was undertaken to evaluate the integrated effect of microbial antagonist, organic amendments and biofertilizer consortia on the suppression of sheath rot pathogen that survives in rice seeds, stubbles and consequential improvement of soil health. Among the different microbial antagonists evaluated, *Pseudomonas fluorescens* was found to be the most effective inhibiting maximum (82.06%) radial growth of *S. oryzae* *in vitro* followed by *Bacillus subtilis* (7.35%) and *B.megatorium* (67.38%), respectively. Among the fungal antagonists, *Trichoderma harzianum* was found to be the most efficient inhibiting maximum (65.21%) radial growth of *S. oryzae* followed by *T. viride* (57.76%) and *T. asperellum* (52.09%), respectively. Talcum powder based formulation of the best microbial antagonist (*P. fluorescens*) was found to be most effective when applied as seed treatment, seedling root dip treatment and foliar spray at boot leaf stage in reducing maximum disease incidence (68.24%) and percent disease index (57.26%) over control and increased the yield attributing characters such as number of effective tillers per hill, number of healthy grains per panicle, 1000 grain weight and grain yield etc tested under pot condition. Dhaincha (*Sesbania aculeata*) as organic amendment along with biofertilizer

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consortia enriched FYM and microbial antagonist (*P. fluorescens*) was proved to be the most effective method for management of sheath rot disease as evidenced by maximum reduction of disease incidence (69.94%) and percent disease index (60.95%) over control and also found to increased the yield attributing characters under field condition. The *S. oryzae* could survive only upto 120 days in *S. aculeata* amended plot followed by 150 days in plots amended with azolla and vermicompost, respectively whereas, it could survive upto 180 days in the control plot at different soil depths (0cm, 2 cm and 4 cm) that were evaluated. However, in all the situations, the survival and viability of *S. oryzae* declined with increase in time. Soil amendment with organic materials along with biofertilizer consortia and microbial antagonist (*P. fluorescens*) has significantly increased the N, P, K content, organic carbon and microbial biomass carbon. Among all the organic amendments, *S. aculeata* as in situ green manure crop along with biofertilizer consortia and microbial antagonist (*Pf*) was found to increase maximum N, P, K (305.4, 17.77, 106.43 kg/ha) content of soil and ranked next to RDF. Moreover, organic amendments have significantly increased the Boron content of soil. Among all the organic amendments, the plot amended with *S. aculeata* along with biofertilizer consortia and microbial antagonist (*Pf*) recorded the highest (0.66 mg/kg) B followed by azolla (0.64 mg/kg) and vermicompost (0.63 mg/kg) plot, respectively. Among all the different amendments, *S. aculeata* as in situ green manure crop along with biofertilizer consortia and microbial antagonist (*Pf*) recorded the maximum OC and MBC (0.67%, 281.58 µg/kg) followed by azolla (0.63%, 273.46 µg/kg) and vermicompost (0.61%, 267.88 µg/kg) plot, respectively. The enhancement of OC and MBC in the dhaincha amended plot over control was recorded to the tune of (23.88%) and (12.86%), respectively and considered as the most effective treatment combination not only in terms of improvement of plant health, soil health and disease suppression ability but also found to enhance the grain yield.

Evaluation of rice varieties against *Ustilaginoidea virens* and its management

Hiranya Kr. Deva Nath

Rice false smut caused by *Ustilaginoidea virens* (Cooke) Takahashi has become the most devastating grain disease in almost all the rice growing areas throughout the world. It is predicted as an upcoming major disease in India and in recent times, the disease has been observed to show an increasing trend in rice fields of Assam. In the present study evaluation of rice varieties for resistance and susceptibility against rice false smut was done and studied the effect of management strategies under field conditions in Assam. Among the twenty two varieties tested with artificial inoculation, three varieties *viz.*, Manohar Sali, Pareshash Biroyin and Keteki Joha showed highly resistant reaction (*i.e.* completely free from the disease), while Ranjit and Bahadur were found to be resistant. Besides, eleven varieties were found moderately resistant, four varieties were moderately susceptible and two varieties *viz.*, Mahsuri and Bhogali Bora showed susceptible reaction to rice false smut. Rice false smut has significantly reduced the per cent seed germination in all the varieties tested and was maximum in Bhogali Bora (24.80%) and minimum in Ranjit (6.80%). Seedlings emerged out of seeds from infected panicles had poor vigour measured in terms of reduced shoot length, root length, fresh and dry weight of shoot and root. The disease has significantly increased chaffiness (up to 29.75%) and decreased 1000 grain weight (up to 30.37%) and panicle weight (up to 27.89%). Biochemical analysis showed that, healthy seedlings had high amount of phenol and starch than the seedlings that emerged from the infected panicles. Among the different sowing dates, highest incidence of false smut (21.55%) and severity (75.06%) with lower grain yield (28.98 q/ha) were recorded in late sown crop (9th July) which flowered during last week of October. The early sowing (10th May) when the crop flowered during last week of August to first week of September showed lower disease incidence (4.98%) and severity (4.76%) with higher grain yield (35.94 q/ha). Correlation studies on the influence of weather parameters on false smut development revealed that minimum temperature, evening relative humidity and rainy days were playing an important role in the disease development compared to other

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weather parameters. Multiple regression analysis indicated that minimum temperature alone caused variation in false smut incidence and severity to the extent of 97 and 95 per cent, respectively. *In vitro* evaluation of different fungicides and bioformulations revealed that copper oxychloride, copper hydroxide and propiconazole completely inhibited the mycelial growth of *U. virens* (100%), while Taegro Eco (a *Bacillus* based bioformulation) could suppress up to 95.95 per cent after 14 days of inoculation. In *in vivo* condition propiconazole (0.1%) as seed treatment and two foliar application (at booting stage and flowering stage) effectively controlled rice false smut disease with a significant reduction of disease severity (91.93%) and increased grain yield up to 18.63 per cent over control. Among the bioformulations, Taegro Eco was found to be highly effective next to chemicals in controlling rice false smut with a reduction of disease severity (74.95%) and enhanced grain yield up to 11.40 per cent over control.

Molecular Characterization of potato viruses of North Eastern region of India

Mohamad Hussam Halabi

The present research focused on the viral disease diversity of potato in the North-Eastern states of India. The potato producing potential of these states remain untapped even though the region provides suitable climatic and varied soil conditions. One of the significant challenges to potato cultivation is the high susceptibility of the crop to infections from disease-causing organisms such as bacteria, fungus, and viruses. The bacterial and fungal agents can be treated using suitable chemical control. However, viral infections remain without any control methods such as viricides. Moreover, the aphid pest, acting as vectors for viruses responsible for infection in potato, also remains at large in the region owing to the suitability of abiotic and biotic factors. The viral infections often cause reduced yield, under-sized tubers, lower production and are further transferred to crops propagated from the infected seed stocks. The farmers in North-East also deprived from lack of access to good seed material; hence the problem continues to intensify. Thus, in lieu of increasing problems, the present research entailed towards molecular characterization of plant viruses infecting potato crops in the region. Additionally, the phylogenetic analysis was also undertaken to study the evolutionary relationships shared by the viruses with other isolates across India. The efficacy of suitable methods was also assessed in acting as a quick diagnostic of viruses in infected plants.

The investigation initiated in the potato fields itself surveyed for infected plants, through visual identification of symptomatology. Following the identification of infected plants, the collection procedures were performed, wherein the plant material was stored in cold boxes and maintained at low temperatures to preserve integrity. The serological Double Antibody Sandwich – Enzyme-linked Immunosorbent Assay (DAS-ELISA) was employed for confirmation of the presence of different viruses using suitable antibodies. Post the DAS-ELISA, the molecular techniques of Reverse transcription-polymerase Chain Reaction (RT-PCR), RT- Loop-mediated Isothermal Amplification (RT-LAMP), Multiplex-PCR, and Touch-Down PCR were employed.

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RT-PCR technique was employed to confirm the presence of virus infections. Other techniques of RT-LAMP, Multiplex PCR, and TD-PCR were employed to assess and compare the sensitivity of RT-PCR techniques. Further, The National Center for Biotechnology Information NCBI Blast tools, multiple sequence alignment, and techniques of Phylogenetic tree construction were used for studying phylogenetic clusters.

The results showed the high prevalence of Potato leafroll virus (PLRV) and Potato virus Y (PVY), with the highest prevalence of viral infection in the Shillong region of Meghalaya. The RT-PCR amplification and agarose gel electrophoresis confirmed the presence of PVY, PLRV, Potato virus X (PVX), Potato virus M (PVM), Potato virus S (PVS) and Alfalfa mosaic virus (AMV) in the potato fields of North-east India. Also, different strains of the PVY virus, namely PVYO, PVYN, and PVYNTN, were also confirmed. In the present study AMV infection on potato was detected and identified for the first time in India. In terms of comparative sensitivity and efficacy, the RT-LAMP assay was found to exhibit high efficacy as compared to RT-PCR. The phylogenetic clustering showed the relationship shared among the different isolates pan-India, while the AMV isolates shared a close relationship with virus isolates from Iran.

The findings from the study contributed to the present literature available for potato virus prevalence in North-East India. Also, the identification of the AMV virus also paves the way to novel research into pathways leading to infection in India. Such knowledge related to specific potato varieties can help improve intelligent breeding of the improved potato varieties for the better cultivar. Future plans of the Indian authorities to boost the agriculture and farmer's income for a better future need to be supplemented with better technologies. It is imperative to catch the infections at early stages to avoid the use of infected seed stock produced locally for the propagation of crops in future growing seasons. This could be achieved using sensitive techniques for early diagnosis in the future, of which High-throughput sequencing can form an important part.

Potential rhizospheric microbes of Assam for the management of rhizome rot of Ginger

Nanjunda Swamy J. C.

The present investigation was carried out to explore the potential rhizospheric microbes of Assam for the management of rhizome rot of Ginger caused by *Pythium myriotylum.*, *Fusarium oxysporum*f.sp. *zingiberi.* and *Ralstonia solanacearum*. A total of 338 rhizospheric and rhizoplane microbes including 151 fungi and 187 bacterial were isolated from different Agro climatic zones of Assam in different seasons during 2017-2018. Those isolates were screened for their *in vitro* efficacy against the all three pathogens. Among these two rhizospheric fungal isolates viz., KBR52 from Karbi Anglong, GLRS42 from Golaghat and one rhizoplane bacterial isolate KOR7 from Kokrajhar isolate showed significant inhibition upto 82.49, 81.83 and 69.03 per cent against *Fusarium oxysporum*f.sp. *zingiberi.*, respectively, 86.88, 85.43 and 70.09 per cent against *P. myriotylum.*, respectively and 35.43, 33.58 and 28.77 per cent of zone of inhibition against *R. solanacearum.*, respectively. The three most promising rhizospheric and rhizoplane microbes were further considered for cultural, morphological and molecular studies. The 18S rRNA sequencing of ITS1 and ITS4 region of the genome revealed that the first and the second best promising rhizospheric fungal microbes were *Trichoderma asperellum.*, while the third best promising rhizoplane bacterial isolate was tested for biochemically and along with 16S rRNA sequence was revealed *Bacillus siamensis.* Two rhizospheric fungi and one rhizoplane bacterial microbes were found compatible with each other and combination of the three microbes were found most effective against all three pathogens. The effective compatible microbial combination treatments able to reduce the ginger yellowing and rhizome rotting and also increased the ginger growth and yield parameters during in planta experiment conducted in pots under shade net house conditions. Those promising rhizospheric and rhizoplane microbes were further studied for their PGPR activities viz., volatile metabolites, Antibiosis assay, HCN, Siderophore, Ammonia, IAA production, Phosphate and Zinc solubilization. All the microbes were recorded maximum volatile production and also found to produce IAA, Ammonia, siderophore, HCN and solubilize

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zinc and phosphate and those three microbes were recorded maximum extracellular enzyme activities viz., Cellulolytic, Pectinolytic and protease activities except *B.siammensis* recorded Xylanase activity. Biochemical assay carried out for ginger plants after challenge inoculation with rhizospheric and rhizoplane microbial combination showed higher activities of Phenylalanine ammonia lyase, Polyphenol oxidase, peroxidase and β -1,3-glucanase content in combination treatments than individual microbial and pathogens combination treatments and also recorded PAL and PPO activities reached peak at 48 hours after inoculations and PO and β -1,3-glucanase were reached peak at 72 hours after inoculation.

Bioprospecting actinobacteria of Assam for some rice disease management and growth promotion

Nripen Kumar Gogoi

Actinobacteria, an important group of Gram positive bacteria are potent producers of wide variety of secondary metabolites with diverse biological activities including biocontrol and plant growth promotion abilities. The members of the genus *Streptomyces* are especially prolific as they alone constitute 50% of the total soil actinobacteria and 18% of all biologically active secondary metabolites (nearly 7600 out of 43,000) known so far. The present investigation was undertaken to explore potent actinobacterial strains to contain two major rice diseases viz. sheath blight (ShB) and bacterial leaf blight (BLB). Total seventy five isolates of actinobacteria were isolated and their morphological, biochemical and molecular characterization were carried out. Among twelve antagonistic actinobacterial isolates observed *in vitro*, isolate 'Act 116' and 'Act 119' recorded the maximum inhibition of ShB pathogen *Rhizoctonia solani* and BLB pathogen *Xanthomonas oryzae* pv. *oryzae* by 66.7% and 26.3%, respectively. Scanning electron microscopy of these two isolates showed rectiflexible and retinaculiaperti type of polysporous spore chains. Molecular identification of 'Act116' and 'Act 119' done through 16S rRNA gene sequencing revealed the strains as *Streptomyces corchorusii* and *S. sasae*, respectively. The partial gene sequences of the two isolates were submitted to NCBI GenBank (GenBank No.KY393359.1 & GenBank No. MH988751.1). The pot culture and field experiments showed significant reduction of per cent disease index (PDI) of ShB and BLB of rice (cv. Mahsuri) in strain 'Act 116' and 'Act 119' treated plants. The application of actinobacteria 'Act 116' and 'Act 119' as seed treatment, root dip and foliar spray could reduce PDI of ShB and BLB to 24.6% and 30.8%, respectively over control (70.4 and 66.7 PDI, respectively). These combinations were also resulted in significant plant growth promotion. In field experiments, the microbial population increased in treated plots compared to control. Significant uptake of nitrogen, phosphorous and potash were observed in actinobacteria treated plots compared to control. The crude bioactive compounds extracted were analyzed through LCMS and revealed the possible presence of antibiotic compounds

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like Difloxacin, Dicloxacillin, Nystatin, Tetracycline and Doxycyline. Hence, it can be inferred from the present study that actinobacterial strains 'Act 116' and 'Act 119' have significant biocontrol potential against the two major rice diseases ShB and BLB, respectively and can be efficient candidates for management of other plant diseases also.

Regulation of microbial dynamics and nutrient status in the rice micro-ecosystem due to application of bioagents for management of bacterial blight of rice (*Xanthomonas oryzae* pv. *oryzae*)

Parveen Khan

The present study was made to evaluate an ecofriendly management strategy using different microbe based bioformulations, viz., Bioveer (Talc based formulation of *T. viride*), Biotime (Talc based formulation of *M. anisopliae*, *P. fluorescens* and *T. harzianum*), Biogreen (Talc based formulation of *T. viride*, *P. fluorescens*, *B. thuringiensis*, *B. bassiana* and *M. anisopliae*), Biosona (Talc based formulation of *B. bassiana*) and Biofor-Pf (Vermicompost based formulation of *T. harzianum* and *P. fluorescens*) for management of bacterial blight (BB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*). Regulation of microbial dynamics and nutrient status in rice micro-ecosystem due to application of these bioformulations was also assessed. About 30 isolates of *Xoo* were collected, of which *Xoo2* was selected for further experimentations, due to its aggressiveness in causing BB in rice. *In vitro* efficacy results revealed that Bioveer was significantly highest in inhibiting the growth of *Xoo* (54.14%). Field evaluation of bioformulations against BB showed lowest disease incidence (29.20%) and disease severity (29.43%) when Biogreen was applied as seed treatment, seedling root dip treatment and foliar application @ 2% along with enhancement in rice grain yield (31.06 q/ha) and plant growth parameters. The total phenol content (23.16%) was significantly highest in rice leaves treated with Biogreen @ 2%. Moreover, Biogreen @ 2% was most effective in increasing the nutrient availability and uptake in rice plants and enhancing the microbial biomass carbon and soil enzyme activity. Population dynamics study of both endophytic and rhizospheric microbes revealed that maximum colonization frequency of both bacterial and fungal dynamics was associated in rice plots treated with talc based bioformulation Biogreen @ 2%. The study also revealed higher count of bacterial diversity as compared to fungal diversity. Two endophytic (EPK 5 and EPK 10) and rhizospheric (RPK 2 and RPK 8) microbes showed maximum inhibition against *Xoo in vitro*, which were found compatible among each other. Based on morphological, cultural, biochemical and

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molecular gene sequencing studies, the isolate EPK 5 was identified as *Pseudomonas fluorescens*, RPK 2 as *Bacillus amyloliquefaciens*, EPK 10 as *Trichoderma asperellum* and isolate RPK 8 as *Talaromyces flavus*. Compatible combination of these microbes could inhibit the growth of *Xoo* *in vitro*. Five best compatible combinations were tested for *in planta* along with a Biogreen @ 2% for suppression of BB. Studies revealed that combination of EPK 5 (*P. fluorescens*) + EPK 10 (*T. asperellum*) + RPK 2 (*B. amyloliquifaciens*) + RPK 8 (*T. flavus*) showed lowest BB incidence (17.75%) with highest grain yield (46.74 g/plant) and growth attributing characters.

Botanical and Bioagent Mediated Regulation of Defense Related Phytochemicals in Tea, *Camellia sinensis* (L.) O. Kuntze against Major Diseases and Pests

Popy Bora

The present investigation aimed at exploring some native botanicals used by the small tea growers of Assam engaged in organic tea cultivation as well as microbial bioagents for management of major disease and pests of tea and their response in modulating defense related phytochemicals, response on green leaf yield and quality parameters of tea. Our preliminary studies identified grey blight as major disease and tea mosquito bug (TMB), red spider mite (RSM) and tea looper caterpillar (TLC) as predominant pests, hampering the quality production of tea in the study area of Experimental garden of plantation crops, AAU, Jorhat. The grey blight pathogen was identified as *Pseudopezalotiopsis curvatispora* based on cultural, morphological and molecular characterization through sequencing the ITS region of 18s rRNA of the fungus, the first ever report of such species from Assam. The initial *in vitro* screening of seven botanicals at three different concentrations (2.5%, 5.0% and 10.0%) showed that 10% concentration of two botanicals *viz.*, *X. strumarium* and *P. pinnata* were most effective against *P. curvatispora* and all the three tea pests considering type of botanicals, their concentration and their interaction effect. These two botanicals were selected for onward field study. Similarly, among the bioformulations, Biogreen (2%) and Biometra (2%) showing significant suppression of grey blight pathogen and mortality against tea pests *viz.*, tea mosquito bug, red spider mite and looper caterpillar were identified for subsequent field study. Attempts were further made to identify the antimicrobial and pesticidal phytoconstituents of *P. pinnata* and *X. strumarium*, which showed the presence of as many 27 and 42 different compounds, respectively, mostly secondary metabolites with known pesticidal/antimicrobial properties.

The field study involving *P. pinnata* and *X. strumarium* along with Biogreen and Biometra (singly as well as in combination) showed significant reduction of grey

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blight disease and tea pests, from 0 days to 150 days after spray. Combination of Biogreen and Biometa at 2% each, was most effective in terms of reduction of 87.52%, 88.41%, 88.97% and 90.52% against grey blight, tea mosquito bug, red spider mite and looper caterpillar respectively followed by sole application of Biogreen at 2%. Botanicals also showed significant reduction, however, inferior to bioagent consortium based treatment in field study. Combination of *P. pinnata* and *X. strumarium* was observed more effective than their individual counterparts in terms of post-treatment reduction of disease and pests. Assessment of the botanicals and bioformulations in triggering host defense in tea revealed that both microbial bioagents and botanicals showed similar response in modulating the activity of defense enzymes viz., PAL, PPO, β 1, 3 -glucanase and PO, although the magnitude of enzyme activity was observed higher in bioagent consortium treated plants than the botanical treated plants. Apart from these responses, tea leaves were also assessed for responses on polyphenol content and antioxidant activity, which revealed better performance of bioagents based treatments with corresponding higher antioxidant activity. The combination of Biogreen + Biometa proved most effective by registering the highest polyphenol (22.62%) and antioxidant activity (86.20%) followed by Biogreen and combination of botanicals in decreasing order. Field response of different botanicals and bioagents based treatments further showed the maximum biomass of green tea leaves of 88.4q/ha with Biogreen + Biometa followed by 85.0q/ha with Biogreen application and 72.6q/ha with *P. pinnata* + *X. strumarium* (5.0% each), corroborating further with higher concentration of caffeine content. The correlation study among grey blight and three important quality parameters of tea viz., polyphenol content, antioxidant activity and caffeine content showed negative correlation of these parameters with grey blight incidence, thereby, establishing their definitive role in grey blight disease incidence and related plant defense involvement.

Potentiality of Banana endophytes from Assam against *Fusarium oxysporum* f. sp. *Cubense*

Savani Ajit Kumar

In the present study an attempt was made to study the potentiality Banana endophytes from Assam against *Fusarium oxysporum* f.sp. *cubense*, the causal organism of Fusarium wilt of banana. A total of 300 banana samples from leaf, pseudo-stem and root were collected from different agro-climatic zones considering season, topography and type of cultivars for isolation of endophytes. Present Investigation revealed that highest number of endophytic microflora was recorded during monsoon season (May to September) where as lowest number of endophytic microflora during post monsoon season (October to December). Tissue specificity studies resulted highest number of endophytic microflora in root tissue samples used. Of the 330 endophytes were isolated from 300 samples only three endophytic microbes (2 fungi and 1 bacteria) found to be most antagonistic against Foc. The promising endophytes based on *in vitro* studies and PGP index, were further studied for their efficacy in reducing the vascular wilt incidence under *in vivo* (pot culture) and the combination treatment of all the three microbes was most effective in reducing the vascular wilt. A positive correlation of biometrical parameters of banana plant such as height, girth, number of leaves and number of roots was also observed with the treatment of combinations of three microbes. In assessing AUDPC and rate of infection (r) plants inoculated with combination treatments were significantly effective in reduction of disease with 99.9 units² and with an epidemic rate at 0.02 units d⁻¹. The three most promising endophytic microbes were further considered for cultural, morphological and molecular studies. The 18S rRNA sequencing of ITS1 and ITS4 region of the genome revealed that the first and the second best promising endophytic microbes were *Trichoderma reesei*, *Rigidiporus vinctus* while the third best promising endophytic microbe was *Sphingobacterium tabacisoli*. Study on the different modes of action of the promising endophytes revealed that all endophytes were able to produce volatile and non-volatile compounds, IAA, NH₃, siderophore and HCN, though at different levels. However, *Sphingobacterium tabacisoli* failed to solubilize phosphate on solid medium containing insoluble inorganic phosphorus source. On the other hand,

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Sphingobacterium tabacisoli failed to produce non-volatile compounds, siderophore, but the endophytes could produce different levels of extracellular enzymes and can tolerate different levels of salt concentrations. The result of the biochemical test revealed that there was a higher activities of different defence related enzymes viz. peroxidase, polyphenol oxidase, phenylalanine ammonia lyase in plants inoculated with endophytic combinations as compared to single endophytes treatments after inoculation with Foc. The result of the present investigation suggested that the higher activity of these enzymes is an indicative for activation of innate plant immunity by application of endophytes combinations.

Biochemical, histopathological and molecular characterization of sesamum phyllody disease in Assam

Shankar Hemanta Gogoi

The field of phytoplasma diseases witnessed a new height of systematic study and research works throughout the world. An effort was made for biochemical, histopathological and molecular characterization of the sesamum phyllody disease. Sixteen (16) different alternate hosts were identified by molecular technique and out of that 9 were characterized. Three different groups of phytoplasma viz., aster yellows (16SrI), clover proliferation (16SrVI) and stolbur phytoplasma (16Sr XII) were identified to be associated with the phytoplasma alternate host samples. By using *iPhyClassifier* tool Brinjal phytoplasma isolate was grouped into the subgroup level 16SrVI-D. *Exitinus indicus* was detected for phytoplasma presence; characterization was done and it was found that it may play a new role for sesamum phyllody phytoplasma transmission. Ten (10) sesamum cultivars were grown in the field and pot conditions to observe the disease reactions and the cultivars were found moderately resistant (MR) to moderately susceptible (MS). The sesamum phyllody disease was successfully transmitted from infected to healthy sesamum plants by graft transmission (80%). Membrane-bound, phytoplasma-like bodies were detected in Transmission electron microscopy. Total chlorophyll content was reduced by 41.02 per cent in severely infected plants, while in mildly infected plant it was reduced by 28.20 per cent. Ratio between chlorophyll “a” and chlorophyll “b” progressively reduced as a result of infection. The ratio was 1.02 in healthy plants, while it was 1.01 and 0.96 in case of mild infection and severe infection, respectively. Phyllody disease considerably increased the dry matter content in the infected plant. Increase in dry matter content was 12.41 per cent and 19.85 per cent in mildly infected and severely infected plants, respectively. However, no considerable difference in moisture content was observed in both mildly and severely infected plants compared to the healthy ones. Phyllody disease decreased the total nitrogen as well as protein content. The reduction in protein content

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Major Advisor : Dr. P. Deb Nath

was 8.50 per cent in mildly infected leaves and 13.29 per cent in severely infected leaves. Phenol content was increased as disease advanced from milder to severe symptoms stage from 2.24 mg/g to 2.68 mg/g, respectively, as compared to healthy leaves i.e., 1.85 mg/g. Molecular characterization of *Sesamum* phyllody phytoplasma was done from all the agro-climatic zones of Assam and all the phytoplasma isolates were grouped into 16SrI-B. Restriction Fragment Length Analysis (RFLP) was done with three restriction enzymes viz., *BamHI*, *EcoRI* and *RsaI*. Sequence analysis, *iPhyClassifier* and the comparison between virtual and actual RFLP pattern revealed that there is no genetic difference among the *Sesamum* phyllody phytoplasma isolates of Assam.

Molecular characterization of aroid germplasms of North East India – assessment of host resistance and biological management of bacterial blight disease

Star Luikham

Bacterial blight disease of Taro incited by *Xanthomonas axonopodis* sp. *dieffenbachia* (*Xad*) is a quarantine importance causing extensive damage and loss to the crop in recent decades. The present study was attempted to collect, conserve and characterize the aroid cultivars/ germplasms of North East (NE) India based on 29 RAPD markers, to find out the resistant cultivars/ germplasms amongst them and also in controlling the disease through microbial based biopesticides. 64 Taro cultivars/ germplasm collected from different regions of NE along with two national released varieties, viz., 'Muktakeshi' and 'SreeKiran' as check varieties were grouped into two main clusters based on RAPD markers. Colony and morphological studies, biochemical and pathogenicity test, Field emission scanning electron microscope (FESEM) and molecular studies confirmed that the pathogen isolated from infected plant parts of colocasia was *Xad* which was short rod-shaped. Screening of the various cultivars/ germplasms against *Xad* in actual field condition was performed based on the disease severity and disease rating scale and revealed that the number of resistant, moderately resistant, moderately susceptible and susceptible cultivars were 4, 21, 26 and 15 respectively, while none of the germplasms were immune and highly susceptible to the disease. Disease severity per cent ranged from 14.17 % (*Nepali-2*) – 67.50 % (*SC-1*). *In vitro* studies of the various bioagent combinations for four bio-formulations (Biofor-pf, Bio-time, Biogreen-5, Biozin-PTB) along with streptomycin @ 100 ppm as chemical check were evaluated against *Xad*. Highest per cent inhibition (66.22 %) was observed for the combination of five bio-agents, viz., *Trichoderma viride*, *Beauveria bassiana*, *Metarhiziumanisopliae*, *Pseudomonas fluorescens* and *Bacillus thuringiensis*. Two moderately susceptible germplasms, i.e. 'Pijayikochu' and 'SC-1' were selected and the four bio-formulations along with streptomycin @ 100 ppm were evaluated for their

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efficacy against *Xad* under pot condition, by applying these as corm treatment, soil application and foliar spray. Highest disease reduction for 'Piyajikochu' (71.42 %) and 'SC-1' (72.69 %) as well as yield and yield attributing characters were recorded for the bioformulation Biogreen-5 comprising of the five bio-agents while the highest corm and cormels yield (g/plant) recorded were 1194.47 (*Pijayikochu*) and 1039.06 (*SC-1*).

The present study seems to be the first report for screening of different Taro cultivars/ germplasm against bacterial blight of colocasia under field condition. Exploration of different microbe based biopesticides also seems to be the first report of investigation for controlling the disease.

Standardization of mass multiplication technique for *Cordyceps bassiana* and study on its medicinal properties

Supriya Sharma

Cordyceps, as an insect-borne mushroom, has been studied for diverse medicinal use and pharmacological activities. *Beauveria bassiana* has been linked developmentally and phylogenetically to the asian sexual species *Cordyceps bassiana*, providing evidence that *B. bassiana* is facultatively sexual.

In the present study, the attempt to induce isolate combinations of *Beauveria bassiana* to its teleomorphic state viz., *Cordyceps bassiana* could be partially attained through development of primordia. Out of five carbon sources tested as base fruiting media viz., Brown rice, Black rice, Maize meal, Rice Bran and Wheat Bran, only two grain based fruiting media (Brown rice and Black rice) yielded primordia with varying number and size by all the isolate combinations of *B. bassiana* (BB-1x1, BB-2x6, BB- 6x14, BB-14x14) considered for this study. Higher number of primordia was formed by the isolate combinations BB-2x6 and BB-6x14 in both the fruiting media compared to BB-1x1 and BB-14x14.

The use of pupal powder as organic source of nitrogen in fruiting media have exhibited promising results in better growth of primordia. Among the three nitrogen sources examined viz., Eri pupae (*Samia ricinii*), Muga pupae (*Antheraea assama*) and Mulberry pupae (*Bombyx mori*), primordia formation was observed only in fruiting media with Eri pupae. Out of three levels (5g, 10g and 15g) of the selected nitrogen source viz., Eri pupae tested, primordia production was recorded only in the fruiting media containing 15g of Eri pupae by both the isolate combinations of *B. bassiana* (BB-2x6 and BB-6x14).

The ideal temperature for primordial growth was found to be 25°C than the other treatment temperatures viz., 20°C or 15°C. No primordia could be produced under complete dark condition, indicating the importance of light in inducing fruiting body. Also primordia development could not be observed in an established mass culture media (RH+SD+RB), which is usually used for rapid multiplication of *Beauveria bassiana*.

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Department : Plant Pathology

Major Advisor : Dr. Dilip Kumar Sarma

Analysis of primordial extracts through GC-MS technique have displayed the trend in identified metabolite intensity obtained from different nutrient and incubation conditions, indicating the changes in metabolism during primordia development and its tendency to form cordycepin. The chromatographic (HPLC) technique assisted in identification and quantification ($\mu\text{g/ml}$) of targeted metabolite *viz.*, cordycepin in traces which was found to be higher in Black rice fruiting media than Brown rice fruiting media at 20°C.

Nitrogen dynamics in a rice-rice system of Upper Brahmaputra Valley Zone (UBVZ) of Assam

Babita Tamuli

The study investigated mineral N and labile soil organic N dynamics at different growth stages of rice and their distribution within soil depth (0-80 cm) under various combinations of inorganic and organic fertilization in a rice-rice cropping system of UBVZ of Assam. Further partial balance of mineral N and total N stock of the soils were determined. The study was conducted in a long term fertility experiment at Regional Agricultural Research Station (RARS), Assam Agricultural University, Titabar, Jorhat in 2017 taking the selected treatments *viz.*, Control, 100% NPK, 100% NPK + FYM 5t/ha, 50% NPK, 50% NPK+ 50% (FYM) N and FYM 10t/ha for *rabi* and *kharif* rice cropping sequence. Soil samples were collected from different depth (0-20, 20-40, 40-60 and 60-80 cm) before transplanting of *rabi* rice, at active tillering, flowering and physiological maturity stages of *rabi* and *kharif* rice and after harvest of *kharif* rice. Physiochemical properties analysed in the soils collected before transplanting of *rabi* rice of 2017 was considered as initial. Soil samples of three growth stages of *rabi* and *kharif* rice were analysed for mineral and labile soil organic N. Straw and grain samples collected at harvest of *rabi* and *kharif* rice were analysed for their N concentration and N uptake. Partial balance of soil mineral N in surface soils (0-20 cm) and total N stock within 0-80 cm soil depth was estimated at the end of the cropping sequence.

The pH of the soils was higher in treatments FYM 10t/ha (5.87), 100% NPK+ FYM 5t/ha (5.72) and 50% NPK+ 50% (FYM) N (5.67) than the control (5.33) but was significantly lower in treatments 100% NPK (5.13) and 50% NPK (5.25). Soil organic carbon (OC) content had built up significantly in all the treatments compared to control. Organic carbon decreased significantly with increased soil depth. The bulk density (BD) of the soils varied from 1.18 (FYM 10t/ha) to 1.36 g cm⁻³ (control). The highest total and mineral N before transplanting of *rabi* rice and after harvest of *kharif* rice was recorded in 100% NPK+ FYM 5t/ha which was significantly higher over rest of the treatments.

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Department : Soil Science

Major Advisor : Dr. D. Bhattacharyya

In the study of mineral N dynamics, $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ were found to be significantly higher in 100% NPK+FYM 5t/ha fertilized plots at the three growth stages in both *rabi* and *kharif* rice. The higher $\text{NO}_3\text{-N}$ at active tillering stage was 12.73 and 11.53 mg kg^{-1} in *rabi* and *kharif* rice, respectively, in 100% NPK+FYM 5t/ha fertilization, which gradually decreased at physiological maturity stages of both the rice season (10.70 mg kg^{-1} in *rabi* and 9.94 mg kg^{-1} in *kharif*). Similar decreasing trend was also observed in $\text{NH}_4\text{-N}$ from active tillering (10.67-17.59 mg kg^{-1} in *rabi* and 8.67-16.67 mg kg^{-1} in *kharif*) to physiological maturity stages (9.22-16.53 mg kg^{-1} in *rabi* and 6.76-14.39 mg kg^{-1} in *kharif*). Both $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ showed a distinct decreasing trend with increase in soil depth.

The significantly the highest grain (4.66 and 5.54 t ha^{-1}) and straw (6.58 and 6.64 t ha^{-1}) yield of *rabi* and *kharif* rice and total N uptake were observed in 100% NPK+ FYM 5t/ha treated plots. However, this grain yield was statistically at par with yield in treatments 100% NPK at *rabi* and FYM 10t/ha and 100% NPK in *kharif* rice. The soil partial mineral N balance revealed that with application of inorganic fertilizer (100% NPK and 50% NPK) and with no fertilizer application (control) resulted in a negative partial soil N balance. However, application different combinations of organic FYM and inorganic NPK fertilizers as well as 10t/ha FYM alone had lead to positive N balance in soils as well as higher N stock. The highest N balance (18.74 kg ha^{-1}) and N stock (1.51 Mg ha^{-1}) was found in application of 100% NPK + FYM 5t/ha followed by that in application of FYM 10t/ha (3.63 kg ha^{-1} and 1.33 Mg ha^{-1} , respectively).

The labile soil organic N fractions of the soils *viz.*, microbial biomass N (MBN), particulate organic N (PON) and water extractable organic N (WEON) was decreasing with increase in crop growth from active tillering to physiological maturity stage. The decrease in MBN, PON and WEON in *rabi* varied from 10.85-16.85 to 9.65-16.03 mg kg^{-1} , 0.21-0.89 to 0.14-0.68 g kg^{-1} and 6.64-12.43 to 5.31-10.68 mg kg^{-1} , respectively; and in *kharif* from 8.45-13.04 to 7.28-12.0 mg kg^{-1} , 0.16-0.57 to 0.1-0.48 g kg^{-1} , 4.87-9.49 to 3.48-7.95 mg kg^{-1} , respectively. The labile soil organic N fractions were significantly higher in FYM 10t/ha treated plots which might be due to creation of suitable conditions for microbial growth by FYM. All the labile fractions of soil organic N decreased significantly with increase in soil depth. This might be due to decrease of OC with soil depth.

The N fractions of the soils *viz.*, $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, MBN, PON and WEON showed a significant positive correlation with soil OC and total N content at the three growth stages in *rabi* and *kharif* season. Multiple regression analysis of grain yield with various fractions of N showed that $\text{NH}_4\text{-N}$ ($R^2=0.745$) was the main contributor to the grain yield at early growth stage of *rabi* rice. Whereas, WEON ($R^2=0.901$) was the main contributor to the grain yield in *kharif* rice. The results of the investigation indicated that the $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ were the main contributor to the total uptake of N at three different growth stages in both the rice season. All the fractions of N were significantly and positively correlated with each other ($p<0.01$). Most of the N mineralized in the soil

was expected to occur in the labile N fractions. The positive correlation observed between labile N fractions and mineral N also supported their close interrelation. The multiple regression analysis of various N fractions with total N stock indicated that $\text{NH}_4\text{-N}$ was the main contributor to the N stock of the studied soils under rice-rice cropping system.

The present investigation leads to the conclusion that combined applications of 5 t/ha FYM with 100% NPK at present could be considered as the best nutrient management practices in rice-rice system of UBVZ of Assam in terms of the highest yield, N balance, N stock and sustainable soil health (pH, OC and BD). Moreover, the treatment of organic nutrient management 10t FYM/ha could also produce rice yield statistically at par with 100% NPK + FYM 5t/ha, had positive N balance and was the best treatment for sustainable soil health. Therefore, better organic nutrient management which could produce higher yield than 10t FYM/ha might be the present requirement for the rice-rice system of the UBVZ of Assam.

Soil nutrient assessment and GHG emissions of puddle rice soils under integrated nutrient management practices

Bhabesh Gogoi

The present work was carried out during 2016-2018 which forms a part of the long-term Permanent Plot Experiment on *Integrated Nutrient Supply System in Cereal Based Cropping Sequence* laid out during 1987-1988 under All India Coordinated Research Project on Integrated Farming System at Assam Agricultural University (AAU), Jorhat. The experiment was laid out in a randomized block design at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat replicating 3 times with 8 treatment combinations *viz.*, T1: no fertilizer, no organic manure (control), T2: 100% RDF (chemical), T3: 50% RDF (chemical) + FYM @ 2.5 t/ha for winter rice and 100% RDF (chemical) for autumn rice, T4: 75% RDF (chemical) + FYM @ 1.25 t/ha for winter rice and 75% RDF (chemical) for autumn rice, T5: 50% RDF (chemical) + rice stubble @ 3.0 t/ha for winter rice and 100% RDF (chemical) for autumn rice, T6: 75% RDF (chemical) + rice stubble @ 1.5 t/ha for winter rice and 75% RDF (chemical) for autumn rice, T7: 50% RDF (chemical) + *Azolla* @ 0.5 t/ha for winter rice and 100% RDF (chemical) for autumn rice, T8: 75% RDF (chemical) + *Azolla* @ 0.25 t/ha for winter rice and 75% RDF (chemical) for autumn rice. Results revealed that the application of 50% RDF (chemical) + *Azolla* @ 0.5 t ha⁻¹ in case of winter rice and 100% RDF (chemical) in case of autumn rice (*i.e.* T7) showed the highest NH₄-N, NO₃-N and available N content in soil followed by the application of 50% RDF (chemical) + FYM @ 2.5 t ha⁻¹ in winter rice and 100% RDF (chemical) in autumn rice (*i.e.* T3) in case of the rice-rice sequence after 32 cycles of the cropping. On the other hand, different fractions of P (*viz.*, available P, Occluded P, Saloid P, Ca-bonded P and total P) and K (*viz.*, water soluble K, available K, exchangeable K, non-exchangeable K, lattice K and total K) were found maximum in case of T3 followed by T5. Different fractions of C in rice soil were increased and varied significantly due to INM practices

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Department : Soil Science

Major Advisor : Dr. Nilay Borah

over unfertilized control (T1). The total organic carbon (TOC), total inorganic carbon (TIC) and total C was found to be highest in case of T3; whereas, the highest content of Walkley & Black C, less labile C and non-labile C in soils were recorded in case of T5. Yet again, T7 [50% RDF (chemical) + *Azolla* @0.5 t ha⁻¹ in winter rice and 100% RDF (chemical) in autumn rice] was registered with the maximum content of water soluble C, microbial biomass C, very labile C and labile C in the soils under rice system. In this study, all the fractions of NPK and C were found to be lowest in T1 (unfertilized control) treatment. The sensitivity index revealed that the microbial biomass C and water soluble C fractions were the most sensitive ones for different nutrient management practices as compared to other C fractions under study; whereas, the lowest sensitive fractions included non-labile C, less labile C, total inorganic C, total organic C and total C. Data on SOC stock due to INM practices varied significantly from 39.11 Mg ha⁻¹ under T1 (unfertilized control) to 67.14 Mg ha⁻¹ under T3 (receiving FYM @2.5 t ha⁻¹ + chemical fertilizers). The soil C sequestration ranged between (-)2.77 Mg ha⁻¹ under T1 and 24.07 Mg ha⁻¹ under T3. Over the control treatment (T1), 41.81 to 71.67% build up of C in the soils were recorded due to various INM treatments after 32 years of rice-rice cropping sequence. In this study, the highest bacterial population was recorded in case of T7 (receiving *Azolla* @0.5 t ha⁻¹ + chemical fertilizers); whereas, fungal population was found maximum in case of T3 (receiving FYM @2.5 t ha⁻¹ + chemical fertilizers). Various soil enzymes *viz.* dehydrogenase (DHD), phosphomonoesterase (PMEase), fluoresce in diacetate (FDA) and urease, involved in energy flow and nutrient cycling showed significantly higher activities under INM treatments. Significantly highest activity of DHD and urease was found in T7, while PMEase and FDA hydrolysis activities were found to be maximum in T3. There was a decrease in all the enzymatic activities over initial in the unfertilized control treatment (T1) after 32 years of rice-rice cropping. The pattern of CO₂, CH₄ and N₂O emissions under rice-rice cropping system varied significantly with the stages of rice growth as well as by the different INM treatments under study. The CO₂ and CH₄ emissions peaked at 60 days after transplanting (DAT) of winter rice (cv. Ranjit) and 45 DAT of autumn rice (cv. Disang). On the other hand, N₂O emission peaked first at 30 DAT and secondly at 60 DAT of winter rice (cv. Ranjit) in case of all the treatments except unfertilized control. However, only one N₂O emission peak was observed at 45 DAT in case of autumn rice (cv. Disang) under study.

The highest emissions of CO₂ and CH₄ during winter crop (cv. Ranjit) were observed in case of T5 receiving rice stubbles @3.0 t ha⁻¹ + chemical fertilizers. In contrast, N₂O emission during winter crop cv. Ranjit initially (up to 45 DAT) was found to be highest in case of the T2 (100% RDF, chemical); and afterwards, highest N₂O emission was observed in case of T7 receiving *Azolla* @ 0.5 t ha⁻¹ + chemical fertilizers. In case of autumn rice (cv. Disang), the maximum emissions of CO₂, CH₄ and N₂O were recorded in T5 (receiving rice stubbles @3.0 t ha⁻¹ + chemical fertilizers). The lowest CO₂, CH₄ and N₂O emissions were recorded in T1. It was

evident in this study that the GHG emissions for the control (T1) and for *Azolla* cover + chemical fertilizer treatments (*i.e.* T7 and T8) were relatively low and similar during the initial stages of winter rice *cv.* Ranjit (up to 60 DAT) and autumn rice *cv.* Disang (up to 30 DAT). Among all the organic sources, supplementation of *Azolla* along chemical fertilizers resulted maximum reduction in GHG emissions from rice-rice system over FYM and rice stubbles. Pearson correlation matrix between the GHGs indicated that the emission of CO₂ had a positive and significant correlation with CH₄ ($r=0.874^{**}$) and N₂O ($r=0.748^{*}$) emissions from the rice-rice cropping system. However, the correlation between the CH₄ and N₂O emission was positive and non-significant ($r=0.623$ NS) in this study. Significant and positive correlation of CO₂ and CH₄ emissions from rice-rice cropping system were recorded with different fractions of C *viz.*, WSC, WBC, MBC, VLC, LLC, LC, NLC, TOC and TC. The correlations of N₂O emission with NH₄-N, NO₃-N and available N were found to be significant and positive; whereas, it was positive but nonsignificant with total N in soil. Likewise, microbial activities, enzymatic activities in soil and yield and yield attributing characteristic of rice crop were positively correlated with the emissions of CO₂, CH₄ and N₂O from the rice-rice system of cropping. Yet again, in this study, GHGs were found to have not significant correlation with the plant height of rice crop.

Overall, the findings of the present study lead to the conclusion that application of 50% RDF (chemical) + rice stubbles @ 3.0 t ha⁻¹ in winter rice (*cv.* Ranjit) followed by 100% RDF (chemical) in autumn rice (*cv.* Disang) *i.e.* T5 could be considered as the best nutrient management practice for the rice-rice sequence in terms of highest yield (7.27 Mg ha⁻¹), gross return (67.72 × 10³ Rs. ha⁻¹) and net return (39.79 × 10³ Rs. ha⁻¹) with a B:C ratio of 2.42 in one way, enhancing the soil health under long run condition, in other. However, so far as the issue of GHG emission and global warming is concerned, application of 50% RDF (chemical) + FYM @ 2.5 t ha⁻¹ in winter rice and 100% RDF (chemical) in autumn rice (2nd best treatment in terms of soil properties and yield with the B:C ratio 2.41) may be considered as better option for rice-rice cropping system under the prevailing climatic condition of Assam.

Sulphur and boron fertilization on rapeseed- greengram cropping sequence as influenced by liming in acid soils of North Bank Plain Zone of Assam

Britan Rahman

Application of optimum dose of micronutrient along with macronutrient will promote crop yield, quality of harvest and soil health. Keeping in this view, a field experiment was conducted to study the effect of S, B and lime application on soil properties, nutrient use efficiency and yield of rapeseed and greengram crop in a sequence. The direct effect of S, B and lime application was studied in rapeseed and residual effect was assessed in greengram. The experiment was conducted during *rabi* and *summer* seasons of 2016-17 and 2017-18 at the Instructional farm of KVK, Udalguri, Assam Agricultural University, Assam. The design of the experiment was factorial RBD with two factors (limed and unlimed) and four levels of S and B (S0B0, S15B0.75, S20B1.0 and S25B1.25 kg ha⁻¹) and three replications. The recommended doses of NPK were applied to both the crop while S, B and lime were applied only to rapeseed crop. The soils of the experimental site was sandy loam in texture, moderately acidic with high organic carbon content, medium in available N and K and low in available P, S and B level. The combined application of S and B had significant direct effect on seed yield and its attributes of rapeseed. The treatment LT3 receiving RD of NPK + 20 kg S + 1.0 kg B + 490 kg lime ha⁻¹ had shown significantly highest seed yield (10.17 q ha⁻¹) and stover yield (30.91 q ha⁻¹) which are 13.38 and 43.50% higher over control respectively. The residual S, B and lime also showed significant influence on seed yield and its attributes of succeeding crop *summer* greengram. The same treatment LT3 applied to the preceding crop rapeseed recorded significantly highest seed yield (8.74 q ha⁻¹) and stover yield (34.38 q ha⁻¹) of greengram which are 15.17 and 44.35% higher over control respectively. A significant decrease in soil pH was observed with increasing S and B dose under both lime and unlimed conditions in all the three stages of the crop but could not show significant impact on organic carbon content

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Department : Soil Science

Major Advisor : Dr. Samiron Dutta

of soil. The S and B resulted significant increase in available N, P₂O₅, S and HWS-B in treatment LT4 (S₂₅+B_{1.25}+L₄₉₀ kg ha⁻¹) and LOT4 (S₂₅+B_{1.25}+L₀ kg ha⁻¹) and K content in LT3 (S₂₀+B_{1.00}+L₄₉₀ kg ha⁻¹) and LOT3 (S₂₀+B_{1.00}+L₀ kg ha⁻¹) under limed and unlimed factor in all the three stages of crop. Identical results were also recorded in greengram crop reflecting the significant residual effect of S, B and Lime application. Significant decrease in soil pH with increasing S and B dose under both limed and unlimed factor was observed in greengram. The available S and HWS-B also showed a decreasing trend with successive increasing growth stages of greengram. The S and B exhibited a significant direct effect under both limed and unlimed factor on nutrient uptake by seed and stover of rapeseed. Among both factors, the total uptake of N, P and K was highest in treatment LT3 receiving RD of NPK + 20kg S + 1.0kg B + 490kg lime ha⁻¹ and total uptake of S and B was highest in treatment LT4 receiving RD of NPK + 25kg S + 1.25kg B + 490kg lime ha⁻¹. The residual S and B exhibited a significant influence under both limed and unlimed factor on nutrient uptake by seed and stover of greengram. The total N, P and K-uptake under both the factor was highest in treatment LT3 and total S and B-uptake was highest in treatment LT4. The direct interaction effect of limed and unlimed treatments on yield and its attributes of rapeseed showed significant higher results in treatment T3 (receiving 20 kg S + 1.0 Kg B ha⁻¹ +RDF). Among treatment combinations, the limed factor treatments showed the significantly highest mean yield and its attributes of rapeseed compared to unlimed factor treatments. Similar observation was made in the succeeding greengram crop.

Both the direct and residual interaction effect of limed and unlimed treatments on soil pH showed significantly higher values at 30, 60 and 90 DAS in treatment T1 (Control with only RDF). Among treatment combinations, the direct and residual liming factor treatments showed significantly higher mean pH at 30, 60 and 90 DAS compared to unlimed factor treatments. The soil available N, K₂O, S and B content also showed significant results due to direct and residual interaction effect of limed and unlimed treatments with significantly highest available N, S and B content in treatment T4 (S₂₅+B_{1.25}) and available K₂O in treatment T3 (S₂₀+B_{1.00}). Both the direct and residual interaction effect did not show any significant influence on SOC and available P₂O₅ content. Among treatment combinations, the both direct and residual liming factor treatments showed significantly higher mean available N, K₂O, S and B content compared to unlimed factor treatments. The direct interaction effect of limed and unlimed treatments on N-uptake by seed and stover of rapeseed showed significant higher results in treatment T3, Seed P-uptake and stover K-uptake in treatment T3, stover P-uptake, seed K-uptake, seed and stover S and B uptake in treatment T4. Among treatment combinations, the liming factor treatments showed significantly higher mean seed and stover N, P, K, S and B-uptakes compared to unlimed factor treatments. The residual interaction effect of limed and unlimed treatments also exhibited similar results as on the direct effect. Among treatment combinations, the liming factor treatments showed significantly higher mean seed and stover N, P, K, S and B-uptakes compared to

unlimed factor treatments. In economic expressions, the highest gross return, net return and B: C ratio was found under treatment LT3 in both rapeseed and succeeding crop greengram. Among both the crops, higher net return (₹ 32368.38) and B: C ratio (2.44) was recorded on succeeding greengram crop. The S, B and lime application showed a clear impact on the comparative economics of rapeseed-greengram cropping sequence with highest gross return (₹ 105930.00), net return (₹ 61000.00), equivalent yield (9.46 q ha⁻¹) and B: C ratio (2.36) in treatment LT3. Considering the positive effect on soil properties, fertility status, nutrient uptake, crop yield and economic returns, application of 20 kg S + 1.0 kg B + 490 kg lime ha⁻¹ along with recommended dose of NPK was found superior for rapeseed-greengram cropping system.

Changes in Soil Biological Parameters as Effected by the Application of Organic Inputs in Rice-Toria Sequence

Manoj Kr. Chauhan

The field trials were conducted to assess the changes in soil chemical and biological parameters along with yield and yield attributing characters of rice and toria crops in sequence during 2015-17. The treatment combinations were as Control (T₁), 50% recommended dose of fertilizer (RDF)+50% biofertilizer (BF) (T₂), 50% RDF+50% Enriched Compost (EC) (T₃), 100% RDF (T₄), 100% BF (T₅) and 100% EC (T₆). The data were recorded at various stages of crop growth and soil samples were analysed for different characters at different stages of rice and toria crops. The results showed that the treatment T₃ consisting of 50% EC and 50% RDF recorded the highest accumulation of N (265.49 and 258.01 kg/ha), P (23.14 and 23.00 kg/ha), and K (152.94 and 148.38 kg/ha) at maximum tillering stage of rice and flowering stage of toria, respectively but remained at par with 100% RDF treatment in both the crops during the period of investigations. The accumulation of organic carbon (12.49 g/kg soil in rice and 12.14 g/kg soil in toria) was recorded significantly higher than 100% RDF treatment (11.01 g/kg soil in rice and 10.60 g/kg soil in toria) at similar stages of both the crops which remained at par with 100% EC (T₆) treatment. Soil accumulation of Organic carbon (OC), N, P and K was found higher in T₆ treatment over T₅ treatment. However, soil accumulation of OC, N, P and K gradually declined from maximum tillering stages of rice and flowering stage of toria to harvesting stage of both the crops. Although no significant changes in soil pH was recorded, but the lowest pH was recorded in T₄ treatment in both the crops ranging from pH 5.19 to pH 5.22, even lower than the initial soil pH value of 5.24. The results revealed that the bacterial, fungal and actinomycetes population varied with the treatments and with the stage of the crops. The treatments comprising of 50% EC and 50% RDF (T₃) recorded the highest bacterial population of 19.63 cfu x10⁵/g and 19.25 cfu x10⁵/g soil at flowering stages of rice and toria, respectively. The fungal population was 9.12 cfu x 10⁵/g soil in rice and 8.88 cfu x10⁵/g

Abstract of Ph.D. Thesis

Department : Soil Science

Major Advisor : Dr. Rajen Baruah

soil in toria, respectively. The actinomycetes population was $45.75 \text{ cfu} \times 10^4/\text{g}$ soil in rice and $45.12 \text{ cfu} \times 10^4/\text{g}$ soil in toria at flowering stages of rice and toria crops and declined thereafter at harvesting stages of both the crops. The microbial diversity in T_3 and other organic treatments found significantly higher than 100% RDF and control treatment. Soil respiration, microbial biomass carbon, and soil enzymes (fluorescein diacetate activity, dehydrogenase activity, acid phosphatase activity and urease activity) behaved differently with different treatment whereas T_3 (50% EC + 50% RDF) exhibited the best performance over other treatments at all the stages of rice and toria crops during both the years. All the biological parameters were found at their peak at flowering stages and declined thereafter at harvesting stages of both the crops. All the bio-chemical properties in treated plots in rice-toria sequence were found significantly higher than the untreated control and even over the initial values of each parameters. Unlike soil bio-chemical properties, agronomic parameters of rice (no. of tillers/hill, plant height, panicle length, grain and straw yield) and toria (plant height, no. of siliqua/plant, grain and stover yield) crops recorded higher values in 100% RDF (T_4) treatment which remained at par with, 50% EC + 50% RDF treatment (T_3). The grain yield of rice (45.09 q/ha) and toria (893.38 kg/ha) in the 100% fertilized plots (T_4) were found at par with T_3 treatment (43.72 q/ha in rice 885.63 kg/ha in toria) receiving 50% EC and 50% RDF, but both recorded significantly higher yield over sole application of biofertilizer, enriched compost and control treatment. The beneficial effect of INM treatment (T_3) that facilitated favourable soil conditions were reflected in grain yield of both rice and toria crops which was equivalent even with 100% RDF treatments. Rice yield was more closely and positively correlated (at $p < 0.05$) with OC ($r = 0.587^*$), N ($r = 0.932^*$), P ($r = 0.746^*$) and K ($r = 0.972^*$) as compared to soil enzymes such as acid phosphatase ($r = 0.637^*$), urease ($r = 0.512^*$). Similarly, a strong relationship was also recorded among toria yield with OC, N, P and K and other soil biochemical properties. Furthermore, soil respiration and MBC exhibited strong relationship both in rice ($r = 0.961^*$) and toria ($r = 0.966^*$) crop. All the soil biological properties registered positive correlation with chemical properties of soil.

Variability of ground water recharge characteristics and quality in Jorhat district, Assam

Mridupawan Saikia

The present investigation was carried out in Jorhat District aimed at assessment of the groundwater, its recharge characteristics and quality. The district spread from 93°58'32" to 94°36'24"E longitude and 26°20'51" to 26°56'29" N latitude. Soil and water samples were collected from 265 randomly selected GPS enabled locations of Jorhat district at an interval of around 4-5 km. Representative soil and water samples were collected from each location (both disturbed and core sample) from two depths viz. 0-30 and 30-60 cm. Depth of groundwater in each location were recorded during the months of January, April, July and October in 2017 and 2018 as well. Thematic maps were prepared using the GIS software TNTMips. Geostatistical parameters were computed following standard methods.

The bulk density and particle density ranged from 1.16-1.59 and 2.24-2.65 mg/m^3 in 0-30 cm depth and 1.19-1.61 and 2.28-2.68 mg/m^3 in 30-60 cm depth. The bulk density of the soil showed negative significant correlation with porosity and water content at 0.1 to 15 bar matric suction in both the depths. The Organic carbon content 0-30 cm depth ranged from 0.87-1.86 per cent while at 30-60 cm depth it ranged from 0.38-1.21 per cent. The soil pH in both the depths were acidic and ranged from 4.50-6.60 and 4.23-6.84 at 0-30 and 30-60 cm depth, respectively. The texture of the soils ranged from heavy towards the higher elevation to light towards the lower elevation areas. The Porosity and Saturation water content ranged from 33.47-53.28 and 19.87-43.19 per cent in 0-30 cm depth and 34.76-53.28 and 19.73-42.34 per cent in 30-60 cm depth respectively. Porosity showed significant positive correlation with organic carbon and clay and negative significant correlation with sand. With increase in matric suction of the soil from 0.1 bar to 15 bar the water content of the soil decreased. The pore interaction (b) parameter ranged from 2.03-3.56 in 0-30 cm depth and 1.94-3.96 in 30-60 cm depth. The mean saturated hydraulic conductivity of the soils for the two depths

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were 1.01 and 0.65, respectively, indicating higher saturated hydraulic conductivity at surface as compared to sub-surface soil. Saturated hydraulic conductivity showed positive correlation with sand and negative correlation with clay.

Ground water table depth during January and April were very low, while it reached surface during July and October for both 2017 and 2018. Groundwater depth during all the months during 2017 showed mixed correlation with physico-chemical properties. Thematic maps revealed the pattern of groundwater movement in different range. The decline during first quarter in both the years indicated wide ranging variability. Thus, it is quite obvious that the soil properties associated with transport of water both in saturated and unsaturated condition favoured transport of water. The groundwater table during the quarter July to October, 2017 and 2018 indicated that in some of the areas, the same did not decline at all and were at surface. The rate of decline of groundwater table becomes faster with the arrival of the dry season for which during the quarter from October, 2017 to January, 2018 groundwater table declined from 64.00 to 139.00cm. During the quarter from January to April, 2018 decline in groundwater table indicated that although there were general decline, the same was less than that of the corresponding quarter in the previous year. This maybe due to the fact that the region received some amount of rainfall during the quarter and the entire quantity may have helped reduce the rate of decline of groundwater in 2018. The region received pre-monsoon shower during the months of April and May and the groundwater table during the quarter from April to July, 2018 rose from 82.00 to 220.00 cm. This rise is considerable considering the fact that the average rise was 170.30 cm indicating that whatever the rainfall is received, the same had invariably gone down the profile and recharged it. Thus, it made up for the decline of groundwater table during the previous months.

The pH, zinc, calcium, magnesium, fluoride, aluminium and boron content of groundwater of the district are all within permissible limit set by WHO. However, iron and arsenic content in groundwater are far beyond permissible limit set by WHO and need some treatment to make it potable.

The semivariogram parameters for depth of groundwater in Jorhat District during the period of study reveals that the trend of nugget and sill variance followed the trend of fluctuation of depth of groundwater table during the period of study. The nugget/sill ratio revealed that in almost all the months the variability was medium to high. Data on semivariogram parameters for the different quality parameters for groundwater revealed that Arsenic and Chloride showed the lowest and highest nugget and sill, respectively.

The ratio of MAE, MRE and RMSE between kriging and IDW revealed that the ratios were more than 1, indicating that kriging estimated these parameters higher than that of Inverse distance weighting (IDW). Thus, this indicated that IDW was a better method of interpolation for these parameters. IDW method of interpolation improvised the maps from 0.93 to 12.25 per cent.

Assessment of soil quality under different land uses in Hill Region of Assam

Nilim Kalita

Land use changes are known to have significant and long lasting effects on soil quality and productivity. There are different types of land uses in the hill region of Assam, but little quantitative information is available on the effects of these land uses on soil physical, chemical and biological properties and overall soil quality. The present study was undertaken to assess and compare influence of most common land uses namely, natural forest, Jhum land, rubber plantation, upland paddy/maize crop land, home garden and bamboo plantation on soil physical, chemical and microbiological properties in the hill region of Assam. The soil properties such as texture, bulk density, particle density, porosity, water holding capacity, water stable aggregates, mean weight diameter, pH, EC, CEC, organic carbon, available N, available P, available K, exchangeable Ca and Mg, MBC, MBN, DHA and soil erodibility were investigated for each land use system for assessment and comparisons of soil fertility, soil organic carbon stock, soil erodibility and overall soil quality as influenced by the land uses. One hundred and sixty two soil samples were collected at 0-15 cm, 15-30 cm and 30-50 cm depth from three randomly selected plots with identical slope and landscape positions representing six land uses from three selected villages totaling nine plots for each land-use type. Sand, silt and clay fractions showed variations by land use system and soil depth. On the surface layer (0 - 15 cm), the maximum mean sand was observed in paddy/maize crop land (52.67%) followed by jhum land (51.44%), rubber plantation (48.00 %), bamboo plantation (47.11%) and home garden (47.00 %), while the minimum in forest land use (44.56 %) with an maximum increase of 18.20 % in paddy/maize cropland over natural forest. The clay content in the surface layer was observed highest (30.44 %) in forest land use while the lowest was recorded in paddy/maize land (25.78 %). Different land uses exhibited significant impact on soil physical properties viz. bulk density, particle density, total porosity, water holding capacity, water stable aggregates and mean weight diameter. The bulk density varied from 1.14 to 1.40, 1.29 to 1.43 and 1.32 to 1.48 g cm⁻³ at 0-15, 15-30 and 30-50 cm

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respectively. Lowest value (1.14 g cm⁻³) of bulk density was recorded in the surface layer under natural forest which was significantly lower than the bulk density noted under other land uses except bamboo plantation and home garden. A reduction of 5.0 % and 4.7 % total porosity due to shift of forest land to paddy/maize cultivation and Jhum cultivation respectively in the surface soil was observed. The maximum mean WHC in surface soil was found in forest soils followed by bamboo plantation, rubber plantation, home garden, jhum land and paddy/maize crop land. In the surface layer highest water holding capacity was recorded under bamboo plantation (47.68 %) which was statistically at par with forest (46.97%), rubber plantation (46.22 %) and home garden (44.00 %) and significantly higher than jhum land (40.10 %) and paddy/maize crop land (34.69 %). The highest per cent aggregation in both surface and sub-surface soils was found in forest soils followed by home garden, rubber plantation, jhum land, bamboo plantation and paddy/maize crop land. The pH ranged between 4.90 - 5.32, 4.53- 5.02 and 4.54 – 4.97 in 0-15 cm, 15 –30 cm and 30-50 cm depth respectively. In the surface layer, highest (5.32) mean pH was observed in forest land followed by bamboo plantation (5.27), rubber plantation (5.18), home garden (5.05), jhum land (5.00) and lowest (4.90) in paddy/maize fields. The highest (10.11 cmol(p+)kg⁻¹) CEC was recorded on the surface layer of forest land while the lowest (6.39 cmol(p+)kg⁻¹) on the surface layer of cultivated land with a decrease of 33.5%. Among the land use types under study, higher organic carbon content was recorded for natural forest and lower for cultivated lands. SOC concentration was in the order: Forest > Home garden > Rubber plantation > Bamboo plantation > Jhum land > Paddy/maize crop land with profile weighted mean values of 0.77, 0.66, 0.62, 0.57, 0.51 and 0.42 per cent, respectively. Significantly highest available N (561.68 kg ha⁻¹), available P (26.30 kg ha⁻¹) and available K (312.46 kg ha⁻¹) was recorded in natural forest and lowest in paddy/maize crop land (226.21 kg ha⁻¹, 11.31 kg ha⁻¹ and 158.10 kg ha⁻¹ respectively) with significant differences among the land uses. The total soil organic carbon stock (SOC Stock) in the profile (0-50cm) followed the order as Forest > Home garden > Rubber plantation > Jhum land > Bamboo plantation > Paddy/maize crop land with the total SOC Stock in each land use being 44.30 Mg ha⁻¹, 41.74 Mg ha⁻¹, 38.56 Mg ha⁻¹, 33.73 Mg ha⁻¹, 32.26 Mg ha⁻¹ and 27.29 Mg ha⁻¹ respectively. A maximum loss of SOC Stock was recorded when forest was converted to crop land (-17.01 Mg ha⁻¹) followed by bamboo plantation (-12.04 Mg ha⁻¹), shifting cultivation (-10.57 Mg ha⁻¹), rubber plantation (-5.74 Mg ha⁻¹) and the least in home garden (-2.56 Mg ha⁻¹). The conversion of natural forest into other land uses resulted in a significant decrease in the MBC, MBN and DHA. The highest mean dispersion ratio was found in paddy/maize crop land (20.30) followed by shifting cultivation (19.98), rubber plantation (17.52), bamboo plantation (18.09), home garden (17.21) and forest soils (16.34). The erosion ratio was in the order of paddy/maize crop land (17.72) > Jhum land (15.75) > rubber plantation (14.28) > bamboo plantation (14.38) > home garden (13.63) > forest (13.20) indicating soils under all land uses were highly vulnerable to erosion except forest and

home garden land uses which are slightly erodible. The PCA identified nine key indicators *viz.* SOC, CEC, pH, WSA, MWD, available P, MBC, exchangeable Ca and exchangeable Mg for estimation of soil quality index (SQI). In the surface 0-15 cm soil, the highest SQI was recorded in forest land (0.84) followed by home garden (0.77), bamboo plantation (0.76), rubber plantation (0.70), jhum land (0.61) and lowest in paddy/maize crop land (0.50). WSA contributed highest towards SQI (40.48 to 52.46 %) followed by SOC (26.23 to 39.29 %), MBC (6.67 to 8.57 %), CEC (7.14 to 8.57 %) and lowest (2.67 to 5.33 %) by exc. Ca. In the 15-30 cm soil, the highest SQI was recorded in forest land (0.82) followed by home garden (0.70), rubber plantation (0.69), jhum land (0.60), bamboo plantation (0.58) and lowest in paddy/maize crop land (0.46) where WSA contributed highest towards SQI (29.27 to 39.66 %) followed by SOC (25.7 to 27.49 %), available P (5.52 to 25.61 %), MBC (6.90 to 8.70 %), CEC (6.52 to 7.32 %) and lowest (2.86 to 4.35 %) by exchangeable Mg. In the 30-50 cm soil, the highest SQI was recorded in forest land (0.78) followed by home garden (0.69), rubber plantation (0.68), jhum land (0.62) paddy/maize crop land (0.52) and lowest in bamboo plantation (0.47) where SOC contributed highest towards SQI (29.87 to 33.33 %) followed by exc. Mg (23.8 to 27.14%), MWD (16.67 to 23.38%), MBC (7.14 to 9.80 %), CEC (4.76 to 7.25 %), pH (3.90 to 6.25%), and lowest (1.96 to 3.90 %) by available P. The results of SQI indicated that the soil quality deteriorated due to conversion of natural forest land to other land uses while jhum land and crop land showed highest deterioration of soil quality in the surface soil. Tree based home garden land use with multiple plant species recorded better soil quality both in surface and sub surface soil depths. Therefore reducing intensive cultivation of maize and upland rice and jhum cultivation and integration of multiple tree species and horticultural crops (agroforestry) could arrest further declining of soil quality for sustainable agricultural production and productivity in the Hill Zone of Assam.

Morphometry, soil erodibility and productivity potential of a transect of Moridhal River basin in Dhemaji district of Assam

Prem Kumar Bharteey

The present investigation was carried out to study the morphometry, soil erodibility and productivity potential of Moridhal river basin in Dhemaji district of Assam. The Moridhal watershed, encompassing 30,730 ha geographical area, is situated between 94052 E to 94069 E longitude and 27038 N to 27064 N latitude. Based on total variation in satellite data (Resourcesat-2, LISS-4), four distinct physiographic units of the Moridhal watershed were delineated which includes: upper piedmont plain (1,844 ha), lower piedmont plain (2,391 ha), alluvial plain (9,888 ha) and flood plain (16,607 ha). The stream order map of the Moridhal river basin was prepared by on screen digitization using Q GIS software and the morphometric parameters were evaluated through measurement of linear, areal and relief aspects. The drainage streams were delineated up to 4th order with stream numbers of 36, 14, 5 and 1, for I, II, III and IV order, respectively. The mean bifurcation ratio and Rho coefficient for the Moridhal watershed was computed to be 2.22 and 0.41, respectively. The computed value of aerial aspects like elongation ratio, circulatory ratio, form factor ratio and shape factor revealed elongated shape of the watershed area. The studied relief aspects include parameters like basin relief, relief ratio, ruggedness number, and relative relief. The calculated value of ruggedness number (0.03) and relative relief (0.055 per cent) indicated higher infiltration and lower runoff in the studied area.

GPS based surface and core soil samples representing different physiographic units were collected and analyzed for various physico-chemical properties. The texture of the studied soils varied from loamy sand to clay, sandy loam being dominant. There was an increasing trend of very fine sand and silt content from upper piedmont plain to floodplain. The bulk density and particle density of studied soils varied from 1.10 to 1.67 Mg m⁻³ and 2.16 to 2.74 Mg m⁻³, respectively. The value of porosity, water holding capacity and hydraulic conductivity of the studied soils ranged from 24.99 to

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54.68 per cent, 19.88 to 63.12 per cent, and 0.11 to 6.54 cm hr⁻¹ respectively. Field capacity and available water content showed significant positive correlation with clay content and porosity, while permanent wilting point exhibited significant positive correlation with sand content.

The pH of the soils was extremely acidic (4.2) to slightly acidic (6.3). The electrical conductivity in the studied soils varied from 0.01 to 0.16 dS m⁻¹ which was almost negligible. The cation exchange capacity of the studied soils varied from 3.88 to 19.40 cmol (p+) kg⁻¹ with a mean value of 9.69 cmol (p+) kg⁻¹. Amongst the exchangeable cations, Ca⁺⁺ was found to be the dominant in the studied soils followed by exchangeable Mg⁺⁺, K⁺ and Na⁺. The exchange capacity of clay and apparent CEC showed wide variation in the studied area. The base saturation varied from 33 to 83 per cent and the organic matter content was medium to high (range 5.50 to 29.60 g kg⁻¹). The available N, available P₂O₅ and available K₂O content varied from low to high with a range between 137.98 to 570.75 kg ha⁻¹, 18.47 to 67.20 kg ha⁻¹ and 37.23 to 549.16 kg ha⁻¹, respectively. The nutrient index for available N, P₂O₅ and K₂O were found to be 1.88 (Medium), 2.15 (Medium) and 1.32 (Low). The principal factor analysis, which was carried out using 35 characters, could explain 71.20 per cent of the total variance with the seven number of extracted eigen values.

There was an increasing trend of macroaggregate from upper piedmont plain (mean 24.9 per cent) to flood plain soils (mean 47.4 per cent). The microaggregate in the studied soils varied from 17.8 to 89.8 per cent and the mean weight diameter ranged between 1.00 to 2.74 mm. The erodibility of the studied soils was assessed by computing various erodibility indices like clay ratio, silt clay ratio, modified clay ratio, dispersion ratio, erosion ratio and erosion index. The mean value of clay ratio, silt/clay ratio and modified clay ratio were found to be 4.02, 1.35 and 3.63, respectively. The dispersion ratio of the soils varied from 0.06 to 1.18 with a mean value of 0.19. It was observed that 48.82 per cent of the total studied soil samples had dispersion ratio values above 0.15 which may be considered as erodible. The erosion ratio and erosion index of studied soils varied from varied from 0.01 to 0.55 and 0.03 to 0.71, respectively. It was observed that almost all the studied physico-chemical properties influenced the erodibility indices to a great extent. The soil loss varied from very slight to very severe (range 0.87-67.77 t ha⁻¹ yr⁻¹) with a mean value of 16.19 t ha⁻¹ yr⁻¹. A significant positive correlation of soil loss was noticed with very fine sand ($r = 0.229^{**}$), silt ($r = 0.212^{**}$), microaggregate ($r = 0.351^{**}$) and relief ($r = 0.711^{**}$). The studied soils exhibited a decreasing trend of soil loss from upper piedmont plain towards flood plain. The productivity indexes of the studied soils varied from 12.13 to 62.14 with a mean value of 35.22. The potentiality index and coefficient of improvement values of studied soils varied from 41.04 to 90.25 and 1.11 to 4.69, respectively. Soil site suitability criteria for crops viz., *Sali* rice, *Ahu* rice, *Boro* rice, wheat, mustard/rapeseed, sesame, pea, potato, onion and coconut were evaluated. The study revealed that the soils were permanently unsuitable (N1) to moderately suitable (S2) for *Sali* rice, *Ahu* rice, *Boro*

rice, wheat, pea, mustard/rapeseed, sesame, potato, onion and coconut. Major constraints identified in the watershed lies in acidity, organic carbon, texture, flooding, drainage and low precipitation in early growth stage during *rabi* season. GIS based maps for various themes like pH, organic matter, available N, available P₂O₅, available K₂O along with soil loss, productivity, potentiality, and soil-site suitability for studied crops were also prepared to depict the spatial distribution under different classes.

Assessment of Carbon Footprint in Rice-Rice Cropping System as affected by Fertilizer Management

Rupjyoti Borah

The present study aimed at assessing the carbon footprint in rice-rice cropping system as affected by various fertilizer management combinations and source of nitrogen was carried out in the ICR Farm, AAU (26°71'N, 94°18' E) 91.0 m above MSL during the years 2016-17 and 2017-18. The initial pH, organic carbon, available N, P₂O₅ and K₂O of the experimental plot were 5.84, 0.61%, 132.561 kg ha⁻¹, 214.48 kg ha⁻¹ and 33.734 kg ha⁻¹, respectively.

There were no significant differences in soil pH amongst the variety while significant differences were observed within various fertilizer combinations and source of N. Soil organic carbon values ranged between 0.62 to 0.85% and significant difference was observed amongst the fertilizer treatments and source of N. The various fertilizer combinations in case of available nitrogen also showed a similar trend with the highest mean value of 169.84 kg N ha⁻¹ in the treatment with full recommended dose of fertilizer (RDF). Available P₂O₅ in the system also followed a similar trend (36.07 kg ha⁻¹) while available K₂O significantly varied within the varieties and fertilizer combinations with higher values in Mahsuri-Banglami system (49.94 kg K₂O ha⁻¹). Significant differences in methane emissions were observed amongst the varieties and also in between the fertilizer combination treatments. The methane emission was 388.33 mg m⁻²hr⁻¹ in Ranjit-Lachit system and 285.61 mg m⁻²hr⁻¹ in the Mahsuri-Banglami cropping system. High methane emission was observed in RDF followed by 50% RDF+Vermicompost and INM. During the entire crop growing season, the largest variation in methane emission was observed in the early growth period. Methane emission indicated two distinct peaks during the entire crop growth period, irrespective of the treatments. Peaks of nitrous oxide emissions were obtained after topdressing of nitrogenous fertilizers. Significant variations were also observed in between the fertilizer combination treatments may be due to varying organic carbon in the various treatments. Ranjit -Lachit system recorded higher mean cumulative N₂O emissions

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(10.72 μ gm⁻²) than Mahsuri-Banglami system (4.92 μ gm⁻²). The RDF treatments recorded highest mean cumulative N₂O emissions amongst the fertilizer combinations. Temporal pattern of flux irrespective of treatments showed a trend of gradual increase with the growth of the crop, thereafter a slow decline in fluxes. The highest mean cumulative CO₂ emissions (2953.43 mg m⁻²) was recorded in the Ranjit-Lachit system and within the fertilizer combinations, the highest mean value of 3125.20 mg m⁻² was recorded under RDF treatment. Mapping of the three different tiers of carbon footprint showed that the tier-1 was the dominant contributor of carbon footprint.

The Total System Spatial Carbon Footprint (SCF) under different treatments recorded higher values in case of INM treatments involving 50%NP + Full K + 5t/ha enriched compost and vermicompost treatments in both the cropping systems. Within the INM treatments, higher SCF of 62.00 t CE ha⁻¹ was obtained in Ranjit-Lachit system while in case of Mahsuri-Banglami system, the highest SCF was obtained in INM treatment with NCU and UCU (48.91 t CE ha⁻¹). Yield scaled carbon footprint (YCF) indicated highest value of 13.23 kg CE kg⁻¹ grain in case of Mahsuri-Banglami system while 50% RDF supplemented with 5 t ha⁻¹vermicompost and uncoated urea recorded the highest YCF with 15.96 kg CE kg⁻¹ of grain in Ranjit-Lachit cropping system. Considering the yield compensation and sustainability of the soil resources, the INM with slow release N source proved to be the better in rice-rice cropping system.

Assessment of potassium use efficiency in transplanted rice

Seema Bhagowati

Potassium (K) the third major essential plant nutrient with diverse roles to play in plant metabolism is required in large amount by crops and is the seventh most abundant element in the earth crust. The total K reserves are generally large in most soils but large portion of soil potassium (90 – 98%) remains chemically bound in the crystal structure of minerals and thus unavailable or slowly available for plant uptake. Based on availability to plants, potassium is categorized into four groups viz., water soluble, exchangeable, non-exchangeable/fixed and lattice K. Potassium supply to crop is a complex phenomenon involving relationships among various K fractions, potassium fixation and release patterns in soil and quantity-intensity relationships. Moreover, the net negative balance for K in current agriculture scenario is 69% which is very high as compared N (19%) and P (12%). This vast difference is partly because of crop removal where 1.5 times more K is removed than N and the application of potassium through fertilizer is considerably lower than that of N or P. Keeping these points in view, a study was carried out on “Assessment of Potassium use efficiency in transplanted rice” in Nagaon district which is famously known as the 'Rice bowl of Assam'. A series of laboratory analysis along with field experiments was carried out to assess the potassium use efficiency in transplanted rice.

The soil of the experimental plot was analysed for salient characteristics such as texture including mineralogy of sand, silt and clay, pH, EC, OC, CEC, available NPK contents and various forms of K. An incubation study was conducted upon imposition of ten different treatments for a period of 150 days to know the availability of various forms of potassium in the soils at 20, 40, 60 and 90 days after incubation. After completion of incubation period, soils from various treatments were taken for study the release pattern of step K, constant rate K and cumulative K and fixation of potassium in these soils. Along with the incubation study, a field study was also conducted consecutively for two years with the same ten treatments in rice crop (var. Ranjit) with three replications in RBD design. Post harvested soils were analyzed for various physico-chemical characteristics and different K forms. Crop related data were recorded

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Major Advisor : Dr. K. N. Das

to study the effect of potassium management on growth and yield of rice. The texture of the soil of the experimental plot was clay loam with very strongly acidic pH (= 4.92). Initial status of SOC (0.91%) was high in upper surface (0-15 cm) and medium (0.65%) in lower surface (15-30cm), available N and P medium and K was low in upper surface and low available N and K and medium P was found in lower surface. X-ray diffraction study clearly indicates that clay fraction of this soil contains minerals like clay mica, mixed-layer minerals, vermiculite, smectite and kaolinite. Sand fraction is dominated by resistant minerals like quartz, zircon and weatherable minerals like mica, feldspars and chlorite and silt fraction contains same minerals as that of sand along with kaolinite. Initial water soluble K (WS-K), exchangeable K (Exch. K), non exchangeable K (Non Exch. K), lattice K and total K were 9.20, 41.00, 1020.00 8856.00 and 9480.00 mg kg⁻¹ respectively in the upper surface (0-15 cm) of the soil. In the lower surface the values were 5.40, 28.40, 1454.00, 10222.00 and 10885.00 mg kg⁻¹ respectively for WS-K, Exch. K, Non Exch-K, Lattice K and total K. In incubation study, where biofertilizers (T2 and T4) and organic manures (T9 and T10) were applied increase in WS-K was found with progression of the incubation period and in field study, it was highest with 21.35 mg kg⁻¹ in the plot receiving T10 = INM Package (50% NP + Full K + 5t/ha Vermicompost) and was the lowest 8.17 mg kg⁻¹ in the control plot. A perceptibly significant increasing trend of Exch-K was found, irrespective of the nutrient source except control treatment in incubated soil. In field condition, Exch. K corresponded to the amount of chemical K fertilizer applied and also to the INM package including microbial consortia and highest amount was observed in INM Package (50% NP + Full K + 5t/ha Vermicompost). Exchangeable K was found to be highly and significantly correlated with available K ($r= 0.993^{**}$), non-exchangeable K ($r=0.602^*$), total K ($r=0.826^*$) and lattice K ($r=0.769^{**}$). With the increase in incubation time the non exch. K decreased in the treatments T2 = Microbial consortia (Azospirillum + PSB + KSB) @ 4 kg/ha, T4 = 100% RDF + KSB @ 4 kg/ha and T6 = Potassium nano-fertilizer @ 100 ml/1.2 L. Lower values of non-exchangeable K were recorded in all the treatments with different levels of potassium as compared to initial (1.020 mg kg⁻¹) in the field experiment maximum being found in 100% RDF application. The increase of non exchangeable K in the control treatment with concurrent decrease in exchangeable K indicates the existence of dynamic equilibrium among different forms of potassium. Lattice K content of the treatments varied differently with different treatments but the changes were statistically insignificant in all the treatments in 40 DAI (Days after incubation) to 60 DAI and the changes was statistically at par in 60 to 90 DAI. Maximum amount of lattice was recorded in plot receiving 100% K fertilizer along with N & P fertilizers and INM components while lowest was recorded in plots which did not receive any fertilizer in field condition. The lattice K was significantly and positively correlated with available K ($r= 0.791^*$), water soluble K ($r=0.801^{**}$), exchangeable K ($r=0.769^*$), nonexchangeable K ($r=0.697^*$) and total K ($r=0.865^{**}$). Increased levels of fertilizers brought about significant increase in total K content *i.e.* in the treatments

where application of full dose of recommended fertilizers were done the total K tended to increase. In field condition, treatments where 100% K fertilizers were applied alone or in combination with INM components for 2 years continuously observed an increase in total K, highest being observed in T10 = 100% NP + Full K + 5 ton/ha Vermicompost) (11015.50 mg kg⁻¹). Highly significant positive correlation values among various forms of K implied the existence of dynamic equilibrium. The amount of K released in successive extraction with boiling 1N HNO₃ decreased step wisely in all treatments and reached to a constant level at 8th number of extraction. Reverse was happened in cumulative K. K release was higher in INM packages than plots received either organic or inorganic fertilizer alone. Cumulative K release was significantly correlated to lattice K ($r=0.881^{**}$) suggesting that 1.0 mol L⁻¹ HNO₃ chiefly extracted K from nonexchangeable K pool in the soil. The amounts of step K of the treated soils ranged within a limit of 1837.0 to 3529.0 mg kg⁻¹, which is high and thereby expected to be nonresponsive to K fertilization for a longer duration to the growing crops. The absolute amount of K fixed in soil progressively increased while percent K fixation decreased with increase in level of added K in all the treatments. Least percent K fixation was observed in T10 and the maximum in control. As this soil contains minerals like mica, vermiculite and smectite in clay fraction so K fixation is also high in this soil. Grain and straw yield was significantly affected by various treatments with the highest yield (= 56.22 q ha⁻¹) in T10 which received 100% NP + Full K + 5 ton /ha vermicompost and the lowest in control. Yield was always better in INM package plots. Grain yield exhibited significant positive correlation with NPK uptake ($r = 0.891^{**}$, 0.946^{**} and 0.970^{**}), water soluble K ($r = 0.785^{**}$) exchangeable K ($r = 0.897^{**}$) and available K (0.867^{**}), suggesting their availability to rice crop. The highest potassium use efficiency (PUE) of 51.96% was found in the plot receiving 50% NP + Full K + 5 t/ha Vermicompost (T10) while the lowest of 40.49% in the plot receiving Potassium nanofertilizer @ 100 ml/1.2 L of water (T6) treatment. The information generated in the present study related to the status and distribution of different forms of potassium and its availability, releasing behavior and fixation evaluated through plant utilizable non-exchangeable K *i.e.* step K and constant rate K gave a general idea about the availability of K under the influences of varying doses of applied K and INM packages. Finally it can be concluded that INM Packages were found to be better for maintaining available K status, K release from none available pools and low K fixation in the soil and the resultant crop yield compared to inorganic treatments.

Assessment of Soil and Groundwater Quality as influenced by continuous monoculture of Tea (*Camellia sinensis*) in the Upper Brahmaputra Valley Zone (UBVZ) of Assam

Shyamal Kumar Phukon

Tea (*Camellia sinensis*) is one of the most important perennial cash crops of Assam used for domestic consumption and export. Assam produces 55% of the tea produced in India and 1/6th of the tea produced in the world. Most of the small tea gardens are confined to Upper Brahmaputra Valley Zone (UBVZ). Tea crop is cultivated since years and predictions are made that due to prolonged monoculture it may be deteriorating soil health and depletion of nutrients or nutrient imbalance compounded by poor physical, chemical and biological conditions of the soils appear to contribute significantly. So the present investigation was undertaken to find out the soil and water qualities of the tea gardens in five districts *viz.* Golaghat, Jorhat, Sivsagar, Dibrugarh and Tinsukia with a special reference to the age groups (0-5, 5-30, 30-45, >45) years of cultivation in identifying the key quality indicators for assessing the effect of continuous monoculture of tea on soil and water quality and the concentration of Aluminium and Fluoride in tea plant and their correlation with yield. Through identification of Minimum Data Set (MDS) for soil and water quality with principal component analyses, the critical soil quality indicators were identified in continuous tea cultivation in reference to the age.

In Golaghat district the SQI was found to be 17.29, 16.68, 14.46 and 12.50 for the age groups of 0-5, 5-30, 30-45, >45 years of continuous tea cultivation with MDS. Similarly, in Jorhat, Sivsagar, Dibrugarh and Tinsukia the SQI values were 16.41, 14.08, 10.57, 10.32; 14.01, 12.71, 11.25, 10.97; 13.57, 12.59, 11.97, 11.62; 11.31, 10.22, 10.13, 9.01 under 0-5, 5-30, 30-45, >45 years of continuous cultivation, respectively with MDS. The most sensitive indicators of soil quality were pH, Avl N, Avl P2O5, Avl K2O, OM, Zn, Ex Al and Avl S which contributes the most towards SQI in all the districts.

Abstract of Ph.D. Thesis

Department : Tea Husbandry & Technology

Major Advisor : Dr. R.P. Bhuyan

Water Quality Index (WQI) indicates the quality of water and the best quality was being found in Dibrugarh (54.37) followed by Tinsukia (44.40), Sivasagar (33.65), Golaghat (26.24) and Jorhat (19.30) respectively, with MDS. Most of the age group of the districts of the present study revealed no significant correlation of tea yield with F and Al concentration indicating that F and Al concentration had no impact on tea yield. Though, average Al and F concentration was found to increase with the increase in age of cultivation irrespective of cultivated area under the UBZ of Assam. Moreover, among all the age groups of the districts, no significant correlation of tea yield with stem girth and bush spread were observed. Based on the secondary data, tea average yield was found to be highest in Tinsukia followed by Dibrugarh, Sivasagar, Jorhat and Golaghat under all the age groups.

Efficacy of nano bioformulation for the management of red spider mite (*Oligonychus coffeae*) in tea

Supriya Sonowal

The present investigation was conducted in the Department of Tea Husbandry and Technology, Nano Lab of Department of Plant Pathology and field experiment were conducted in Experimental Garden for Plantation Crops (EGPC), Assam Agricultural University (AAU), Jorhat, Assam during 2016-2020 to carry out the experiments to obtain nanoparticle and characterization.

The nano particles were synthesized from *Fusarium oxysporum*, fish and crab and used as NP-1, NP-2 and NP-3 respectively. The nanoparticle used were characterized by UV-VIS, Zeta Sizer, TEM and DLS. UV-VIS spectroscopy of chitosan nanoparticles was carried out a range of wavelength of 314.00, 340.00, 348.50 nm 200-600 nm and results showed maximum absorption at critical wavelengths for a particular nanoparticle respectively for *F. oxysporum*, fish and crab chitosan nanoparticles. Zeta potential values of the present nanoparticles were recorded positively charged with zeta potential of 3.85, 16.89 and 20.48 respectively for chitosan nanoparticles of *F. oxysporum*, fish and crab. Similarly, TEM study showed the present nanoparticles were smooth surfaced with spherical in shape. On the other hand DLS study showed the size of the nanoparticles as 105.6, 98.0, 285.0 nm respectively for *F. oxysporum*, fish, crab. *In vitro* evaluation of chitosan NPs synthesized from *F. oxysporum*, fish and crab in combination of *M. anisopliae* and *V. lecanii* against red spider mite was tested at different doses (5 ml/lit, 7 ml/lit and 10 ml/lit) at 100 ppm concentration. At first day after treatment highest per cent mortality recorded from *M. anisopliae* + NP-2 (38.55%) at dose of 7 ml/lit. At third days of spray the highest per cent mortality was recorded from *M. anisopliae* + NP-2 (65.42%) at 7 ml/lit. This was followed by *M. anisopliae* + NP-2 (58.79%) and (58.05%) at 10 ml/lit and 5 ml/lit respectively. At fifth days after treatment *M. anisopliae* + NP-2 showed maximum mortality against *O. coffeae* (81.66%) at 7ml/lit followed by *M. anisopliae* + NP-2 (79.76%) and (76.48%) at dose of 10 ml/ lit and 5 ml/lit respectively and lowest mortality per cent (21.51%) was observed at control.

Abstract of Ph.D. Thesis

Department : Tea Husbandry & Technology

Major Advisor : Dr. I. P. Sahewalla

Ph.D (Veterinary Science)

- **Animal Biotechnology**
- **Animal Genetics and Breeding**
 - **Animal Nutrition**
- **Animal Reproduction, Gynaecology and Obstetrics**
 - **Veterinary Anatomy and Histology**
 - **Veterinary Extension Education**
- **Veterinary Epidemiology and Preventive Medicine**
 - **Veterinary Microbiology**
 - **Veterinary Pathology**
- **Veterinary Pharmacology & Toxicology & Jurisprudence**
 - **Veterinary Physiology**
 - **Veterinary Public Health**
- **Veterinary Surgery and Radiology**
 - **Livestock Products Technology**
 - **Poultry Science**

Phenotypic and molecular characterization of extended spectrum β -lactamase producing *Escherichia coli* and *Klebsiella* isolates from animal sources

Dr. Leena Das

Extended-spectrum beta-lactamase producing Enterobacteriaceae has become a major threat to both animals and human health globally. The present study was undertaken to isolate and identify ESBL producing *Escherichia coli* and *Klebsiella pneumoniae* from various sources, to study their resistant gene profile, to detect insertion sequences, to genogroup the isolates and to compare the efficacy of REP-PCR and PFGE to discriminate ESBL producing *E. coli* and *K. pneumoniae* isolates.

Out of 385 samples from various sources, 31 (8.05%) were positive for ESBL producing *E. coli*. Such isolates could be isolated from 10.05, 8.33, 15.63, 6.67 and 4.35 per cent of cattle milk, curd, chicken, pork and cattle faeces samples, respectively. However, no ESBL producing *E. coli* could be isolated from goat milk, goat faeces and beef samples. A total of 59 (15.32%) samples were positive for ESBL producing *K. pneumoniae*, which could be isolated from 14.35, 6.25, 21.43 and 34.78 per cent samples of cattle milk, chicken, beef and cattle faeces, respectively. No ESBL producing *K. pneumoniae* isolates could, however, be isolated from goat milk and faeces, curd and pork.

In-vitro drug susceptibility assay against 3rd and 4th generation cephalosporins showed resistance of all the 90 ESBL isolates to at least one antibiotic. In CDT, 93.55% of *E. coli* and 88.14% *K. pneumoniae* and in ESBL –E test, 96.77% *E. coli* and 88.14% *K. pneumoniae* showed positive results.

Antibiogram of the ESBL producing *E. coli* and *K. pneumoniae* showed resistance of 74.19% and 69.49%, respectively to ceftizoxime, 25.81% and 23.73% to

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Department : Animal Biotechnology

Major Advisor : Dr. Probodh Borah

both co-trimoxazole and tetracycline, 19.35% and 25.42% to ciprofloxacin, 9.68% and 16.95% to chloramphenicol, 3.23% and 5.08% to piperacillin-tazobactam, and 3.23% and 3.39% to gentamicin.

Resistance gene profiling showed *bla*CTX-M gene to be present in all the 90 (100%) ESBL isolates. The *bla*TEM gene was found in 54.84% and 55.93%, *bla*SHV gene in 90.32% and 77.97%, *Sul* 1 gene in 90.32% and 86.44% isolates. The *Int*1 gene was detected in 70.97% and 62.71% isolates, while *qnr*B gene was found in 3.23% and 10.17% of *E. coli* and *K. pneumoniae* isolates, respectively.

Out of the insertion sequences under study, *ISEcp*1 was found to be present in all the 90 (100%) ESBL producing isolates, followed by *IS*26 (100% and 90.32%) and *ISCR*1 (80.65% and 45.76%) in *E. coli* and *K. pneumoniae* isolates, respectively. All the 90 ESBL producing isolates were subjected to PCR for detection of CTX-M genogroups. All the 90 (100%) ESBL producing isolates were found to be positive for group 1 gene. A total of 80.65% and 55.93% *E. coli* and *K. pneumoniae* isolates, respectively showed presence of group 2 genes. The corresponding percentages for group 25 gene were 27.27% and 67.8%. However, group 9 gene could be detected in 5.08% of *K. pneumoniae* isolates only. None of the *E. coli* isolates were found to be positive for group 8 and 9 genes, while no isolate of *K. pneumoniae* was found to be positive for group 8 gene.

The two molecular typing methods, REP-PCR and PFGE were found to show similar discriminatory power and could distinctly differentiate the ESBL producing *E. coli* and *K. pneumoniae* isolates. As both the methods were found equally competent, REP-PCR may be recommended as the preferred method of typing for epidemiological investigations owing to its advantages over PFGE in terms of rapidity, simplicity and ease of performance.

Characterization of Ghumusari and Raighar Goats of Odisha

Dr. Subhashree Panigrahi

The present study was conducted to characterize two indigenous goat population of Odisha viz. the Ghumusari and the Raighar. Data were collected through field survey from the breeding tracts of these two varieties. Objectives of the investigation were to study some of the important morphometric traits, certain important traits of growth and reproduction and polymorphism of *IGF1* gene. Records were obtained from 859 animals for coat colour, 216 animals for ear length and horn measurements, 375 animals for body measurements and growth traits and 272 animals for reproductive traits in Ghumusari goat. For Raighar goat, the corresponding number of animals for these traits were 667, 314, 394 and 338. Polymorphism of *IGF1* gene was investigated on 50 animals from each of these two goat populations of Odisha. Coat colour was found to be predominantly black (66.13 per cent) in Ghumusari and deep brown (74.52 per cent) in Raighar. The overall least-squares means for ear length, horn length, horn circumference at base, space between two horns at base and the space between two horns at tip were 12.570±0.06, 5.111±0.03, 6.584±0.03, 4.598±0.03 and 9.778±0.03 cm respectively in Ghumusari. In Raighar goat, the respective values for these traits were 13.004±0.02, 5.243±0.02, 6.337±0.02, 2.986±0.02 and 10.440±0.03 cm. The LSM for body length at birth, 3, 6, 9 and 12 months of age were 27.069±0.10, 40.755±0.09, 46.282±0.11, 51.084±0.13 and 54.842±0.15 cm respectively in Ghumusari. The corresponding values for these traits were found to be 26.027±0.10, 45.545±0.13, 50.066±0.12, 53.852±0.15 and 55.887±0.14 cm in Raighar. Location had significant effect on body length at 9 months, season of birth at 12 months, and parity at 6 months of age in Raighar goat. Body length was significantly higher in males than in females at birth, 3 and 6 months of age in Ghumusari, and at 3 and 9 months of age in Raighar. Among the birth types, singletons had significantly higher body length at 3 months in Ghumusari, and at 6, 9 and 12 months of age in Raighar. The overall LSM for height at withers at birth, 3, 6, 9 and 12 months of age were 27.648±0.12, 42.048±0.09, 47.929±0.14, 52.380±0.15 and

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Department : Animal Genetics and Breeding

Major Advisor : Dr. Bula Das

54.678± 0.18 cm respectively in Ghumusari; and 27.591±0.13, 46.548±0.12, 52.882±0.15, 53.628±0.14 and 54.858±0.19 cm respectively in Raighar. Significant effect of parity at birth, sex at 3, 6, 9 months and type of birth at all the age groups was observed in both the populations. Raighar goat of Nuapada district showed significantly higher height at withers at birth, 6 and 9 months of age compared to those of Kalahandi and Nabarangpur districts. The overall LSM for heart girth at birth, 3, 6, 9 and 12 months of age were 25.346±0.09, 41.606±0.09, 47.701±0.15, 51.397±0.15 and 54.105±0.17 cm respectively in Ghumusari. The respective values were found to be 26.713±0.12, 46.273±0.17, 51.061±0.15, 54.612±0.15 and 58.540±0.16 cm in Raighar. Location (district) exhibited significant effect on heart girth at 6 and 9 months in Ghumusari and at 6 months of age in Raighar. Significant effect of parity at birth and birth type was found in Raighar goat at 3 months of age. The overall LSM for paunch girth at birth, 3, 6, 9 and 12 months of age were 26.866±0.09, 44.747±0.14, 49.333±0.16, 55.748±0.17 and 57.105±0.17cm respectively in Ghumusari. In Raighar goat, the corresponding values were found to be 28.101±0.09, 52.097±0.16, 53.791±0.16, 58.457±0.17 and 59.938±0.15 cm. The effect of parity and birth type at 3 months and sex at birth, 3, 12 months of age were observed in Ghumusari. Location influenced paunch girth significantly at 3 months, birth type at 12 months and sex at 12 months of age in Raighar goat. The overall LSM for body weight at birth, 3, 6, 9 and 12 months were found to be 1.294±0.02, 6.376±0.04, 11.491±0.06, 14.597±0.06 and 16.630±0.09 kg respectively in Ghumusari goat, the respective values being 1.485±0.02, 6.432±0.04, 11.520±0.06, 14.739±0.06 and 16.668±0.09 kg in Raighar goat. In Ghumusari goat, with regard to body weight at all the ages, location and season of kidding showed non-significant effect. Parity at 3 months, sex and birth type at all the ages exerted significant effect on this trait. In Raighar goat, significant effect of location and sex at 3, 6, 9, 12 months of age; parity and birth type at all the ages; and season of kidding at 12 months of age for this trait was noted. The overall LSM for age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding, kid size at birth, kidding interval, gestation period and service period in Ghumusari were found to be 204.52±1.02 days, 11.64±0.05 kg, 375.49±1.18 days, 16.68±0.06 kg, 1.51 ± 0.03, 241.79±1.72 days, 148.09±0.13 days and 93.78±1.71 days respectively. For Raighar goat, these values were respectively 292.32±1.07 days, 14.63±0.05 kg, 456.66±1.22 days, 17.01±0.06 kg, 1.45 ± 0.03, 234.15±1.61 days, 147.67 ± 0.12 days and 86.65±1.60 days. In Ghumusari goat, kid size at birth was significantly affected by season of kidding. Parity had significant influence on age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding and kid size at birth. In Raighar goat, location had significant effect on age at sexual maturity, kidding interval and service period. Season of kidding exerted significant effect on age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding, kid size at birth, gestation period, and parity on weight at sexual maturity, kid size at birth, kidding interval and service period in this goat variety. The PCR-RFLP analysis was used to

identify the variants in *IGF1* gene based on the variants produced by digestion of 505 bp amplified product with *HaeIII* restriction enzyme. On restriction digestion, the 505 bp amplicon produced 4 fragments of 333, 234, 172 and 99 bp. The PCR-RFLP studies on *IGF1* gene in both Ghumusari and Raighar goats of Odisha using *HaeIII* restriction enzyme revealed three banding patterns, arbitrarily designated as AA, AB and BB genotypes. Out of these, AA genotype yielded two fragments (333, 172 bp), AB genotype yielded four fragments (333, 234, 172, 99 bp), and BB genotype yielded three fragments (234, 172, 99 bp). In Ghumusari goats, the frequencies of AA, AB and BB genotypes were 0.28, 0.32 and 0.4 respectively, and the frequencies of 'A' and 'B' alleles were 0.44 and 0.56 respectively. In Raighar goat, the frequencies of AA, AB and BB genotypes were 0.1, 0.5 and 0.4 respectively, and the frequencies of 'A' and 'B' alleles were 0.35 and 0.65 respectively. In the present study, the results showed polymorphic banding patterns in both the goat populations with respect to *IGF1* gene. Chi-Square (χ^2) test revealed that the population under study was in Hardy-Weinberg equilibrium. *HaeIII* restriction site was detected at 171th position of a total 505 bp by partial sequencing. The sequence alignment of the samples detected an SNP at 405th position with nucleotide transversion from G to C. Based on the uniformity in their productive and reproductive performances both the population are potent to be recognized as breed.

Effect of Feeding Distillers Dried Grain with Soluble (DDGS) with or without Multi-Enzymes on the Growth Performance of Indigenous Chicken

Dr. Ashim Kumar Saikia

The present study was undertaken to investigate the effect of dietary incorporation of distillers dried grains with solubles (DDGS) with or without multi-enzyme supplementation on the growth performance of indigenous chicken. A total of one hundred and eighty (180) day-old indigenous chicks were procured from a few villages of Dhemaji district. The chicks were reared together for a period of 21 days, up to the point when the sex of the chicks could be identified, by feeding standard chick feed. On 22nd day, after knowing the numbers of male and female chicks, they were weighed and randomly divided into six groups viz. T1, T2, T3, T4, T5 and T6 containing 30 chicks with 3 replicates of 10 chicks in each group. The chicks were wing banded and reared under deep litter system of management throughout the experimental period following standard and uniform managerial practices. The birds of T1 group (control) were offered the standard chick, grower & layer feeds as per BIS, 2007. The birds of T2 group were fed with the same standard chick, grower and layer feeds as per BIS, 2007 with supplementation of multienzyme (Xzyme). Maize DDGS was incorporated at 10% level in all the rations for T3 and T4 groups and the rations for T4 group was supplemented with multi-enzymes. In the same way, the birds of T5 and T6 groups were fed with rations containing 20% DDGS without and with enzymes, respectively. The maize DDGS used in the rations was procured from Brahmaputra Biochem Pvt. Ltd., Jambari, Guwahati.

The feeding trial was conducted for a period of 182 days (13 fortnights) using chick feeds for first 3 fortnights (0-42 days), grower feeds for next 7 fortnights (43-140 days) and layer feeds for last 3 fortnights (141-182 days). A metabolic trial was conducted for a period of 8 days after the completion of feeding trial. During the experiment, average fortnightly and total feed consumption, fortnightly and total body

Abstract of Ph.D. Thesis

Department : Animal Nutrition

Major Advisor : Dr. Robin Bhuyan

weight and body weight gain, feed conversion ratio (FCR), various blood bio-chemicals constituents, balance of nutrients, survivability rate, carcass characteristics like dressing percentage, relative organ and giblets weight, organoleptic evaluation, egg quality parameters and economics of production were studied and recorded.

The average final body weight of indigenous chicken was highest in T2 group (1643.93±25.22 g) followed by T1 (1607.86±16.29 g), T4 (1603.21±13.88 g), T6 (1596.07±11.78 g), T3 (1589.26±13.83 g) and T5 (1580.00±14.50 g) groups. The average total feed consumption per bird for different experimental groups was highest in T6 group (11748 g) and lowest in T1 group (11653 g). The overall FCR of the birds for entire period was least in T2 group (7.37) followed by T1 (7.51), T4 (7.51), T3 (7.62), T6 (7.64) and T5 (7.69) groups. The per cent survivability of birds was 93.33 in T1, T2, T4 and T6 groups and 90.00 in T3 and T5 groups. No significant difference ($P>0.05$) was observed in respect of final body weight, total and mean daily gain in body weight among the groups and total feed consumption as well as overall FCRs were found to be comparable among the treatment groups. Positive balances were observed in N, Ca and P utilization and significant difference ($P<0.05$) was recorded between T1 and T4 and T6 groups, between T3 and T6 and between T5 and T6 groups in percent phosphorus retention. No significant differences ($P>0.05$) were observed among the groups in respect of the blood constituents viz. Hb., blood glucose, total serum protein, blood lipids, blood cholesterol, AST and ALT levels and serum calcium and significant difference ($P<0.05$) was found in serum inorganic phosphorus between T1 and all other groups. All the carcass characteristics like dressing percentage, relative organ and giblets weight showed non-significant ($P>0.05$) differences among the experimental groups. The average proximate principles (%) of breast meat of experimental birds of different groups for moisture, protein, fat and total ash contents were estimated and no significant difference ($P>0.05$) was found among the groups in respect of these proximate principles. Non-significant ($P>0.05$) difference was found in colour, tenderness, flavor, juiciness and overall acceptance of the breast meat among the treatment groups. Comparable values were also observed among the experimental groups in respect of both the external as well as internal egg quality parameters of the eggs laid by the birds of different groups. The costs of feeding and production were highest in group- T2 i.e. ₹284.48 & 405.67 and lowest in group- T5 i.e. ₹ 245.28 & 366.47, respectively.

Effect of Fermented Liquid Feed on the Performance and Gut Health of Grower-Finisher Large White Yorkshire Pigs

Dr. Rajat Buragohain

A 180-days feeding trial was conducted on 24 weaned Large White Yorkshire pigs (11.45±2.42 to 11.46±2.37 kg body weight, 42-days of age) to investigate the effect of feeding fermented liquid feed on growth performance, nutrient digestibility, gut health and immunity, carcass characteristics, blood haemato-biochemical parameters and economics under intensive management. Basal rations (NRC, 2012) were assigned as dry feed (DF), non-fermented liquid feed (NFLF), fermented liquid feed prepared with *Lactobacillus acidophilus* (FLF-LA) and fermented liquid feed prepared with *Enterococcus faecium* (FLF-EF) to 4 homogenous groups of pigs (3 males and 3 females in each group). NFLF was prepared by mixing basal ration with drinking water at 1:2 (w/w) immediately before feeding. For preparation of FLF-LA, from stock culture of *Lactobacillus acidophilus*, a loop full of culture was transferred aseptically to 100 ml of De Man, Rogosa and Sharpe (MRS) broth and was incubated for 24 hours at 37°C in an automatic incubator shaker. Ground yellow maize mixed with water (1:1, w/w) was fermented with 24 hr. old culture of *Lactobacillus acidophilus* at 37°C for 24 hr. The fermented maize was then mixed with basal ration mixed with water at 1:2 (w/w) and fermented for 48 hrs. to prepare FLF-LA (1-2 10⁹ cfu/g). 50% of the fermented feed was utilized for feeding and rest was used for backslopping for another 7 days after which the process was started from the beginning. The same procedure of preparation was followed for FLF-EF, except Brain Heart Infusion broth was used instead of MRS. The feeding trial was conducted for 180 days. Two digestibility trials were conducted 1st at the end of 17th week of age (growing phase) and 2nd at the end of 29th week (finishing phase). Faeces and blood samples were collected from three randomly selected pigs from each treatment on day 0, 60, 120 and 180 for estimation for faecal metabolites and faecal microbial counts, and evaluation of haemato-biochemical parameters. For carcass characteristics study, three pigs from each treatment were slaughtered at the end of the feeding trial. The cell-mediated immune response was

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Department : Animal Nutrition

Major Advisor : Dr. B. N. Saikia

assessed through *in vivo* sub-cutaneous delayed-type hypersensitivity (DTH) reaction against phytohaemagglutinin-p and humoral immune response by micro-hemagglutination assay. Study revealed improvement in feed consumption in the growing phase and significantly ($P<0.05$) higher feed consumption in the finishing phase in pigs fed FLF than pigs fed NFLF than DF. Apparent digestibility co-efficient (ADC) of all the nutrients was comparatively higher in FLF fed-groups than DF and NFLF in growing phase. ADC of CP was significantly ($P<0.05$) higher in FLF-LA and FLF-EF with improved digestibility of other nutrients than DF and NFLF in the finishing phase. The average daily body weight gain (ADG) was significantly higher in FLF fed-groups and resulted significantly ($P<0.05$) higher total gain and final body weights than pigs fed DF and NFLF. Diarrhoea score and incidence was significantly reduced on feeding of FLF. Higher faecal lactic acid bacteria count with low faecal counts of *E. coli* and *Salmonella*; and high faecal pH, less faecal lactic acid and NH₃-N level were recorded in FLF fed-pigs compared to DF and NFLF. Significantly higher villi height, crypt depth and apparent villi surface area were found in FLF fed-groups than DF and NFLF. More numbers of mononuclear and glandular epithelial cells and presence of lymphoid follicles were observed in the duodenal and jejunal sections of small intestine of FLF fed-groups. No such infiltration and lymphoid follicles were observed in duodenal and jejunal sections of DF and NFLF groups. Pigs of FLF-LA & FLFEF showed more skin indurations and high antibody titre post-inoculation to phytohaemagglutinin-p and 20% sheep RBC, respectively as the measure of cell-mediated and humoral immune response. No significant difference was observed for carcass traits, physico-chemical and nutritional properties of meat and sensory attributes on feeding of FLF compared to DF and NFLF. All blood haemato-biochemical parameters were within the normal range in all the treatment groups. No pathological lesions were found in the liver and spleen on feeding of FLF. The FCR at the end of feeding trial was calculated as 3.82 ± 0.07 , 3.64 ± 0.05 , 3.36 ± 0.04 and 3.46 ± 0.07 , respectively for DF, NFLF, FLF-LA and FLF-EF indicating significantly better FCR in FLF fed-groups. The feed cost/kg gain in body weight (Rs./kg) was calculated as 128.36 ± 2.82 , 120.43 ± 1.67 , 112.87 ± 2.26 and 115.51 ± 1.96 , respectively for DF, NFLF, FLF-LA and FLF-EF, respectively, which indicated significantly reduced feeding cost/kg body weight gain in FLF fed-pigs compared to DF and NFLF. Findings of the study revealed that feeding of FLF-LA and FLF-EF significantly improved growth performance, digestibility of nutrients, gut health and immunity and gain: feed ratio of the grower-finisher LWY pigs than the DF and NFLF. Thus, feeding of FLF prepared with either *Lactobacillus acidophilus* or *Enterococcus faecium* may be recommended to LWY grower-finisher pigs for remunerative and sustainable profit.

Key words: Liquid feed, fermented liquid feed, *Lactobacillus acidophilus*, *Enterococcus faecium*, grower-finisher LYW pigs, growth, gut health, economics.

Effect of Vitamin E and Selenium Feed Supplements on Performance, Oxidative Stress, Immunity and Heat Shock Protein Expression in Broiler Chicken

Dr. Subhalakshmi Bora

The present study was undertaken to investigate the effect of dietary supplementation of vitamin E and Selenium on the growth performance, oxidative stress, immunity and heat shock protein expression in Broiler chicken. Two hundred and forty (240) day-old commercial Vencobb 400 broiler chicks were randomly divided into four experimental groups viz. T0 (unsupplemented control), T1 (Vitamin E @ 100 mg/kg and Selenium @ 0.2 mg/kg), T2 (Vitamin E @ 125 mg/kg and Selenium @ 0.25 mg/kg) and T3 (Vitamin E @ 150 mg/kg and Selenium @ 0.3 mg/kg) groups of 60 chicks each subdivided into 3 equal replicates. The experimental birds were offered *ad libitum* quantities of four experimental rations either without supplementation or with supplementation of different levels of vitamin E and selenium from 0 to 7 days, 8 to 21 days, and 22 to 42 days of age.

During the experiment, weekly body weight and daily feed intake, total body weight gain, total feed intake, feed conversion ratio (FCR), survivability rate, BPEI, various blood haematological and bio-chemicals constituents, antioxidant enzymes, heat shock protein, immunity, cortisol, carcass characteristics like dressing percentage, cut up parts percentage, relative organ and giblets weight, physicochemical properties of breast meat were studied and recorded.

The mean total body weight (g) was 2120.0±33.5, 2292.9±14.7, 2219.0±16.4 and 2179.9±9.08 and mean total weight gain (g) was 2077.7±14.5, 2250.6±14.7, 2176.6±14.3 and 2137.6±9.08 for T0, T1, T2 and T3 groups, respectively. The mean total feed intake (g) was 4062.75±0.08, 4156.53±0.77, 4151.91±0.35 and 4117.85±11.67 and the average feed conversion ratios was 1.92±0.04, 1.81±0.01, 1.88±0.04 and 1.87±0.04 for T0, T1, T2 and T3 groups, respectively. T1 group attained significantly higher ($P<0.05$) final body weight and body weight gain compared to all the other groups. T2 group did not differ significantly ($P>0.05$) with T3 group; but, had

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a significantly higher ($P<0.05$) final body weight over T0 group. Total feed intake (g) in T1 group was significantly higher ($P<0.05$) than the rest of the groups. The other groups did not differ significantly ($P>0.05$) in mean total Feed Conversion ratio.

BPEI was found to be significantly ($P<0.05$) higher in T1 (126.67 ± 1.764) group than the other groups; however, no significant ($P>0.05$) difference was observed among T0 (110.67 ± 4.67), T2 (118.00 ± 0.58) and T3 (116.33 ± 0.33) groups.

Economics of production showed that difference in the total feed cost (Rs.) and the total cost involved per bird (Rs.) were highly significant ($P<0.05$) among the all the groups. Average profit per bird and per kg body weight did not differ significantly ($P>0.05$) among the experimental groups.

Overall mean haematological values was, for Hb (%) 9.75 ± 0.50 , 11.22 ± 1.56 , 10.56 ± 1.11 and 10.50 ± 1.19 ; for PCV (%) 25.7 ± 0.60 , 28.22 ± 1.67 , 27.20 ± 1.01 and 27.23 ± 0.86 and for WBC (thousand mm^3) 28.03 ± 2.95 , 24.13 ± 0.47 , 25.13 ± 0.75 and 25.14 ± 0.83 for T0, T1, T2 and T3 groups respectively. Hb (%), PCV (%), WBC (thousand mm^3) level in T1 treatment group was significantly higher ($P<0.05$) than the rest of the groups. However, T2 and T3 groups did not differ significantly ($P>0.05$) but, were significantly higher ($P<0.05$) than T0 group.

Overall mean of blood biochemical were, for serum glucose (mg/dl) 213.3 ± 27.9 , 186.7 ± 7.90 , 202.9 ± 1.36 and 201.9 ± 21.5 ; for serum total protein (g/dl) 2.40 ± 0.37 , 3.21 ± 0.85 , 2.91 ± 0.54 and 2.94 ± 0.60 ; for Albumin (g/dl) $1.16a\pm 0.14$, $1.44c\pm 0.27$, $1.27b\pm 0.13$ and $1.31b\pm 0.18$ and for Globulin (g/dl) 1.25 ± 0.25 , $1.77b\pm 0.60$, $1.64b\pm 0.44$ and $1.63b\pm 0.44$ in T0, T1, T2 and T3 groups respectively. Serum glucose (mg/dl) level in T1 treatment group was significantly lower ($P<0.05$) than the rest of the groups. Total protein (g/dl), Albumin (g/dl) level in T1 treatment group was significantly higher ($P<0.05$) than the rest of the groups. However, T2 and T3 groups did not differ significantly ($P>0.05$) but, were significantly higher ($P<0.05$) than T0 group. Globulin (g/dl) level in all the treatment group was significantly higher ($P<0.05$) than the unsupplemented group.

The overall mean of AST (U/L) level was 202.4 ± 19.4 , 180.2 ± 8.67 , 194.6 ± 16.1 and 188.4 ± 5.58 and of ALT (U/L) level was 8.73 ± 2.80 , 7.05 ± 1.56 , 7.76 ± 1.96 and 7.94 ± 1.92 in T0, T1, T2 and T3 groups respectively. AST (U/L) and ALT (U/L) levels in T1 treatment group was significantly lower ($P<0.001$) than the rest of the groups. T0 group had significantly higher ($P>0.05$) AST (U/L) and ALT (U/L) level than rest of the groups. The overall mean values of serum superoxide dismutase (SOD, unit/mg protein) was 2.03 ± 0.39 , 3.46 ± 0.64 , 2.94 ± 0.68 and 2.69 ± 0.45 ; serum GPx (microgram/mg protein) was 2.37 ± 0.27 , 3.61 ± 0.18 , 2.99 ± 0.27 and 2.83 ± 0.30 and serum GSH (mg/g protein) was 0.90 ± 0.07 , 1.36 ± 0.53 , 1.21 ± 0.41 and 1.17 ± 0.36 , respectively in T0, T1, T2 and T3 groups, respectively. SOD, GPx and GSH levels in T1 group were significantly higher ($P<0.05$) than the rest of the groups.

The overall mean of serum Cortisol (ng/ml) in T1 (1.26 ± 0.01) group was significantly lower ($P < 0.05$) than T0 (2.65 ± 0.28), T2 (1.71 ± 0.04) and T3 (1.77 ± 0.05) groups, respectively.

The HSP70 in T1 (2.28 ± 0.05) group was significantly lower ($P < 0.001$) than T0 (6.20 ± 0.08), T2 (2.81 ± 0.07) and T3 (2.65 ± 0.0) groups, respectively. T2 and T3 groups did not differ significantly ($P > 0.05$); but, were significantly lower ($P < 0.05$) than T0 group. The overall mean of humoral immune response against NDV was 1.51 ± 0.33 , 2.13 ± 0.36 , 1.91 ± 0.34 and 2.01 ± 0.35 , respectively and the overall mean of humoral immune response against IBDV was 1.85 ± 0.17 , 2.65 ± 0.23 , 2.25 ± 0.26 and 2.35 ± 0.25 in T0, T1, T2 and T3 groups, respectively. Both the immune responses were significantly higher ($P < 0.05$) in T1 group than T0, T2 and T3 groups. However, T2 and T3 groups did not differ significantly ($P > 0.05$).

The carcass parameters like dressing percentage with giblet in T0, T1, T2, T3 group was 77.42 ± 0.21 , 80.13 ± 0.59 , 78.64 ± 0.09 and 78.54 ± 0.21 , respectively. The dressing percentage without giblet in T0, T1, T2, and T3 groups was 71.86 ± 0.25 , 74.79 ± 0.53 , 73.12 ± 0.05 and 72.87 ± 0.24 , respectively. Dressing percentages were significantly higher ($P < 0.05$) in T1 group than rest of the groups.

Among the cut up parts, thigh, neck, drumstick and breast as percentage of dressed weight were significantly higher ($P < 0.05$) in T1 group (15.07 ± 0.19 , 4.64 ± 0.43 , 13.05 ± 0.49 , 32.46 ± 0.32) than T0 (13.61 ± 0.34 , 5.86 ± 0.32 , 11.65 ± 0.39 and 29.64 ± 1.08), T2 (14.27 ± 0.17 , 5.38 ± 0.38 , 12.59 ± 0.62 , 31.25 ± 0.53) and T3 (14.16 ± 0.72 , 5.54 ± 0.18 , 12.56 ± 0.15 , 31.03 ± 0.14) groups.

The giblet yield as percentage of dressed weight was significantly lower ($P < 0.05$) in the unsupplemented T0 group (5.34 ± 0.07) compared to antioxidant supplemented T1 (5.56 ± 0.11), T2 (5.52 ± 0.04) and T3 (5.68 ± 0.04) groups.

Among the lymphoid organs, spleen (as percentage of dressed weight) in T1 (0.12 ± 0.01) group was found to be significantly bigger ($P < 0.05$) than that of T0 (0.10 ± 0.01) group but not that of T2 (0.11 ± 0.00) and T3 (0.11 ± 0.00) group. Thymus and bursa sizes of all the experimental groups did not differ significantly ($P > 0.05$).

The abdominal fat % in T1 (2.09 ± 0.50) group was significantly lower ($P < 0.05$) than T0 (3.49 ± 0.16), T2 (2.89 ± 0.29) and T3 (2.72 ± 0.12) group, however T2 and T3 groups did not differ significantly ($P > 0.05$).

In breast meat the pH was 5.47 ± 0.19 , 6.14 ± 0.09 , 5.79 ± 0.06 and 5.74 ± 0.19 ; WHC(%) was 58.17 ± 1.83 , 72.38 ± 1.25 , 65.08 ± 1.70 and 67.95 ± 1.45 ; drip loss (%) was 6.96 ± 0.48 , 4.71 ± 0.45 , 6.08 ± 0.46 and 5.70 ± 0.39 ; SFV (Kg/cm²) was 3.80 ± 0.10 , 2.77 ± 0.38 , 3.23 ± 0.15 and 3.30 ± 0.10 and TBARS (mg MDA/Kg) was 3.30 ± 0.10 , 1.18 ± 0.04 , 3.23 ± 0.15 and 2.77 ± 0.38 in T0, T1, T2 and T3 groups, respectively. PH and WHC (%) level in T1 group was significantly higher ($P < 0.05$) than the rest of the groups. However, T2 and T3 groups did not differ significantly ($P > 0.05$) but, were significantly higher ($P < 0.05$) than T0 group. The drip loss (%), SFV (Kg/cm²) and

TBARS (mg MDA/Kg) in T1 group was significantly lower ($P<0.05$) than the rest of the groups.

Proximate composition (per cent dry matter) of the breast meat of broiler chickens of different experimental groups i.e. moisture, crude protein, ether extract and total ash did not differ significantly ($P>0.05$).

Management of Postpartum Anoestrus and Repeat Breeding in Crossbred Cattle Through Nutritional and Therapeutic Interventions

Dr. Arunoday Das

The relationship of managerial condition with infertility, reproductive status and incidence of different reproductive problems of crossbred cattle were studied in a few parts of Lower Brahmaputra Valley Agro-Climatic Zone of Assam. A total of seven nutritional and hormonal interventions and six nutritional and therapeutic interventions were used for addressing postpartum anoestricity and repeat breeding in crossbred cattle respectively. The incidence of infertility was significantly ($P < 0.01$) higher under poor as compared to good housing and feeding conditions. The mean age at puberty, age at first service, age at first calving, postpartum interval of oestrus and calving interval were significantly ($P < 0.05$) higher in poor managerial condition as compared to good one. Among the reproductive disorders, post-partum anoestrus (19.75%) and repeat breeding with or without infection (17.73%) were most predominant in crossbred cattle.

The response to different treatments was studied based on oestrus response, interval from treatment to onset of oestrus and conception rate in postpartum anoestrous cows. The response to treatment in case of repeat breeder cow was estimated on the basis of conception rate. The blood biochemical constituents, *viz.* IGF-1, oestrogen, progesterone, cortisol, T3, T4, calcium, inorganic phosphorus, zinc, magnesium, total protein and albumin were estimated before treatment, on day of oestrus and day 20 of oestrus in postpartum noestrous cattle, and on day of oestrus, day of subsequent oestrus and day 20 of subsequent oestrus in repeat breeding crossbred cows for different interventions.

The conception rate at induced oestrus of postpartum anoestrous cows in groups treated with Bypass fat, Probiotics, Injectable phosphorus, Area specific mineral mixture+ Bypass fat + Probiotics + Injectable phosphorus, Progesterone + eCG and Area specific mineral mixture + Bypass fat + Progesterone + eCG was 83.33, 66.67,

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60.00, 83.33, 83.33 and 100.00 per cent respectively. Out of five nutritional interventions, Area specific mineral mixture + Bypass fat + Probiotics + Injectable phosphorus regime brought about the highest rate of oestrus induction and conception rate in postpartum crossbred cattle. Progesterone + eCG supplemented with Area specific mineral mixture + Bypass fat resulted in higher rate of oestrus induction, lower interval from the end of treatment to onset of oestrus and higher conception rate in postpartum anoestrous cows as compared to without supplementation.

The conception rate in infectious and non-infectious repeat breeder crossbred cows following different treatment regimes was 60.00, 71.43, 85.71, 42.86, 83.33, 57.14, and 16.67 per cent in Intrauterine antibiotic, *E. coli* Lipopolysaccharide, Selenium + Vitamin E orally + *E. coli* Lipopolysaccharide i.u., Area specific mineral mixture + Bypass fat + Probiotics, GnRH + Injectable Progesterone + COX-2 inhibitor, AI+ hCG on day 0 and on day 10 of the oestrous cycle treatment regime and control group respectively. *E. coli* LPS intrauterine fortified with oral selenium + vitamin E, and GnRH + Injectable progesterone + COX-2 inhibitor were superior for treatment of infectious and non-infectious repeat breeder cows respectively.

Biochemical Profile with Special Reference to Acute Phase Protein and Energy Balance in Crossbred Cows During Post-Partum Uterine Infection

Dr. Pranjal Borah

The present research work was conducted to evaluate the haematobiochemical status on supplementation or without supplementation of bypass fat in periparturient cows that developed or not developed uterine infection subsequently following calving. Study was also carried out to find the haemato-biochemical changes on different days of cycle in post partum cyclic cows with uterine infection along with treatment response. A total of 48 crossbred cows comprising 24 peri-partum and 24 post-partum cyclic cows at their third to fifth lactation were used as experimental animals in the study.

Haemato-biochemical investigation carried out in four groups comprising six peri-partum cows in each, viz., non-supplemented with uterine infection (Group-I), nonsupplemented without uterine infection (Group-II), supplemented with uterine infection (Group-III) and supplemented without uterine infection (Group-IV) on day - 14, 2, 7 and 14 of peri-parturition revealed that the mean lymphocyte and neutrophil count varied significantly between groups and between days, while monocyte, eosinophil and basophil counts and haemoglobin levels differed significantly between days of observation. WBC and RBC counts and PCV level showed no significant variations. The mean level of serum Hp, total protein, GGT, ALT, AST and ghrelin differed significantly between groups and between days while SAA varied significantly between days of sampling. No significant variations could be observed in serum albumin, IGF-I and Leptin levels. In non-supplemented and supplemented groups, 66.67 and 69.44 per cent uterine samples were positive for presence of bacteria. The frequency percentage of occurrence of bacterial isolates on day 2, 7 and 14 postpartum was 75.00, 66.67 and 58.33 and, 66.67, 75.00 and 66.67 in non-supplemented and supplemented group respectively. *Staphylococcus spp.* and *E. coli* were isolated from both the groups, *Staphylococcus spp.* being predominant.

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Serum ghrelin level had significant negative correlation with WBC count and serum total protein level while IGF-I had significant positive correlation with serum albumin and negative correlation with serum AST activity when assessed in nonsupplemented crossbred cows with uterine infection during day 2, 7 and 14 post-partum. The mean first post-partum oestrus in Group I, II, III and IV peri-parturient cows was found to be 118.29 ± 12.33 , 104.00 ± 18.05 , 86.50 ± 9.97 and 82.75 ± 8.27 days respectively with first A.I conception rates of 57.14, 60.00, 62.50 and 75.00 per cent in corresponding groups.

Haemato-biochemical study done in four groups, comprising six post-partum cows in each, viz., normal cyclic (Group-I), antibiotic (Levofloxacin Hemihydrate, Ornidazole and Alpha Tocopherol Acetate)-treated (Group-II), *E. Coli* LPS (100 μ g single dose at oestrus)- treated (Group-III) and *E. coli* LPS + bypass fat supplementation for 21 days (Group-IV) indicated that among the haematological parameters (estimated on day 0, 7 and 21 of oestrus) the mean haemoglobin level, PCV per cent, WBC, lymphocyte and eosinophil counts varied significantly between groups, the mean RBC and monocyte counts differed significantly between groups and between days of observation, neutrophil count varied significantly between days while basophil count did not vary significantly. Among the biochemical parameters (estimated on day 0 and 21) the levels of mean SAA, GGT, ALT, IGF-I, leptin and ghrelin differed significantly between groups, that of Hp and AST varied significantly between groups and between days while there was no significant variation in the level of mean serum total protein and albumin. Bacteriological study revealed that in uterine infected cows cent per cent uterine samples were positive for bacterial growth; while post-treatment it reduced to 33.33, 16.67 and 16.67 per cent in Group II, III and IV cows respectively. Two types of bacteria isolated were *Staphylococcus* spp. and *E. coli*; *Staphylococcus* spp. being predominant. First A.I conception rate was higher in group of cows treated with *E. coli* LPS 100 μ g I.U + bypass fat supplementation (83.33 %) in cyclic uterine infected crossbred cows followed by *E. coli* LPS 100 μ g I.U (66.67 %) and antibiotic (50.00 %). SDS- PAGE analysis of pooled samples for different days in different groups of parturient and normal cyclic and post-partum infected and treated cows revealed 10 protein bands with molecular weight of 157.65, 90.41, 72.73, 59.94, 55.74, 51.84, 47.07, 39.74, 34.37 and 33.55 kDa. No difference in band profile was observed among groups and days indicating no expression of new protein.

Effect of Probiotic and Zinc in Gut Integrity of Pre and Post Weaned Piglets: An Immunomorphological and Biomolecular Analysis

Dr. Arup Kalita

Present study was undertaken to elaborate alteration of histomorphological, histochemical, ultrastructural, immunofluorescence, gut microbiota, cytokine gene profile and brush border enzyme activity of histocompartments of small intestine in control (basal diet) and treatment (basal diet + probiotic + zinc) group piglets during pre and post-weaned period. This study was assumed to understand the effect of probiotic and zinc on gut digestibility and immunity compared to the control piglets so that the productivity of this important species of farm animal could be enhanced. Besides, this information was assumed to help to control the post-weaning diarrhoea in piglets that causes significant economic losses in pig production. Eighteen (18) numbers of apparently healthy Large White Yorkshire piglets, irrespective of their sex were utilized in the present study. These piglets were selected from three litters (6 piglets from one litter) and were divided into control (basal diet) and treatment (basal diet + probiotic + zinc) groups, consisting of 3 animals in each group.

The probiotic (dosed daily with 1.25×10^9 CFU/gm) and zinc (ZnO dosed daily with 2000 ppm) was supplemented orally to the treated piglets from birth to 10 days of age. The weaning of the piglets was done at 28 days. The animals were sacrificed at day 20, day 30 and day 60 from both the groups. The histomorphological, ultrastructural, histoenzymatic, immunofluorescence and cytokine gene expression were performed to study the alteration in treatment group of piglets. Besides, examination of brush border enzyme activity was done to evaluate the conversion of disaccharide into monosaccharide in these two groups of piglets.

The villus and crypt morphometry revealed higher villus height, villus width, crypt depth, crypt width, villus enlargement factor and crypt enlargement factor, and lower villus crypt ratio in treatment group of piglets. This might indicate greater absorptive capacity of available nutrients and higher epithelial turn-over rate to

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Major Advisor : Dr. Manmath Talukdar

compensate losses in height of villi in treated piglets especially during early postweaning period.

In the mucosa of villus and crypt, the number of goblet cells, argentaffin cells and tuft cells were increased in treatment group of piglets. These findings might be concluded with better enhancement of epithelial barrier, higher production of gastrointestinal hormones, better microenvironment of gut and defense mechanism which resulted in effective immunity and digestibility in this group of piglets. In the lining epithelium of small intestine, the number of intraepithelial lymphocytes (IEL) was higher in treatment group piglets that could be the result of a nonspecific stimulation of the local immune system possibly by certain antigens of probiotic bacteria. The increased number of IEL might be an indicative of more mature and efficient adaptive immune response in piglets fed with probiotic and zinc than the control animal.

In the histotopographic areas, the CD4+ cells, CD8+ cells, IgA+ cells and IgM+ cells were increased in treatment group of piglets. These findings might be interpreted with more production and secretion of secretory IgA, enhancing defense against pathogens, maintenance and enhancement of epithelial cell integrity and production of more immunoglobulin to ensure a fast reaction against potential pathogens. These might led to better mucosal immunity in the probiotic and zinc treated piglets. In the treatment group of piglets, the brush border enzyme activity was higher to convert their respective substrates into glucose that might be indicative of more absorption of glucose from the available carbohydrate present in the intestine, and resulted with better growth and development in this group of piglets. The increased activity of acid and alkaline phosphatase in treated piglets might be correlated with higher secretion of glands and greater absorptive capacity of enterocytes. Similarly, higher ATPase and non-specific esterase activities might be indicative of more concentration of B and T cells in follicular and interfollicular areas of PP in treatment group of piglets, respectively.

The cultivable cell counts of lactic acid bacteria were higher in treatment group of piglets. These more number of beneficial microbiota might reduce the pathogenic bacterial load in the small intestine and provide a healthy environment for better digestion and immunity in treatment group of piglets especially in early post-weaning period.

The marginal up-regulation of cytokine expression of TNF- α , IL-1 β and IL-6 transcripts in treatment group of piglets might have resulted in the stimulation of innate immune cells to eradicate microbes and enhancement of IgA B-cell population in the young ones and increased epithelial cell turn-over. The down-regulation of cytokine expression of IL-8, IL-12 and IL-18 transcripts in treatment group of piglets possibly lead to decreased activity of NK cells and CD8+ cytotoxic T lymphocytes which was an indicative of lesser infections associated with intracellular pathogens and presence of healthy intestinal epithelial cells in the gut.

Postnatal Development of the Harderian Gland of *Pati Duck (Anas platyrhynchos domesticus)* of Assam

Dr. Jiten Rajkhowa

The present study was undertaken to elaborate certain gross anatomical, histomorphological, histochemical, ultrastructural and biochemical aspect of Harderian gland of *Pati ducks (Anas platyrhynchos domesticus)* of Assam during the postnatal development. Total 45 (forty five) numbers of apparently healthy *Pati ducks (Anas platyrhynchos domesticus)* were utilized for present study. The Harderian gland of *Pati duck (Anas platyrhynchos domesticus)* was located within the orbit. The gland was flat, oval and coma shaped with irregular border. The gland had two surfaces i.e. the parietal and the visceral surfaces, two borders and two blunt poles. The parietal surface was found convex and attached to fascia covered by the nasal bones and interorbital septa of the orbit. The visceral surface was concave and it was attached loosely to the eye ball with fascia. The lobes of the Harderian gland became more prominent with the advancement of the age. The gland was light pink while freshly collected. The arterial blood supplied and the venus drainage was by the ophthalmic artery and vein. The slender branch of oculomotor nerve innervated the Harderian gland. The result reflected an ascending trend from 0 week age group to 42 weeks age group in all the gross parameters. There were slight difference between left and right gland in all the gross parameter but statistically not significant (p value > 0.05). A short single duct was observed in the Harderian Gland of *Pati duck (Anas platyrhynchos domesticus)*. The duct opened into the conjunctival sac at the base of the 3rd eyelid. The Harderian gland of *Pati duck (Anas platyrhynchos domesticus)* had a capsule which was consisted of connective tissue, blood vessels, nerves and lymphatics. The thickness of the capsule of the Harderian gland was increased slightly along the advancement of the age i.e. from 0 week to 42 weeks age group. The capsular connective tissue penetrated the parenchyma of the Harderian gland in the form of septa or trabeculae. The collagen, reticular, elastic and nerve fibers were observed along with the capsule and as well as in the septa and trabeculae. The thickness of the capsule and distribution of all the fibers increased along with the advancement of the age i.e. from 0 week to 42 weeks age group. The Harderian gland of the *Pati duck (Anas platyrhynchos domesticus)* was compound tubular gland.

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Major Advisor : Dr. (Mrs.) Kabita Sarma

The columnar epithelial cells lined the tubules. There was no cortex and medulla in the gland and the tubular structures were uniformly distributed within the lobules. A central canal was present in the gland which converged to the duct of the gland. The lymphocytes and plasma cells were found in the intertubular connective tissue. The numbers or population of plasma cell and lymphocytes were accelerated by the advancement of age. The myoepithelial cells with spindle shaped nuclei were present near the basement membrane close to the secretory cells. The histology of the duct of the Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) was like typical hollow tubular organs. There were few lymphatic nodules very distinctly present and extended from the lamina propria to the muscle layer. In the present histochemical study of the Harderian gland of *Pati* duck, the reaction of Alkaline phosphatase enzyme was mild. The reaction of the Acid phosphatase was absent. The Adenosine triphosphatase (ATPase) activity was observed moderate in all the age groups of birds. The activity of non specific Esterase was observed strong in all the age groups. The periodic acid-Schiff (PAS - Alcian Blue 2.5 pH) stain revealed positive reaction in all the age groups which indicated the presence of acid sulfated mucosubstances in the cells. In the Scanning Electron Microscopic studies of the Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) the tubular structures were looked like hole having some secretion inside it. In higher magnification the lining epithelium cells were found with some secretion at the tip of the cells. In Transmission Electron Microscopic study it was found that the secretory mucous vesicles pushed the nucleus of the cell towards the basal border. The nucleus was oval in shape and rough endoplasmic reticulum, mitochondria, golgi apparatus were observed around the nucleus. The quantity of total protein of the Harderian gland reflected a descending trend in advancement of the age of the birds. The quantity of the total lipids in the Harderian gland of *Pati* duck increased from 0 week age to 42 weeks age. The total lipid and total protein content of the Harderian gland of *Pati* duck were inversely proportional to each other.

Ecoprospecting Local Cattle to Navigate Cultural Values in Lower Assam

Dr. Liakot Hussain

Agriculture is the mainstay of the rural people for earning their livelihood and animal husbandry is a subsidiary occupation. Rain fed agro-ecosystem has a distinct place in Indian agriculture, occupying more than 50% of the cultivated area, contributing 44% of the food grains and supporting 40% of the human and 65% of the livestock population. Animal husbandry acts as the buffer in crop failure by providing the subsidiary income to the farming communities by sale of milk, meat, egg, hide, manure and sometimes living animals. The country among the largest population of cattle and buffaloes in the world and all the breeds are admired for their heat tolerance and inherent resistance to so many diseases including ability to thrive under different climatic condition.

The contribution of livestock sector to the national economy in terms of GDP is 4.11 per cent and 25.60 per cent of total contribution of the agricultural sectors to GDP (19th Livestock Census, 2012). India with about 190 million cattle (as per 19th Livestock Census, 2012) has 14.50 per cent of the world cattle population of this 151 million are indigenous. Indigenous cattle are robust and resilient and are particularly suited to the climate and environment of their respective breeding tracts.

Indigenous cattle can be improved with organized breeding programs, cultivated pastures, and silos for storage. Because stronger oxen would pull the plough faster, they could work multiple plots of land, allowing farmers to share their animals. Fewer healthy, well fed cows could provide Indians with more milk. Ecosystem, animal husbandry and sustainability have an inclusive relationship with far reaching impact on world civilization and cultural evolution.

The draught bullocks are a main source of farm power for small farmer to certain extent for medium farmers and for certain operation with large farmer. Livestock sector not only provides essential proteins and nutritious human diet through milk, egg, meat etc. but livestock also provides raw materials and byproducts such as hides and

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Department : Veterinary Extension Education

Major Advisor : Dr. A. Borgohain

skins, blood, bone, fat etc. which have huge economic importance. Women in the North East have a different status. Rural women form the most important productive work force in the economy of majority of the developing nations including India. Agriculture, the single largest production endeavor in India, contributing around 17.00 per cent of GDP, is increasingly becoming a female activity. The demand for meat and meat products is more in Assam and other North- Eastern States because of the higher tenancy towards non-vegetarian foods of the inhabitants of this region. Marketing comprises of the economic activities involving the movement of the produce from the point of production to the point of consumption. Apparently, it is known that local cattle are raised for purposes like drafting, ploughing, cart pulling, fertilizer, social-economic security and milk production for household consumption. But there might be some other unseen and unknown reasons as well. Therefore, to have an empirical study on utility pattern of indigenous cattle rearing by the farmers of lower Assam, the study on "Ecoprosecting Local Cattle to Navigate Cultural Values in Lower Assam" was undertaken.

Keeping the topic of the study and its objectives in view, the present study was carried out in the ten lower Assam districts of the state namely, South Salmara-Mankachar, Dhubri, Goalpara, Bongaigaon, Baksa, Chirang, Barpeta, Nalbari, Darrang and Udalguri. From each of the selected district, two blocks were randomly selected and from where Twenty Five (25) local cattle rearing farmers representing each block were chosen as respondents. Thus, a total of 500 local cattle rearing farmers (fifty from each selected district) formed the sample size for the present investigation. By and large a random sampling technique was followed for the study. A pre-tested, reliable and valid interview schedule was used for data collection by the researcher personally and the responses were collected on the interview schedule comprising of independent and dependent variables. Based on the data collected and the results obtained the conclusions were drawn and findings were expressed.

Salient findings of the study

(1) Majority of the respondents 71.6% belongs to middle age group. (2) Majority 94% of the respondents were male. (3) Among the farmers majority 66% had medium level of education. (4) Majority 21.4% of the respondents were matriculate. (5) Majority of the respondents 61.4% had medium families ranging from 1-20. (6) A large number of respondents 79.20.26 per cent belonged to nuclear family type. (7) Majority 26% of the respondents had business as primary source of livelihood. (8) A high majority of the respondents 92.00 per cent had medium type of own housing, (9) Majority 84.40% of the respondents had medium sq. ft. of house per person in the family. (10) Majority of the respondent had maintained medium herd size of local cattle, ranging from 2-14. (11) Majority 58.8% of the respondents had medium level of annual income per local cattle ranging from Rs.1000/- to Rs.9000/-. (12) Majority 72.20 per cent of the respondents had medium level of land holding ranging from 2-6 (Bigha). (12) In the entire study area 85.4% of respondents had noticed medium level of new

development works. (13) Majority 84.8% of the respondents fall in the medium group of annual family income from all sources ranging from Rs. 40000/- to Rs.384000/-. (14) Majority of the respondent had medium annual income from animal husbandry ranging from Rs.8000/-to Rs.96000/-. (15) Majority of the respondent had low level of annual income from local cattle ranging from Rs.8000/- to Rs.34000/-. (16) Majority 59.4% of the farmers had kutcha type of cattle housing. (17) Majority 83.20 per cent of the respondents reared local cattle in semi intensive system. (18) Majority 90.8% of the respondents had medium Rs. 20000/- to Rs. 364000/- level own annual income. (19) Majority 63% of the respondents had medium level of engagement in social activities. (20) Majority 87.6% of the respondents had medium level time devoted in social activities ranging from 1-10 days in a month and majority 64.4% of the respondents had medium level of annual expenditure on social activities ranging from Rs.100/- to Rs.1000/-. (21) Majority 64.4% of the respondents had medium level of association with social organization or office bearer. (22) Majority 85.8% of the respondents were found to have medium extension contact. (23) Majority 69.4% of the respondents had medium level of exposure to various information sources. (24) Majority 79.2% had medium level of perceived credibility of different media/ agency/network. (25) Majority 63.2% of the respondents were categorized in medium risk orientation group towards local cattle husbandry. (26) Majority 65.6% of the respondent had medium level of attitude towards local cattle rearing. (27) Majority 65.2% of the respondents perform medium level of activities relating to local cattle farm practices. (28) Majority 71.2% of the respondents had devoted medium time to local cattle rearing practices in comparison to other livestock and crossbred cattle ranging from 3-8 hrs. per day. (29) Majority 74.6% of the women farmer fall under medium category, (30) Majority 43.6% of the respondents had medium level of economy on breeding practices. (31) Majority 19% respondents practiced selective natural service followed by, (32) Majority 87.4% of the respondents had medium level of economy towards feeding. (33) Majority 93.8% of the respondents had medium level of economy towards management/ health care practices. (34) Majority respondents placed their opinion to regularly degree in first aid treatment during emergency 96.2% special care for increase milk production and 92.4% self-management of sick animals (35) Majority as high as 96.6% respondent showed their opinion on the statement selling their local cattle in the nearby market in regularly degrees. (36) Majority of the respondent 69.2% had medium level of interaction with Sustainability Dimensions. (37) Majority of the respondent 99.6% fall under medium group relating to utility, occasional important and cultural values of local cattle. The co-efficient of multiple regression determinations (R²) with 23 independent ariables could explain 38.00 per cent variation to the activities relating to local cattle farm practices. The co-efficient of multiple regression determinations (R²) with 23 independent variables could explain 39.00 per cent variation to time devoted to local cattle farming practices. The co-efficient of multiple regression determinations (R²) with 23 independent variables could explain 32.00 per cent variation to role of women in local cattle rearing. The co-efficient of multiple regression determination (R²) with 23 independent variables could

explain 38.00 per cent variation towards economy of breeding practices. The co-efficient of multiple regression determinations (R²) with 23 independent variables could explain 24.00 per cent variation in economy of management and health care. The co-efficient of multiple regression determinations (R²) with 23 independent variables could explain 31.00 per cent variation in marketing. The co-efficient of multiple regression determination (R²) with 23 independent variables could explain 38.00 per cent variation in sustainability dimensions. The co-efficient of multiple regression determinations (R²) with 23 independent variables could explain 53.00 per cent variation in utility, occasional important and cultural values of local cattle. Illiteracy among many of the farmers was not a healthy sign for the scientific management of local cattle farming. So, higher education of the farmer was expected for the adoption of new practices in the livestock rearing to boost national economy. A proper organized marketing system supported by the state owned agencies might work tremendously in this regard. A study on the patterns of local cattle trading in the other International border areas may be undertaken with the economic parameters' dependency on such matters.

Non-Cerebral Coenurosis with Special Reference to Epidemiology and Molecular Characterization of *Coenurus gaigeri* in Goats

Dr. Deepa Lahkar

An epidemiological investigation was carried out to study the occurrence of noncerebral coenurosis in few goat rearing areas of undivided Kamrup district of Assam during the period from August, 2016 to July, 2018.

In the present study, a total of 981 number of goats examined and out of which 53 animals were positive (5.40%), while the occurrence of cerebral coenurosis was recorded only 1.33 per cent. The area wise survey under undivided Kamrup district, revealed highest (7.23%) occurrence of non-cerebral coenurosis in Hajo area while goats from Khanapara area recorded maximum (2.61%) cases of cerebral coenurosis. Non-cerebral coenurosis was significantly ($p<0.01$) highest (10.27%) among goats of 2-3 years of age as compared to other age groups while none of the cases could be recorded in goats below 6 months of age. Similarly, the occurrence of cerebral coenurosis was also recorded highest in the age group of 2-3 years (2.66%). Sex wise, the occurrence of non-cerebral coenurosis was significantly ($p<0.01$) higher (8.10%) in female goats as compared to males (1.69%) in the present study. Similarly, a higher percentage of females were also affected with cerebral coenurosis than the male goats. A significantly (<0.01) higher occurrence of non-cerebral coenurosis was recorded in female goats in the age group of 2 to 3 years (14.10%) as compared to males of the same age group. Likewise the occurrence of cerebral coenurosis was also found to be the highest in adult females in the age group of 2 to 3 years than the male goats.

Thigh region was found to be the most common site (26.42%) for predilection of non-cerebral coenurus cysts from where maximum number of cysts were recovered which had significantly ($p<0.05$) higher cyst volume, significantly ($p<0.01$) larger diameter with significantly ($p<0.01$) maximum number of protoscolices per coenurus cyst, as compared to other body locations while brain was the common site of predilection for cerebral coenurus cysts in goats. Both non-cerebral and cerebral

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Department : Veterinary Epidemiology and Preventive Medicine

Major Advisor : Dr. Bipin Chandra Das

coenurus cysts found in the present study was characterized by a thin transparent wall filled with a translucent fluid of varying volume with presence of numerous invaginated protoscolices, were arranged in clusters and found to attach to the germinal membrane of the cyst wall. However, non-cerebral cyst was additionally enclosed by an outer fibrous connective tissue capsule. Based on the keys and guidelines of Soulsby (1982), the coenurus cysts recovered from the subcutaneous and muscle tissues of goats and from brain in the present study, were tentatively identified as *Coenurus gaigeri* and *Coenurus cerebralis*, respectively.

The mean (\pm SE) prepatent period of adult taeniids following experimental infection of dogs with non-cerebral and cerebral coenurus cysts from goats, was found to be 60.20 ± 1.06 days (ranging between 57 to 63 days) and 56.80 ± 1.91 days (52 to 61 days), respectively. Dogs infected with non-cerebral coenurus cyst resulted in development of adult taeniids in the jejunum of small intestine from where, 32 numbers of parasites were recovered with intact scolex with evidence of hyperaemia on the mucosa. Similarly, dogs infected with cerebral cysts, also showed evidence of adult taeniids in the small intestine particularly in the jejunum and ileum. The adult taeniids of dogs derived from both noncerebral and cerebral origin, were whitish in colour, and measured 70 to 85 cm and 45 to 62 cm in length, respectively. The number of segments per worm from non-cerebral and cerebral origin was ranging from 61 to 102 numbers and 45 to 73 numbers respectively. The scolex of taeniid parasites derived from non-cerebral and cerebral origin was found to be globular in shape with four cup shaped suckers along with a prominent rostellum with double rows of rostellar hooks. The length of the large hooks in taeniids derived from cerebral origin was significantly ($p < 0.05$) higher as compared to the large hooks of taeniids derived from non-cerebral origin. Similarly, the length of the blade of large rostellar hooks of taeniids from cerebral origin was also significantly ($p < 0.05$) higher as compared to the blade length of taeniids from non-cerebral origin.

The PCR reaction targeting amplification *COI* and *NAD1* gene of *Taenia multiceps* yielded the expected 444 bp and 530 bp products in the present study. The pair wise alignment of both the mitochondrial *COI* gene (*CC_COI*, *NC_COI*) sequences of cerebral and non-cerebral cysts showed a similarity of 98-99% and 99-100%, respectively. The phylogenetic analysis based on *COI* gene sequences revealed that the present isolates (*CC_COI* and *NC_COI*) were closely related to an isolate of *Taenia multiceps* reported from China (Accession No. KX 547641.1) and showed 99.76% and 100% similarity, respectively which they formed a single clad and thereby confirmed that both the isolates belonged to *Taenia multiceps*. The *NAD1* gene (*CC_NAD1*, *NC_NAD1*) sequences of both type of cysts also showed similarity of 97-99% and 98-99%, respectively to the identical sequences of *Taenia multiceps* in the GeneBank database and confirmed the identity of the query sequence to be *Taenia multiceps*. The phylogenetic analysis of *NAD1* sequences revealed that the present isolate *CC_NAD1* was closely related with a Greece isolate (Acc. No. KR 604804.1), an

Iranian isolate and two isolates from Turkey showing 99.22, 98.92, 98.60 and 98.00% similarity, with which it formed a single clad and thereby confirmed the present isolate to be of *Taenia multiceps*. The other isolate, NC_NAD1, although showed 99.59% similarity with an isolate of *T. multiceps* from Greece (KR 604804.1) but it formed a separate clad within the same cluster in the phylogenetic tree. Based on the phylogenetic analysis of *COI* and *NAD1* gene sequences, it can be concluded that *Taenia multiceps* is the single valid species and the origin of both non-cerebral (*Coenurus gaigeri*) and cerebral (*Coenurus cerebralis*) coenurus cysts in goats in the present study.

The molecular data based on *COI* and *NAD1* sequences of both non-cerebral and cerebral coenurus cysts in goats was reported for the first time from Assam, India.

Characterizat Ion of Outer Membrane Vesicles (OMVS) of *Pasteurella multocida* of Avian Origin

Dr. Anamika Gogoi

The Fowl Cholera, an infectious disease of poultry, waterfowl and many other birds is caused by *Pasteurella multocida*. To overcome those hurdles in poultry industry, focus has been given to identify immunogenic subcomponent of the causative agent and their use in development of modern vaccines. The present study was undertaken with a view to evaluate immunogenic potential of Outer Membrane Vesicles (OMVs) of *Pasteurella multocida* as well as their release under the influence of various environmental and physico-chemical factors.

The extraction of OMV fraction was made from a highly pathogenic strain of *P. multocida* capsular type A associated with Fowl Cholera. The release of OMVs by the selected isolates was found to be significantly ($p < 0.001$) highest under the influence of iron deficient condition (2, 2 bipyridyl), exhibiting a protein concentration of 18.3 mg/ml. Similarly, the influence of pH in iron restricted environment was also have an impact on OMV release, which was found to be significant ($p < 0.05$) in reverse direction. A positive correlation could also be made in respect to the oxidative and antibiotic stress with release of OMVs. The comparative protein profiling of OMVs, OMPs and whole cell lysate of the selected pathogenic *P. multocida* type A isolate could exhibit more distinct and prominent protein bands in OMV fraction. The OMV fraction could also reveal the ompA (37.7-38.1 kDa), which was not prominently observed in other two fractions.

The immunogenic potential of the extracted OMV fraction revealed an increasing trend of the mean antibody titre in both the immunized groups, with (Group I) or without (Group II) booster. The immunized birds of group I exhibited a significantly rising trend ($p < 0.05$) of the mean serum antibody titre from the day of the vaccination, until it reached its peak (5947.41 ± 62.6). The peak titre was observed on 28th day of post primary immunization, following booster on 21st day post immunization. Similarly, the immunized birds of group II the mean serum antibody titre

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Major Advisor : Dr. R. K. Sharma

of 7th dpi was continued to increase significantly at every weeks of observation till it reached peak on 21st (4576.27 ± 42.9). The declining trend of the mean serum antibody titre was observed in the birds of group II from the day 28th of post immunization (4219.12 ± 64.5) and continued till end of the study, *i.e.* the 60th dpi (3813.83 ± 148.5). No significant difference could be observed between the two preparations, with and without booster in respect to the mean serum antibody titre till 21st dpi. Challenge trial could establish 100 per cent protection of vaccinated birds against homologous challenge, while development of clinical signs in the immunized birds was observed, following heterologous challenge. There was no significant difference between OMVs administered group and control group was observed in terms of blood SOD and GPx activity.

Development of a Suitable Vaccine Formulation Against Type a *Clostridium perfringens* Associated Necrotic Enteritis in Broiler Chicken

Dr. Hiramoni Sarmah

Necrotic enteritis (NE) is one of the most clinically dramatic and important bacterial disease of poultry industry. It has a great negative impact on broiler industry due to production losses, increased mortality, increased feed conversion ratio. The cost of NE worldwide was estimated to 2 billion dollars per year with 1% daily mortality. Most common age of outbreaks of NE in broiler flocks raised on litter are between the second and fifth week of age. NE in broiler chicken is commonly associated with *Clostridium perfringens* toxin type A, while involvement of type C is very rare.

The study was undertaken to develop a suitable vaccine preparation against *C. perfringens* type A associated NE for broiler chicken. During the study clinical samples, viz., intestinal content, intestinal scrapings from broilers died of suspected form of NE and faecal swabs from live affected birds with clinical symptoms suggestive of NE were screened for *C. perfringens*. A total of 26 repository isolates of *C. perfringens* maintained in Department of Microbiology, College of Veterinary Science, Khanapara were also considered for the present study. All the isolated *C. perfringens* recovered from NE affected broiler birds along with the repository were characterized with respect to the toxin types, detection of gene(s) associated with virulence and secretory protein, pathogenicity for mice, release of toxins and secretory proteins in cell free supernatant and resistance patterns towards antimicrobial agents. The detailed characterization was carried out with an idea to identify a suitable vaccine candidate for the development of vaccine preparations against NE in broiler chicken.

Clinical samples, comprising of intestinal scrapings (42), intestinal contents (30) were collected from 72 dead broiler chickens with suspected form of necrotic enteritis. Another 23 faecal samples were collected from an equal no. of clinically affected live broiler birds by swabbing. A total of 41 isolates were identified as toxin type A, only 10 isolates exhibited additional virulent genes viz *netB*, *tpcL* and *gapC* genes either

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Department : Veterinary Microbiology

Major Advisor : Dr. Rajeev Kumar Sharma

alone or in combination. All the eluted amplified PCR products of target genes with respective band sizes were confirmed by DNA sequencing. All total of 10 isolates of *C. perfringens* type A positive for *netB* alone (5), and *netB* with *tpeL* and *gapC* (5), were subjected to mouse pathogenicity trial. The mouse pathogenicity trial revealed variable pathogenicity, producing clinical symptoms in 21 inoculated mice within 72 hrs of observation, while 17 of the clinically affected mice were succumbed to death. The highest mortality was observed in group of mice inoculated with S8. On SDS-PAGE analysis cell free supernatant of S8 could exhibit highest 16 different visible bands with MW, ranging from 12 to 250 kDa. The four additional virulence associated proteins, NetB (33 kDa), GPD (40 kDa), α - toxin (43 kDa) and *tpeL*(180 kDa) were also distinctly visible. On immunoblotting clear immune dominant antigenic proteins identified as *netB* (33 kDa), GPD (40 kDa), alpha (43 kDa) and *tpeL* (180 kDa). were observed in cell free supernatant of S8 and other few strain. On antimicrobial resistance profiling highest resistance pattern was observed against ciprofloxacin (80.0%), followed by norfloxacin and tetracycline (60.0% each), gentamicin (30.0%) and levofloxacin (20.0%). Gatifloxacin, cefmetazole, clindamycin, metronidazole, and tigecycline were found to be effective against all the isolates. After selection of a suitable strain of *C. perfringens* type A, six different vaccine formulations, *i.e.*, non-adjuvanted crude toxoid (I), non-adjuvanted crude toxoid with bacterin (II), non-adjuvanted crude toxoid with sonicated supernatant (SS) and bacterin (III), adjuvanted crude toxoid (IV), adjuvanted crude toxoid with bacterin (V) and adjuvanted crude toxoid with SS and bacterin (VI) were prepared. Comparative evaluation of the six vaccine formulations was carried out in respective groups of broiler birds, with respect to their serum antibody titer. Among the vaccine formulations, combination of crude toxoid, bacterin and SS was found to be superior in respect to the mean serum antibody titer in vaccinated bird (group VI), throughout the study period throughout study period. The passive mouse protection study could reveal that the pooled immunized serum samples of 21st, and 28th day could protect the mice with the challenge with homologous strain of *C. perfringens*.

Pathology and Molecular Diagnosis of Necrotic Enteritis in Chicken

Dr. Debasish Behera

The present research work was carried out with an aim to study the pathology necrotic enteritis with isolation and molecular detection of *C. perfringens* and experimental production of the NE in chicken to compare between the *C. perfringens* type A and C in terms of hematological, biochemical and pathomorphological alterations. Total 320 numbers of samples based on different clinical signs/pathological conditions were collected from 15 districts of Assam. Isolation and identification of *C. perfringens* was done by cultural and morphological characteristics and confirmation was done by detection of *cpa* gene of *C. perfringens* by PCR. In this study 20 (15.03%) intestinal content and 9 (4.81%) cloaca swabs were found to be positive for *cpa* gene of *C. perfringens*. Isolation of bacteria from the samples collected during monsoon was found to be highest in comparison to other seasons. Study showed around 80% of the total isolates of *C. perfringens* was from the birds of 4-6 weeks of age. The *C. perfringens* isolated from the enteritis samples were found to be highest. Total 29 samples were found to be positive for *cpa* gene (324 bp) encoding for alpha gene and *cpb* gene (180 bp) encoding for beta gene was detected in 11 isolates. The additional virulence toxin genes of *C. perfringens* like *TpeL* and *NetB* were also detected. The gross lesions of NE in field condition revealed haemorrhagic, eroded, detached dead mucosal tissues in intestine. Formations of diphtheritic membrane, distention of intestine were also observed in intestine. Liver, kidneys and lungs showed congestion, haemorrhage and focal areas of necrosis. Spleen and Bursa of Fabricious in some birds was found to be moderately enlarged. The gross lesion of brain was found to be limited to mild congestion of meningeal blood vessels. Histopathology of NE in chickens revealed congestion of blood vessels in the lamina propria and submucosa with vacuolation of epithelial cells of intestinal villi along with necrosis making the villi broader and shorter. Different developmental stages of coccidia were also seen in the mucosal epithelial cells. In other organs such as liver, kidneys, heart, lungs, spleen, bursa of Fabricius and brain showed variable nature of histopathological lesions like

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Department : Veterinary Pathology

Major Advisor : Dr. Debesh Chandra Pathak

congestion, haemorrhage and focal areas of coagulative necrosis. Experimental production of NE was done in chicken by infecting *C. perfringens* isolate Type A and type C with and without coccidia in separate groups. The clinical signs shown by the experimentally infected birds were diarrhoea, dehydration, depression, reluctance to move, loss of appetite, ruffled feathers, drooping of wings and head and huddling. The clinical pathology of experimental birds showed, significant decrease in TEC level, hemoglobin (g/dl) level as well as in PCV (%) and significant increase in TLC in the birds of infected group in comparison to the control. Serum ALT and AST both showed a significant increase ($P < 0.01$) and total protein showed a significantly decreased ($P < 0.05$) level. The gross lesion revealed congestion and haemorrhage and focal areas necrosis of mucosa of intestine. Enlargement, congestion, haemorrhage with focal areas of necrosis of the liver were common gross findings in all the experimentally infected groups. This might be due to damage to RBC in entero-hepatic circulation by α toxin of *Clostridium perfringens*. Kidneys, heart, lungs, spleen and Bursa of Fabricius revealed moderate degree of congestion and haemorrhage. Variable degrees of vascular changes in terms of gross lesions were observed in all most all the infected groups. The histopathological lesions revealed developmental stages of coccidia (schizonts & merozoites) and infiltration of large no of mononuclear cells and few polymorhonuclear cells in intestine. The intestinal villi have undergone necrosis and necrosed cells were sloughed off from the mucosa. Liver revealed marked fatty change in hepatocytes, congestion in the sinusoids. Kidneys showed focal areas of inter tubular congestion. Heart and lungs revealed focal areas of mononuclear cell infiltration as well as congestion and haemorrhage. Spleen and Bursa of Fabricius showed depletion of follicles and brain showed neuronal degeneration and necrosis with neuronophagia. Based upon the clinical signs, gross and histopathology, the present study revealed the groups infected by both coccidia and clostridial isolate showed distinctly more pronounced qualitatively and quantitatively in terms of clinical signs and pathological lesions. It has been also observed in this study that *C. perfringens* type A was found to be more virulent in terms of pathogenesis and pathomorphology in comparison to *C. perfringens* type C. TEM evaluation of experimentally infected birds showed disruption of intercellular junctional complexes, formation of gaps between enterocytes and delimitation of boundaries of individual enterocytes. Disintegration of nuclear material, dilatation of endoplasmic reticulum, disruption of cristae of mitochondria, increase intracytoplasmic vacuolizations and membrane bound vesicles were also prominent ultrastructural alterations in this study. Data were subjected to statistical analysis and analyzed by SAS System ('Local', X64_7PRO) using one way analysis of variance (ANOVA). Means were presented as mean \pm standard error (SE) and were compared by the Duncan test at the 0.05 level of probability.

Evaluation of Anthelmintic Efficacy of Certain Indigenous Plants against Experimentally-Induced *Ascaridia galli* Infection on Local Birds (*Gallus domesticus*)

Dr. Archana Hazarika

The present study was an attempt to evaluate the anthelmintic efficacy of certain indigenous plants against experimentally induced *Ascaridia galli* infection in local birds (*Gallus domesticus*). A total of five (5) indigenous plants viz., *Nyctanthes arbor-tristis* (Sewali), *Butea monosperma* (Palash), *Melia azedarach* (Ghora neem), *Erythrina stricta* (Madar), and *Ficus hispida* (Dimoru) based on indigenous technical knowledge (ITK) and ethnomedical uses. Three types of extracts, viz. ethanolic, hydroethanolic and aqueous extracts of each of the five plants were prepared for *in vitro* and *in vivo* studies. *A. galli* was used as the test parasite for *in vitro* studies. Three different concentrations, 10, 25 and 50 mg/ml was used for *in vitro* studies. Rats were used for acute toxicity studies while local indigenous birds of either sex were used for induced infection with *A. galli* and *in vivo* studies. A total of twelve groups (each plant having three types of extracts and three different doses, 100, 500 and 1000 mg/kg body weight, two control groups and one standard group) of each of the two plants consisting of six (6) birds in each group were used for *in vivo* studies.

A total number of 1000 ± 50 infective ova were inoculated to each of the experimental bird except birds of negative control group. Piperazine hydrate liquid was used as standard drug @ 200mg/kg body weight. The percentage yield of ethanolic extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* were found to be 14.56, 12.50, 16.84, 13.16 and 5.84 percent (w/w) respectively, for hydroethanolic extract, the percentage yield were found to be 17.0, 8.3, 38.90, 10.56 and 9.62 percent (w/w) respectively and the percentage yield of aqueous extracts were found to be 27.56, 14.48, 27.26, 47.62 and 19.24 percent (w/w) respectively. Phytochemical analysis of ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* revealed the presence of steroids, alkaloids, phenolic compounds, tannins, flavonoids, glycosides and triterpenes. Acute

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Department : Veterinary Pharmacology & Toxicology & Jurisprudence

Major Advisor : Dr. R. K. Roy

toxicity studies with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* did not show any behavioural change or gross abnormality nor any sign of toxicity upto 14 days of observation and mortality was absent within 48 hours @ 2.0 g / kg body weight in rats. The extracts were considered to be safe up to a maximum dose of 2000 mg/kg.

Among the five plants studied for *in vitro* efficacy *N. arbor-tristis* was observed as the best plant having *in vitro* anthelmintic efficacy followed by *B. monosperma*, *M. azedarach*, *E. stricta* and *F. hispida*. Based on the findings of the *in vitro* studies, *Nyctanthes arbor-tristis* and *Butea monosperma* were selected to undergo *in vivo* studies in birds artificially infected with *A. galli* worms. Oral treatment with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* did not show any signs of hyperactivity or behaviour alterations throughout the study period. The biological evaluation was carried out at doses of 100, 500 and 1000 mg/kg. No signs of toxicity were observed. Birds dosed with the extract continued to feed normally. In birds treated with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at 100, 500 and 1000 mg/kg body weight, there were no significant differences on the 7th and 14th day post treatment. However, the difference in mean body weight gain of this group was significant ($P < 0.05$) on 21st and 28th day post treatment. The changes in body weight were not dose dependent. The increase in body weight after treatment with *Nyctanthes arbor-tristis* and *Butea monosperma* were comparable to standard Piperazine treated group.

Almost all biochemical and haematological parameters showed a significant ($P < 0.05$) increase from 14th day post treatment in all the groups, at all the doses and types of extracts of *N. arbor-tristis* used. However, *B. monosperma* leaf extract showed a significant ($P < 0.05$) increase from 21st day post treatment in all the groups, at all the doses and types of extracts used. Piperazine treated group showed significant increase 14th day post treatment as compared to control. Treatment with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* caused a significant reduction in egg output in the droppings of treated birds from 7th day onwards upto 28th day in comparison with infected controls ($P < 0.05$). Piperazine hydrate brought down the mean EPG from 733.33 ± 268.22 at pre-treatment to 106.67 ± 23.33 at 28th day post treatment. The ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at all the doses used showed an efficacy above 80% indicating that the plants are effective against *A. galli*. Piperazine treated group showed an efficacy of 88.99% and 93.15%. The ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at all the doses used showed FECR above 80 indicating that *A. galli* is not resistant to these two plants. Piperazine treated group showed FECR of 89 and 93 indicating that *A. galli* is prone to resistance to Piperazine as the 95% confidence level is 90 for standard drugs. The plant extracts not only depressed the faecal egg output but also significantly reduced the adult worms population in parasitized birds.

The total worm count at necropsy was significantly lower. Piperazine treated group showed no worm recovery.

In conclusion, extracts found to possess significant *in vitro* anthelmintic activity did not increase the biochemical or haematological values significantly. It is concluded that further study is needed, of longer duration, to study the anthelmintic activity against *A. galli* infection in poultry. The plant extracts not only depressed the faecal egg output but also significantly reduced the adult worms population in parasitised birds. This is desirable as it has the advantage of reducing the deleterious effects on individual birds and contamination of the environment with parasite eggs. *in vivo* studies indicated that both the plant extracts and *Piperazine hydrate* response did not differ significantly. The plant leaves crude extract can be used as alternative de-wormer. *Butea monosperma* and *Nyctanthes arbortristis* reduced FEC by 80%. FEC reductions greater than or equal to 70% was considered biologically significant.

Therapeutic Efficacy and Role of Cytokines on Wound Healing in Rats by Selected Medicinal Plants of Mizoram

Dr. C. Lalmuanthanga

The present study was undertaken to evaluate the potential effect of methanol, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in three different models of wound in rats, incision, burn, diabetic excision wound models and also the polyherbal formulation of the plants at three different combination in diabetic wound model in rats. The cytokine, IL- 6, TNF- α and IL-10, blood biochemical profile, histopathological examination of tissue, antimicrobial effect of different extracts of plant under study and the analysis of the antioxidant property of the plants were undertaken to find the correlation with the wound healing property of plant extracts.

The yields of methanol extract of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* were 166.93gm (16.693%), 78.00 (7.80%), 60.00 (6.00%), 117.00 (11.70%) and 50.68 (5.068%) per 1000 gram of dry powder

The preliminary analysis of phytochemical constituent of plant shows that *Parkia timoriana* extract was found to contain tannins, saponins, flavonoids, terpenoids and alkaloids. *Securinega virosa* extract was found to contain tannins, flavonoids, terpenoids and alkaloids. *Abelmoschus moschatus* extract was found to contain tannins, flavonoids, terpenoids; alkaloids and phlobotannins. *Scoparia dulcis* extract was found to contain tannins, saponins, flavonoids, terpenoids and alkaloids and *Blumea lanceolaria* extract was found to contain flavonoids, phlobotannins, terpenoids, alkaloids and tannins. All the plant extracts were found to be safe @ 2000 mg/kg after testing the acute oral toxicity in rats and mice.

Topical administration of methanol, chloroform and ether extract of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in incision wound model in rats @ 10 and 20 % w/w ointment increased the

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Department : Veterinary Pharmacology & Toxicology & Jurisprudence

Major Advisor : Dr. D. C. Roy

breaking strength of wound when compared with control and standard treated groups at $P < 0.001$ significant level. An increasing trend in the total protein, albumin and globulin level of wound tissue was observed with some variation between control and the treated groups. The level of AST, ALT and glucose in the treatment groups were significantly lower than the control group at $P < 0.05$ and $P < 0.001$.

The percent of wound contraction after topical application of 10 and 20% w/w ointments of methanol, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in burn wound model in rats were significantly higher ($P < 0.001$) on day 4, 8, 12 and 16 as compared to control group and standard group; but individual variation for significant different with standard drug treated group occurs amongst the plant extracts. There were remarkable fibroblast collective tissue proliferation, collagenation, mononuclear infiltration, angiogenesis, vascular engorgement and epithelialisation on histopathological examination. In excision diabetic wound model in rats, the methanolic, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* administered @ 250 and 500mg/kg P.O. showed significantly increased ($P < 0.05$; $P < 0.01$ and $P < 0.001$) percent of wound contraction on day 4, 8, 12 and day 16 as compare to the control group and the epithelialisation time were significantly reduced. Regenerating skin appendages tissue proliferation, mononuclear infiltration which confirm the healing action which are quite comparable to the standard (Vitamin E) treated group. Biochemical analysis revealed that the blood glucose, protein, globulin and albumin levels in control groups are significantly higher in most of the cases and AST, ALT and *creatin kinase* are significant reduced at $P < 0.05$; $P < 0.01$ and $P < 0.001$.

The cytokine analysis of blood plasma on day 1 and day 9 of post wound creation and after treatment with plant extracts shows that the level of IL-6 and TNF- α were decreasing on day 9 as compared to the previous sampling. The different extracts of plants at two different dosing @ 10 and 20 % w/w ointment showed the significance difference ($P < 0.05$; $P < 0.01$ and $P < 0.001$) between the groups. Contrary to the level of IL-6 and TNF- α , the level of IL-10 was increased doubled fold or more on day 9 in all the treated groups. The topical application of Poly I MZ, Poly II MZ and Poly III MZ @ 20% w/w ointment each on diabetic incision wound showed significantly increased the breaking strength when compared to control group.

Optimization of Culture Media for *In-Vitro* Bovine Embryo Development: Growth Factors and Serum Influences

Dr. Dipannita Baishya

The present experiment was conducted to study the effect of certain growth factors (EGF, IGF-1 and their combination) and serum influences on possible potentialization of culture media for *in vitro* cattle embryo development. In experiment I, 224 nos. of cattle ovaries were collected. The mean number ovarian follicles recovered per type-I ovary were 5.30 which was significantly higher ($P \leq 0.001$) than the corresponding values 3.27 of the type-II ovaries. The mean recovery of cumulus oocyte complexes per type-I ovary was 3.41 and the corresponding value was 1.67 in type-II ovaries. Two different types of maturation and culture media viz: SBMM (Serum Basic Maturation Media) containing modified TCM-199+ serum (10%, Fetal Bovine Serum)+ Sodium pyruvate + glutamine + gentamicin + pFSH + hMG inj+ E2 (estradiol), SFBMM (Serum Free Basic Maturation Media) containing modified TCM-199 + PVP + BSA + Sodium pyruvate+ L-glutamine+ p FSH+ gentamicin + hMG inj+ E2 (estradiol), SBCM (Serum Basic culture media): mCR2aa stock +10%FBS+ Gentamicin, SFBCM (Serum Free Basic Culture Media) containing mCR2aa stock+ BSA-V+ PVP+ Gentamicin were used for *in vitro* maturation and *in vitro* culture of the oocytes. EGF (30ng) and IGF-1 (100ng) were added in maturation media as well as embryo culture media singly and in combination in both the groups of media. Frozen bull semen straws of proven fertility were used and prepared for *in vitro* capacitation by density gradient method using B.O. media. The results revealed a significant ($P < 0.05$) increase in maturation rate in serum supplemented media than serum free media (75.43 ± 3.25 vs 64.20 ± 3.77) based on cumulus cells expansion. The cleavage percentages of serum supplemented culture media was found to be significantly higher ($P < 0.05$) than serum free culture media (70.33 ± 3.21 vs 55.81 ± 4.33). In experiment -2: A total of 318 nos. of ovaries were collected with a recovery of 65 per cent culturable oocytes, representing 6.5 COCs per ovary. Growth factors EGF (30ng/ml), IGF-1 (100ng/ml) and their combination (EGF + IGF - 1) were used in serum basic and serum free basic maturation

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Department : Veterinary Physiology

Major Advisor : Dr. Arundhati Bora

and culture media for the study. There was no significant difference in respect of maturation, fertilization and embryonic development between EGF supplemented, IGF-1 supplemented and their combination (EGF+IGF-1) in serum and serum free basic culture media. However, when compared with the results of serum free basic maturation media supplemented with 30ng EGF and serum basic maturation media without EGF, the mean *in vitro* maturation percentage based on extrusion of polar body were found to be significantly higher ($P<0.05$) in supplemented media than the serum basic maturation media (70.00 ± 14.49 vs 54.17 ± 7.19). Similarly, when comparison was made with IGF-1 supplemented serum free basic maturation media with serum basic maturation media without IGF-1, the *in vitro* maturation percentage based on cumulus cells was found to be significantly higher ($P<0.05$) than serum basic maturation media (67.27 ± 6.33 vs 75.43 ± 3.25). However, in case of serum free basic maturation media supplemented with 30ng EGF+100ng IGF-1, the mean *in vitro* maturation percentage based on extrusion of polar body was significantly higher ($P<0.05$) than serum basic maturation media (80.00 ± 10.33 vs 54.17 ± 7.19). The efficacy of EGF supplemented serum free basic culture media and serum basic culture media in respect of cleavage and early embryonic development was comparable at cleavage (2-cell) and blastocyst stage, while significantly higher ($P<0.05$) values were observed in 4 cell (57.14 ± 4.83 vs 47.25 ± 4.86), 8 cell (45.71 ± 4.83 vs 31.87 ± 4.99) 16 cell (37.14 ± 4.72 vs 20.88 ± 3.21) and morula stage (27.62 ± 4.36 vs 7.69 ± 4.32) in EGF supplemented serum free culture media than serum basic culture media. Similarly, when the efficacy of IGF-1 supplemented serum free basic culture media were observed, no significant difference was obtained in 2-cell, 4-cell and blastocyst stages. On the contrary, the serum supplemented media showed significantly higher ($P<0.05$) 8-cell (45.71 ± 4.86 vs 31.87 ± 4.99), 16-cell (37.14 ± 4.72 vs 20.88 ± 3.21) and morula stage (27.62 ± 4.36 vs 7.69 ± 4.32) than serum basic culture media. EGF+IGF-1 supplemented serum free basic culture media when compared with serum basic culture media, significantly higher ($P<0.05$) values were found in respect to 2-cell (79.63 ± 2.35 vs 70.33 ± 3.21), 4-cell (65.00 ± 4.83 vs 47.25 ± 3.23), 8 cell (56.00 ± 3.42 vs 31.87 ± 4.99) 16 cell (48.00 ± 4.72 vs 20.88 ± 3.21) morula (37.00 ± 2.13 vs 7.69 ± 4.32) and blastocyst stage (10.23 ± 2.08 vs 4.40 ± 3.11). From the above findings, it can be concluded that addition of EGF and IGF-1 in combination in serum free basic maturation media has better stimulatory effect on nuclear maturation of oocytes in comparison to EGF and IGF-1 supplementation individually. EGF and IGF-1 in combination in Serum Free culture media significantly increased blastocyste rates when compared with serum based culture media.

Physiological, Behavioural and Molecular Changes in Piglets in Response to Weaning Stress

Dr. Gloria Tigga

The present experiment was conducted to study the effect of weaning stress on various physiological, biochemical, hormonal, hematological response including behavioural changes and pattern of gene expression profile of HSP27, HSP70 and HSP 90 in piglets weaned at different age. The present investigation was carried out in Hampshire x Ghungroo cross-bred piglets of instructional farm of NRC on pig, Rani. Three litters of six piglets were taken for the study and were weaned at different age of 28 days (Gr-I), 35 days (Gr-II) and at 42 days (Gr-III).

Blood collection was scheduled from the day of weaning (0d), 7th day, 15day followed by subsequent collections at 15 days interval up to six months of age. Physiological and behavioural studies were done at the piggery farm and molecular studies were done in the laboratory of NRC on pig, Rani whereas biochemical, hormonal and hematological studies were conducted in the laboratory of the department of Biochemistry, Nuclear research laboratory of the department of Physiology and in the laboratory of Teaching Veterinary Clinical Complex of C.V.Sc., Khanapara, Guwahati respectively.

No significant difference was found in average growth rate and body weight at maturity among the groups. There was significant difference in rectal temperature (day 30, 45 and 60) and respiration rate (day 0 and 15) found between Gr-I and Gr-II. The mean heart rate (beats/ minute) was found towards decreasing trend in all the groups.

The level of biochemical indices were found to be varied within normal range on day 15 post-weaning and the variations in the level in later part were found to be associated with hormonal level and age related. Higher level of phosphorus was found in piglets of Gr-III as compared to Gr-I and Gr-II. During the initial phase of experimental period significantly lower level of iron was found in piglets of Gr-I as compared to Gr-II (day 15 and 30) and Gr-III (day 0 and 15). Significantly higher level ($P < 0.001$) of zinc was found in Gr-III as compared to Gr-I and Gr-II from day 75

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Major Advisor : Dr. Arup Dutta

onwards. Significantly lower level of copper was found in Gr-II as compared to Gr-I and Gr-III on day 15 and 30 which may be the cause of subnormal hemoglobin level (%) in this group during this period. The range of cortisol level was comparatively higher throughout the experimental period.

Significant differences ($p < 0.001$) were found in the level of hematological parameters *viz* TEC, Hb% and PCV between younger and older pigs on day 0 to 45. Significantly higher level of neutrophils and cortisol were observed in younger piglets. Initially, there was increase in neutrophil (%) and decrease in lymphocyte (%) indicating a stress response on day 15 post-weaning in all the groups, with significantly higher level in Gr-I. The mean values of DLC *viz.* neutrophil (%) (day 15, 30, 45, 60, 75, 90) and lymphocyte (%) (day 30, 45, 60, 75, 90) were found to be significantly higher and lower respectively in Gr-I as compared to Gr-II.

Significantly higher number of feeding bouts ($P < 0.05$) and higher level of aggression ($P < 0.05$) on d+2 and d+7 was observed in Gr-III compared to Gr-I and Gr- II. The level of mRNA expression of HSPs *viz.* HSP27, HSP70 and HSP90 were found to be increased significantly ($P < 0.001$) on day 7 in piglets of Gr-I. Significantly higher level of mRNA of HSP90 was expressed in Gr-I on day 15 as compared to piglets of Gr-II and Gr-III indicating that adaptive process were slower in younger piglets.

Sero-Prevalence of West Nile Virus in Poultry Correlating with Mosquitoes in Urban and Peri- Urban Areas of Guwahati

Dr. Archana Talukdar

West Nile virus (WNV), an arthropod-borne virus of public health importance is a member of the genus *Flavivirus* belonging to the Japanese encephalitis virus antigenic complex under family Flaviviridae. In Assam, although poultry rearing has traditionally been popular, most of the farmers lack proper scientific knowledge and technique, thereby increasing their risk to contact with different zoonotic diseases. The present investigation was carried out from April, 2018 to March, 2019 to collect baseline data on poultry farms, study the sero-prevalence of WNV in chicken, study the density pattern and determine the infection rate of mosquitoes with WNV and to prepare WNV prevalence map in urban and peri-urban areas of Guwahati. A total 8 locations comprising of 4 locations each for urban areas *viz.*, Chandmari, Hatigaon, Noonmati, Khanapara, and peri-urban areas of Guwahati *viz.*, Jugukuchi, Kamalajari, Garal and Gadebari were selected.

Baseline data revealed that most of the farmers were educated up to higher secondary (41.67%) level and below 46 years (66.67%), rearing both broiler and indigenous chickens in moderately clean or unhygienic farms (83.33%) with 58.33% of the birds being dirty. Presence of in-contact other animals, including cows, pigs, goats, ducks, quails, pigeons and dogs were recorded in 66.67% of farms and majority of the farmers (54.17%) did not consult veterinarian. Vaccination was practiced in 91.67% farms and the farmers used unsafe method of waste and carcass disposal. Screening of a total of 864 serum samples of chickens by ELISA and further confirmation by HI revealed the overall sero-prevalence of WNV to be 3.13%, with 0.69% sero-positivity in urban compared to 5.56% in peri-urban areas. WNV sero-prevalence was recorded in 1 urban and 3 peri-urban locations showing peak sero-prevalence during monsoon (7.29%). Highest sero-prevalence of WNV was recorded in Jugukuchi (11.11%) of peri-urban Guwahati. Sero-prevalence of WNV was significantly very high ($P < 0.001$) in farms having in-contact other animals, stagnant water and agriculture. The association

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Department : Veterinary Public Health

Major Advisor : Dr. Razibuddin Ahmed Hazarika

between flock size and sero-prevalence of WNV was found highly significant ($P < 0.01$). A total of 21,267 mosquitoes trapped during 1 year study period belonged to 5 genera viz. *Culex*, *Mansonia*, *Aedes*, *Anopheles* and *Armigeres* and 12 different species. Density pattern of mosquitoes revealed *Cx. quinquefasciatus*, *Cx. vishnui* group, *Ma. uniformis*, *Cx. bitaeniorhynchus*, *Ar. subalbatus*, *Ma. annulifera* and *Ae. albopictus* to be dominant species with most predominant species being *Cx. quinquefasciatus* (36.51%). Real time one-step RT-PCR of a total of 288 pooled mosquito samples detected NS5 gene of *Flavivirus* in 26 *Culex* and *Mansonia* mosquito pools. Sanger sequencing of representative amplicons of *Flavivirus* appeared to be negative for WNV but positive for Usutu virus, a mosquito-borne flavivirus which is closely related to WNV. The farms with WNV sero-prevalence in urban and peri-urban areas of Guwahati were spotted and mapped based on their latitude and longitude, which will be of immense support in future for strategic planning to control vector-borne diseases in those areas.

Bacteriological Quality and Molecular Detection of Food-Borne Bacterial Pathogens in *Saum*, an Ethnic Food of Mizoram

Dr. Lallawmzuali Ralte

Saum (a fermented pork fat) is one of the most favourite ethnic foods of the Mizo society. Due to lack of documentation and scanty literature as well as the limited scientific knowledge on *Saum*, the present study was carried out for a period of two year from November 2017 to October, 2019 to collect baseline data on the usage of *Saum*, to study the bacteriological quality and to isolate, identify and detect important food-borne bacterial pathogens viz., *Escherichia. coli*, *Staphylococcus aureus*, *Listeria monocytogenes* and *Salmonella* spp. and to study the antimicrobial resistance as well as to detect the virulence gene of the isolates in *Saum* by PCR. The study area was divided into three agro-climatic zones, viz., Humid Mild Tropical Hill Zone (Western zone); Humid Subtropical Hill Zone (Central zone) and Humid Temperate Sub-alpine Zone (Eastern zone). A total of 120 *Saum* samples collected and 120 questionnaires prepared comprising of 40 each (*Saum* samples and questionnaires) for each zones were sub-divided into 20 (household) and 20 (market) within each zones. The baseline data revealed that out of 120 respondents, the male and female ratio were 1:1 and majority were 40-59 years old (57.50%), educated up to matriculation (27.50%) with 45.00% Government servant. The families reared poultry (34.2%), pig (29.2%), cattle (2.5%) and goat (0.8%) and out of them 33.3% families reared livestock for business purposes. The homemade *Saum* was used by 57.5% families. *Saum* (once procured) were used more than 2 months (31.7%), 1 month (25.0%), 2 weeks (21.7%) and 1 week (21.7%) interval of time. Most of the families (74.17%) never mix old and new *Saum*. Mizo families used plastic sachets (38.3%), glass bottle (34.7%), bottle guard (23.3%) and steel container (3.3 %) for *Saum*. The families stored *Saum* at refrigerator (75.83%), near the fire (22.5 %) and under the sun (1.7%). The families took *Saum* directly (52.5%) while 90.83 % families used *Saum* as seasoning for food and 70.8% families took same preparation of *Saum* more than once. Stomach pain was not recorded in

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Department : Veterinary Public Health

Major Advisor : Dr. Poznur Hussain

97.5% and absence of diarrhoea in 100% families due to *Saum*. Positive samples for coliform organisms and faecal streptococcal organisms were 65.00% and 72.5%, respectively. The overall acceptable *Saum* samples ($m = 10^2$ in 2 class plan) were 44.2% and 33.3%, in Coliform Count (CC) and Faecal Streptococcal Count (FSC), respectively. From all the three zones ($n=20$), the highest contaminated household and market were the Eastern zone household with mean value 1.82 ± 0.30 and 2.45 ± 0.18 \log_{10} cfu/g in CC and FSC and the Western zone Market with 2.16 ± 0.19 and 2.80 ± 0.09 \log_{10} cfu/g in CC and FSC, respectively. Overall ($n=40$) in three zones; the Central zone *Saum* samples was the lowest contaminated with 18% and 52.5% positive sample with mean value of 1.07 ± 0.18 and 1.09 ± 0.18 \log_{10} cfu/g in CC and FSC, respectively and the Western zone *Saum* sample was the highest contaminated zones with 35% positive each with mean value of 1.19 ± 0.15 and 2.23 ± 0.16 \log_{10} cfu/g for CC and FSC, respectively. Out of 120 *Saum* samples, 28, 34, 6 and 4 numbers of *E. coli*, *S. aureus*, *L. monocytogenes* and *Salmonella* spp. were isolated and detected with overall prevalence rate of 23.33%, 28.33%, 5 % and 3.33 % and the 95% Confidence Interval rate were 16%-31%, 20 %- 37 %, 0.9%-8.3% and 1.5- 10.6%, respectively. The highest resistance against ceftriaxone was showed by *E. coli* (42.86%) and *S. aureus* (82.35%) and 100% resistance was showed by *Listeria monocytogenes* against amikacin, ceftriaxone, cefoxitin, kanamycin and nalidixic acid, and *Salmonella* spp. recovered showed 100% resistance against imipenem, nalidixic acid and tetracycline. The virulence genes of 5 *est* gene of *E. coli*, 21 *sea* genes of *Staphylococcus aureus*, 2 *invA* genes of *Salmonella* were detected in *Saum* sample.

Clinical, Cardiopulmonary, Haematobiochemical and Immunological Effects of Isoflurane, Propofol and Ketamine in Glycopyrrolate, Dexmedetomidine and Butorphanol Premedicated Dogs

Dr. Hitesh Bayan

The study was conducted to evaluate the clinical, cardiopulmonary, haematobiochemical and immunological effects of isoflurane, propofol and ketamine anaesthesia in glycopyrrolate, dexmedetomidine and butorphanol premedicated dogs. The study was carried out on twenty four number of female dogs presented for elective ovariohysterectomy. The animals were randomly divided into four groups (A, B, C and D) comprising of six animals each. The animals in all the groups were administered with glycopyrrolate 0.01 mg/kg IM followed 15 min by dexmedetomidine 5µg/kg IV and Butorphanol 0.1mg/kg IV. Two min after administration of dexmedetomidine and butorphanol, induction of anaesthesia was done with propofol IV till effect in Groups A and B and with ketamine IV till effect in Groups C and D. The anaesthesia was maintained with isoflurane in Groups A and C. In Groups B and D, the anaesthesia was maintained with continuous rate infusion of propofol 0.2-0.5 mg/kg/min and ketamine 0.002-0.02 mg/kg/min, respectively. The induction doses of propofol were recorded as 0.67±0.07 mg/kg in Group A and 0.68± 0.06 mg/kg in Group B where as the induction doses of ketamine were recorded as 2.55± 0.24 mg/kg in Group C and 2.63±0.26 mg/kg in Group D. Induction was quick and smooth in all the groups enabling easy endotracheal intubation. The analgesia, muscle relaxation and depth of anaesthesia were sufficient for performing major abdominal operations. The mean maintenance dose (mg/kg/min) of propofol and ketamine were recorded as 0.24±0.01 and 0.013.17±0.60 respectively in groups B and D. The mean vaporizer settings (%) for isoflurane were recorded as 1.34 ± 0.06 and 1.28 ± 0.07, respectively in Groups A and C. The recovery

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Department : Veterinary Surgery and Radiology

Major Advisor : Dr. Kushal Konwar Sarma

time was shortest in Group A and longest in Group D. The quality of recovery was better in Groups B, A & C in sequence as compared to Group D. The changes in the clinical parameters remained within the physiological limits in all the groups. Changes in blood pressure and ECG remained within the physiological limit in all the groups. The respiratory parameters were well maintained with isoflurane but the oxygen saturation values were near the critical level in Group D. The changes in haematological (haemoglobin, TEC, TLC, PCV, granulocytes, platelet and DLC) and biochemical (serum glucose, serum total protein, GGT, ALP, BUN, serum creatinine and LDH) parameters were found to be within physiological limits in all the animals. The immunological parameters exhibited immune suppressions but were transient in nature in all the groups. To conclude, all the anaesthetic combinations were safe and effective for major abdominal surgery in dogs. However, the respiratory parameters were more stable with inhalation agents used for maintenance and near the border line in particularly with ketamine CRI. The CRI with propofol was found to be better than with ketamine for maintenance in dogs premedicated with dexmedetomidine and butorphanol.

Development and Quality Assessment of Solar and Oven Dried Spent Hen Meat Powder

Dr. Bijoy Kumar Sarkar

Chicken occupies one of the important constituents of Indian non-vegetarian diet due to cost competitiveness, nutritional quality, universal availability and absence of religious taboos. Spent hen meat represents hardness, poor acceptability and lowers remunerative prices in spite of its good nutritional quality, because of its higher collagen content and toughness of meat compared to those of broilers and roasters. To overcome the problems of toughness of spent hen meat, perishability of fresh meat, high cost involvement in maintaining refrigeration, lack of cold storage facility, energy deficiency in NER, disadvantages of traditional drying etc. a study was undertaken to develop spent hen meat powder with better shelf life at ambient temperature without affecting its quality.

Keeping in view the above facts, the proposed study was undertaken with the following objectives viz. development of technology for preparation of spent hen meat powder by using oven and solar dryer and by incorporating phytochemicals; determination of physico-chemical, microbiological and sensory qualities of spent hen meat powder; selection of an effective and suitable packaging method; and determination of shelf life and cost of production.

A total of five batches of spent hen meat powder were prepared with different formulations with or without addition of the phytoingredients in solar dryer (60-70°C for 30- 32h) and oven dryer (70°C for 18-20h). Control of solar dried spent hen meat powder was packaged with LDPE (150µm) under aerobic (A) and vacuum packaging (B); similarly treatment was packaged under aerobic (C) and vacuum packaging (D) for assessment of quality and identifies shelf stability. At the same time control of oven dried spent hen meat powder was packaged under aerobic (E) and vacuum packaging (F) and treatment was packaged under aerobic (G) and vacuum packaging (H). The results of the investigation are as follows-

Yield decreased in treatments, whereas hygroscopicity, water hydration capacity, bulk density and solubility do not vary. Water activity, pH and TBARS value

Abstract of Ph.D. Thesis

Department : Livestock Products Technology

Major Advisor : Dr. Mineswar Hazarika

increased during storage. Treated sample show lower pH and TBARS value than control. TBARS values of meat powder under vacuum packaging were lower than aerobic packaging during storage. Tyrosine values were higher in oven dried sample compared to solar dried sample. Lightness and yellowness values shows an increasing trend, whereas redness shows decreasing trend during storage period.

Increasing trends in moisture content were observed during the storage periods. Crude protein, crude fat, total ash and carbohydrate content of spent hen meat powder did not differ much between samples and during storage. Decreasing trends of calorific value of samples were observed during storage period kept under aerobic packaging. All the samples were microbiologically safe throughout the storage period. All the samples were acceptable up to 150 days with good sensory scores. Spent hen meat powder can store up to five months at room temperature under both aerobic and vacuum packaging. Main antioxidant compounds present in phytoingredients extract were identified by LC-MS and large numbers of antioxidant compounds were found to be present in the phytoingredients. Solar drying is economical over oven drying for preparation of spent hen meat powder with similar product quality. Vacuum packaging is better to preserve product quality. Addition of phytoingredients increases the cost of production but provides better product quality and shelf stability.

Based on the above study it can be concluded that chemically, microbiologically and organoleptically acceptable spent hen meat powder can be prepared with the use of low cost solar dryer.

Technology Upscaling of Certain Traditional Pork Products of Nagaland

Dr. H. Moaakum Sangtam

Traditional pork products of Nagaland prepared with locally available plant based ingredients *viz.* *Anishi*, *Silam* and FDS (Fermented dried soya) were evaluated in the present study. Based on the popularity, a purposive survey was conducted in field level to evaluate the level of ingredients used and with an aim to refine and upscale the processing steps and to extend the shelf life of the products. Three formulations were prepared using pork with *Anishi*, *Silam* and FDS along with a control, prepared without adding the above ingredients. On the basis of pilot study, the level of incorporation for *Anishi*, *Silam* and FDS were selected as 5, 10 and 5 percent, respectively. The cooked products were packaged under two different systems *viz.* retort pouch and vacuum packaging. The retort pouched products were subjected to physicochemical, microbiological and sensory evaluation at ambient temperature (25-32oC) for 6 months whereas, the vacuum packaged products were evaluated at refrigeration temperature (4±1oC) for 15 days. The economics of products were also calculated. Under retort processing, the total heating time (min) was recorded to be highest in pork with FDS compared to control, pork with *Anishi* and *Silam*. The proximate composition i.e. percent moisture, crude protein, ether extract and total ash in retort pouch and vacuum packaging revealed highly significant ($p<0.01$) differences in control and the treated products. The pork with FDS revealed highest protein content in both retort and vacuum packaging.

However, no significant differences were observed for different storage periods. For mean scores of pH, TBARS and tyrosine values highly significant ($p<0.01$) differences were observed among control and different product formulations and also during different storage periods. The TPC, coliform and yeast and mould were absent under retort pouch packaging during the entire storage period, conversely under vacuum packaging highly significant differences ($p<0.01$) were recorded in respect of TPC and psychrophilic count among control and all the treated products and at different storage periods. Coliform count was <3 and yeast and mould were absent in vacuum packaged

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products. The amino acid content in control and treated products were decreased with the increase in storage period. Highly significant ($p < 0.01$) differences were observed in texture profile among control and the treated products as well as during different storage periods under retort pouch packaging. In respect of vacuum packaging significant ($p < 0.05$) differences were observed during different storage periods among control and the treated products. Highly significant ($p < 0.01$) differences were observed in colour profile under retort pouch and vacuum packaging in control and among the treated products and during storage period. The sensory evaluation showed highly significant ($p < 0.01$) differences in appearance, flavour, juiciness, tenderness and overall acceptability in control and treated products and during storage period under retort pouch and vacuum packaging and revealed higher scores in pork with *Silam* and FDS compared to *Anishi* and control. The costs of productions were lower in all treated products compared to control under retort pouch and vacuum packaging. Based on the results obtained in the study it might be concluded that traditional pork products could be prepared economically by incorporating traditional ingredients like *Anishi*, *Silam* and FDS at 5, 10 and 5 percent levels using vacuum and retort packaging without any appreciable depreciation in nutritive values and sensory qualities till 15 days for vacuum packaging with refrigeration storage and for retort packaging till 180 days under ambient temperature.

Influence of Coagulating Enzymes, Iron Fortification and Packaging Methods on the Quality Characteristics and Shelf-Life of Mozzarella Cheese

Dr. Masuk Raquib

A study was carried out to develop iron fortified mozzarella cheese from cow's milk, goat's milk and mixed milk using kiwifruit crude extract. The experiment was conducted in the laboratories of Department of Livestock Products Technology, All India Coordinated Research Project on Post- Harvest Engineering and Technology and Department of Veterinary Microbiology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati -781 022.

Kiwifruit crude extract was prepared from fresh kiwi fruits (*Actinidia chinensis*). The proteolytic enzyme present in the crude extract identified through SDS-PAGE was actinidin having an apparent molecular mass of 24.5 kDa. Optimum level of kiwifruit extract can be used @ 150µg/ml of milk for complete coagulation within 27min for preparation of iron fortified mozzarella cheese.

Mozzarella cheese can be efficiently fortified with ferric chloride safely without giving rise to off-flavour in the product at an optimum level of 1g/lts of milk. Maximum retention of iron (51.29mg/kg) was recorded in mixed milk iron fortified mozzarella cheese samples.

Effect of enzymes and different types of milk were studied on the physico-chemical properties (pH, acidity), proximate composition, water activity, meltability, colour profile, texture analysis, yield, organoleptic properties and microbiological quality of iron fortified mozzarella cheese.

Proximate composition revealed highest values for total solid and ash content for goat's milk iron and fat in mixed milk iron fortified mozzarella cheese, while lowest moisture and fat content were recorded in goat's milk iron fortified mozzarella cheese in the treatment group.

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Texture profile analysis of goat's milk iron fortified mozzarella cheese samples showed higher values for hardness, springiness, cohesiveness and chewiness while cow's milk iron fortified mozzarella cheese samples recorded higher value for adhesiveness and mixed milk iron fortified mozzarella cheese for gumminess parameters.

There was a gradual increase in curd syneresis with advancement of time. Curd syneresis was noted to be highest in cow's milk followed by goat milk and least was observed in mixed milk over a period of 120min.

Mixed milk iron fortified mozzarella cheese enjoyed superior ratings for all the sensory attributes, viz., appearance, colour, body and texture, flavour, saltiness and overall acceptability.

The TVC increased gradually from 0d till 15d of refrigerated storage for all the samples of iron fortified mozzarella cheese under both aerobic and vacuum packaging conditions irrespective of the types of milk and enzymes used. Under aerobic packaging condition, higher TVC were observed for goat's milk sample in both control and treatment group all throughout the storage period. Mixed milk iron fortified mozzarella cheese exhibited least count in both the groups. The TVC of all the cheese samples were higher in aerobic packaging compared to vacuum packing.

Nil counts for Yeast and moulds, *E. coli*, Coliform, *Staph. aureus*, *Salmonella*, *Shigella*, *Listeria monocytogenes* and anaerobic spore counts were noted for all the types of cheese samples under both the packaging conditions, all throughout the storage period, under refrigerated condition

Best before use of mixed milk iron fortified mozzarella cheese samples was found to be 15d under both the packaging conditions with lesser TVC in the vacuum packaged samples.

Based on proximate composition, meltability, sensory attributes microbiological quality and cost of production, the technology developed under treatment group for mixed milk mozzarella cheese is recommended and a suitable protocol for commercial production of iron fortified mozzarella cheese has been proposed.

Certain Aspects of Carcass and Meat Quality Characteristics of Swamp Buffaloes of Assam

Dr. Ziaur Rahman

The swamp buffaloes of Assam play an important role in the socio-economic as well as socio-cultural life of the people of Assam. Swamp buffaloes are poor in milk production but yield excellent source of meat.

It is widely recognized that meat is an excellent source of good quality protein provides all essential amino acids and several micro-nutrients in proper proportion to support human health. As some people have wrong conception towards the consumption of red meat that it causes cardiovascular diseases, but in present day situation the best alternative red meat is carabeef, a rich source of hypocholesterolemic fatty acids. Buffalo is the only potential animal that can boost meat industry in India.

A study on the carcass characteristics and meat quality traits including viz. pH, Water Holding Capacity (WHC), Extract Release Volume (ERV), Drip loss, Cooking loss, TBARS, Tyrosine value, Muscle fibre diameter, MFI, Hydroxyproline content, Proximate Composition, Texture and Colour profile analysis along with organoleptic, shelf-life and microbial qualities of meat of swamp buffaloes of the age groups 2-4 years and above 4 years of either sexes were carried out. Twenty buffaloes were slaughtered in service type of slaughterhouses. Their live weight, carcass weight, dressing percentage, carcass length, loin eye area, weight of different wholesale cuts and by-products were recorded. The physico-chemical qualities were assessed on 1st, 2nd, 4th and 6th day. The representative meat samples (*L. dorsi*) were kept at refrigerated temperature ($4 \pm 1^\circ\text{C}$) up to 6th day for quality assessment.

Significant ($P < 0.01$) and progressive increase in live weight, carcass weight, carcass length, loin eye area and dressing percentages were recorded along with increase in age and irrespective of sexes although these were recorded more pronounced in male than female. A progressive increase in by-products yields were recorded as age advanced and were found to be more in female than in male. The weight of fore quarter was more than the hind quarters, round followed by chuck were the heaviest among the wholesale cuts. The meat pH did not show significant differences. Although there was

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significant ($P < 0.01$) increase in the overall mean values of pH and WHC (sq cm) during the refrigerated storage. Yet, there were no significant differences in overall mean pH and WHC values with increasing age of buffaloes of either sexes. The overall mean ERV (ml/100gm) and shear force values (kg/cm²) were higher on 1st day as compared to 6th day of refrigerated storage. There was significant ($P < 0.01$) increase in the overall mean of shear force along with increase in the age of both the sexes of buffaloes but no significant differences were observed in overall mean ERV values. TBARS (mg malonaldehyde/kg) and Tyrosine (mg tyrosine/100gm) values

increased significantly ($P < 0.01$) with the increase in the refrigerated storage period from 1st to 6th day. No significant differences were observed in overall mean TBARS and Tyrosine values with the increasing age of either sex of swamp buffaloes. A significant ($P < 0.01$) decrease in the overall mean values of per cent MFI was recorded with increase in the age of both the sexes of buffaloes. The overall mean per cent MFI values increased significantly ($P < 0.01$) along with the increase in the storage periods from 1st to 6th day. Muscle fibre diameter (μ) and per cent Hydroxyproline content were higher on 1st day as compared to 6th day of storage in refrigeration temperature. The overall mean Muscle fibre diameter and per cent Hydroxyproline content increased significantly ($P < 0.01$) on increase in the age of buffaloes of both sexes.

On Texture Profile Analysis, the overall mean values of hardness (g), springiness (mm), cohesiveness, chewiness and resilience were found to be significantly ($P < 0.05$) decreased from 1st to 6th day of storage. There was no significant differences in the overall mean values of hardness (g), springiness (mm), cohesiveness, chewiness and resilience on increase in the age of both sexes of buffaloes. On colour profile analysis, significant ($P < 0.05$) decrease in the overall mean values of lightness (L^*) with the increase in the age of either sexes of buffaloes. The overall mean values of lightness (L^*) increased significantly ($P < 0.01$) with the increase in the storage period from 1st to 6th day and significant ($P < 0.01$) increase in overall mean values of redness (a^*) with the increase in the age of both the sexes of buffaloes. The overall mean values of redness (a^*) decreased significantly ($P < 0.01$) with the increase in storage period from 1st to 6th day. There was significant ($P < 0.01$) decrease in the overall mean values of yellowness (b^*) with the increase in the age of both the sexes of buffaloes. The overall mean values of yellowness (b^*) increased but non significantly with the increase in the storage period from 1st to 6th day.

A significant ($P < 0.01$) decreasing trend in the overall mean values of per cent moisture was observed on increase in the age of buffaloes irrespective of sexes. However, increase in storage days showed no significant differences. A significant increase in the overall mean values of per cent crude protein, per cent ether extract and per cent total ash were recorded along with increase in the age of buffaloes of either sex. The overall mean values of per cent crude protein, per cent ether extract and per cent total ash showed no significant differences with the increase in storage periods from 1st to 6th day.

Per cent drip loss showed significant ($P < 0.01$) decrease in the overall mean values on increase in age of both the sexes of buffaloes. The mean per cent drip loss increased significantly ($P < 0.05$) with the increase in storage periods from 24 to 48 hours. The overall mean values of per cent cooking loss decreased significantly ($P < 0.01$) with increase in the age of both the sexes of buffaloes during storage periods. Microbial studies revealed that the Psychrophillic, Mesophillic, Coliform, Yeast and Mould counts increased significantly ($P < 0.01$) with increase in storage period from 1st day to 6th day and the counts were in acceptable range up to 3rd day. *Staphylococcus aureus* were detected only on 6th day of storage. Five meat samples out of twenty were found to be positive for *Salmonella*. Organoleptic evaluation of meat revealed that panelist preferred meat of 2-4 years age group of buffaloes.

The above study leads to the conclusion that the meat of 2-4 years of age group of buffaloes of either sex were more tender and juicy and could be stored safely at refrigerated temperature ($4 \pm 1^{\circ}\text{C}$) up to 3rd day. To reduce the initial bacterial load for slaughtering and dressing of buffaloes, should be done on hanging the carcass to enhance the shelf-life of meat. Since swamp buffaloes are considered as meat animals in draft policy of Assam, data obtained in present study would be quite useful for Government to take progressive steps in the processing and marketing of buffalo meat both for domestic and export purpose.

Analysis of Indigenous Chicken Farming System in Selected Districts of Brahmaputra Valley of Assam

Dr. Rafiqul Islam

A study was conducted in all agro-climatic zones of Brahmaputra Valley of Assam to know socio-economic status of indigenous chicken farmers, demographic distribution and morphological characters of indigenous chicken. Different husbandry practices in indigenous chicken, productive and reproductive performances, diseases and mortality pattern, health coverage programme, economics and marketing of indigenous chicken, constraints faced by the chicken farmers, physical and chemical analyses of crop ingesta to know the nutritional status of scavenged chicken and carcass traits were also studied.

One district from each zone was selected on the basis highest indigenous chicken population. Again from each district, 10 villages were randomly selected. Further, 5 numbers of farmers were selected randomly from each district, thus a total of 50 farmers were selected from each district. In this way altogether 200 numbers of farmers were selected for the whole study.

Farmers were selected on the basis of experience and who kept at least 25-30 numbers of indigenous chicken. The data were collected in a pre-structured interview containing all relevant information pertaining to the study by personal interview method. The data were collected during August, 2017 to July, 2018

Majority (42%) of the respondents belonged to middle age group and most of them (83%) were women. Educational background was poor as two-fifth (42.50%) of them had only up to primary level of formal education. Occupationally there were mostly dependent on agriculture and animal husbandry. Some (21.50%) of them were landless and more than half of the respondents had only up to 5 bighas of land. More than fifty per cent of them were economically weaker with a annual income of Rs.1,00,000/-. Majority (64.50%) was married and three-fifth (59.50%) of them were Hindus, followed by Muslims (37.00%). Majority (59.00%) of them belonged to nuclear

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family. Mostly (67.50%) women were the owner of the flock and most (62.50%) of them had more than 10 years of experience in chicken farming.

Most (94.68) of the indigenous chicken were normal feathered followed by naked neck (5.32%). Mostly males had red coloured plumage, while females were mostly brown mixed colored. Majority of the chicken had single comb. All the birds had red coloured comb. Majority of the chicken had black coloured shank.

The overall mean flock size recorded as 29.79 ± 0.28 and each flock constituted mostly by chicks (65.01%), followed by growers (18.78%) and adults (16.20%) in the study areas. Majority (56.50%) of the farmers constructed coop for night sheltering and most (63.00%) of the coops were located outside the dwelling house. The mean dimension and floor space of the coop was $1.73 \times 1.18 \times 1.01$ cubic meters and 2.04 square meters. The coop was constructed by locally available cheap materials. In most of the cases floors (77.50%) and walls (72.50%) were made of bamboo or wooden slated, while 87.50% of the roofs were made of G.I. sheet. The total cost of construction of coop ranged from Rs. 350/- to Rs. 2,250/- with overall mean of Rs. 850/-, which could accommodate up to 30 numbers of chickens. Mostly (74.50%) sand was used as bedding material and 39% of them used bamboo or wooden basket as laying nest. Majority (34.50%) of the respondents cleaned coop weekly once.

All the farmers under study revealed that indigenous chicken were provided with supplemental feed in addition to scavenged feed. Majority (65.50%) of the farmers offered grains followed by crop by-products (18.50%) and concentrate feed (16.00%). Most (70.50%) of them used home-mixed grains, while 57% of the respondents offered supplemental feed twice a day. The amount of supplemental feed ranged from 450 to 1000 g daily with an average of 750 g daily for 25 to 30 numbers of chickens. Majority (59.50%) of the farmers provided feed on the ground by throwing and the feed was provided together irrespective of sex and age in most (71.50%) of the cases. About one-third (32.00%) of them provided feed during monsoon season. Limited access for scavenging was the main problems of indigenous chicken feeding as reported by majority (50.50%) of the respondents. More than 90% of the respondents did not provide water troughs to their birds.

Majority (86.50%) of the respondents used home produced eggs for incubation. All of them practiced natural incubation and most of them used broody hen (96.50%) for incubation. Hatching was done twice in a year by majority (87%) of the respondents. The male-female ratio was erratic and it varied from 1:5 to 1: 20 with an average of 1:8.5. The mean number of eggs set per broody bird varied from 13.06 ± 0.26 to 13.77 ± 0.25 with an overall mean of 13.59 ± 0.23 . Majority (64%) of the farmers retained their cock up to 2 years of age for breeding. More than two-third of the respondents did not practice selection of hatching eggs, while rest (32%) practiced selection on the basis of soundness of shell (68.5). Post-monsoon season was preferred by most (46.5%) of the farmers. Majority (63.5%) of the farmers did not record the duration period for hatching

eggs. Storing eggs in the nest before incubation was practiced by majority (85.5%) of the farmers.

Most (61.5%) of the respondents culled their surplus chicken stock for sale. Majority (58%) of the respondents culled surplus males and females at the age of 6 to 7 months. The overall mean body weights recorded were 32.06 ± 0.26 , 752.50 ± 3.99 and 1082.48 ± 6.27 g respectively at 1st week, male grower at 5 months and adult at 10 months of age. The corresponding values for female grower and adults were 637.15 ± 2.87 and 899.75 ± 4.09 g respectively. There was no significant ($P \leq 0.05$) difference in body weights among different districts. The overall mean age at first egg was 6.45 ± 0.06 months. The overall mean number of laying cycle per hen per year was found to be 3.30 ± 0.04 . The overall mean number of eggs laid in a laying cycle and overall mean annual egg production per hen were found to be 15.91 ± 0.17 and 51.40 ± 0.91 respectively. The overall mean weight was 32.57 ± 0.19 g. The mean fertility and hatchability (On TES) were recorded as 89.73 ± 0.44 and 83.45 ± 1.04 respectively. There was no significant ($P \leq 0.05$) difference in fertility and hatchability among different districts.

Majority (54.5%) of the farmers did not treat their sick birds, while some (18%) of them consulted with veterinarians for their ailing birds. Most (94.5%) of the farmers did not practice any vaccination programme. None of the farmers practiced deworming in the study areas. Greenish diarrhoea was noticed by most of the farmers as symptoms in any disease outbreak. Ranikhet disease was the most important disease that resulted in highest mortality in a flock as reported by majority (84.5%) of the farmers under study. The overall mean per cent mortality in indigenous chicken recorded as 18.97 ± 0.28 , 10.00 ± 0.46 and 5.38 ± 0.17 respectively during 0 to 9, 10 to 20 and above 20 weeks of age in the study areas. There was a significant ($P \leq 0.05$) difference in mortality per cent at above 20 weeks of age between districts.

The total cost of production per bird up to 72 weeks of age was higher in Sivasagar (Rs. 395.62) than other district. However, the net income and B:C ratio were higher in Sonitpur district. The overall mean egg price was Rs. 8.39 ± 0.16 and live chicken was Rs. 340.90 ± 3.25 . The market price of live chicken significantly ($P \leq 0.05$) varied from district to district. Four numbers of marketing channels each were identified for live chicken and egg.

Lack of veterinary services was the major problem and was ranked first with mean score of 67.91 among all the constraints, followed by disease outbreak (67.59), predator (62.79), damaging crops and vegetable (61.70), external parasites (44.83), improper housing (43.64), inferior productivity of local chicken, unorganized marketing and shortage of feed.

The overall mean per cent grains and by-product contents of both male and female crop ingesta were significantly ($P \leq 0.05$) higher during post-monsoon season than other seasons. Further, the values recorded during winter season ($43.29 \pm 0.81\%$) were

significantly ($P \leq 0.05$) higher than pre-monsoon and monsoon seasons. There was no difference in per cent grains and by-product contents of both male and female crop ingesta between districts. The overall mean per cent kitchen wastes contents of male crop ingesta were significantly ($P \leq 0.05$) higher during pre-monsoon ($48.39 \pm 1.14\%$) than other seasons. However the values were comparable between monsoon (41.37 ± 1.23) and winter ($40.91 \pm 1.21\%$) seasons. The male crop ingesta contained significantly ($P \leq 0.05$) higher per cent kitchen wastes in Dhubri ($42.80 \pm 1.82\%$) than Nagaon and Sonitpur districts. Similarly the mean per cent kitchen wastes contents of female crop ingesta were significantly ($P \leq 0.05$) higher during pre-monsoon ($41.02 \pm 1.21\%$) and monsoon ($42.07 \pm 1.94\%$) than post-monsoon and winter seasons. The female crop ingesta contained significantly ($P \leq 0.05$) higher kitchen wastes contents in Sivasagar than Nagaon and Sonitpur districts. The overall mean per cent green forage contents of male and female crop ingesta were significantly ($P \leq 0.05$) higher during monsoon than other seasons. Further, per cent green forage contents were significantly ($P \leq 0.05$) higher in Sonitpur and Nagaon districts in the case of male and female respectively. The overall mean insects and worms contents of male and female crop ingesta were significantly ($P \leq 0.05$) higher during monsoon than other seasons. There was no significant ($P \leq 0.05$) difference in insects and worms contents of male crop ingesta between districts; however, significantly ($P \leq 0.05$) higher insect and worm contents were found in Sivasagar ($3.11 \pm 0.38\%$) district than other district in female crop ingesta. The overall mean per cent indigestible miscellaneous particles present in male crop ingesta were significantly ($P \leq 0.05$) higher monsoon ($14.19 \pm 0.55\%$) than other seasons. The corresponding values were also significantly higher in Nagaon and Sivasagar districts for male and female crop ingesta respectively.

The crop ingesta of male and female chicken constituted significantly ($P \leq 0.05$) higher per cent of DM during monsoon ($51.41 \pm 0.52\%$) and post-monsoon ($51.91 \pm 0.45\%$) seasons respectively. There was no significant difference of dry matter contents of crop ingesta between pre-monsoon and winter season in male chicken, however dry matter content was significantly higher during postmonsoon than pre-monsoon and winter seasons. The crude protein content (on DM basis) was significantly higher during post-monsoon and winter seasons than other seasons in males. The crude protein content was significantly ($P \leq 0.05$) higher in Dhubri and Sonitpur than Sivasagar district. In females, there was no significant difference in crude protein contents of crop ingesta among different seasons. However, crude protein content in Dhubri was significantly ($P \leq 0.05$) higher than other districts in males ($10.86 \pm 0.30\%$) and females ($10.83 \pm 0.30\%$) respectively. The ether extract content (on DM basis) of male crop ingesta was significantly ($P \leq 0.05$) higher during winter season than any other seasons. The corresponding value was significantly ($P \leq 0.05$) higher in Dhubri than Sivasagar, however it was comparable with Nagaon and Sonitpur districts. There was no significant difference in ether extract content of female crop ingesta between districts and between seasons. The crude fiber content (on DM basis) of male crop ingesta was significantly

($P \leq 0.05$) higher during winter than monsoon and post-monsoon, however it was comparable with pre-monsoon season. There was no significant difference in crude fiber contents of male crop ingesta between districts. However, female crop ingesta constituted significantly ($P \leq 0.05$) higher crude fiber contents during pre-monsoon and post-monsoon than monsoon and winter. In Sonitpur district, female crop ingesta contained significantly ($P \leq 0.05$) lower crude fiber contents than other districts. The total ash content (on DM basis) of male crop ingesta was significantly ($P \leq 0.05$) higher during pre-monsoon than any other seasons. Significantly ($P \leq 0.05$) lower content of total ash was found in Nagaon than any other districts. In females, the crop ingesta contained significantly ($P \leq 0.05$) lower total ash during monsoon than post-monsoon and winter; however the value was comparable with pre-monsoon season. There was no significance difference in total ash content of female crop ingesta between districts. The calcium content (on DM basis) of male crop ingesta was significantly ($P \leq 0.05$) higher during pre-monsoon than monsoon and post-monsoon; however the values were comparable with winter season. The calcium content of male and female crop ingesta was significantly ($P \leq 0.05$) higher in Dhubri than any other districts. In winter season, the female crop ingesta contained significantly higher calcium than any other seasons. The total phosphorous content of male and female crop ingesta did not differ significantly between seasons and districts. The pre-slaughter live weight (g), dressed yield (%) and thigh yield (%) of both males and females did not differ significantly ($P \leq 0.05$) either between districts or between seasons. Similarly, wings yield (%), drumsticks yield (%), breast yield (%) and back yield (%) of male did not differ significantly between districts and seasons. The mean per cent giblet yield in both male ($6.15 \pm 0.04\%$) and female ($6.14 \pm 0.05\%$) were significantly ($P \leq 0.05$) higher during monsoon than other seasons but the values were comparable with pre-monsoon season. The overall mean per cent giblet yield was significantly ($P \leq 0.05$) higher in Sivasagar than other districts in both males and females. The overall mean per cent head yield was significantly ($P \leq 0.05$) higher during premonsoon than other seasons; however it was comparable with post-monsoon season.

Effect of Drinking Water of Different Sources on The Performance of Commercial Broiler Chicken During Monsoon Season

Dr. Sanghamitra Kalita

The present study was undertaken with a view to compare the effect of drinking water of different sources on the performance of commercial broiler chicken during monsoon season. A total of 450 day-old commercial broiler chicks (Cobb 400) having similar body weight from a single hatch were procured from a local hatchery of Guwahati city. The chicks were weighed and randomly divided into ten experimental groups namely, untreated group with ring well water, treated group with ring well water, untreated group with tube well water, treated group with tube well water, untreated group with bore well water, treated group with bore well water, untreated group with pond water, treated group with pond water, untreated group with rain water and treated group with rain water. Each group consisted of 45 chickens. Further each group was again subdivided in 3 replicates containing 15 chicks in each group. The chicks were wing banded and reared under deep litter system of management throughout the experimental period of 6 weeks following standard and uniform managemental practices. The birds were offered both untreated and treated drinking water of these five sources. The treatment of water was done with the combination of acidifier and sanitizer at the rate each of 0.05 ml per liter of drinking water. The water samples from all the untreated and treated groups were analysed for various physico-chemical and microbiological parameters. During the period of experiment, performance traits of broiler chicken comprising of daily water and feed intake, weekly water and feed consumption, weekly body weight and body weight gain, FCR, BPEI and economy of production were recorded. The carcass traits, certain haematological and biochemical parameter of broiler chicken offered different sources of water were also determined

The average value of pH and turbidity of both untreated and treated drinking water differed significantly ($P < 0.01$) among the different sources of water. The pH value of different sources of water ranged from 6.45 to 7.35. However, after treatment of

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water the pH value of all the five sources of water decreased significantly ($P < 0.05$). On the other hand, turbidity of ring well and rain water increased significantly ($P < 0.05$). All the water samples of different sources were found to be colourless in untreated and treated drinking water throughout the study, except for untreated tube well water which was partially brown in colour.

The quantitative analysis of chemical impurities comprising of TDS, total hardness, iron, calcium, magnesium, sulphate, fluoride, chlorine, chloride and nitrate indicated that the mean value of chemical impurities differed significantly ($P < 0.01$) among the different sources of both untreated and treated drinking water. The treatment of water significantly ($P < 0.05$) increased the TDS and chloride content of all the sources of water under study. The total hardness of all the sources of water became nil after treatment. The iron content of untreated tube well water (1.97 ppm) was beyond the maximum permissible level and after treatment the level decreased significantly ($P < 0.05$) to permissible level of 0.88 ppm. After treatment, the calcium content of tube well and bore well, magnesium content of tube well and pond, sulphate content of ring well, tube well, bore well and pond and nitrate content of pond water decreased significantly ($P < 0.05$). The rain water was free from total hardness, iron, magnesium, sulphate, fluoride, chlorine and nitrate content.

Among the different sources of water, the total bacterial load was higher in pond water as compared to other sources of water. However, after treatment the microbiological qualities that included total viable count, total *E. coli* count and total coliform count of all the sources of water under study were found to be reduced. The rain water was free from *E. coli*.

The average total water consumption (l/bird) of broiler chicken offered untreated pond water was lowest (12.055) and it was highest for bore well water (14.560). However, after treatment of water the total water consumption per bird increased numerically for all the groups. The overall water/ feed consumption ratio of broiler chicken offered different sources of water ranged from 3.67-4.07 wherein, it was lowest for untreated pond water (3.67) and highest for untreated rain water (4.07).

The total feed consumption of broiler chicken offered both untreated and treated bore well water was numerically higher as compared to other groups of broiler chicken. The weekly body weight and body weight gain of broiler chicken offered both untreated and treated groups of different sources differed significantly ($P < 0.05$) among the broiler chicken. The bore well water offered broiler chicken of both untreated and treated exhibited significantly ($P < 0.05$) highest final body weight. The treatment of water showed significantly ($P < 0.05$) increased body weight of broiler chicken offered bore well, pond and rain water.

The overall feed conversion ratio for untreated ring well, tube well, bore well, pond and rain water was 1.81, 1.77, 1.88, 1.77 and 1.79 respectively. The corresponding values for treated drinking sources were 1.75, 1.73, 1.71, 1.72 and 1.76 respectively.

Among the untreated sources of drinking water, the broiler chicken offered tube well and pond water exhibited the best FCR values of 1.77. In respect of treated sources best result (1.71) was found in bore well water offered group followed by pond water, tube well, ring well and rain water. The treatment of drinking water improved the FCR values numerically for all the five sources of water. Among the untreated and treated sources, highest BPEI values were shown by the broiler chicken offered rain and bore well water. The per cent livability of broiler chicken offered untreated ring well, tube well, bore well, pond and rain water were 91.11, 91.11, 88.89, 95.56 and 100.00 respectively. On the other hand, cent per cent livability was found to be the broiler chicken offered treated drinking water. Among the untreated sources, the cost of production per broiler was found to be highest in broiler chicken offered bore well water (₹ 179.24), whereas it was lowest for pond water (₹ 163.15) offered group. In respect of treated sources, the cost of production per broiler was highest (₹ 178.70) in bore well water offered group and it was lowest (₹ 170.12) in tube well water. Among the treated sources gross profit was highest (₹ 37.20) in broiler chicken offered bore well water.

The average carcass quality traits, per cent yield of cut up parts and per cent weights of relative organs of broiler chicken did not differ significantly ($P < 0.05$) among the sources except the dressing percentage, per cent weights of kidneys and thymus (untreated). The treatment of bore well water showed significantly ($P < 0.05$) increased dressed weight, dressing percentage, giblet weight and giblet yield. The abdominal fat content increased significantly ($P < 0.05$) in broiler chicken offered treated ring well and tube well water. The per cent weight of heart increased significantly ($P < 0.05$) in broiler chicken offered treated pond water offered group.

Among the haematological parameters studied, the mean values of haemoglobin and PCV levels did not differ significantly ($P > 0.05$) among the broiler chicken offered different sources and treatment of water.

The biochemical parameters namely total serum protein and serum glucose were estimated for broiler chicken offered different sources and treatment of water. The total serum protein levels did not differ significantly ($P > 0.05$) among the broiler chickens offered different sources and treatment of water. However, the serum glucose levels differed significantly ($P < 0.05$) among the broiler chicken offered different sources and treatment of water. The treatment of water significantly ($P < 0.05$) increased the total serum glucose levels of all the groups of broiler chicken offered different sources of water.

Thus, it is concluded that during monsoon season, all the physico-chemical and microbiological qualities of drinking water were found to be within the maximum permissible level after treatment with the combination of Acidifier and Sanitizer @0.01%. Hence, all the treated sources of water under study will be more useful for broiler chicken production during monsoon season.

Ph.D (Home Science)

- **Extension and Communication Management**
 - **Family Resource Management**
 - **Food Science and Nutrition**
- **Human Development and Family Studies**
 - **Textile and Apparel Designing**

Improving the socio-economic status of marginal farmers in Jorhat district of Assam through organic farming

Gitasree Goswami

Agriculture is the primary source of livelihood for most of the developing countries in the world. It is the largest economic sector in India and plays a significant role in the growth and development of the nation. About 70 percent of the population in our country is directly engaged in agriculture. Agriculture not only provide people with food and raw materials but also contributes to national income by bringing in valuable foreign exchange. After the green revolution was launched in India (1967-68), substantial increase in the production of food grains was achieved through the use of improved crop varieties, higher levels of inputs of fertilizers and plant protection chemicals. But it has now been realized that the increase in production was achieved at the cost of soil health and sustainable production at higher levels is possible only by the proper use of resources, to sustain the fertility of the soil. Therefore, organic farming has become one of the alternatives, which helps to overcome these problems by limiting the use chemical-synthetic inputs and through maintaining harmony with nature. Organic farming involves holistic production systems that avoid the use of synthetic fertilizers, pesticides and genetically modified organisms, thereby minimizing their deleterious effect on environment.

The present study entitled “Improving the socio-economic status of marginal farmers in Jorhat district of Assam through organic farming” with the objectives, i) To develop a concrete understanding of the marginal farmers with special reference to knowledge, attitude and practice in organic farming, ii) To improve the capacity of marginal farmers through intervention programme on organic farming and iii) To find out the impact of intervention programme on organic farming in terms of improving the socio-economic status of marginal farmers.

The study was carried out in Jorhat district of Assam state which is one of the eight North Eastern states of India. All the six (6) blocks from both the Jorhat and Titabor sub divisions were purposively selected for the present study. All total twenty

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Department : Extension & Communication Management

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four (24) villages and 480 respondents were identified for the first objective of the present study. Further, total of sixty (60) marginal farmers from respective subdivisions of Jorhat district were selected for conducting second and third objectives of the study. Data were collected by using structured interview schedule. The findings revealed that 50.21 percent respondents of the study areas belonged to middle 5 aged group i.e. (36-50 yrs). Large majority (84.17%) of respondents were married and 58.13 percent had farm size between 2.0-4.0 bigha. 57.29 percent respondents had education up to high school level, 49.58 percent had kaccha type of houses and 26.67 percent respondents engaged themselves in cultivation as main occupation and occupied as daily wage earner for cash income. 37.92 percent respondents belonged to ST/SC category, 66.04 percent possessed poultry as farm power followed by cow (65.00%). 91.67 percent respondents had mobile phone followed by television (80.83%). 55.00 percent respondents belonged to nuclear family, 57.50 percent had small size of family, 39.21 percent respondents had membership in only one formal social organization. As a whole 69.17 percent respondents belonged to medium socio-economic status category. Family land was used as cultivable land by majority of the respondents (67.08%) while 76.25 percent engaged themselves in farming without involving hired labour. It is very interesting to note that 95.63 percent respondents used seeds from their own farm. 79.17 percent respondents obtained fertilizer from their respective houses and 75.83 percent marketed their crops by themselves in the nearest market. 79.58 percent respondents had their own savings. 68.12 percent respondents had obtained agriculture related information from television. Majority of the respondents (66.02%) did not attend any training related to organic farming. Nearly half of the respondents (50.00%) never had contact with Agricultural Development Office followed by 48.96 percent with ATMA, 66.66 percent with KVK and 61.04 percent with NGO. 57.29 percent respondents sometimes had contact with AAU. Majority of the respondents (51.87%) sold their produce in the weekly market and 74.38 percent were regularly accessing mobile phone followed by watching television (70.42%). Respondents faced problems in accessing knowledge about organic farming (ranked I) followed by lack of man power (ranked II), high cost of production resources (ranked III), lack of adequate training on crop production (ranked IV) and attack crops by animals (ranked V). Majority of the respondents had medium level of achievement motivation (81.04%), economic motivation (61.45%), innovation proneness (66.13%), self-confidence (62.29%), risk bearing ability (83.12%) and leadership ability (69.37%). Majority of the respondents (62.92%) of had medium level knowledge on organic farming. 75.00 percent respondents had favorable attitude and 71.04 percent had moderate level of practice towards organic farming. The outcome of the intervention programme indicated that there were tremendous changes in knowledge and practice of the trainees. The overall picture of the knowledge level of trainees revealed differential knowledge score 5 of trainees on soil fertility (ranked I) followed by pest control (ranked II) and application of manure (ranked III) achieved after the intervention programmes. Majority of the marginal farmers were found to be in the

moderate and good practice category after the intervention programmes. The percentage of marginal farmers in moderate practice category ranged from 66.67-100.00 percent, while in good practice category percentage of marginal farmers ranged from 0-33.33 percent in the four villages. Majority of marginal farmers who were in poor and moderate practice category before the intervention programmes shifted to moderate and good practice category and those from moderate, graduated to the good practice category after the intervention programmes. The results revealed significant 't' values for all the four villages. This is an indicator of the effectiveness of the intervention. To fulfill the third objective, impact study was carried out after six (6) months of intervention programmes. The data reveals that 71.67 percent improvement was observed in business of the trainees along with cultivation after the six months of intervention programmes. This might be due to the reason that training programmes have aroused an interest among them for taking up of vermicompost as a business along with farming. They (13.33%) also spend money in buying electronic equipment especially mobile phone followed by capable of engaging additional paid labour for better production of vegetable crops (10.00%). They (10.00%) also engaged in other activities as daily wage earner for cash income along with cultivation as a main occupation. Nearly 8.34 percent respondent contributed cash money for improvement of their existing katcha house followed by 8.33 percent spend for possession of cow and 8.12 percent had encouraged to join social organization after intervention programme. Very less percentage of respondents were able to buy poultry (6.67%), household furniture (6.66%) and goatery (5.00%) to enhance their farm power. Only 5.00 percent respondents became self entrepreneur i.e. engaging themselves in grocery shop as start up business along with cultivation as a main occupation. It was also found that 48.33 percent trainees earned income in between Rs. 5000 - Rs. 6000 followed by 25.00 percent between Rs. 6000 - Rs. 7000, 16.67 percent up to Rs. 5000 and 10.00 percent above Rs. 7000 per month. Trainees were also motivated to save their earned money from selling organic product as well as vermicompost in different sources. Majority of the trainees (53.33%) saved in between Rs.1000- Rs.3000 followed by 25.00 percent saved below Rs.1000, 15 percent saved in between Rs.3000- Rs.5000 and 6.67 percent saved in between Rs.5000 and above per month. The psychological behavior of the respondents was improved after six months of intervention programmes. 5 Majority of the trainees (91.67%) had medium level of innovation proneness followed by risk bearing ability (90.00%), economic motivation (85.00%), achievement motivation (81.66%), self-confidence (78.33%) and leadership ability (73.33%). It was interesting to note that 20.00 percent trainees had high leadership ability followed by self-confidence (18.34%), achievement motivation (16.67%), economic motivation (10.00%), innovation proneness and risk bearing ability (8.33%) after availing the intervention programmes.

Status of Sanitary and Hygienic Condition in Schools of Rural areas of Assam

Jitumoni Neog

The study entitled “Status of Sanitation and Hygiene in Schools of Rural Areas of Assam” was undertaken with the following objectives: i) To study the existing sanitary facilities in the selected schools of rural areas of Assam. ii) To assess the existing knowledge and practices of students and MDM functionaries regarding sanitation and hygiene. iii) To identify the role played by the teachers and SMC members of schools in maintaining sanitation and hygiene. iv) To identify the problems faced by the students, teachers, SMC and MDM functionaries for maintenance of sanitary and hygienic condition of the school and their suggestive measures to overcome. v) To assess the impact of an intervention programme on sanitation and hygiene. The present study was carried out in three districts namely Jorhat, Nagaon and Nalbari representing upper Assam, central Assam and lower Assam respectively. Three educational blocks in Jorhat district, 5 educational blocks in Nagaon district and 2 educational blocks in Nalbari district i.e., total 10 educational blocks were selected under the study. Thus, there are 22 MV schools in 3 selected educational blocks of Jorhat district, 46 MV schools in 5 selected educational blocks of Nagaon district and 22 MV schools in 2 selected educational blocks of Nalbari district of Assam. From the lists, 30 per cent MV schools from each of the selected educational block of each district were selected randomly for the present study. Thus, total 28 MV schools were considered from selected 3 districts of Assam for the present study. From each selected school, five teachers were selected randomly as one of the respondents for the present study which comprised of total 140 teachers from 28 sampled schools. All the students present on the day of survey of the selected schools of class VI, VII and VIII were considered for the present study, thus, 96 from Jorhat district, 148 from Nagaon district and 56 students from Nalbari district, totaling 300 students of MV schools were the respondents, to assess the knowledge and practices of students regarding sanitation and hygiene. The Jorhat district was selected randomly for imparting the intervention programme on sanitation and hygiene. All the students of class VI to VIII from 7 MV

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schools of Jorhat district (96 students) were considered for the intervention programme in order to assess the gain in existing knowledge and practices regarding sanitation and hygiene. Each MV school consists of one cook and one helper under MDM programme. Thus, all the cooks of the selected 28 schools were considered for the present study. Thus, the total numbers of cooks under the study were 28. Each MV school of rural area consists of School Management Committee (SMC). In this study, members included were 1 ward member, 1 village headman, 1 health worker (ASHA), 1 Anganwadi Worker and 3 parents from each school. Thus, the total 196 members of SMC have been selected as the respondents under the present study. It can be observed that all the sampled schools had the provision of water facilities within the school. Also, it can be noted that not a single school had disable friendly toilets and the provision of disposal of sanitary pads. It is also very alarming to note that none of the sampled schools used dust free chalks for writing and good dusters for cleaning the black board. There was no provision for dusting of wooden furniture regularly. It can be concluded that though all the schools had the provision of water, toilet and urinal facilities, but the maintenance of these facilities was very poor in most of the schools. The provision of good water and sanitary facilities in the schools helps to create a good environment. It can be noticed from the findings that though most of the respondents from all the selected districts of three different regions had medium level of knowledge on sanitation and hygiene. The data also revealed that though most of the respondents belonging to moderate level of practice was higher in Nagaon (64.86%). It can also be observed that though the role of the teachers were found satisfactory in maintaining sanitation and hygiene, but the role of SMC members need to be emphasized more for the betterment of the school. It can be identified from the findings that the students, teachers, SMC members as well as MDM functionaries had faced lots of problems in maintaining sanitation and hygiene. Therefore, suggestive measures were identified for consideration to overcome those problems so that the sanitary and hygienic condition of the school can be improved. Lastly, we have observed in the findings that there was change in knowledge and practice of the students through intervention programme.

Socio economic Empowerment of Rural Women Through Krishi Vigyan Kendra

Mayuri Bora

The study on Socio economic empowerment of rural women through Krishi Vigyan Kendra was conducted with the objective (i) To find out the participation of women in different extension activities of KVKs, (ii) To study the extent of adoption of the technologies by the respondents and its impact, (iii) To identify the constraints faced by the respondents in adoption of technologies and (iv) To explore the factors affecting transfer of technology. The present study was conducted in Assam where twenty three Krishi Vigyan Kendras (KVKs) are functioning under administrative control of Assam Agricultural University, Jorhat. Seventeen KVKs out of 23 were selected to find out the participation of women in different extension activities of KVKs. To study the extent of adoption of the technologies by the respondents and its impact, 300 rural women were randomly selected from the operational villages of six selected KVKs, where 150 respondents were participants of the selected vocational trainings and equal numbers were nonparticipants. For studying the factors affecting transfer of technology, thirty SMSs were selected. The findings revealed that during 2012-2017 the selected seventeen KVKs conducted 5152 numbers of training programmes where number of participant was 1,38,809. In trainings under 'Home science' and 'Agricultural extension' discipline, percentage of women participant was found to be highest with 93.99 and 54.52 respectively. However in subjects like Horticulture, Fisheries science, Soil science, Plant protection and Agronomy, women participation was less than 20.00 per cent. The seventeen KVKs conducted 379 numbers of vocational trainings during the study period covering a total of 10,940 participants of which 53.55 per cent were men and 46.45 per cent were women. It was found that in some vocational training, all participants were women where as in some other trainings there was no women participant at all. Similarly the KVK wise analysis of data reflected a large variation among the KVKs.

Three vocational trainings namely 'Food processing and preservation', 'Mushroom cultivation' and 'Vermicompost production' were selected to study the

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extent of adoption of the technologies by the respondents and its impact on socio economic empowerment of rural women. The findings reflected a clear picture that participation in the selected vocational trainings increased the level of knowledge of the respondents, increased inclination for adopting the technology by inculcating favourable attitude which led to adoption of technology. Highest percentage participant respondents had medium level of knowledge on the technology they learnt in the vocational trainings and highest percentage had moderately favourable attitude. Regarding extent of adoption, highest percentage (52.00%) respondents fall in medium level of adoption, followed by low adoption with 36.00 per cent and high with 12.00 per cent. Participant respondents had more knowledge, better level of adoption than the nonparticipant respondents. Data on change in level of empowerment reflects that after the selected period, highest percentage i.e. 52.00 per cent were in high level of empowerment whereas 'before' the highest percentage was in medium level of empowerment with 43.33 per cent. Significant difference in level of empowerment was observed among participant and nonparticipant respondents after the selected period. Data on constraints faced by the respondents in adoption of technologies reveals that highest percentage of respondents faced medium level of constraints. 'Lack of financial resource for starting a new venture' was reported as a major constraint with mean score 1.33 by the rural women. Regarding facilitating factors affecting transfer of technology, 70.00 per cent of the respondents (SMSs) had collaborative programmes with state and national level NGOs followed by line departments and district administration. 'Electricity problem at field level' was reported as a major constraint faced by the SMS while transferring technology. It is concluded that KVKs are playing vital role in transferring technology to the target groups including rural women which have significant impact on socioeconomic empowerment of rural women.

Promoting rural women for use of ICT in agriculture and allied areas

Pompy Malakar

The present investigation on “Promoting rural women for use of ICT in agriculture and allied areas” was undertaken with the objectives (i) to analyse the situation of the rural women with regard to knowledge and use of ICT in agriculture and allied areas (ii) to build the capacity of the rural women on use of selected ICT application through intervention and (iii) to assess the impact of the intervention on use of selected ICT application by the rural women. The study was conducted in two agro-climatic zones of Assam. A multistage random sampling design was followed for selection of the sample. From each zone one district namely Jorhat from Upper Brahmaputra Valley Zone and Nagaon from Central Brahmaputra Valley Zone were selected randomly. Altogether 400 rural women were selected as the respondents for the present study. Data collection was done by using structured interview schedule. The findings revealed that majority (42.25 %) of the rural women were belonged to lower middle age group and are married (70.75%). Majority (39.75%) of respondents had education upto high school level. A high majority (83.75%) of respondents was from nuclear family and has small family size (54.00%) with farming as the main family occupation (82.50%). Majority have ICT tools like mobile phone (92.50%), television (86.25%), internet (28.00%) and radio (17.00%). A large majority (99.18%) of respondents use mobile phone for contacting their friends and 97.83 per cent for contacting different organized groups. Participation of respondents in training related to ICT was found to be very less (1.50 %). The findings indicated that majority (64.50%) of the respondents had medium level of knowledge on ICTs and have favourable attitude towards ICTs (77.00%). Among the various problems faced by the respondents in utilization of ICTs, “Lack of confidence in operating ICTs” was ranked I (0.96), followed by “ICT Services are costly”, ranked II (0.91) and “Erratic power supply”, was ranked III (0.89). Finding shows a significant association between knowledge on ICTs with age, size of family, organizational membership and extension contact. The finding also shows significant association between attitude towards ICTs with age, educational qualification, organizational membership and extension contact. Based on the existing

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knowledge of respondents on ICTs an intervention programme was organized. Before interventions mean score of their knowledge was 18.4 and after intervention immediate post knowledge scores was 41.26. Further it was found that before interventions mean score of their existing practices was 7.76 and after intervention immediate adoption of practices scores was 13.33. Impact of the intervention programme was found to be significant in terms of gain in knowledge and adoption of practices thus, leading to capacity building of the rural women.

Assessment of ergonomic risk factors among female workers in vegetable cultivation

Manorama Devi

Ergonomic assessment of risk factors is one of the starting points to address the problem of work-related occupational stress. The rural women participate in a broad range of agricultural activities such as production, processing, preservation and utilization of food. In the case of vegetable cultivation, they play a key role in the entire vegetable cultivation process starting from land preparation to harvesting of vegetable crop. The present study was designed with four objectives: (1) To study the activity profile of female workers in vegetable cultivation, (2) To identify work-related health hazards experienced by the female workers, (3) To assess the prevalence of ergonomic risk factors in vegetable cultivation among female workers, and (4) To evolve suitable ergonomic measures to enhance comfort and productivity of the female workers. To conduct the study the North West Development Block of Jorhat district was selected purposively. Four villages namely Upper Deuri, Hokai Khangia, Bormer Chapori and Sonari No. 2 of North West Development Block in Jorhat district of Assam were selected. The study was conducted on 300 female workers who are actively engaged in all the activities of vegetable cultivation starting from land preparation to harvesting of vegetables. Both interview and experimental methods were followed to collect information. Modified Nordic questionnaire and body part discomfort scale were used as tools to collect information. To assess the risk factors 10 per cent from the total sample was selected, who were actively involved in all the activities of vegetable cultivation contributing 5-6 hours a day. RULA and OWAS techniques were for postural assessment; repetition was assessed by using Wiley *et al.* (1996) standard scale and exertion was measured by following Rating of Perceived Exertion (RPE) scale. Personal and demographic characteristics of female workers revealed that 60.33 per cent of the respondents were from the age group of 30-40 years. Majority (65.67%) of the respondents body height falls in the category of 151-155 cm and 70 per cent of the respondents body weight was in between 41-50 kg. Most of the respondents (70.67%) were having mesomorph body type and normal BMI. In case of caste, majority (40.33%)

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of the respondents were other backward class. 62 per cent of the respondents family occupation was agriculture. It was observed that land preparation (30.66%) was performed —partially by the female workers; while other tasks of vegetable cultivation such as removing of stalks and stubbles (72%), sowing (82.67%), transplanting (100%), weeding (100%), spreading of manure (100%) and harvesting (86.67%) were performed fully and irrigation (100) was performed —rarely which indicates this activity is performed by male workers. Age and years of involvement of the respondents were found to be highly significant with their extent of participation while BMI was found to have insignificant with the extent of participation of female workers in vegetable cultivation. Majority of the respondents were found to be involved in vegetable cultivation from 5-15 years. Work-rest pattern indicated that the total working time for weeding and harvesting was 8.29 hours and 8.47 hours in a day respectively, and total rest was 2.19 hours and 2.21 hours for both weeding and harvesting. Squatting and bending postures were adopted mostly by the workers in performing majority of the activities. The level of discomfort in weeding and harvesting is severe. Assessment of body part discomfort revealed that weeding and harvesting had intolerant pain in hand. The MPI (Mazziotta Pareto Index) indicates that majority (54.67%) of the respondents experienced moderate work related health hazards and 45.33 per cent of the respondents experienced severe work related health hazards. RULA score in ‘weeding and harvesting’ were found to be the level (3-4) and (5-6) respectively which means change may be needed in the postures and work methods of weeding and immediate change is required in harvesting. OWAS score indicated that work posture in harvesting was found to have an extremely harmful effect on musculoskeletal system and immediate solution should be found to solve the posture (action level IV). Harvesting and weeding operations were found to be ‘highly repetitive’ in nature as the cycle time obtained was within 30 seconds. Rating of perceived exertion indicated for weeding (64.33%) and transplanting (58%) activities were moderately heavy and harvesting activity (59%) was heavy. Intervention with ergonomically designed —Brinjal picker increased output efficiency by 8.16 per cent, reduced the exposure level by 30.37 per cent as well as reduced grip fatigue and exertion. 76.67 per cent of the respondents found the newly designed —Brinjal picker very comfortable. Evaluation of the newly designed —Brinjal picker expresses that exposure level; exertion and comfort were found to be highly significant with 0.00 —p value which indicates that the intervention has an effect on the female vegetable cultivators.

Design requirements for ease of operation of consumer electronic products used for cooking

Moonty Baruah

In the past few years there has been a tremendous change in the consumer electronic market with availability of wide ranges of products. Though the people possess these products and are dependent on it but still they are not satisfied since they face problems while using it, especially in case of products used for cooking activities. These problems are not related to the technical problems but with usability problems while using the user interface. User interface is the panel through which the users interact with the products. It may be due to incorporation of multiple functions in the products along with digitalization of user interface; in many cases the use of products is becoming complex. There is a gap between the intention of the manufacturers and the needs and understanding of the users while using these products. Solution lies in following a framework of guidelines on design requirements for ease of operation of the products, which can reduce these usability problems of user interface. These guidelines should be based on the opinion of users, their needs, etc. This will not only increase the usability of the product but will also try to capture the market in long run. Keeping these points in view the present study was undertaken with the following objectives (1) to study the Taxonomy of user Interfaces of Consumer Electronic Products used for cooking. (2) to identify the usability problems in use of selected products. (3) to generate design requirements for ease of operation of a selected product. The study was conducted in three phases. In the phase I, data on different consumer electronic products possessed by the respondents, dependency on the products, problems faced by the users, etc were collected through a survey. For the survey a total of 200 samples were selected randomly from Jorhat town by following purposive sampling procedure. In the Phase II, a user workshop was conducted to find out the design requirement of user interface. The information generated from the user workshop was used for developing mock up models/stimuli for further laboratory analyses. While developing the stimuli paired preference test was performed. Finally 32 stimuli were selected for the next phase of analyses in the laboratory. The user workshop was conducted with 40 numbers of respondents (20 percent of sampled respondents). In Phase III of the study, design

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requirements for user interface were generated for ease of operation of the selected product through usability study by using eye tracking experiment. The gathered data revealed that the respondents possess almost all types of electronic appliances and are dependent on it but still they are they have fear in using it. This fear is mostly because of the complicated user interfaces. In order to study the usability problems, the different aspects of dimensions of taxonomy of the user interface was studied in details. It was seen from the analyses of data that user interfaces of many of the consumer electronic products are not user friendly. Especially, in case of microwave oven the interface is problematic due to the presence of many functions. From the paired preference test few guidelines came into foreface. These guidelines were people mostly preferred font size of 7.5 point with black font in white background, regarding the position of user interface the respondents mostly prefer vertical down position. Buttons were more preferred than knobs. From the eye tracking experiment three aspects were tested and it was found that the respondents prefer to have the start/stop button at the middle of the panel. The number of buttons in the interface should be adequate, it should neither be too less nor too more for ease of operation and as regards to colour contrast the mostly preferred combination found was white font in black background.

Process standardization and shelf-life evaluation of Instant rice based meal

Lipika Chatterjee

The present study entitled “*Process standardization and shelf life evaluation of Instant rice based meal*” was carried out with the objective to standardize the processing conditions of the ingredients of the developed instant rice based meal, to develop for the improvement of the formulation using different levels of the developed meal ingredients, to assess the reconstitution and organoleptic property of the best selected instant rice based meal and to evaluate the shelf life of the selected formulation using different packaging materials. The study was carried out in the Food Science laboratory of the Department of Food Science and Nutrition, Post Harvest Technology Laboratory of the Department of Horticulture, Nanotechnology Laboratory in the Department of Plant Pathology, Assam Agricultural University, Jorhat during 2016-2019. The raw materials were procured from the local market of Jorhat district and Horticulture farm, Assam Agricultural University, Jorhat. To develop the instant rice based meal formulations, precooked dehydrated ingredients were used. Initially a base meal (35% rice, 25% pulses, 20% vegetables, 5% RBO, 12% spices and condiments) was prepared by combining cereal, pulses, vegetables, spices and condiments and from the Base meal three formulations were developed and standardized *viz.*, Formulation I (30% rice, 28% pulses, 24% vegetables, 5% RBO, 11% spices and condiments), Formulation II (30% rice, 29% pulses, 23% vegetables, 5% RBO, 11% spices and condiments) and Formulation III (30% rice, 30% pulses, 22% vegetables, 5% RBO, 11% spices and condiments) by changing the proportion of ingredients used in base meal and by incorporating other new ingredients. All the ingredients were individually processed by microwave cooking + blanching (MCB) and pressure cooking + blanching (PCB) and then dried at different temperatures. Nutrient analysis was done following the standard methods and acceptability trial was conducted using 9 point hedonic scale by semi-trained panelist. Process standardization for all the ingredients used in the formulation of instant rice based meal was done by trial and error method following the standard procedures. According to the acceptability score, it was found that Formulation III

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Department : Food Science and Nutrition

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(PCB) had scored the highest score in terms of flavour (7.90 ± 0.13), taste (8.00 ± 0.07), texture (8.01 ± 0.10) and overall acceptability (8.15 ± 0.12) by the base meal (PCB) *i.e.*, 7.78 ± 0.12 , 7.78 ± 0.15 , 7.70 ± 0.11 and 7.90 ± 0.09 for flavour, taste, texture and overall acceptability respectively. Formulation I (PCB) was judged with the score of 8.10 ± 0.15 followed by Formulation II (PCB) *i.e.*, 7.95 ± 0.18 in terms of overall acceptability. Among the formulations processed by microwave cooking + blanching, Formulation III was judged best with the highest overall acceptability score of 8.26 ± 0.20 , followed by Formulation I (8.10 ± 0.17), Base meal (8.05 ± 0.19), and Formulation II (7.90 ± 0.18). The results showed that highest acceptability was in Formulation III (MCB), whereas lowest acceptability was recorded in Formulation II (MCB). The instant meal prepared from pressure cooked + blanched (PCB) ingredients showed that the moisture content of Base meal, Formulation I, Formulation II and Formulation III and were not statistically different ($p < 0.05$) from each other. The results of the protein content of the instant rice based meal formulations prepared by using microwave cooked + blanched (MCB) and pressure cooked + blanched (PCB) ingredients were found to be in the range of $22.63\pm 0.23\text{g}/100\text{g}$ (Base meal) to $26.77\pm 0.17\text{g}/100\text{g}$ (Formulation III) and $21.54\pm 0.21\text{g}/100\text{g}$ (Base meal) to $25.19\pm 0.16\text{g}/100\text{g}$ (Formulation III) respectively and were significantly different at $p < 0.05$. The total mineral, crude fibre and carbohydrate content of the instant rice based meal formulations prepared by using microwave cooked + blanched (MCB) were found to be significantly higher ($p < 0.05$) as compared to the instant formulations prepared from pressure cooked + blanched (PCB) ingredients. But the mineral content did not vary significantly ($p < 0.05$) between the instant rice based meal formulations prepared by using microwave cooked + blanched (MCB) and pressure cooked + blanched (PCB) ingredients and this may be because of the fact that minerals like iron, calcium and phosphorus are heat stable therefore cooking method and temperature do not appear to reduce the quantity or availability of this mineral but they were found to differ significantly ($p < 0.05$) within the formulations

The best selected formulation on the basis of sensory scores and nutrient composition *i.e.*, Formulation III was then vacuum packed in two packaging material *i.e.*, aluminium laminated pouch and HDPE pouch of 200 gauge and was further subjected to storage studies *i.e.*, sensory evaluation, nutrient composition, peroxide value, free fatty acid value and total microbial count at a regular interval of 2 months for a period of 6 months. With the advancement in storage period, nutrient content, peroxide value, free fatty acid value and total microbial count increased significantly ($p < 0.05$) and was however within the permissible limit indicating acceptability of the formulations upto a period of 6 months. Highest peroxide value of Formulation III was observed in HDPE pouch starting from 0 day till 6 months *i.e.*, from 1.81 ± 0.26 meq O₂/kg (0 day) to 4.42 ± 0.12 meq O₂/kg (6months) in MCB and from 1.87 ± 0.27 meq O₂/kg (0 day) which gradually increased to 4.84 ± 0.32 meq O₂/kg after 6months of storage.. The free fatty acid (FFA) content of Formulation III (MCB) stored in the

aluminium laminated pouch was in the range of $0.18 \pm 0.04 \text{mg}/100\text{g}$ at 0 day to $3.45 \pm 0.12 \text{mg}/100\text{g}$ after 6 months of storage and that stored in HDPE pouch showed a gradual increase from $0.18 \pm 0.04 \text{g}/100\text{g}$ at 0 day and finally to $3.79 \pm 0.14 \text{g}/100\text{g}$ at 6 month across storage. The FFA content of Formulation III (PCB) stored in the aluminium laminated pouch increased from an initial value of $0.18 \pm 0.03 \text{mg}/100\text{g}$ at 0 day to a final value of $3.40 \pm 0.12 \text{mg}/100\text{g}$ at 6 month while the Formulation III stored in HDPE pouch increased significantly ($p < 0.05$) from $0.18 \pm 0.04 \text{mg}/100\text{g}$ in 0 day to $3.82 \pm 0.26 \text{mg}/100\text{g}$ in 6 months. Statistically, it was observed that a significant decrease ($p < 0.05$) in the FFA content was observed in the Formulation III packed and stored in aluminium laminated pouch when compared to the Formulation III stored in HDPE pouch. The total microbial count of the formulations significantly increased ($p < 0.05$) with the increase in the period of storage. The results of total microbial count of Formulation III (MCB) stored in the aluminium laminated pouch and HDPE pouch increased significantly ($p < 0.05$) from $1.72 \times 10^3 \text{cfu}/\text{g}$ (2 months) to $4.02 \times 10^3 \text{cfu}/\text{g}$ (6 months) and $1.90 \times 10^3 \text{cfu}/\text{g}$ to $5.14 \times 10^3 \text{cfu}/\text{g}$ respectively. The total microbial count of the Formulation III (PCB) stored in aluminium laminated pouch and HDPE pouch increased significantly ($p < 0.05$) with the advancement of storage days from $1.84 \times 10^3 \text{cfu}/\text{g}$ at 2 months to $4.21 \times 10^3 \text{cfu}/\text{g}$ at 6 months and $2.12 \times 10^3 \text{cfu}/\text{g}$ at 2 months to $5.38 \times 10^3 \text{cfu}/\text{g}$ at 6 months of storage respectively. Thus, it can be concluded that microwave processed Formulation III packed and stored in aluminium laminated pouch is the best packaging material for storing instant rice based meal due to its barrier function against the migration of moisture, oxygen and other gases.

Bioactivity of medicinal plants used in traditional rice beer starter cultures of Assam

Radali Duarah

The present study entitled “Bioactivity of medicinal plants used in traditional rice beer starter cultures of Assam” was undertaken with the objectives of documentation of plant species used in the preparation of rice beer starter culture of Assam, analysis of phytochemicals and antioxidant capacity of selected plant sample and assay of antimicrobial activity of them against five human pathogenic bacteria. Six major communities of Assam were selected for the documentation of the plant materials used in the preparation of rice beer starter culture. The information was collected using a semi-structured questionnaire from experienced local men and women of three districts of Assam viz., Sibsagar, Nagaon, and Bongaigaon. A total of thirty-six plants were found to be used in the preparation of the starter culture by the *Mishing* community, twenty-seven plants by the *Ahom* community, thirteen plants by the *Deori* community, twenty plants by the *Tiwa* community and seven plants by *Bodo* and *Rabha* community for their respective starter cultures. A total of fifty-one plants were documented from the survey, many of which were commonly used by all the communities for preparation of rice beer starter culture as well as in their traditional health care system for curing many diseases. Twelve commonly used plants were screened out based on their importance in the preparation of rice beer among all the communities. These plants are *Curcuma longa*, *Sphaerostepheras unitus*, *Polygonum hydropiper*, *Drymaria cordata*, *Psidium guajava*, *Cinnamomum bejolghota*, *Zanthoxylum nitidium*, *Elsholtzia blanda*, *Rubus hexagonus*, *Vitex negundo*, *Justicia gendarussa* and *Scoparia dulcis*. Proximate analysis showed that the moisture content ranged between 4 to 10.5 (g/100g); ash content 6.09 to 16.61 (g/100g), crude fiber content 6.12 to 13.40 (g/100g); protein content 0.23 ± 0.10 to 6.81 ± 0.45 (g/100g); crude fat content 0.60 to 6.22 ± 0.36 (g/100g) and lastly carbohydrate content 69.91 to 85.85 ± 0.16 (g/100g) in the selected plants. The percentage yield of extracts in studied medicinal plants is found to be higher in the aqueous extracts than ethanolic extracts. The antioxidant activity of plant extracts was assessed by ABTS and DPPH method. For ABTS assay, the aqueous extract of *Psidium*

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Department : Food Science and Nutrition

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guajava leaves showed the highest scavenging activity (77%) at 200 µg/mL with IC₅₀ value 74.05 µg/ml, whereas ethanolic extract of *Curcuma longa* showed the highest scavenging activity (87.4%) with IC₅₀ 68.52 µg/ml. Similarly for DPPH assay, the aqueous extract of *Psidium guajava* showed the highest scavenging activity (65.22%) with IC₅₀ 113.25 µg/ml. Ethanolic extract of *Curcuma longa* showed the highest scavenging activity (70.6%) with IC₅₀ 99.02 µg/ml. The qualitative phytochemical screening of selected plant extracts showed the presence of various components. The total flavonoid content for both aqueous and ethanolic extracts varies from 0.7 mg QE/g to 185.7 mg QE/g, and 12.14 mg QE/g±0.51 to 260±0.08 mg QE/g. Total phenol content was noticed to be in the range 1.96 mg GAE/g to 153.7 mg GAE/g for aqueous extracts and 3.96±0.99 to 205.9 mg GAE/g for ethanolic extracts. Tannin ranged between 0.30 mg TAE/g to 1.58±0.03 mg TAE/g for aqueous extracts and 0.73±0.03 to 1.61±0.05 mg TAE/g for ethanolic extracts. Alkaloid content was found highest in *Polygonum hydropiper* in both aqueous (7.7 g/100g) and ethanolic (13.26 g/100g) extracts. A significant correlation was observed between the antioxidant and phytochemicals like total phenols, flavonoids and tannin content however, did not show any correlation between antioxidant and alkaloid content of the selected plant extracts. By FTIR analysis the various functional groups observed in the samples indicate the presence of alcohol, total phenol, alkane, 1° amine, aromatic amine, conjugated alkene, aliphatic amines, ester, carboxylic acid etc. In the antimicrobial activity of the selected plants, the Zone of Inhibition (ZOI) against *Escherichia coli* was found highest in *Vitex Negundo* (15.5 mm) among aqueous extracts and *Curcuma longa* (25 mm) among the ethanolic extracts which can be compared with standard antibiotic ciprofloxacin showing ZOI 25 mm. Against *Listeria monocytogenes*, *Psidium guajava* leaves showed the highest ZOI among both aqueous (15 mm) and ethanolic extracts (20 mm). Against *Salmonella typhi*, *Drymaria cordata* showed the highest ZOI in both aqueous (13 mm) and ethanolic extracts (24 mm). In the case of *Serratia marcescens*, *Psidium guajava* showed the highest ZOI in both aqueous (12 mm) and ethanolic (19 mm) extracts. Many of the plants are found to be a good source of phytochemicals and possess antibacterial activity against all the selected pathogen except *Shigella*. This validates the use of these selected plants by different communities in the preparation of rice beer starter culture. Based on the present study it can be concluded that among all the selected plant samples used in the preparation of rice beer starter culture, most of the plant samples possess dose-dependent antioxidant ability in both aqueous and ethanolic crude extracts. The outcome of the present study can be recommended for in-depth analysis of the medicinal plants, and further, the rice beer prepared using the selected plants to find out the efficacy of the plants as therapeutic agent for prolonging longevity and attaining positive general health.

Formulation and characterisation of millet incorporated food products

Sushmita Khatoniar

The present study was undertaken to formulate millet incorporated food products to utilize the inherent health benefits of millet grains. The ingredients used in the present study along with finger, foxtail and proso millet were wheat, buckwheat, Bengal gram, green gram, soybean and red kidney bean. The physico-chemical properties of the raw materials used were analysed. The bulk density of the raw ingredients used in the present study ranged from 0.71 ± 0.02 to 0.83 ± 0.09 g/ml respectively, with no significant difference between them at $p \leq 0.05$ level. The water absorption capacity, oil absorption capacity, foaming capacity and foam stability were found highest in soybean flour among the raw ingredients used. The moisture content of the selected raw ingredients was ranged from 7.24 ± 0.05 g/100g (soybean flour) to 10.51 ± 0.04 g/100g (buckwheat flour). The protein content of the raw ingredients used was in the range of 7.45 ± 0.11 g/100g (finger millet flour) to 41.43 ± 0.10 g/100g (soybean flour). The crude fibre content was highest in red kidney bean flour (6.64 ± 0.03 g/100g) and lowest in Bengal gram flour (2.11 ± 0.01 g/100g). The carbohydrate content was found highest in wheat flour (70.88 ± 0.24 g/100g) followed by finger millet flour (68.23 ± 0.23 g/100g), buckwheat flour (66.72 ± 0.11 g/100g) and proso millet flour (66.58 ± 0.45 g/100g). Highest energy content was observed in soybean flour (425.92 ± 0.63 kcal/100g) followed by Bengal gram flour (369.86 ± 0.67 kcal/100g), proso millet flour (352.86 ± 2.43 kcal/100g) and also whole wheat flour (345.86 ± 1.21 kcal/100g). The total dietary fibre was highest in Bengal gram flour (21.46 ± 0.20 g/100g), followed by soybean flour (19.76 ± 0.18 g/100g) and red kidney bean flour (16.65 ± 0.13 g/100g). The ingredients used for preparation of multigrain mixes i.e., whole wheat flour, finger millet flour, foxtail millet flour, proso millet flour, buckwheat flour, Bengal gram flour, green gram flour, soybean flour and red kidney bean flour were added in three different ratios such as MM I (60:10:10:5:5:2.5:2.5:2.5:2.5), MM II (50:10:10:10:5:5:5:2.5:2.5) and MM III (40:10:10:10:10:5:5:5:5) and physico-chemically evaluated. Among the multigrain mix formulations, the functional properties

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such as water absorption capacity, oil absorption capacity, foaming capacity and foam stability were significantly higher in MM III than MM I and MM II. In case of proximate composition, the crude protein, crude fat, total minerals, crude fibre and total energy content was found highest in MM III formulation as 14.42 ± 0.11 g/100g, 3.23 ± 0.03 g/100g, 2.44 ± 0.04 g/100g, 4.01 ± 0.06 g/100g and 352.60 ± 2.14 kcal/100g, respectively. Similarly, the minerals such as calcium, iron, phosphorous, zinc, sodium, potassium and magnesium were found highest in MM III formulation. While studying the starch fractions, MM III contained highest amount of resistant starch (18.67%). The *in vitro* protein digestibility was significantly higher in MM III whereas *in vitro* carbohydrate digestibility and Glycemic Index (GI) is lower in MM III than the other mixes which makes it superior in terms of health protective factors. Shelf life was studied using three different packaging materials such as LDPE (100 gauge), HDPE (200 gauge) and plastic bottle (Tarson) and analysed for moisture increment, free fatty acid, peroxide value and total plate count during storage. The HDPE pouch was found significantly better in preserving the flour than the other two packaging materials as moisture increment, free fatty acid, peroxide value and total plate count was found lowest after completion of storage period of 180 days. Value added products such as Indian flat bread (*chapati*), cookies, muffins, buns and pasta were prepared from MM I, MM II and MM III and sensory evaluation was carried out. The products prepared using MM III were found more acceptable in terms of sensory parameters such as flavor, texture, appearance, taste and overall acceptability. After analysing the nutritional parameters such as proximate composition, mineral contents and bioactive components of the developed products using MM I, MM II and MM III; the products prepared using MM III was found containing significantly higher amount of proximate constituents such as crude protein, crude fat, total minerals, crude fibre and total energy content. The mineral constituents such as calcium, iron, phosphorous, potassium, magnesium, sodium and zinc was also found highest in products prepared using MM III than MM I and MM II. As the MM III found superior in many aspects than the other multigrain mix formulations, it was selected for further *in vivo* study. *In vivo* study of the multigrain mix as compared to whole wheat flour revealed that Glycemic Index (GI) of MM III was 41 whereas GI of whole wheat flour was found 58. The mean blood glucose response of normal healthy rats after feeding MM III was found lowest (79.00 mg/100g) after 120 minutes of feeding. The supplementation of MM III on alloxan induced diabetic rats showed significant improvement in blood glucose level in both the experimental groups. The results of impact of supplementation of MM III on plasma lipid profile of experimental rats showed significant improvement in plasma high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, total cholesterol, triglycerides, AST, ALP and ALT level after maintaining 28 days feeding period in comparison to the group feed with only high fat diet. On the basis of the present study, it can be concluded that the developed millet based multigrain mix has low glycemic index with functional efficacies in terms of hypoglycemic and

hypolipidemic effect. The outcomes of the present study can be recommended for popularization and consumption of the mix and to create awareness related to health benefits of such multigrain mixes to reach the vulnerable populations who are at risk of developing non-communicable diseases.

Adolescents' Aggression: a Mindfulness-Based Interventional Approach

Arifa Momtaz Begum

Aggressive behaviour has become a topic of vital importance and a major concern in most of the societies. Identifying, controlling and managing highly aggressive behaviour and its ill effect of school going adolescents have not yet been a major focus of education system of India. Hence, the present study was undertaken to identify the aggression level of adolescents, its locus of control, develop and implement mindfulness-based intervention programme to manage aggression and to assess its efficacy. A total of 32 adolescents of the age group of 14-16 years were selected from two different schools of Sonitpur district of Assam. Sociometry was used to identify the aggressive students. A standardized questionnaire namely Direct & Indirect Aggression Scales developed by Bjorkqvist *et al.* (1992) was used to gather data from self, peers and teachers to assess the types and levels of aggression of respondents. For assessment of locus of control, the scale developed by Nowicki *et al.* (1973) was used. An intervention package was also developed to reduce the level of aggression of adolescents. Intervention programme was carried out for a period of one month. Data was collected once before the intervention and then again during the 3rd month and 5th month after implementing the intervention programme. The findings of the study revealed the prevalence of three types of aggression *viz.*, physical, verbal and social aggression among adolescents. Verbal and social aggressions were much more prevalent than the physical aggression among the respondents. Barring two respondents, all of them were found to have external locus of control which has a positive correlation with their aggression. There were significant ($P < 0.01$) changes in the level of aggression of all the respondents in physical, verbal and social aggression after implementing the intervention programme. Significant increase in the percentage of respondents in low category of all three types of aggression revealed that a large section of respondents abate the level of aggression considerably after intervention. High social acceptability of the package is also an evidence to establish its effectiveness. Hence, this mindfulness based interventional activities can be a new start for bridging the gap of adolescents' emotional need and challenging behavior.

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Department : Human Development and Family Studies

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Development of learning tool for promotion of spatial intelligence in children during concrete operational period

Tulika Borah

Spatial intelligence, one of the nine types of intelligence proposed by Howard Gardner (1983) has been highlighted in recent years and regarded as an integral component of human cognition. Research studies have provided evidences of relation of spatial intelligence to achievement in science, technology, engineering and mathematics (STEM) streams. In the present study the investigator attempted to develop a learning tool for promotion of spatial intelligence in children during concrete operational period. An Embedded mixed method research design was adopted for the study. The sample of the study constituted of 120 children belonging to the age group of 8-11 years, who were selected randomly from three schools of Jorhat district, Assam. The young people's version of 'Multiple intelligence test' developed by Chislett and Chapman (2005) was used as quantitative technique to assess the type of intelligence found among children under the study. In addition to it, observation and interview methods were also used. The data collected from both quantitative and qualitative methods were analysed and the results were obtained after triangulation of quantitative and qualitative data. Seven types of intelligences were identified and inter-correlations between the types of intelligences were analysed. Positive inter-correlations found among different types of intelligence indicated that, spatial intelligence of children can be developed by administering spatial tasks to children, irrespective of the type of dominant intelligence they possess. The topological framework of spatial skills proposed by Uttal *et al.* (2013) was followed for preparation of spatial tasks, which consists of four dimensions i.e. intrinsic-static, intrinsic-dynamic, extrinsic-static and extrinsic-dynamic. Spatial tasks in all the four dimensions were prepared and difficulty level of each task was assessed. It was found from the study that, the task difficulties of dynamic tasks were more than static tasks. Moreover it was found that, the tasks under the dimension of extrinsic-dynamic were more difficult as compared to other three dimensions. A 2 way

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ANOVA was conducted to analyse the main effects and interactive effect of types of intelligence and dimensions of spatial tasks on performance of children in spatial tasks. The two way ANOVA test indicated that maximum differences in the performance of children in spatial tasks were accounted by different dimensions of spatial tasks ($\eta^2 = 0.516$) than the types of intelligence ($\eta^2 = 0.219$). Based on the analysis carried out, finally a learning tool, consisting of forty numbers of spatial tasks covering all four dimensions, was developed for promotion of spatial intelligence in children, during concrete operational period.

Risk and Protective factors contributing towards Adolescents' Emotional Resilience

Zionvarzing Thiek

Resilience is all about how an individual is able to bounce back after encountering an adversity. Many researchers have proved that adolescent's resilience is affected by various factors related to social and familial environment. A resilient adolescent is likely to enter adulthood with a better chance of adapting well even if he encountered negative events in life. The present study attempted to identify the risk and protective factors contributing toward adolescent's emotional resilience. The study was conducted in Dima Hasao District of Assam. A total of 360 adolescents belonging to the age group of 14-17 years from both private and government schools were selected through probability proportional sampling. A self-developed general information schedule was used to collect the background information of respondents. A checklist consisting of 20 statements of negative events was prepared and used to identify the negative life events among the adolescents. The Resilient Quotient developed by Jeffrey and Linda Russell in the year 2009 was used to assess the level of emotional resilience of adolescents. To assess the personal attributes of the adolescents, The Big Five Inventory developed by John and Srivastava (1999) was used. The attachment of parent-adolescent was studied by using an inventory of Parent and Peer Attachment by Greenberg and Armsden (1987). To study the family related factors such as cohesion, family conflict, control and independence, A Family Environment Scale (FES) by Harpeet Bhatia and Chadha (1993) was used. The most reported negative events by the adolescents were class work load, obtaining low grade than expected, getting pressure from parents, restrictions at home, financial problems and rebuke by parents. Gender difference was found to be statistically significant in the three negative life events namely experiencing arguments between parents, pressure from parents and having to repeat the same grade. The highest serious negative life events experienced by the adolescents was death of the family member and natural calamities. There was no significant relationship between the NLEs and emotional resilience of adolescents. This implies that NLEs neither act as protective factor nor as risk factor towards adolescent's

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emotional resilience. The relationship between the demographic variables and resilience of adolescents was also seen and was found that, the age of the respondents, types of family and birth order showed statistically significant relationship with the emotional resilience level. Statistically significant difference was also found between the gender, types of school and adolescents' resilience. The personal attributes (extraversion, agreeableness, conscientiousness and openness) were identified as protective factors and neuroticism as a risk factor. The family factors such as cohesion and parental attachment were identified as protective factors and the factors such as family conflict and family independence act as a risk factors of emotional resilience of adolescents.

Application of copper nanoparticles generated on plant extract for antimicrobial finish on cotton fabric

Gitanjali Boruah

The present study deals with the application of copper nanoparticles synthesized by plants for antimicrobial finishing on cotton fabric. Based on a pre antimicrobial test against selected microbes such as *Staphylococcus aureus*, *Escherichia coli*, *Candida albican*, and *Aspergillus niger*, three plants were selected out of twenty eight plants for green synthesis of copper nanoparticles. Plant extracts selected for the present experiment were namely, *Emblica officinalis* (amla), *Phyllanthus fraternus* (Bhumi amla), and *Syzygium cumini* (Jamun). Methanolic extract of plant extracts showed the presence of various phytochemicals such as alkaloids, flavonoids, phenols, tannins, and resins compounds, etc. In case of aqueous extract, most of the phytochemicals were found to be absent. TPC and TFC showed specific contents in each extract. Antioxidants activities of plant extracts possess potent antioxidant and reduction power. After these preliminary tests, plant extracts were used for reducing copper nanoparticles. The resulting copper nanoparticles were characterized by UV-Vis spectroscopy around 416.00nm, 415.00 nm, and 420.50 nm for E.CuNPs, P.CuNPs, and S.CuNPs respectively. FTIR analysis of CuNPs confirms the surrounding of these organic molecules such as polyphenols, alkaloids, and terpenoids, involved in the synthesis of CuNPs. XRD and SAED pattern indicates the crystallinity of the nanoparticle. DLS exhibited the average particle size around 142.01-203.65 nm whereas TEM micrograph indicated the shape and size of the nanoparticles, which were polydispersed and predominantly round, spherical, and cubical or square with particle size in the nano range between 24-38nm. Pharmaceutical analysis exhibited the anti-inflammatory and non-toxicity of the plant extracts and CuNPs. It was found that synthesized CuNPs showed effective antimicrobial activity than plant extracts. SEM micrograph indicated that the surface of CuNPs treated fabrics were coated with minute particles, certain particles are found to be agglomerated. The presence of CuNPs in the fabric is supported

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by the EDS analysis. After finishing treatment with the CuNPs and plant extracts, CuNPs treated fabrics retain more antimicrobial properties than the plant extracted treated fabric against test organisms. Furthermore, nanocoated fabrics enhance some of the physical properties, for instance, tensile strength and elongation, crease recovery, cloth weight as well as breathability don't exhibit any significant difference compared to the untreated fabric. Unlike *E. officinalis*, the total color value (K/S) of all the treated samples increased in comparison to the untreated fabric. Hence, it can be suitable for technical applications viz., medical textile, intimate clothing, sports textiles as well as it can use in dyeing purposes also.

Nano finishes on eri silk and its union fabric

Mamoni Probha Borah

Nano science and nanotechnology are considered to be the key technology for the recent era. The “nano” in nano technology refers to the material or chemical with a particle size of one billionth of meter. In textiles & apparel product nanotechnology can be used to provide performance characteristic like water repellent, fire retardant, UVresistance, stain resistance etc. Nano finishing of fabrics with different nano particles made the fibers to achieved desirable hand, surface texture, color and other special aesthetic and functional properties. Water-repellent means not easily penetrated by water. Water repellent is a state characterized by the non-spreading of water globules on a textile material. Fabric flammability is an important textile issue. The goal of flame retardancy is to inhibit or suppress the combustion process acting chemically or physically in the solid, liquid or gas phases. Eri silk fiber, yarn and fabric are the most unexplored, underutilized sector in textile industry and tremendous scope for application of nano finishes with different functional and aesthetic end uses. Australian merino wool produces a yarn of good quality. Preparation of union fabric from wool with eri silk had reduced maintenance cost and more productivity in the subsequent processes, cost effective too. Union fabrics used for better serviceability of fabrics but are also used for improved appearance and hand. Surface modification through nanotechnology was used to impart unique properties to fibers and fabrics. Nano-finishing has been done on different fibers like cotton, polyester, and other blended fibers for different functional end uses. However, no research on the properties of apparel and ability for eri silk fabrics and its union fabrics after being treated with flame retardant and water repellency has been reported in the literature Therefore, an attempt was made and studied on “Nano Finishes of Eri Silk and Its Union Fabric” with the following objectives-Selection of suitable chemicals for fire retardant and water repellent finishes; Optimization of finishing methods for fire retardant and water repellent finishes and assessment of physico- chemical and functional properties of finished fabrics. For water repellent and fire retardant nano finishing the plain weave eri silk and union fabric woven from eri silk and wool yarn were selected. The nano silica particle from rice husk, titanium dioxide was selected for water repellent nano finish. For fire retardant

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Major Advisor : Dr. Binita Baishya Kalita

nano finishing the nano clay and ammonium sulphamate were selected purposively. The nano particle from selected sources was applied in eri silk and union fabrics for water repellent and fire retardancy with and without polymer. For that, the optimization of application process was carried out where, different pH, concentrations of nano particles, material to liquor ration and application methods were optimized on the basis of drop test and 45° Inclined flammability test . The optimized condition for nano finishing on selected fabrics were done and evaluated for its physico-chemical and mechanical properties by using standard methods. The properties like fabric count, thickness, crease recovery bending length, tensile strength, elongation, stress, drapability, air permeability, wicking heights etc were accessed. The analytical properties like drop test, spray test, optical contact angle, were done for water repellency test and 45° inclined, Flammability test & limiting oxygen index was done for fire retardancy test. Apart from that particle size analysis, SEM, EDS etc was also carried out. The particles size analyzer confirmed that the chemical and natural sources that used for imparting nano finish in eri silk and union fabrics are nano in size which is less than 10000nm. From the study it was found that by using the optimized conditions for nano finishing of eri silk and its union fabric for functional finish with nano silica, titanium dioxide, nano clay and ammonium sulphamate with and without polymer the water repellency and fire retardancy properties have been successfully achieved. From SEM, it was found that the nanoparticles are penetrate uniformly inside in the fibers matrix and form a thin film on the surface of the fabrics leading to water repellency and fire retardancy of the treated fabrics and the EDS also confirmed the presence of nano particles elements are present in the treated fabric. For water repellency, the different standard tests are performed. Under drop test, it was observed that fabrics treated nano silica and titanium dioxide along with silicon polymer are more water repellent than without polymer. This was affirmed by optical contact angle showing above 150° means providing super hydrophobic fabric at higher percentage of nano particles, however it was also found that all the selected concentration showed hydrophobicity with water contact angle above 100° of contact angle. But after dry cleaning & washing the water repellency decreased to some extent but still at higher concentration, the water repellency was retained with contact angle above 100 degree. It was interesting to note that after abrasion the water repellency enhanced though some amount of distortion in fabric surface was observed. The enhancing in the water repellency may be attributed due to deposition of nano particles in the fabric surface forming a layer and inhibiting the water to penetrate. Other factors like weave structure, yarn twist and density also affecting the water repellency properties. The fire retardancy property of eri silk and union fabrics treated with optimized conditions for nano finishing with nano clay and ammonium sulphamate was carried out and the treated fabrics are evaluated for fire retardancy properties through 45° inclined flammability test & limiting oxygen index test. The char length and flame speed of treated samples were recorded and found that the control fabric burn entire length and the nano finished fabric took more flame speed

to burn and the char length was found to be very less when expose to flame and also lesser than the fire retardant classified class I, II and III. The flame speed was also recorded very less compared to control fabric, self extinguishing property was observed and no afterglow was recorded after burning. Hence, the nano finished fabric with nano clay and ammonium sulphamate produced fire retardant fabrics. Through SEM and EDS, it was observed that the nano particles adhered in the fabric uniformly and forming a thin film of the surface of the fabric thereby prohibiting the fire to catch easily by the fabric. The LOI test also showed that the fire retardancy property was achieved successfully. All the treated fabric showed the good fire retardancy property. But at the higher percentage of nano particles concentration showed excellent flame retardancy with LOI value $28 < LOI < 100$ with self extinguishing properties. The eri silk and union fabric treated with nano clay, ammonium sulphamate along with sodium poly acrylate polymer showed more flame retardancy property than without polymer. The atomic absorption spectroscopy analysis also confirmed the absorption of silica, titanium, silicone, sulphur in the treated fabrics and ensured the deposition and entanglement of nano particles are made appropriately. Textile with improved properties was created via a process called nano-finishing. The nano finishing technology development from this study can be commercialized and used for textile & apparel industry. The physical, chemical and functional properties analyses were carried out and results showed the positive trend in its property without much affecting the quality. From this study, it was found that, the nano silica with 5% & 7.5 %, 1.0 % of titanium dioxide, 2.5 % nano clay and 7.5% ammonium sulphamate along with and without polymer showed the best water repellency and fire retardant nano finishes on eri silk and its union fabric. The hydrophobic fabric surfaces were successfully prepared by treating nanoparticles with and without polymers in eri silk and union fabrics. Silica and TiO₂ nano particles are promising materials for functionalization of fibers and textiles because of their outstanding properties obtained from their nano size and extremely high specific surface made them as most useful additives to provide functional properties to fibers and textiles as well as suitable for industrial application. And the fire retardancy was also successfully achieved on eri silk and union fabrics. Based upon the above facts, it could be concluded that the developed water repellent and fire retardant nano finishes on eri silk fabric could find applications in domestic and industrial textiles.

Master of Science (Agriculture)

- **Agricultural Biochemistry**
- **Agriculture Biotechnology**
- **Agricultural Economics and Farm Management**
 - **Agronomy**
 - **Agrometereology**
 - **Crop Physiology**
 - **Entomology**
 - **Extension Education**
 - **Horticulture**
 - **Nematology**
- **Plant Breeding and Genetics**
 - **Plant Pathology**
 - **Sericulture**
 - **Soil Science**
- **Tea Husbandry and Technology**

Nutritional composition and antinutritional factors of Millets of Assam

Debanjal Borah

Millets are a group of small-grained, gluten-free cereal food crops belonging to the Poaceae family. Millets are characterised by a higher content of protein, dietary fibre, crude fat, carbohydrates, minerals, micronutrients and phytochemicals. Millets nowadays have become more relevant because of its health-promoting benefits along with its ability to thrive in extreme climatic conditions, low fertiliser, and pesticide requirement.

In the present investigation, eight millet germplasms from Regional Agricultural Research Station (RARS), Gossaingaon were evaluated and compared for biochemical constituents of quality significance and antinutritional effects with Mahsuri (Aijong) variety of rice, popular in Assam. Millet germplasms were found varying significantly in their proximate composition with moisture content ranging from 9.59 - 12.24 %, crude fat from 1.64 - 3.49 %, crude protein 6.67 - 12.04 %, crude fibre 3.85 -7.58 % and ash content from 2.07 - 3.27 % on a dry weight basis. Starch and amylose content were found to be in the range 63.38 -72.87 % and 20.99 - 32.76 % dry weight, respectively. Total phenol content and antioxidant activity of millet germplasms ranged from 190.58 - 280.89 mg GAE/100 g and 163.07 - 335.73 µg/ml respectively. Millet contained calcium and iron in the range from 23.62 - 291.87 mg/100 g and 3.83 - 6.52 mg/100 g dry weight, respectively. The antinutritional factors in millets like tannin, phytate P and oxalate were found in the range from 53.48 – 136.13 mg/100 g, 193.83 – 663.81 mg/100 g and 4.84 – 13.74 mg/100 g dry weight, respectively. Rice exhibited less crude fat, crude protein, crude fibre, ash, minerals, phenol and antioxidant activity as well as low levels of tannin, phytate P, oxalate compared to the millet germplasms. Of the eight millet germplasms used in the study, released genotypes VR-1117, KMR-652 and local genotypes Red, Local appeared to be superior over the others in terms of nutritional quality.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Samindra Baishya

Nutritional evaluation of few Sesame genotypes of Assam

Horipriya Thengal

Sesame (*Sesamum indicum* L.) is an important and oldest oilseed crop of tropical and sub-tropical region with high oil content and hence it is known as the king of oil seeds. Sesame seeds are popularly known as 'til' in India. The sesame oil is markedly different from other vegetable oils due to its high nutritional and therapeutic values. Besides, its high oil content, it is also known for the properties of good health which consists of plethora of nutrients viz., proteins, carbohydrates, antioxidants, lignans, tocopherols and other micronutrients. Sesame seeds with high amounts of nutritional components are consumed as a traditional health food for its specific antihypertensive effect, anticarcinogenic, anti-inflammatory and antioxidative activity.

In the present investigation, thirteen sesame genotypes from RARS (Regional Agricultural Research Station, Diphu) were evaluated for its nutritional composition and characterization of oil. The genotypes showed a considerable variation among different constituents analyzed. Moisture contents of sesame genotypes ranged from 5.19 to 7.66 per cent, carbohydrate from 11.25 to 19.54 per cent, crude protein from 19.32 to 22.81 per cent, crude fat from 35.81 to 49.25 per cent, crude fiber from 3.23 to 9.74 per cent and ash from 1.50 to 5.53 per cent on dry weight basis. Total phenolic content was found between 0.88 to 1.98 mg catechol equivalent/g, flavonoids content between 0.11 to 0.19 mg quercetin equivalent/g and DPPH inhibition percentage between 59.30 to 67.75 per cent on dry weight basis. The iodine, saponification value and acid value were found in the range of 81.64 to 113.79 g I₂/100g oil, 159.89 to 206.64 mg KOH/g oil and 0.56 to 2.16 mg KOH/g oil respectively. Sesame contains minerals like iron, calcium, sodium and potassium ranged from 1.34 to 10.01 mg/100g, 975.33 to 1282.67 mg/100g, 17.80 to 65.40 mg/100g and 108.00 to 379.33 mg/100g respectively. From the results of the present investigation, it can be concluded that the genotypes '*Nemposoksu*, *AUDT-303-1-1* and *Meghalaya local-1*' are found to be superior. The present findings suggest to study the complete fatty acid profiling, protein profiling, mineral profiling, amino acid profiling, vitamin contents etc. for nutritional evaluation of the sesame genotypes. The study also necessitates for the evaluation of some sesame genotypes so that the nutritionally superior cultivars which can be differentiated.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Khanin Pathak

Studies on metabolism of iron in rice

Madhusmita Baruah

Rice, though rich in carbohydrates and proteins, lacks micronutrients like iron and zinc. Considering several disadvantages of fortification of iron in food, emphasis is given on biofortification of iron in plants, including rice grains. Though, there exists threat of iron toxicity in some of the rice varieties grown in lowland acid soils of this region, the present study was conducted to know the effect of two different levels of soil iron content on some biochemical parameters including grain iron content of rice plant.

Three rice varieties, including two popular varieties of Assam, *Ranjit* and *Mahsuri*, and one traditional pigmented variety *Kajoli chakua* were cultivated in pots at two different levels of iron: marked as control and treated; in which DTPA extractable iron content of soil were 159.40 mg/kg and 182.35 mg/kg, respectively.

Within the range of soil DTPA extractable iron content (159.40 mg/kg - 182.35 mg/kg), iron toxicity was not observed. The analysis revealed that the iron content, chlorophyll content of leaves and the activities of antioxidative enzymes *viz.* peroxidase, superoxide dismutase and catalase varied significantly at different growth stages. Among the three rice varieties, uptake of iron in rice leaves and grains were found in the order *Ranjit* > *Kajoli chakua* > *Mahsuri*. The iron content of brown rice significantly differed according to its position on the rachis, the order being: top primary rachis > top secondary rachis > middle primary rachis > middle secondary rachis > bottom primary rachis > bottom secondary rachis. The iron content of brown rice of all the three varieties increased significantly (more than 100 % than that of control) in plants grown in soils of higher iron content. Specific activity of all the three enzymes showed that higher the iron content, more the specific activity.

Considering initial iron status of the soil, application of iron solution of suitable concentration may be advocated for increasing grain iron content of these three rice varieties.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Priyanka Das

Nutrient composition and total antioxidant activity in selected eggplant (*Solanum melongena* L.) germplasms

Minakshi Dutta

Eggplant, also known as brinjal is one of the most popular vegetable across the world. It ranked as one of the top ten vegetable amongst 120 different vegetables having antioxidant capacity. It contains powerful antioxidants like ascorbic acid and phenolic along with other nutrients like protein, carbohydrate and dietary fibre. In the present investigation, Matured fruits of six selected eggplant germplasm collected from Horticultural Experimental Farm, AAU, Jorhat were evaluated for their nutrient composition and antioxidant properties. Germplasm were found varying significantly in their proximate composition with moisture content ranging from 88.140-91.327% on fresh weight basis, ash content (6.576-9.5%), total soluble sugar content (4.559-6.827%), reducing sugar content (0.575-3.383%), crude protein content (0.783-2.736%), crude fibre content (1.410-3.420 %) and crude fat content (0.940-1.813%) on dry weight basis. Antioxidant properties like ascorbic acid content found in the range of 12.486-31.78 mg/100g on fresh weight basis. Total phenol content, chlorogenic acid content and flavonoid content from 604.920-1007.006 mg GAE/100g, 150.820-342.650mg/100g and 10.729-22.192 mg/100g respectively on dry weight basis. Anthocyanin content was found in the range of 5.156-14.5174 mg/100g on fresh weight basis. DPPH radical scavenging activity was found in the range of 88.860-205.070 µg/ml IC50 value on fresh weight basis. Of six eggplant germplasm used in the study JC1 was found superior over other varieties in terms of nutritional quality having highest amount of crude protein, reducing sugar, ascorbic acid and chlorogenic acid content and SM-6-7 was found superior in terms of antioxidant properties having highest content of total phenol and highest antioxidant properties. The germplasm found superior in terms of nutritional and antioxidant properties among the others can be recommended for consumption and can be used as starting material for different breeding purposes. Also they can be used for evaluating other factors like glycoalkaloids which gives an off-flavour for determining a superior variety in terms of both the aspect of nutrition and flavour.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Sunayana Rathi

Quality analysis of buckwheat (*Fagopyrum esculentum* Moench) genotypes of Assam

Mousumi Thakur

Buckwheat (*F. esculentum*) is a gluten-free pseudocereal with high biological value. It occupies a special place amongst cultivable crops due to its nutritional, dietetic and therapeutic properties. Buckwheat grain is characterized by a high content of starch, protein with an advantageous amino acid composition, a low content of α -gliadin and a high content of dietary fibre. The protein of buckwheat is of excellent quality and is high in the essential amino acid lysine, unlike common cereals. It was a very popular food during the 17th-19th centuries, lost its popularity because of competition from wheat during 20th century, but has recently become popular again because of its health-promoting properties.

In the present investigation, sixteen buckwheat germplasm from RARS, North Lakhimpur were evaluated for biochemical constituents of quality significance. Buckwheat germplasm were found varying significantly in their proximate composition with moisture content ranging from 7.52-9.11%, crude protein from 7.23-9.53%, crude fat 1.97-3.62%, ash 1.83-2.93% and crude fibre from 3.71-4.78% on dry weight basis. Starch, amylose and resistant starch were found in the range of 63.18-72.61%, 22.45-24% and 15.20-20.53% respectively with nitrogen free extract ranging from 71.41-76.97%. Total soluble protein ranged from 4.58% to 7.40% and globulin was the major fraction (2.12-3.53%), followed by glutelin (0.96-1.65%), albumin (0.76-1.35%) and prolamin (0.13-0.24%). Buckwheat contained calcium, iron, phosphorus, potassium and sodium from 144.00-215.33, 2.50-3.50, 242.61-282.00, 237.00-298.27 and 1.56-4.24 mg/100gm respectively. Total phenolic content was found between 378.41 to 652.71 mg/100g and flavonoids between 33.80 to 60.11 mg/100g on dry weight basis. Of the sixteen buckwheat germplasm used in the study, released genotypes Himpriya, VL-7 and PRB-1; local genotypes BWC-1, BWC-2, Jonai and Kharupetia-2; accession genotypes EC-218742 and EC-27242 were found superior over the others in terms of nutritional quality.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Samindra Baishya

Nutritional and antinutritional properties of some edible insects of Assam

Saihlupuii Sailo

Edible insects are considered as underutilized foods that offer significant potential to meet the future global food demands. Insects, traditionally were an integral element of human diets in nearly 100 countries of the world, especially in Asia, Africa and Latin America. Edible insects provide satisfactory energy, protein, monounsaturated fatty acids, polyunsaturated fatty acids and rich in several minerals such as copper, iron, magnesium, manganese, phosphorous, selenium, zinc and vitamins such as riboflavin, pantothenic acid, biotin and folic acid etc. Besides nutritional importance, the edible insects also possess an ample sources of antioxidant properties such as phenol, flavonoid as well as some antinutritional components.

In the present investigation, five different edible insects like red ant (*Oecophylla smaragdina*), muga silkworm (*Antheraea assamensis*), honey bee (*Apis cerana*), winged termite (*Odontotermes obesus*) and eri silkworm (*Samia ricini*) were evaluated for biochemical constituents. The range of moisture, crude fat, crude protein, total soluble protein, crude fibre, carbohydrate and ash were between 6.30-16.04 per cent, 10.20-36.08 per cent, 23.31-52.35 per cent, 12.54-18.71 per cent, 3.16-9.71 per cent, 7.20-16.84 per cent and 2.58-5.60 per cent respectively. Five different edible insect species had sodium content ranging from 10.67-149.10 mg/100g, potassium from 9.68-710.49 mg/100g, calcium from 20.65-222.83 mg/100g, iron from 5.70-25.18 mg/100g and zinc from 5.40-35.18 mg/100g respectively. Antinutritional components like tannin, phytic acid and oxalate were recorded as of 97.82-236.31 mg tannic acid equivalent/100g, 8.55-97.91 mg/100g and 1.49-3.79 mg/100g respectively. The range of phenol content, flavonoid content and antioxidant activity (DPPH) were recorded between 25.78-210.06 mg catechol equivalent/100g, 4.96-44.68 mg quercetin equivalent/100g and 89.36-94.41 per cent respectively. All the five edible insect species exhibited a well-balance nutrient profile and therefore, these could be the potential source for human food and animal feed.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Khanin Pathak

Extraction and characterization of natural colourants from indigenous plant species for use in food industry

Simanta Das

Color appearance of food products is one of the major concerns of food industry. Pigments from natural sources may display a wide range of colors and are usually safe compared with synthetic derivatives. Among different pigments widespread in nature, anthocyanins play a crucial role when dealing with natural colourants. Anthocyanins comprise a group of naturally occurring pigments which are responsible for the blue, red, purple, violet and magenta coloration of most species in the plant kingdom.

The present investigation was intended to study the phytochemical composition as well as characterization and stability analysis of anthocyanin extracted from selected plant samples for use as food colourants. Selected plant samples viz. *S. cumini* L., *S. cumini* L. (wild), *Basella alba* L., *Basella rubra* L., *R. indica* L., *R. damascena* Mill. and *R. bracteata* J.C. Wendl. were collected from different places of Jorhat district. The morphological data were taken from the mature plant samples. The selected plant samples were found to contain varying amounts of percent moisture content, total phenolics, total flavonoids, total alkaloid, total terpenoid, total soluble protein, ascorbic acid, total ash content and minerals like phosphorous, sodium, calcium, potassium and iron. Total phenolics content was found highest in *Rosa indica* L. (1516.52 mg GAE/100g) and the flowers of *Rosa damascena* Mill. was found with higher total flavonoids content of 262.88 mg QE/100g followed by other selected plant samples. The anthocyanin content was found highest in *S. cumini* L. (124.87 mg/100g) followed by *R. indica* L.(115.26 mg/100g) and *S. cumini* L. (wild) (91.41 mg/100 g).UHPLC analysis of the extracted colourant showed that pelargonidin-3-glucoside was the major anthocyanin followed by delphinidin-3-glucoside in extracted colourant of both *S. cumini* L. and *S. cumini* L. (wild) fruits. On the other hand, delphinidin-3-glucoside was the major anthocyanin followed by pelargonidin-3-glucoside in *R. indica* L. The

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Ranjan Kandali

anthocyanin pigments was found to be stable at an acidic pH (up to pH 5) and below 40° C temperature. The percent pigment retention of *S. cumini* L., *S. cumini* L. (wild) and *R. indica* L. at 40° C were 72.72, 68.79 and 77.31 %, respectively. Moreover, the light stability study showed that the colourant illuminated with 2,500 lux for 6 hour could retain the activity of anthocyanin.

A new food product was developed by immobilizing the extracted colourant on *Colocasia esculenta* (var *Ahina*) powder. The final food product contained total phenol content of 71.83 mg GAE/100g (Colourant from *S. cumini* L.). The anthocyanin content increased to 44.76 mg/100g. The change in starch content was also found very less after one month of storage period. Also, heating the final food product at 100°C for half an hour resulted in marginal decrease in total anthocyanin content.

Juice extracted from selected plant samples were analyzed to study color hue, color intensity, juice pH, percentage of juice content, total soluble solid content, ascorbic acid content and titrable acidity.

Assam Lemon (*Citrus limon*) beverage enriched with extracted colourant was also prepared. The nutritional analysis such as total soluble solid, pH, acidity, total soluble sugars, vitamin C, total ash and minerals (iron and phosphorous) of Assam Lemon (*Citrus limon*) pulp were analyzed. Assam Lemon (*Citrus limon*) added with colourant showed total anthocyanin content varying from 87.48 mg/100g (*S. cumini* L., wild) to 119.91 mg/100g (*S. cumini* L.).

Further studies will be required for assessing the other nutritional parameters of carrier materials mixed with colourants. The antioxidant activity as well as anti nutritional factors of final food product are required for better development of food colourants. The study further suggested that besides anthocyanins the selected plant samples may contain other pigments which have the potentiality to act as a substitute for synthetic food colourants.

Carbohydrate and micronutrient profiling of a few indigenous rice varieties of Assam and their products

Suchandra Bhattacharjee

Rice is known as the ‘grain of life’. It is the staple food for more than half of the world’s population. Approximately 20% of the world’s dietary energy supply is exclusively from rice-based nutrition. Due to processing, alteration of nutritional quality takes place either by changes in nutrients or by an improvement in digestibility of nutrients. *Hurum, komal chaul, bhoja bora*, puffed rice, popped rice, flaked rice, *korai, sandahguri* are the rice products obtained from specialty rice varieties of Assam. A unique characteristic of these rice products is that the products can be used instantly. In Assam, both the low and intermediate amylose containing rice varieties are used for preparation of such products. Considering availability of few information on such products having ethno economic importance and also on changes taking place during processing of those products, the present study was proposed.

In the present study, the moisture content of specialty rice and their products were found to be 6.55% to 14.43%. On dry weight basis, the total carbohydrate, starch, amylose, resistant starch and total soluble sugar content ranged between 88.53% - 92.17%, 42.39% - 76.34%, 6.60%- 14.29%, 3.96% - 6.15% and 6.22% - 10.85%, respectively. On dry weight basis, the total ash (%) and the minerals (mg/100g) like sodium, calcium, potassium, phosphorus, zinc, and iron ranged between 0.66- 1.34, 37.33- 63.33, 11.32- 27.67, 64.32-220.33, 250.26- 494.50, 2.14-4.08 and 2.13- 6.91, respectively. The crude protein, crude fat and crude fibre content were observed to be 5.83-9.20%, 0.10-0.41% and 0.62-1.13%, respectively. The total phenol and thiamine content ranged between 61.67-103.30 mg catechol equivalent /100g and 0.233- 0.397 mg/100g, respectively. The phytic acid phosphorus (antinutritional factor) content ranged between 92.74- 345.92 mg/100g. The present study reveals higher amount of resistant starch, crude protein, crude fibre, thiamine, total ash, iron and zinc content are present in products like *hurum, komal chaul, bhoja bora*, flaked rice, *korai and sandahguri* than their respective raw forms. However, the observation of decrease in phytic acid content in all these products reveals that the processing improves digestibility.

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. Priyanka Das

Biochemical Changes in *Khasi* Mandarin (*Citrus reticulata* Blanco) during Ripening

Surajit Moni Deka

Physical and biochemical constituents of the fruit *khasi* mandarin (*Citrus reticulata* Blanco) cultivated in Assam was studied during different stages of development after 90 days after fruit setting (DAFS) to 210 DAFS. The fruits were analysed for physical parameters such as fruit weight, diameter, volume, pulp weight, peel weight and pulp-peel ratio as well as moisture, juice percentage, TSS, titratable acidity, sugar, juice pH, organic acid, ash and minerals (Na, K, P, Ca).

Fruit weight increased from 23.46 g at 90 DAFS to 78.32 g at 210 DAFS. Fruit diameter increased from 3.13 cm at 90 DAFS to 5.20 cm at 210 DAFS. Fruit volume also increased from 24.66 cc at 90 DAFS to 78.67 cc at 210 DAFS. Pulp and peel weight increased from 16.98 g and 6.48 g respectively at 90 DAFS to 61.06 g and 17.26 g at 210 DAFS respectively. Pulp: peel ratio also increased from 2.62 at early stage to 3.52 at last stage of observation. Juice content increased from 29.23 % at 90 DAFS to 46.03 % at 210 DAFS. The highest moisture content 87.37 percent was observed at 210 DAFS which was significantly higher than that of moisture content at 90 DAFS (74.48 %). Lowest TSS content 5.83 percent was observed at 90 DAFS then it increased to 8.84 percent at last stage of observation (210 DAFS). There was a decreasing trend of titratable acidity from 3.19 percent at 90 DAFS to 0.85 percent at 210 DAFS. TSS/Acidity ratio showed increasing trend in a significant manner towards maturity. Reducing, non reducing and total sugar increased from 1.65, 0.87 and 2.52 percent respectively at 90 DAFS to 2.85, 3.86 and 6.7 percent respectively at 210 DAFS. Citric acid content was found to decrease from 644.17 to 94.24 mg per 100 ml fresh juice. Oxalic acid content in the fruit was observed to be increased up to 150 DAFS then it decreased. Highest fumeric acid content was recorded at 90 DAFS as 20.78 mg/100ml of fresh juice. Highest ascorbic acid content 83.88 mg/ 100 g was observed at 210 DAFS. Ash content decreased from highest 5.14 per cent at 90 DAFS to the lowest 1.94 percent. Calcium content in the fruit decreased from 0.63 to 0.39 g/100 g. Potassium content also decreased gradually from 90 DAFS to 210 DAFS. Highest Sodium content was found at 90DAFS and found to decrease upto 180 DAFS. Phosphorus content of the pulp increase from 0.15g/100g (90 DAFS) to 0.26g/100g (150 DAFS) then decreased to 0.15 g/100g (180 DAFS) and then again increased to 0.17 g/100g (210 DAFS).

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. A. M. Baruah

Studies on *Neptunia oleracea* Lour. (Water Mimosa) - A plant with phytoremediation potentiality

Yenkokpam Supriya

Because of the enormous diversity in flora & fauna, the north eastern region of India has long been recognized as the biodiversity hotspot. A great diversity has also been observed in aquatic plants growing in this region. These plants are widespread in natural and man-made wetlands. Although a number of studies have reported several of them as being useful, but many of them are still unexplored. *Neptunia oleracea* Lour. commonly known as water mimosa or water sensitive plant is a wild aquatic legume. In India, the plant is distributed in Assam, Manipur and Tripura in North-East India. In Manipur, this plant is used as a vegetable by the Meiteis, the valley inhabitants and is considered as a local delicacy. Moreover, the ability of this plant to accumulate heavy metal can be explored for its use in phytoremediation of soil. The present investigation was intended to study the morpho-phenological as well as biochemical characteristics of *Neptunia oleracea* Lour. and evaluation of its phytoremediation potentiality on arsenic contaminated water. The plant materials were collected from West Imphal district, Manipur. The study of plant morphology revealed that the stem length at the maturity was 1.47m. Mature leaves were green in color with length and breadth of 7.06 cm and 4.9 cm, respectively. The roots were adventitious and fibrous with average number of root nodules to the extent of 20.66 per plant. The phenological characteristic showed that flower developed during July-September in rainy season. The flowers were bright yellow in color, silky and bloomed for about 7-11 days. The inflorescence type was spike where it was a type of raceme with flowers that were absence of pedicel and erect. The mean length of inflorescence was 11.1 cm with peduncle length of 9 cm. The fruit occurred in October-November with mean length of 6.16 cm. An average of 32 seeds/fruit was observed where as in each pod 5 seeds with mean seed weight of 12.9 mg were recorded.

The percent moisture content in shoot and root was found to be 79.200% and 71.033%, respectively which significantly varied (C.D_{P>0.05}=5.732). The crude protein content in the shoot was 6.410 g/100g and in the root 7.933 g/100g. There was a

Abstract of M.Sc. Thesis

Department : Agricultural Biochemistry

Major Advisor : Dr. R. Kandali

significant difference (C.D $P_{>0.05}$ =0.586) in the crude protein content in shoot and root of *Neptunia oleracea* Lour. In this investigation the crude fat content in shoot was 0.403g/100g and in root it was recorded to be 0.173g/100g. The amount of vitamin C in the shoot was found to be 1.698 mg/100g and in root it was recorded to be 1.357mg/100g on fresh weight basis. Statistically, there was a significant difference (C.D $P_{>0.05}$ =0.272) in the shoot and root vitamin C content. Soluble protein recorded in the shoot of *Neptunia oleracea* Lour. was 2.560g/100g and in root it was 1.377g/100g on a dry weight basis. Statistically, there was a significant difference in the shoot and root content of soluble protein in *Neptunia oleracea* Lour (C.D $P_{>0.05}$ =0.316). In this investigation the starch content in shoot was 1.355g/100g and in root was 1.177g/100g on dry weight basis while the total soluble sugar found in the shoot was 0.572g/100g and in root it was 0.320g/100g on dry weight basis. There was a significant difference found in the total soluble sugar content in shoot and root (C.D $P_{>0.05}$ = 0.0874). The ash content obtained in this investigation was 1.390g/100g and 0.940g/100g in shoot and root respectively with a significant difference (C.D $P_{>0.05}$ =0.0642). The mean calcium content recorded in the shoot was 344.960 mg/100g and in root was 358.830 mg/100g on dry weight basis which varied significantly (C.D $P_{>0.05}$ =7.321). The sodium content in shoot was 224.100 mg/100g and in root was 197.660 mg/100g on dry weight basis which significantly varied (C.D $P_{>0.05}$ =7.542). There was high potassium content in shoot of about 622.330 mg/100g and in root it had a value of 530.033 mg/100g on dry weight basis. The zinc content was recorded to be 10.310 mg/100g in shoot and 9.960 mg/100g in root on dry weight basis. The experiment on phytoremediation of arsenic contaminated water using *Neptunia oleracea* Lour revealed that the plant tissue with the treatment T₃ (2.5mg/L) showed an arsenic accumulation to the tune of 1472 ppb which was about 60% of the initial arsenic content in water thus making it a strong candidate for phytoremediation of arsenic contaminated water.

From the present investigation it can be concluded that *Neptunia oleracea* Lour. had high crude protein, potassium, calcium and ash content. Further, a low crude fat was advantageous. The high content of some important minerals, such as potassium and calcium makes it nutritionally superior. The plant also displayed a strong phytoremediation potentiality by removing as much as sixty per cent of the arsenic present in water which might be useful to develop suitable technology to remove excess arsenic in freshwater systems as well as underground water in north east India where arsenic is a major contaminant.

Identification and Validation of drought-responsive genes in the upland rice cultivar 'Banglami'

Akankshita Borah

Drought is one of the most important and highly unpredictable abiotic stresses causing drastic reductions in yield under rainfed rice environments, affecting 20% of the total rice-growing area in Asia (Pandey and Bhandari, 2008). Assam has diverse germplasm of rice which includes Banglami, a traditional drought-tolerant Ahu rice cultivar found locally in the state. Since 2013, crossing has been carried out between this drought-tolerant cultivar and Ranjit, a high yielding but drought-susceptible elite cultivar. Many drought-related QTLs were identified and reported from this cross-population. For the current study, twenty QTLs identified in the F4 population were selected for mapping on the parental genome. The results revealed that 17 of the 20 QTLs were present on the parent genomes where 11 of the 20 QTLs (*qEBT3.1*, *qEBT6.2*, *qNOT6.1*, *qNOT2.1*, *qPL1.1*, *qPL1.2*, *qPL9.1*, *qPL9.2*, *qPL1.1*, *qNOG9.1*, *qNOG12.1*) were found common to both the cultivars. From these, two of the QTLs (*qGY1.1*, *qGY7.1*) were found to be exclusively contributed by Banglami while four of the QTLs (*qRLWC9.1*, *qRLWC9.2*, *qPH7.1*, *qDTF12.2*) were found to be contributed by Ranjit to the cross-population. Genes associated with the QTLs were identified from whole-genome sequence data of both the cultivars. In total, 2454 genes were located in the 13 QTLs found in Banglami while 1585 genes were found in Ranjit in the 15 QTLs. The differential expression of the candidate genes in water-stress and irrigated conditions were calculated with the help of available RNA-seq data. Differential gene expression was calculated for each of the candidate genes under drought and control. Fifty DEGs in Banglami and seventy-two DEGs in Ranjit having a Log₂ Fold change greater than ± 2.5 up to \pm infinity were considered significant. Few of the differentially expressed genes having a significant Log₂Fold change as revealed by the sequencing data, were confirmed experimentally under drought situation using qRT-PCR. Stress-responsive candidate genes involved in nitrate uptake, DNA repair, ubiquitination, enzymatic activities, cell cycle activities, etc. which can play a significant role in

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conferring drought tolerance were identified in the drought-related QTLs. The expression pattern of the candidate genes in qRT-PCR was found similar to transcriptome studies, signifying important role of the candidate genes in drought tolerance mechanism in rice.

A study on the prospect of microbe-mediated enhancement of anaerobic germination in few popular rice cultivars of North-East India

Amrita Churaman

Rice (*Oryza sativa* L.; family: *Gramineae*) is the predominant cereal crop and its cultivation is the backbone of the economy of several countries including India. The crop is traditionally established by raising seedlings in seed beds followed by transplanting them into the main field. The Direct Seeded Rice (DSR), promoted as a means of sowing to manage the time and labor-intensive system of traditional transplantation, is constrained by low crop establishment due to recurrent floods during the sowing season since the rice seeds are sensitive to low oxygen stress during germination. Pre-treatment of hypoxia-susceptible rice cultivars with efficient plant growth-promoting rhizobacteria can enhance germination under flooded condition and provide a solution to recurrent flood-induced crop damage. In this study, one hundred and twenty-six popular rice varieties of the NE region were screened for hypoxia germination and categorized as susceptible (82), intermediate (26) and tolerant (18) varieties. Cultivars positive for hypoxia showed germination percent of $\geq 80\%$ and coleoptile length of $\geq 8.5\text{cm}$. Further, forty bacterial isolates from a core microbial collection were screened for hypoxia germination promoting traits following a series of biochemical and molecular analyses; and the most efficient isolates were evaluated for their growth promoting efficacy in the different categories of rice cultivars through seed biopriming. As compared to the untreated controls, the bio-primed rice seeds with the efficient isolate ABT_AC37 (*Bacillus altitudinis*) revealed a significant ($p < 0.05$) increase in the germination percentage (at least by 40%) and mean coleoptile length (~25%) in all the categorical representative varieties. Biochemical analysis showed significantly higher amylase and trehalase activity in the treated varieties which were in congruence with the Quantitative Real-Time PCR (qRT-PCR) data revealing increased transcript levels for *ADHI*, *RAmy3D* and *CIPK15* gene in the treated varieties as compared to the untreated varieties for day 3 and day 5 post-germination. Principal

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component analysis (PCA) indicated the bio-primed plants with elevated levels of stress-responsive metabolites such as LysoPE 18:0, Aspe Aspe, Tryptophan, MAG (18:3), Gibberellin, Acetic acid etc. Biopriming of hypoxia-sensitive landraces with the PGPB, *B. altitudinis* can enhance their survival rate under flooded conditions. Validation of the findings of this study at the Field level can encourage the adoption of DSR.

Genetic diversity analysis of mild insect resistant wild and cultivated chickpea (*Cicer arietinum* L.) genotypes

Ankur Mahanta

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crop grown all over the world and India is the major producer. Despite being the largest producer, India still imports chickpea from other countries because of its low productivity. In Assam, the chickpea growers suffer as the cultivars available in the state are susceptible to various insect pests which appear to be the most important reasons for low productivity. In order to enhance the genetic potential of cultivated chickpea one has to assess the extent and the pattern of real diversity available in the existing cultivated and wild accessions (Croser and Ahmad *et al.* 2003). In the present study, we have characterized 18 chickpea genotypes belonging to *C. arietinum*, *C. reticulatum* & *C. judaicum*, based on morphological traits and molecular data of 48 SSR markers to analyze their genetic diversity and phylogenetic relationship. Morphological diversity analysis showed a significant variation for seed yield/plant, growth habit and flower colour. Considerable diversity was recorded from the SSR data analysis with a polymorphic information content ranging from 0.12 to 0.47 with a mean of 0.31. Most of the diversity was confined to the *C. judaicum* genotypes with respect to its average Jaccard's similarity coefficient (0.246) and average Euclidean distance (9.098). The dendrogram generated for both morphological & SSR data reflects similarities between the cultivated and *C. reticulatum* genotypes while genotypes of *C. judaicum* were diverse and distinctly unique from the other genotypes. A better understanding of the diversity and relationships within and among the genotypes will contribute to identification and utilization in breeding program to widen the genetic base of this cultivated species, for the development of elite lines with superior yield and improved adaptation to diverse environments.

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Major Advisor : Dr. B. K. Sarma

Characterization of xylanase enzyme from fungal strains of North Eastern region of India

Dipankar Saha

Xylanases are hydrolytic enzymes produced by a variety of microorganisms including fungi. The enzyme hydrolyzes the main hemicelluloses component by cleaving the β -1, 4 backbone of the complex plant cell wall polysaccharide xylan. Fungi are reported to produce a wide variety of xylanases that are not only capable of degrading xylan to renewable fuels and chemicals but have also found industrial application in food, paper and pulp industries. In recent years, there has been growing awareness in applying green biotechnology to industrial processes to decrease pollution as well as improve the quality of the product produced. Scouring for readily available and cost-effective source of this enzyme is important in the context of environmental sustainability. The Northeastern region is known for its biodiversity harbors. Several species of fungi whose industrial application or as a source of important products has been reported scantily. The present study focuses on the isolation and characterization of xylanase enzymes from selected fungal isolates of this region. Twenty five (25) previously isolated fungal isolates were taken from the Microbial Biotechnology Lab, Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat for the study. Preliminary plate screening of the isolates revealed xylanase activity in four isolates viz. *Lentinus squarrosulus*, *Fusarium oxysporum*, *Lentinussajor-caju* and *Fusariumfujikuroi*. The Xylanase positive isolates were grown in liquid media and enzyme activity was assayed up to 15 days at a 2 days interval. Highest xylanase activity was recorded on the 7th day of inoculation in *Lentinussquarrosulus*, *Fusarium oxysporum*, whereas *Fusariumfujikuroi* and *Lentinus sajour-caju* showed the highest xylanase activity on the 5th and 9th day of inoculation respectively. Xylanase enzyme was partially purified from culture supernatant by precipitation using ammonium sulphate (80% saturation). The precipitated crude enzyme was dialyzed against 1mM sodium acetate buffer (pH 5.3). *Fusarium oxysporum* showed the highest xylanase activity (28.71 ± 0.11 U/mL) in the partially purified extract. Zymogram analysis of partially purified enzymes suggested the presence of single active xylanase in each sample. However, electrophoretic mobility of the xylanase of each sample was different. SDS PAGE

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analysis indicated the presence of multiple subunits in the xylanase enzyme. Xylanase activity and stability were optimized in different pH and temperatures. All the samples are pH and temperature specific and highly stable at 5.0-6.0 pH and 20°C-50°C. Further studies with improved purification techniques will pave the way for purified xylanase enzyme that may be useful in different industrial purposes.

Study of mitochondrial morphology and membrane potential during electron transport chain dysfunction in the model organism *C. elegans*

Gadi Sri Harsha Vardhan

Mitochondria are highly dynamic, double membrane-bound cell organelles ubiquitously found in most eukaryotic cells. The major source of cellular energy in the form of ATP is generated through oxidative phosphorylation through Electron Transport Chain (ETC) of innermitochondrial membrane. Mutations in ETC complex proteins and mitochondrial toxicants will lead to ETC dysfunction which results in the disruption of mitochondrial membrane potential ($\Delta\Psi_m$). Mitochondria undergo coordinated cycles of fission, fusion, biogenesis, and degradation (mitophagy) and these process are linked with $\Delta\Psi_m$. Disruption of ETC is directly associated with many mitochondrial, metabolic, neuronal diseases and also with aging. So, it is important to understand the mitochondria morphological adaptations in maintaining cellular function and cellular homeostasis.

Using *Caenorhabditis elegans* as a model, we studied the effect of ETC dysfunction on mitochondrial morphology and membrane potential. We analyzed the pattern of change in mitochondrial shape, distribution along with $\Delta\Psi_m$ during ETC dysfunction caused by mutations in mitochondrial proteins and paraquat (produce superoxide) induced oxidative stress. The *C. elegans* mitochondrial mutant strain *isp-1(qm150)* with a defective complex- III (Reiske iron-sulfur protein) is used to study mutation induced ETC dysfunction. A consistent significant difference in mitochondrial morphology and membrane potential between ETC mutant *isp-1(qm150)*, paraquat treated and control (wild type) has been observed using confocal microscopy. We observed consistent decrease of mitochondrial quantity, $\Delta\Psi_m$ and increase in circularity of mitochondria in worms treated with different concentrations of paraquat compared to control. Even though we didn't found significant difference of mitochondria morphological between wild type and *isp-1(qm150)* but there is a notable difference in $\Delta\Psi_m$, indicating decreasing in the rate of respiration. As mitochondrial function is conserved from worm to human and plants, understanding these basic process will helps in future intervention of diseases to improve human health and also crop productivity.

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Major Advisor : Dr. Aiswarya Baruah

Genomic studies for aroma in Joha rice of Assam

Kingsuk Das

The *badh2* locus for aroma in Basmati and Jasmine rice has been extensively studied and the present study was intended to target the functional marker for aroma, *badh2* to determine the fidelity of the marker and validate the same to group the joha rice of Assam in particular. A total of 90 small-grained rice cultivars including 60 joha rice was included in the study. All the fieldwork and laboratory work were carried out at the ICR farm and in the Department of Agricultural Biotechnology, AAU, respectively. The study revealed that the majority of the joha cultivars (44) and 22 non-joha types including four chakhaw, three jeera rice were detected with the aroma allele for *badh2*. The cultivars could be grouped into three based on the results of marker profile using the primer pairs for *badh2* (Group I: cultivars possessing aromatic *badh2* allele, Group II: cultivars with non-aromatic *badh2* allele and Group III: Heterozygous for *badh2*). The cultivars were genotyped further using 23 markers linked to aroma (other than *badh2*), and those loci (mostly minor) were mapped previously flanking the regions of *badh2*. The markers used in the study detected 43.47% polymorphism, and only those polymorphic marker loci were analysed for allelic composition among the three groups of cultivars. The number of marker alleles ranged from 2-4 with a mean of 3.11. Except for 10L03, RM223, RM282, the rest of the markers showed higher homozygosity, indicating that high resolution of allelic difference among the groups of cultivars would be possible. The cultivars of Group I, i.e., with aromatic *badh2* are distinctly unique from the other two groups, suggesting the allelic composition within the Group I was intact (share the same allele most of the time) and could be different from Groups II and III at many times. The Group I was detected a significantly higher number of expected alleles as compared to the other two groups except for RM 282, indicating the determinant of aroma might be governed by *badh2* along with some other minor loci in the case of Group I. The present study could throw some light that in joha rice cultivars, the involvement of *badh2* along with few other minor loci is mainly responsible for the aroma.

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Major Advisor : Dr. A. R. Baruah

Expression profiling of pathogenesis related (PR) genes in response to *Pseudocercospora eumusae* infection in Banana (*Musa* spp.)

Kumar Nupur Hrishikeshan

Eumusae leaf spot disease caused by *Pseudocercospora eumusae* is an economically important disease of banana (*Musa* spp.). The disease has a significant impact in India's key banana growing areas, including the North Eastern regions. *Eumusae* leaf spot causes a significant reduction in yield, particularly in the Cavendish subgroup of cultivars. The disease is very destructive if left uncontrolled and its management is highly dependent on the use of chemical fungicides. Plants activate number of pathogenesis related (PR) genes upon infection by pathogens which encode proteins involved in host plant resistance. PR proteins are low molecular weight, acid soluble, protease resistant proteins which function in the form of enzymes, receptors and structural proteins. These proteins are grouped into 17 different classes according to their functions. In the present study, a differential profiling of gene expression patterns of PR genes was conducted between banana cultivars resistant and susceptible to the pathogen, in order to elucidate the important PR genes implicated in response to defense against this serious disease. The banana cultivars, Simolu Monuhar and Sapor Jahaji, were selected for the present investigation, which have been reported to be resistant and susceptible to *Eumusae* leaf spot respectively. Pathogenicity assays were conducted using pure culture of *P. eumusae* through artificial inoculation of the plants. In the susceptible cultivar, the intensity of infection was severe and the disease progression was very fast. The symptoms were first observed by the 7th day of infection as small, linear, light brown streaks which gradually increased in size and turned into grayish lesions with dark brown borders, by the 20th day of infection. On the other hand, in the resistant cultivar Simolu Monuhar, symptom development was slower and less intense. The symptoms were observed after about 18 days of infection. Moreover, the disease progression was restricted by 40 to 45 days of infection as the necrotic lesions did not grow any further. For semi-quantitative RT-PCR analysis, leaf samples were collected

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from plants artificially inoculated with *P. eumusae* as well as uninoculated plants (water treated control) at 48 and 96 hpi (hours post inoculation) for RNA extraction and cDNA synthesis. Five PR genes namely PR1, Chitinase, PR4, Germin-like protein and Thaumatin-like protein were selected for differential expression profiling among the resistant and susceptible cultivars. The expression analysis revealed that, all the PR genes were highly upregulated after infection in Simolu Monuhar and the expression levels remained high across both the time points as compared to those in controls. On the other hand, in Sapor Jahaji, the expression levels of the genes were very low as compared to those in case of Simolu Monuhar, even after infection by the pathogen. Thus, all the PR genes are clearly implicated to have a possible role in active defense responses in the resistant cultivar, contributing towards resistance against the pathogen *P. eumusae*.

Comparative evaluation of acaricidal properties of *Datura stramonium* and *Datura metel*

Manisha Priyam Goswami

Ticks are group of arthropod vectors that not only cause disease but also transmit diverse pathogens that affect human and animal health. Indiscriminating use of synthetic acaricides have led to development of acaricide resistance in ticks. Several plant secondary metabolites are known to exhibit toxic affect on insects. Phyto-extracts are also environmentally friendly and have thus become attractive alternative in insect management strategies. *Datura* has long since been used in folklore medicine and is reported to have other pharmaceutical uses. My research involved the use of two different species of *Datura*, viz., *D. stramonium* and *D. metel* that grow abundantly in the North East India especially, in Assam. The two species of *Datura* were collected from different locations of Jorhat district and evaluated for their acaricidal properties. Chemo-profiling of both the plant species revealed the presence of some phyto-metabolites with known biocidal properties, more specifically acaricidal properties. Saponin, Flavonoids, Tannins, Phlobatannins and Steroids were analyzed in both the species and revealed that except for Saponin all others metabolites were present in both the species of *Datura*. Atropine and Scopolamine earlier reported for their acaricidal activity were assayed using HPTLC technique. Shoots of *D. stramonium* showed the presence of Atropine (0.04238%) and Scopolamine (0.21554%) whereas; the presence of Scopolamine (0.00754%) was detected only in the roots. Presence of Atropine (0.08083%) only was detected in shoots of *D. metel*. The variation in Atropine as well as Scopolamine in roots and shoots of the same plant species might be due to variance in tissue specific concerned gene(s) expression, and among the different species might be due to genetic variation or variation in eco-geographical conditions which are yet to be explored. Acaricidal properties of both the plant species were assayed in terms of LC50 as well as Inhibition in Oviposition (IO%) against a tick line of *Rhipicephalus microplus* collected from Assam. Between the two plant species, *D. metel* showed lower LC50 (6.37%) than *D. stramonium* (12.27%). In case of IO also, more IO value (76%) was observed in *D. metel* than *D. stramonium* (35.27%). The lower LC50 and higher IO values indicate that *D. metel* has more acaricidal potential than *D. stramonium*. Findings from the study also showed that shoots of *D. stramonium* contains both Atropine (0.04238%) and Scopolamine (0.21554%) whereas, *D. metel*-shoots contain only Atropine (0.08083%) and

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it is almost double of what *D. stramonium* contains. The present study indicates that Atropine may be directly associated with acaricidal activity with little or no role of Scopolamine. Although, the study did not involve the analysis of other compounds, their involvement in acaricidal activity cannot be denied. This research can be extended further to explore specific metabolites having acaricidal properties present in other plant systems including *Datura* for the better and greater interest of development of plant based-based acaricides/insecticides.

Validation of drought responsive miRNA in a drought tolerant rice cultivar

Oindrila Debsarma

Drought like situation in non-irrigated agriculture system often limits rice production, necessitating introduction of drought tolerance trait into the cultivar of interest. In Assam, effect of dry spells on varieties cultivated on low lands was reported to be reduced up to 43.07%. miRNAs, a class of abundant small noncoding RNAs, have been identified as important regulators of gene expression in both plants and animals and are involved in many aspects of plant development, including the modulation of plant response to stress. Despite technical hurdles to miRNA functional analysis, there is a growing body of evidence that alteration of miRNA accumulation plays an important role in reprogramming plant responses to biotic and abiotic stresses.

Assam having a diverse germplasm of rice, might have evolved an unique response to various stress. ARC-10372, a proven drought tolerant landrace may be a good source of drought related miRNAs and can provide insight into the role of miRNA in drought stress. In a previous effort in the Dept. to identify novel variety specific miRNA, small RNA sequencing had been employed to systematically investigate the tissue specific miRNAs responsible to drought stress, which are understudied in rice. The study revealed few novel miRNA in addition to known under drought stress. Differentially expressed miRNA as revealed by sequencing data are confirmed experimentally under drought situation using qRT-PCR. Out of 31 miRNAs, 7 known and 5 novel miRNAs were found to respond to drought stress. The identified target for these miRNAs revealed several conserved miRNAs targeting transcription factors like homeodomain-leucine zipper, MADS box family protein, zinc finger protein and Myb, well known for their importance in drought tolerance in plants. Drastic decrease in abundance of a few of the members of the novel miRNA (nmiR4, nmiR25, nmiR32, nmiR84 & nmiR86) might suggests important role of these miRNAs in drought tolerance. Further work on revealing its confirmatory role shall yield more information in this regard.

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Major Advisor : Dr. Priyabrata Sen

***In vitro* regeneration of *Musa spp.* cultivars Malbhog and Bhimkol, and assessment of genetic fidelity of regenerated plantlets using molecular markers**

Raghav Kataria

Banana (*Musa spp.*), belonging to the plant family *Musaceae*, is one of the major fruit crops of the world. Banana cultivars Bhimkol (*Musa balbisiana*, BB) and Malbhog (*Musa paradisiaca*, AAB) are popularly grown in the North-Eastern parts of India. Both cultivars are popular and important from the evolutionary and commercial point of view and, particularly Bhimkol banana is associated with improved vigor and tolerance to biotic and abiotic stresses. Malbhog is highly valued and the most desired for its excellent fruit qualities particularly marvelous taste, appealing aroma and a greater number of fruits per hand and higher post-harvest life. Since ancient times, people have been consuming banana fruit as dessert, dietary supplement, and for nutrition as it is rich in carbohydrates, vitamins and proteins. However, conventional banana propagation is time-consuming and gives lower yields due to various constraints such as biotic/abiotic stresses and lack of availability of healthy suckers. Moreover, the production by conventional means is not able to meet the demands of the growing market. So, the use of tissue culture technique and development of *in vitro* regeneration protocol for popular cultivars such as Malbhog and Bhimkol will not only lead to mass multiplication with better yields but also help in conservation of local genotypes.

In the present investigation, an attempt has been made to optimize an efficient *in vitro* shoot regeneration system for Bhimkol and Malbhog. The study was initiated by standardizing shoot regeneration protocol, using banana shoot tips as explants in modified MS medium by using different concentrations of BAP (6-Benzylaminopurine) (2, 3, 4, 5, 6, 7, 8, 9 and 10 mg/l). In Bhimkol, although shoot regeneration was observed in 7 mg/l BAP, but the regeneration was much slower and no multiple shoot formation was seen. Since, it is a slow growing genotype and also the level of phenolic compounds is very high, regeneration was not found to be satisfactory even on treating

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the explant with ascorbic acid. Hence, for Bhimkol the *in vitro* regeneration protocol needs further standardization. In Malbhog, MS medium supplemented with various combinations of BAP and NAA (1-Naphthaleneacetic acid) were used for the optimization of multiple shoot regeneration. The results indicate that shoot regeneration and proliferation was significantly higher in the presence of 10 mg/l BAP and 0.2 mg/l NAA as compared to other concentrations in terms of the number of days required for shoot initiation, number of shoots developed per explant and length of shoots. For assessment of genetic fidelity of the multiple shoots, DNA was isolated from leaves of *in vitro* regenerated shoots and the field grown mother plant. Thirteen SSR primer pairs (already reported) were used in the analysis which resulted in banding patterns that were uniform and monomorphic for all the clones tested and comparable to the mother plant from which the cultures had been established. This indicated that all the regenerated shoots are true to type with no variation in their genetic makeup. Thus, the optimized shoot regeneration protocol could be potentially used for mass multiplication of Malbhog, once the *in vitro* rooting and hardening of regenerated plantlets is standardized.

Optimization of an Efficient Regeneration and Transformation Protocol for Black Rice *Chakhao Poireiton*

Reynold George

The black rice germplasm suffers from inherent low productivity due to inefficient performance of yield attributing characters. Besides, the crop is also susceptible to biotic and abiotic stress. Gene technology can provide an effective approach for improvement of black rice. The availability of a robust and reproducible plant regeneration system that is amenable to transformation plays a major role in achieving this objective. Therefore a study was conducted to establish a stable and reproducible regeneration system in black rice *Chakhao poireiton*.

The main plant hormone responsible for callus induction 2,4-D was used in combination with vitamin assay casamino acid in 2N6 medium with varying concentrations to establish a better callus inducing medium. It was revealed that a combination of 2mg/l 2,4-D and 1g/l vitamin assay casamino acid stood better in terms of callus induction frequency, callus weight and relative growth rate compared to the already established protocol by Hiei *et al.*, (2008). The best shoot inducing hormone combination was found out by using kinetin in varying concentration and kinetin in combination with BAP. Kinetin at 4.5mg/l proved to have the highest regeneration percentage. *Agrobacterium* strain LBA4404 harbouring pCAMBIA1304 binary vector containing *hptII* gene (selectable marker gene) and *gusA* gene (reporter gene) was used for genetic transformation. GUS histochemical Assay showed visual confirmation of genetic transformation. Varying concentrations of hygromycin 30mg, 40mg, 50mg and 60mg/l were tried for screening transformants, but gave 100% mortality in all the concentrations. In future, better transformation protocols for *Chakhao poireiton* need to be established.

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Major Advisor : Dr. A. Baruah

Study on effects of $qDTY_{3.1}$ contributing yield under drought in Ranjit x Apo derived F_4 population

Shahnaj Parbin

Tolerance to low land drought stress in rice is under polygenic control and numerous quantitative trait loci(QTLs) have been identified, out of which a major QTL for yield under drought ($qDTY_{3.1}$) derived from 'Apo' has been detected with significant additive effects. Intermittent drought profoundly affect the yield of 'Ranjit', a predominant high yielding variety for *sali* season in Assam. Therefore, a study was conducted to improve drought tolerance in 'Ranjit' and to understand the genetics of $qDTY_{3.1}$ in the F_4 lines of Ranjit x Apo. The screening of F_4 populations for $qDTY_{3.1}$ using the nearest marker RM520 revealed 45 Ranjit type, 69 Apo type and 66 with heterozygous alleles, respectively. Although indicated a slight bias towards Apo type allele yet the Chi square test showed that the data were in good fit, and were not significantly deviated from the expected values. Further, screening with markers far from the $qDTY_{3.1}$ revealed a total of 35 Ranjit/Apo recombinants having $qDTY_{3.1}$ intact, indicating suitability of these lines for advanced breeding materials. To check the nucleotide diversity and informative sites within and near the QTL region, sequencing analysis was performed in coding sequences (CDS) for some of the proteins expressed under drought/abiotic stress. Out of the CDSs sequenced, two CDSs within the QTL region did not show any polymorphism. The one CDS for NAC family detected with one non synonymous substitution in which the Apo type (with $qDTY_{3.1}$) was encoded with 'Proline' and Ranjit type with 'Arginine', warrants detail study to validate the data along with inclusion of more regions to be sequenced. The effect of the $qDTY_{3.1}$ allele was also estimated. Mean values showed the better yield performance of 'Apo' types than the 'Ranjit' types in drought condition. Although symptomatically the leaf rolling scores of 'Ranjit' is comparable to 'Apo', however the yield penalty for both these types was evident. Significant correlation was observed for panicle length and number of grains, effective booting tiller and tiller number, effective booting tiller and grain yield

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in 'Ranjit' and panicle length and number of grains, spikelet fertility with number of grains in 'Apo' under drought stress. The effects of qDTY_{3.1} in Ranjit x Apo imparting drought tolerance in F₄ lines was observed. However, the role of other minor effect QTLs with the change of other background may not be ruled out. The study will help in generating promising breeding lines for low land drought tolerance in Assam rice.

***Agrobacterium* mediated genetic transformation of *Citrus reticulata* cv. Khasi mandarin**

Sangeeta Bhandari

Citrus is number one fruit of the world on accounts of its high nutritional value. India is the fourth largest producer of *Citrus* in the world. The north-eastern region of India is a rich treasure of various *Citrus* species. Khasi mandarin is the most economically important one and plays a vital role in the socio-economic development of the people in this region. Khasi mandarins are declining at a very high rate due to its vulnerability to different pathogen and insect/ pest. Conventional breeding for overcoming these problems are limited in *Citrus* and are directly associated with the reproductive biology of *Citrus*. Recent advances in genetic engineering have made it possible to incorporate desirable genes from elite genotype mainly through *Agrobacterium*-mediated genetic transformation. *Citrus* species showed varied response to *in vitro* regeneration and genetic transformation. Cultivar specific optimization of *in vitro* regeneration and transformation protocol is very important. In the present investigation, *in vitro* regeneration and *Agrobacterium* mediated genetic transformation protocol for Khasi Mandarin was optimized using different explants like epicotyl, hypocotyl, nodal and inter nodal segment obtained from six-week-old *in vitro* grown zygotic seedling. Explants were transformed with *Agrobacterium* strain LBA4404, harbouring plasmid pBI121-AtSUC-GUS containing *nptII* as a selectable marker and *gus* as a reporter gene. Hypocotyl was found to be the best explants for khasi mandarin transformation and regeneration. MS medium supplemented with BAP (2mg/L), NAA (0.5 mg/L), 2, 4-D (1mg/L), MES (0.5g/L), sucrose (30g/L) and acetosyringone (100µM) was found to be best medium for co-cultivation. Modified MS medium containing BAP (4mg/L), MES (0.5g/L), sucrose (30g/L), phytigel (4g/L), kanamycin (50mg/L) and timentin (150mg/L) showed highest regeneration efficiency (18%). Modified MS medium containing BAP (4mg/L), GA3 (0.5mg/L), MES (0.5g/L), sucrose (30g/L), phytigel (4g/L), kanamycin (50mg/L) and timentin (150mg/L) showed highest multiple shoot induction (6%). *In vitro* regenerated shoots that survived up to 3rd selection cycle were subjected to GUS assay for confirmation of *GUS* expression in the phloem tissues. Present investigation is a preliminary study for optimization of an *in vitro* regeneration and genetic transformation protocol in Khasi Mandarin.

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Department : Agricultural Biotechnology

Major Advisor : Dr. S. Singh

Molecular characterization of the gut microbes of greater wax moth (*Galleria mellonella*)

Silpi Shikha Saikia

Greater wax moth (GWM), *Galleria mellonella* (Lepidoptera: Pyralidae) is a notorious honey-bee pest found throughout the world. The moth is very destructive to the honeycomb, lays eggs and their larva grows up eating beewax. Beewax is a natural polymer, mainly composed of saturated/ unsaturated, linear/ complex monoesters, hydrocarbons etc. The most frequent hydrocarbon bond in beewax is the CH₂-CH₂ which is found in polyethylene (PE). Meanwhile, biodegradation of PE by gut microbes of Indian meal moth, *Plodia interpunctella* and lesser wax moth (a close species of GWM) was reported. As wax-digestion is not a common character of animals, we hypothesized to encounter some microbes in GWM-gut, which could also be responsible for the PE degradation. Therefore, we aimed this investigation to isolate and identify the gut-microbes from GWM following culture-dependant approach. We had characterized several bacterial and fungal species based on culture characteristics, Gram-staining and several biochemical tests such as carbohydrate utilization test, catalase test, citrate utilization test, MR-VP test, motility test etc. Using 16S-rDNA sequencing with conserved primer-sets from representative types, thirteen bacteria and one microalgae were obtained from the digestive tract of *G. mellonella*. These species includes Gram-positive *Exiguobacterium aestuarii*, *Bacillus circulans*, *Microbacterium zaea*, *Microbacterium paraoxydans*, *Enterococcus faecalis* and Gram-negative *Agrobacterium* sp., *Sphingomonas pseudosanguinis*, *Sphingobium yanoikuyae*, *Acinetobacter radioresistens*, as well as a microalgae (*Picochlorum oklahomensis*). Several of these species/ isolates have been reported to degrade polycyclic aromatic hydrocarbon, low density polyethylene, 2-methylphenanthrene etc. Interestingly, *P. oklahomensis* is a marine microalgae; it steals genes from bacteria and adapt themselves to abiotic stress. Further investigation will be required to find out more precise details about plastic degrading candidate microbes and their biotechnological applications.

Abstract of M.Sc. Thesis

Department : Agricultural Biotechnology

Major Advisor : Dr.

Isolation and characterization for pesticide tolerant bacteria and their application in remediation of pesticides contaminated soil

Subangshi Borah

Application of agrochemicals to reduce the infestation of pests and disease, a major constrain in improving crop yields has become a worldwide practice in the intensive agricultural production system. Although agrochemicals have no doubt helped in reducing crop damage and increasing food production, their indiscriminate use has led to several negative impacts on the environment including human health. Many of the pesticides are slow degrading and are retained in the soil long after their application which leads to entry into ecosystems and in turn may show lethal effects on the living system. Microbial degradation is an attractive alternative method to remove the pollution created by the use of pesticides. Many soil microorganisms have the ability to degrade many pesticides by converting them into non-toxic compounds. Therefore, the present study was undertaken to isolate and identify imidacloprid-degrading microbes from pesticide-contaminated soil and to test their utility in field conditions. Soil samples were collected from three different plots with and without history of pesticide application and enumerated for bacterial diversity and also screened for pesticide tolerant/degrading bacteria by plating in minimal media agar plates containing four different pesticides viz., Deltamethrin, Quinalphos, Glyphosate and Imidacloprid at a concentration of 25 ppm each. Bacterial abundance was observed in media plates containing imidacloprid as a sole carbon source indicating the presence of pesticides degrading bacteria. Imidacloprid, a neonicotinoid group of pesticide used in tea gardens to control aphids, mites, spiders and whitefly was thus taken for study. The bacterial isolates were exposed up to a range of concentration (25 ppm -25,000 ppm) of Imidacloprid to test the tolerance ability of the bacterial isolates. Among the 30 bacterial isolates, four isolates (MBSB-1, MBSB-9, MBSB-11 and MBSB-12) were able to grow in 25,000 ppm of imidacloprid. The isolate MBSB-12 was able to grow and survive for a longer period in culture containing 25,000 ppm imidacloprid and thus taken for further study and identified as *Pseudomonas plecoglossicida* (Accession number MW091028)

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Department : Agricultural Biotechnology

Major Advisor : Dr. M. Barooah

on the basis of its cultural and 16S rDNA sequence homology. The High Performance Liquid Chromatography (HPLC) analysis of samples drawn from *in-vitro* experiment liquid culture and soil revealed *Pseudomonas plecoglossicida*. MBSB-12 to decrease 94% and 87% imidacloprid in 7 days and 90 days respectively. The imidacloprid degraded products were identified through High Resolution Mass Spectrometry (HRMS) analysis as two non-toxic compounds *viz.*, imidacloprid guanidine olefin and imidacloprid urea. A greenhouse experiment conducted to evaluate the imidacloprid degradation efficiency of *Pseudomonas plecoglossicida*. in pots sown with *Solanum melongena* (variety-COBH.1) was set up. The soils in the pots were inoculated with 10⁶ CFU per gram of soil and sprayed with 100 ppm imidacloprid on infestation with whitefly/aphids. However, no pesticide residue was detected in the soil which may be due to single dose of imidacloprid application. This study revealed the successful degradation of imidacloprid to non-toxic compounds by a native bacterial isolate. Further study to understand the conditions that influences pesticide degradation in soil (pH, temperature, soil moisture) along with identification of the genes involved in the catabolic pathway will open new vista to improve the biodegrading ability of the isolate.

Development of CAO-1 mutant in rice using CRISPR/Cpf1 technology

Suprava Priyadarsini Nayak

CRISPR (Clustered Regularly Interspaced Short Pallindromic Repeats) is originally a bacterial immune system against virus based on RNA guided bacterial defence mechanisms designed to recognize and eliminate foreign DNA of invading bacteriophage and plasmid. Although the most successful genome editing tool used at present is CRISPR/Cas9 (Jaganathan *et al.*, 2018), the newly developed CRISPR/cpf1 (CRISPR from *Prevotella* and *Francisella 1*) is a single RNA guided endonuclease of a class-II CRISPR-Cas system that has several advantages over CRISPR/Cas9 (Zetsche *et al.*, 2015). Cpf1 needs single guiding RNA (*sgRNA*) while Cas9 requires two guide RNAs (*crRNA* and *tracrRNA*). While Cas9 make a blunt end cut of the DNA molecule after recognizing a PAM sequence NGG (Moon *et al.*, 2018), the Cpf1 endonuclease makes a staggered cut of the DNA after recognizing a PAM sequence *viz.* NTTT, offering researchers more option when selecting an editing site. The current study employed CRISPR/Cpf1 construct *pSS09* harbouring *sgRNA* of *CAOI* gene of rice that was developed at Prof. Okita's Lab, Institute of Biological Chemistry, Washington State University, Pullman, USA. The main objective of the present study was to validate the efficacy of CRISPR/Cpf1 system in rice. Chlorophyllide-*a*-oxygenase (*CAOI*) is an enzyme that converts chlorophyll *a* to chlorophyll *b*. Knockout of the gene using CRISPR technology is expected to produce "pale yellow" leaf phenotype. We introduced CRISPR/Cpf1 binary vector harbouring *sgRNA* of *CAOI* gene into *Japonica* rice *cv.* Kitaake through *Agrobacterium* genetic transformation. Embryogenic calli were induced from mature seed with efficiency of 96.3% and regeneration efficiency of embryogenic calli was observed as 63.3%. 43 putative transformed lines were generated in the current study. Out of 43 transformed lines, 20 lines were selected based on varied level of pale green colour of the leaves and subjected to PCR analysis using gene specific primers for the targeted sequence of *CAOI* gene. Transformed lines number 8, 9 and 13 showed mutations in the *CAOI* gene with 9 bp, 12 bp and 25 bp deletions, respectively. We observed fairly high efficiency of mutation rate (2.22%) with CRISPR/Cpf1 system and the mutations occurred at very near the targeted *sgRNA* sequence of *CAOI* gene.

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Department : Agricultural Biotechnology

Major Advisor : Dr. Salvinder Singh

Studies on phosphate solubilizing fungal isolates from root rhizospheric soils

Tuhinendu Dey

Phosphorus (P) unavailability is one of the limiting factors that adversely affect agricultural production though it is present abundantly in soils both in organic and inorganic forms. Although, chemical fertilizers are being applied to the soil to increase the availability of P for plants, a large proportion of it gets rapidly immobilized and becomes unavailable to the plants that can lead to an overall reduction in soil fertility after application. Also, the high reactivity of soil-P with Fe and Al in acidic soils of Assam causes its precipitation and it is rendered insoluble by forming complex molecules. However, P-solubilizing microbes play an important role in increasing the availability of soil-P for plant growth. The aim of my research was to isolate and purify indigenous potential P-solubilizing fungi from the rhizospheric soils of Maize, Cow pea and Soybean for the development of an eco-friendly and effective P-solubilizing fungal formulation. With this aim and objective, initially, five fungal isolates viz., PSF1, PSF2, PSF3, PSF4 and PSF5 were isolated and purified based on their ability to hydrolyse Tricalcium phosphate present in Pikovskaya (PVK) agar plates. These were further screened for P-solubilizing efficiency both qualitatively in PVK agar plate and quantitatively in PVK broth. In case of qualitative test, the solubilization Index (SI), and in quantitative test, the P-solubilization percentage (PS,%) were considered as the assayed parameters. Among the five fungal isolates, PSF4 showed the highest P-solubilizing efficiency in both PVK agar (SI, 1.88) and PVK broth (PS, 91.1%). Therefore, only PSF4 was taken for further study. The PSF4 isolate was characterized based on colony morphology, microscopic observations and molecular studies. Finally, from all the observations and studies, PSF4 was identified as *Aspergillus* spp. A pot culture experiment was carried out in the Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat with rapeseed, variety TS29 and rock phosphate (RP) as the source of P for the efficacy evaluation of the fungal isolate both in free as well as encapsulated forms. The experiment was fitted to CRD with 9 treatments and 3 replications for each treatment. The application of recommended dose of P was

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Major Advisor : Dr. Tankeswar Nath

considered as 100%. As the treatments, 50% and 25% RP were applied along with the encapsulated and free formulation of PSF4. Recommended doses of N and K were given in all the treatments at 2 days before sowing. Controls were kept accordingly. Soil analysis showed that the application of both free and encapsulated PSF4 formulations increased the available P significantly but not the soil-N and -K over controls. However, significant increase in P absorption, plant biomass and yield was observed due to application of both free and encapsulated formulations of PFS4 over all the different controls. But, the application of encapsulated formulation of PSF4 showed better results in terms of P-absorption, biomass production and yield than that of application of free formulation. From the present study, finally, it can be concluded that the isolate, PSF4 (*Aspergillus* sp.) has good potential to solubilize insoluble P-compounds in soils and that's why it can be used as an important bio-resource for soil fertility management, more specifically, in improvement of soil-P nutrient status. Its use as biofertilizer also can be helpful in reducing application of phosphoric fertilizer in crop production. Use of PSF4 formulation can be extended to cereals and legumes besides other oil seeds crops. Trial of use this formulation can be further extended to alkali soils. PSFs along with Arbuscular Mycorrhizal fungi (AMF) can be much more effective in the utilization of soil-P. Even, the use of different combinations of P-solubilizing bacteria (PSB) along with PSF could also be studied to increase their P-solubilization efficiency for better crop-soil-P management practices.

Regional Disparities of Selected Fruit Crops in Tamil Nadu

Ananth. R

Indian agriculture is known for its diversity, which is mainly the result of variations in resource endowments, climate and topography, historical, institutional and socio-economic factors. Regional disparity in agricultural development is referred to as the variations in agriculture performance and productivity. In India, Tamil Nadu has a unique position in Fruit crops production and also it is one of the largest producers of fruit crops in India. In Tamil Nadu, there are 7 Agro-Climatic regions or zones which cover 33 districts. Hence, the study was limited to major fruit crops namely Banana, Sapota, Mango and Guava due to its importance of production. The present study was about the growing tendency in area, production, productivity, regional disparities of the selected fruit crops of different Agro-Climatic regions and factors affecting the selected fruit crop's production in Tamil Nadu. Time series data of area, production and productivity of the selected fruit crops of Agro-Climatic Regions of Tamil Nadu were collected for twenty years (1996-97 to 2015-16). Three functions i.e., linear function, quadratic function and exponential function were consider in order to study the growing tendency in area, production and productivity. Best fitted trend equation had been selected based on highest R² value and lowest MSE value. Regional disparity in crop production was studied with the help of composite index of development. The index was given by selected indicators. The important Factors affecting the selected fruit crop's production in overall Tamil Nadu was studied by multiple regression analysis. In this study, it was seen that the quadratic function was the best fitted trend equation for area, production and productivity of different regions for the study period 1995-96 to 2015-16 of the selected fruit crops. In case of Banana, the increasing trend of the area was observed in all the Agro-Climatic regions except Southern Zone. The production and productivity was showing the increasing trend in all the zones except High Rainfall Zone. In the case of Sapota, the increasing trend of the area was observed in all the zones except Hilly Zone. The increasing trend of production and productivity was found in all the zones except High Rainfall Zone. In the case of Mango, the increasing trend of

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area was observed in all the zones except Hilly Zone and High Rainfall Zone and also the increasing trend of productivity was observed in all the zones except North Eastern Zone. Though the decreasing of area and productivity was found in some zones, the increasing trend of production was observed in all the zones. In the case of Guava, the decreasing trend of area was observed in all the zones except North Eastern Zone and High Rainfall Zone. The increasing trend of productivity was observed in all the zones except North Western Zone and Southern Zone. Regarding the production, the increasing trend was observed in North Eastern Zone, Western Zone, Cauvery Delta Zone and High Rainfall Zone and the decreasing trend was observed in remaining zones viz., North Western Zone, Southern Zone and Hilly Zone. By using composite index of development, Western Zone was the high level zone; North Eastern Zone, Cauvery Delta Zone and Southern Zone were high middle level zones in Banana crop. In Sapota crop, Western Zone, North Western Zone and Southern Zone were high middle level zones. In Mango crop, North Western Zone was high level zone; North Eastern Zone and Western Zone were the high middle level zones. In Guava crop, Western Zone was the high level zone followed by North Eastern Zone, North Western Zone and Southern Zone were the high middle level zones. In Banana, Mango and Guava crops, High Rainfall Zone and Hilly Zone were found that low middle level and low level developed zone respectively. By using multiple regression analysis method, area had been identified as the key factor of Banana, Sapota, Mango and Guava crop's production. In addition to area, average temperature also had been identified as important factor in Guava crop.

Regional variation of rice production in Kerala

Anagha V. Gopal

Rice is the most important food crop grown in Kerala. It occupies 7.46 % of the total cropped area of the state. The agriculture in Kerala has undergone significant structural changes in the form of a decline in the share of Gross State Domestic Product and commercialization of agriculture. However, a large share of the rural population is still dependent on agriculture for employment and livelihood.

In this present study, an attempt has been made to examine the trends of area, production, and yield of different types of rice crops in three different geographical regions as well as in the state of Kerala. For the trend analysis of the area, production and yield of autumn, winter, summer, and total rice in different geographical regions, the three different models *viz.* linear, quadratic, and exponential have been fitted. The functional form having the highest coefficient of determination (R^2) and lowest Mean Square Error (MSE) has been selected for fitting the trend of area, production, and yield of autumn, winter, summer, and total rice in all the three geographical regions of Kerala. The region wise Compound Growth Rate (C.G.R) and Coefficient of Variation (C.V) have been computed to study the region wise instability of rice production. A multivariate linear discriminant function and associated Mahalanobis D^2 statistics have been carried out by considering eleven variables *viz.* area and yield of respective rice, area under HYV, irrigation, and fertilizer consumption for estimating the potential index of rice production in each district of Kerala.

The study reveals a decreasing trend of area and production for all the types of rice in three geographical zones as well as in the state. But in the case of yield, it has shown an increasing trend in all the geographical zones and also in the State of Kerala. The empirical estimate of growth rates shows that area and production are having negative growth while yield is having a positive growth rate and even though all are significant. The multivariate discriminant analysis with zero misclassification shows that relatively good performing districts have a larger discriminant score than that of the districts having relatively poor performance in yield.

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Department : Agricultural Statistics

Major Advisor : Dr. R. P. Paswan

Symbolic Data Analysis: A New Approach of Analyzing Complex Data

Dipanka Bora

Statistically, classical data on P random variables are represented by a single point in P -dimensional space. These data can be analyzed using some basic statistical tools and techniques. However, when the size of the data set along with variables become large and also if multi response occurs under a categorical variable then classical data analysis create hurdles to get the desired result. In such situations, symbolic data analysis can be ready to lend a hand. Symbolic data may arise as an outcome of aggregating very large data set into a smaller manageable sized data set or aggregating into data set that provide information about categorise of interest (Diday and Fraiture, 2008). In symbolic data analysis, symbolic values may be lists, intervals, categorise and so on. Symbolic values can be single-valued, interval valued, multi-valued with or without logical or hierarchy dependency rules. It typically represents the set of individuals which satisfy the description of the associated symbolic concept or category.

This study tries to establish the difference between classical and symbolic data analysis through the basic statistical tools of the univariate and bivariate cases. In order to do that secondary data set was being used. As an outcome of the study, it had been observed that symbolic data analysis is useful to extract information from the complex data set at a lesser time with greater efficiency for univariate and bivariate cases. Univariate and bivariate statistics of symbolic data analysis was the appropriate statistical procedure and a way to draw inferences for the large and complex data sets.

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Department : Agricultural Statistics

Major Advisor : Dr. Hemanta Saikia

Classifying the states of India through rice, wheat, and groundnut using statistical graphics

Stanley Tornam Tsigbey

India's economy is mainly contingent on agriculture which accounts for 17-18 percent of India's gross domestic product (GDP) and provides sufficient employment to 50-60% of the total population. The India position in terms of rice, wheat, and groundnut production all over the world call for vital information on area, production, and productivity as well as agricultural states of India.

In this study an effort has been made to classify the agriculture states of India using statistical graphics i.e. regression analysis and tri linear plot of the three selected major crops; rice, wheat, and groundnut. And in order to do that the 50 years data (1966-2016) trend of area, production, and productivity of the various crops are converted into index number. Thereafter a scatter plot is depicted considering 'area index' as an independent variable and 'productivity index' as a dependent variable and then a linear regression line is being fitted along with confidence band for classification of the states. Tri-linear plot was considered as one of the graphics in classifying the states where the indices values of the three variables (area, production, productivity) were first brought within the range 0 to 1. Afterwards percentage contributions of each of the three variables are taken where the total of the three variables sum to unity (100%) and are represented as one point on a triangular diagram.

The study reveals that some states recorded less productivity despite of being adequate increasing area trend and some states also shown productivity increased with decreased area.

The classification of Indian states is to provide essential information to the planners and policymakers responsible for designing efficient agricultural policies, and for making significant decisions concerning resources allocation for the development of agricultural sector in the various states.

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Department : Agricultural Statistics

Major Advisor : Dr. Hemanta Saikia

Structural Break Analysis of Rapeseed and Mustard Production in Jorhat District of Assam

Sujata Baruah

Oilseed crops play a vital role in the Indian agricultural economy and so does in any parts of Assam in terms of area and production. Rapeseed and mustard production in Jorhat have increased from 7817 tonnes in 2012-13 to 9118 tonnes in 2013-14 and then decreased to 8129 tonnes in 2014-15. This reflects the structural change in the economy of the district. The present study is performed to determine the exact time of the structural break in the rapeseed and mustard production, followed by the identification of the factors affecting the crop's production and finally by examining the presence of cointegration between the crop productivity and the various variables under investigation. The data collected for the study pertained to the annual time series of area, production, productivity, maximum temperature, minimum temperature, total rainfall, bright sunshine hours, and wind speed for the periods 1988-89 to 2014-2015. The results of the structural break analysis reveal that the variables for the crop are non-stationary at levels, indicating the existence of structural breaks. The production of rapeseed and mustard is found to have breaks in the years 1995-96 and 1996-97. Amongst all the factors under investigation, the area is found to have a significant effect on the production of the crop in Jorhat district of Assam. This implies that increasing the land area in the study location may increase the production of the crop in the same place. Johansen's cointegration test was used to check for the presence of the cointegration between the variables under the crop. It is concluded that the variables in the model are cointegrated. This is followed by the employment of the Vector Equilibrium Correction Model, finally proving the presence of a long-run relationship between the variables. It is found that minimum temperature has a negative relationship with the productivity of the crop whereas area and total rainfall have positive and significant short-run effects on the productivity of rapeseed and mustard crop in the study location.

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Department : Agricultural Statistics

Major Advisor : Dr. R. P. Paswan

Economics of Conservation Agriculture Practices followed in Rainfed Farming Situation in Mayurbhanj District of Odisha

Abhisek Das

The present study was conducted in the Mayurbhanj district which comes under the North-Central plateau zone of Odisha. The study intended to examine the impact of conservation agriculture and conventional agriculture on the quality of life of the farmers. The study also includes the cropping pattern and different farming methods adopted by the farmers.

The three key principles of CA (Conservation Agriculture) are minimal soil disturbance, retaining of permanent soil organic cover, and diversified crop rotation. It was found that the farmers were cultivating different types of field crops. The cost and returns of different field crops for this study namely maize, cowpea, green gram, and rice have been calculated. The study revealed that the farmers were following different types of cropping patterns in the study area. It was found that all 120 farmers were growing rice as a monocrop in the *Kharif* season. Maize and green gram were grown as a double crop by 96 farmers which were 80 per cent of the sample size. There were 24 farmers cultivating maize and cowpea as an intercrop in the *Kharif* season which was 20 per cent of the sample size. The farmers were following five different Methods of farming practices for the cultivation of the four selected crops. Different Methods of farming will give different results, which may or may not be in favour of the farmers. In the case of maize and green gram cultivation, out of 120 farmers, 22 were following Method 1, 22 were following Method 2, 34 were following Method 3, 18 were following Method 4 and 24 were following Method 5. It was found that 18.33 per cent, 18.33 per cent, 28.34 per cent, 15.00 per cent, and 20.00 per cent of the total sample were following Method 1, Method 2, Method 3, Method 4, and Method 5, respectively. But in the case of rice farming, it was found that 18.33 per cent, 18.33 per cent, 28.34 per cent, and 35.00 per cent, of the total sample, were following Method 1, Method 2, Method 3, and Method 4, respectively. There were 12 medium and 12 large farmers

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cultivating cowpea and maize as intercrops under Method 5 which was collectively 20.00 per cent of the sample size.

As per the study, all the marginal and small farmers were following Method 1, Method 2, and Method 3, and 12 medium farmers were following Method 3. So, the cost of cultivation, gross income, and net income from Method 1, Method 2, and Method 3 of marginal, small, and medium farmers were comparable. The medium farmers were following Method 3, Method 4, and Method 5 whereas all large farmers were following Method 4 and Method 5. The cost of cultivation, gross income, and net income from Method 3, Method 4, and Method 5 of medium and large farmers were comparable but the marginal and small farmers following Method 1 and Method 2 cannot be compared with medium and large farmers following Method 4 and Method 5. The classification of the farmers as per the methods followed by them was also the same in the case of maize and green gram cultivation but it is different in cowpea and rice cultivation.

Land Use Pattern of Rice Farmer with Special Reference to Nalbari district of Assam

Anindita Devi

Land is the fundamental resource for all agricultural activities. Proper utilization of land directly contributes to the economic and agricultural development of a region. The economy of the state of Assam is agrarian in nature. Assam occupies a geographical area of 78438 sq. km out of which net cropped area is 28.27 lakh hectares. The average cropping intensity of the state is 145.9 percent. One of the main reasons for low cropping intensity is that the area under Rice cultivations are mostly kept as fallow land after harvesting of the crop. The state is more or less self sufficient in rice production. But, in case of pulses, oilseed and other crops the state is dependent on other parts of the country and it is very essential to increase the total production of all these crops to feed the growing population. Despite of the effort of both the state and central Govt. to develop agricultural sector over the time yet there is no significant improvement in case of cropping intensity. So, the present study was undertaken to explore the factors responsible for monocropping of Rice.

The study was conducted in the three blocks *viz.*, Pub Nalbari, Pachim Nalbari and Borbhag blocks in Nalbari district of Assam. Primary data was collected using multistage stratified random sampling technique. A total of 135 farmers were selected as the final sample.

The study revealed that the average size of the operational holding of the rice farmer was found to be 1.648 hectares per farm. Land use pattern of the study area did not follow any particular trend. However, the highest percentage of fallow land was found in medium-sized farm while homestead land and net sown area was found to be the highest for large size farm and small sized farm. On an average all the sample Rice farmer kept 63.78 percent of the net sown area as fallow land after harvesting of Sali rice. Land used for single cropping of Rice was the highest for small sized farm (71.6 percent). Mostly five Rice based cropping sequence was followed in the study area namely Rice-Fallow, Rice-Toria, Rice-Potato, Rice-Black gram and Rice-Pumpkin. Sali rice mono crop shared the highest percentage (55.15 percent) of the total gross cropped

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Department : Agricultural Economics and Farm Management

Major Advisor : Dr. R. K. Sarma

area with 1.07 hectares of land per farm. Rice-Pumpkin was found to be the most profitable cropping sequence amongst all four cropping sequences. Regarding the cost and income per hectare of different crop cultivation, not much difference was observed across the farm sizes. However, medium-sized farm was found to generate more income from all the cropping sequences except for Rice-Pumpkin. In case of Rice-Pumpkin, large sized farm gained more net income per hectare of land. Availability of irrigation facility, availing of institutional credit and commercialized nature of cultivation were the major factors affecting the choice of cropping pattern. Study also revealed that the problem of stray cattle and unavailability of proper irrigation was the major constraints in multiple cropping patterns. To promote multiple cropping sequences, community cultivation of crops should be popularized as well as timely supply of irrigation water should be provided.

Rural Livelihood Diversification in Dibrugarh district of Assam

Anjana Sonowal

India is primarily an agrarian society with two third of its population living in rural areas. For majority of the population, agriculture and its allied activities are the main source of livelihood hence performance of the agriculture sector plays an important role in economic growth of our country. Livelihood is defined as the set of all activities involved in finding food, searching for water, shelter, clothing and all necessities required for human survival at individual and household level. Diversification has been defined as “the process by which rural households construct an increasingly diverse portfolio of activities and social support capabilities in order to survive and to improve their standard of living” (Ellis, 1998). The present study entitled “Rural livelihood diversification in Dibrugarh District of Assam” was carried out to examine the rural livelihood diversification. A total of 90 sample respondents were randomly selected using multi stage random sampling technique. For analysing the data, various statistical tools like average, percentage, Simpson index of diversification, multiple regression function, Garret’s ranking technique and cost concepts were used. To study the existing pattern of rural livelihood diversification, analysis was carried out across farm size and livelihood groups. Farm size groups were Marginal, Small, Medium and Large, and Livelihood groups were Agriculture group, Agriculture & allied activities group, salaried group, Business group.

The findings revealed that for all the farm size groups, different sources of livelihood were crop farming, livestock farming, fish farming, salaried job, business and wage earning. For an average farm, per farm annual income across farm size, crop contributed highest (51.55%) to the total income followed by salaried job (23.40%), fishery (7.96%), livestock (7.33%) and business (7.23%) and lowest by wage earning (5.52%). In case of livelihood groups, for agriculture group, income from crop component to the total annual income was highest (86.69%), for agriculture & allied group, highest income was contributed by crop component with 63.02 per cent. Whereas for salaried group highest income was contributed by salary (65.72%) and only 27.36 per cent was contributed by crop component and for business group, 67.12 per cent was

Abstract of M.Sc. Thesis

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contributed by business. Pattern based on on-farm income sources across farm size indicates that diversification index value for marginal farmers was highest (0.58) and lowest for large farms (0.28). Based on the income from non-farm sources, marginal farmers had highest diversification index value (0.48) & small farmers had lowest diversification index value (0.37). Based on total income from on-farm and non-farm income sources, diversification index for small farmers was 0.46 and 0.32 for large farmers. Based on income generated by on-farm and non-farm income sources across livelihood groups, agriculture & allied activities group had least diversification index (0.20) and salaried group had highest index value (0.45). Based on all income sources across livelihood groups, agriculture & allied activities group was most diversified with highest value of diversification index (0.56) followed by salaried group (0.50). Apart from farm income and employment generation, risk minimization can be done up to a considerable extent. There were few factors such as age, education, family size, access to credit, training, which were affecting the livelihood diversification. Constraints related to the diversification of rural livelihood were also studied according to different farm size groups. Constraints were classified as: infrastructural, promotional, economic, and environmental constraints.

Characterization and economic appraisal of farming systems in Kamrup (Metropolitan) district of Assam

Arindita Bishaya

In the present agricultural scenario of Assam, diversification of farms is one of the most potential ways of raising and stabilizing productivity and profitability levels of farm income, augmenting farm employment, risk reduction, maintaining food security, managing environmental pollution and supporting sustainable agriculture by optimum utilization of land, labour and other resources. Due to the availability of limited land resource in the rural areas of Kamrup (M) district on account of increasing population, land fragmentation and other associated factors in the current times, farming system and integrated farming system approach is gaining popularity in the region. The study undertaken is an attempt to investigate the prevalent farming systems, their types and patterns of diversification, estimate the economics of the identified farming systems and analyze the major constraints faced by the sample farmers practicing the farming systems. The study was conducted in two blocks, viz. Chandrapur Development Block and Dimoria Development Block of Kamrup (M) district of Assam following the multistage stratified random sampling design. A total of 100 farmers were selected as the ultimate sample in the ratio 4 marginal: 3 small: 2 medium: 1 large for the purpose of study. The study pertaining to land utilization and characterization of farming systems revealed that total area of operational holding in the entire sample was 48.91 hectares, of which 82.78 per cent was utilized for cultivation of field crops and 5.64 per cent for allied agricultural enterprises. Crop alone (40 per cent), Crop + Dairy (25 per cent), Crop + Dairy + Poultry (19 per cent) and Crop + Dairy + Poultry + Duckery (10 per cent) constituted the major identified farming systems. Highest gross cropped area (2.35 hectares) and net sown area (1.97 hectares) was found in crop + dairy + poultry + duckery farming system, while, highest cropping intensity of 122.09 per cent was found in crop + dairy + poultry farming system. The study on economics of the farming systems revealed that in crop farming system, average total cost (Cost C2) incurred and

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average total income gained per hectare of operational holding were Rs. 66748.74 (Rs. 221539.06 per farm) and Rs. 92341.55 (Rs. 306481.60 per farm) respectively. Sali rice had the highest contribution (47.28 per cent) to the total income while boro rice was the most profitable crop with B:C ratio of 1.49. In crop + dairy farming system, the average total cost incurred per farm was Rs. 358289.17 and average total income gained per farm was Rs. 500261.84 from the entire system. Both crop and dairy enterprise showed a B:C ratio of 1.4 each. On the other hand, in crop + dairy + poultry farming system, the average total cost incurred and average total income earned per farm was Rs. 337392.82 and Rs. 473846.27 respectively. Both crop and dairy enterprises were equally more profitable in the system (B:C ratio 1.41 each) than the poultry enterprise (B:C ratio 1.3). In crop + dairy + poultry + duckery farming system, the average total cost incurred per farm was Rs. 462682.80 and average total income gained per farm was Rs. 332029.33. The duckery component was the most profitable enterprise (B:C ratio 1.46), followed by dairy (B:C ratio 1.4), crop (B:C ratio 1.39) and poultry (B:C ratio 1.27) enterprises. No particular trend was observed across the size classes in the sample in regard to the total cost (Cost C2) of the farming systems while the net income mostly exhibited a positive trend alongwith the increase in size of farms. The crop component was the dominant enterprise in all the farming systems contributing more than 85 per cent to the total income. Both crop + dairy and crop + dairy + poultry were the most profitable farming systems in the sample displaying a B:C ratio 1.4 each, followed by crop + dairy + poultry + duckery (B:C ratio 1.39) and crop (B:C ratio 1.38) farming system. The study on the main constraints encountered by the sample respondents brought to light that high cost of inputs was the major constraint identified in the crop enterprise, while inadequate knowledge of disease prevention and control, and, vulnerability to diseases were the highest ranked constraints in the dairy and, poultry and duckery enterprises respectively.

Production and Marketing of Mushroom in Sivasagar district of Assam

Bidisha Buragohain

Mushroom is fleshy, spore bearing fruiting body of a fungus, typically produced above ground on soil or on its food source. Mushroom cultivation is labour intensive, indoor activity where high profitability provides employment to small farmers, landless labourers, women and unemployed youth in rural areas. Mushrooms have nutritive and medicinal importance. In Assam, mushrooms are greatly desired item of food. The study was performed in undivided SIVASAGAR district of Assam. In Sivasagar district of Assam, oyster mushroom is cultivated by the growers due to its easy and cost effective cultivation.

The study pertains to the year 2019-2020. There were three crop cycles in a year in the survey area. The sample size was 120. The sampling design followed for the survey was Simple Random Sampling. Primary data were used for the study. Primary data was collected from the sample mushroom growers through questionnaire by face to face interview method. The sample mushroom growers were stratified into 4 size groups on the basis of number of mushroom bags prepared, by the cumulative frequency distribution method. The stratification was as follows: Group I prepared 1-50 bags, Group II prepared 51- 150 bags, Group III prepared 151- 300 bags and Group IV prepared 301 and above bags. The objectives of the study were: to study the resource utilization pattern in mushroom cultivation, to examine the economic feasibility of mushroom cultivation, to estimate the marketing efficiency of mushroom, to analyse the constraints faced by the mushroom growers. Results of the present study revealed that per grower utilization of variable resources increased from group I to group IV but per bag utilization decreased from group I to group IV except straw and rope. This may be due to the tendency of small growers to use more quantity of resources to minimize risk. Paddy straw and spawn were the major inputs in mushroom cultivation because of their highest values among the items of variable resources. Highest labours required for cutting of straw followed by harvesting and transferring the bags to cropping room. Most of the growers used only family labours in the study area. In utilization of

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equipments, per grower utilization increased from Group I to IV and per bag utilization decreased from Group I to IV. Production per grower increased from group I to IV but per bag production decreased from group I to IV. Mushroom production was financially profitable due to its high value of benefit cost ratio based on variable cost and total cost. Breakeven price and production were much lower than the average price and production which indicated economic feasibility of mushroom production in the study area. Marketing efficiency was highest in group I and II because of lack of involvement of middlemen. Lack of local market for fresh and dried mushroom, lack of regular market, non-availability of spawn in time were the major constraints faced by the sample mushroom growers.

Economics of organic farming in Upper Brahmaputra Valley Zone(UBVZ) of Assam

Brishti Saikia

Ecological sustainability is threatened when the desire of human beings to acquire more and more from natural resources escalates in a never ending manner. To maintain this sustainability, there comes an ardent need for successful supervision of the gifted resources of the Mother Nature. Over the years after extensive research by the intellectuals across the globe, it was realized that organic farming is the only solution to attain the objectives of sustainability. Codex Alimentarius Commission proposed that organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes on the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions required locally adapted systems. This is accomplished by using, wherever possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system. India's North-east, comprising eight states, including Assam is largely unspoilt by modern agricultural practices that involve heavy use of agrochemicals and chemical fertilizers. For this precise reason, the region is a natural choice for promoting organic farming in the country.

A comprehensive study entitled "Economics of organic farming in Upper Brahmaputra Valley Zone (UBVZ) of Assam" was conducted in the three districts of Upper Brahmaputra Valley Zone of Assam namely, Sivasagar, Jorhat and Golaghat with the objectives to examine the status of organic farming, resource utilization pattern in organic farming, to estimate the comparative economics of organic vis-à-vis inorganic farming and to identify the constraints faced by the organic farmers of the region. Multi stage random sampling method was used to select a total of 120 farmers, 60 practising organic farming and 60 practising inorganic farming from the sample area. Crops such as *Sali* paddy, rape and mustard, potato, ginger and turmeric were considered for the study since these crops accounted for the maximum cropped area of the surveyed area and also these crops were grown commonly among the sample farmers. Various statistical

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tools such as average, percentage, Compound Growth Rate concept, cost and income concepts and simple ranking technique were employed in conducting the analysis.

Results from the analysis revealed that the area of Assam under organic certification increased significantly in the last five years from 2013 till 2018 with a CGR of 64.49. Among all the crops grown organically in Assam, production from cereals & millets (37,948.60 tons) and plantation crops (14,865.30 tons) were found to be the highest. Regarding resource utilization pattern in organic farming, along with organic seeds, other material inputs utilized in organic farming were farmyard manure, vermicompost, compost, biofertilizers and biopesticides. Vermicompost was one of the major material inputs in organic farming. High amount (in quintals) of vermicompost was essential to be applied at the organic crop fields to obtain good production and productivity such as 3.11 quintals/ha in *Sali* paddy, 9.28 quintals/ha in rape and mustard, 21.33 quintals/ha in potato, 13.46 quintals/ha, and 16.29 quintals/ ha in turmeric cultivation were found to be applied in organic cultivation of these crops. Organic farms were found to have utilized high labour force in the cultivation process as it involved additional round of operations in ploughing, manual weeding .etc. Such as in case of *Sali* paddy, organic cultivation required 116.24 mandays, 8.38 machine hours and 9.77 bullock pair days while inorganic cultivation required 107.49 mandays, 5.45 machine hours and 5.72 bullock pair days. The similar results were found in case of other crops. Furthermore, the study also brought to the fore that cost incurred by the farmers practising organic farming was more than the farmers practising inorganic farming. Also, the income generation was found to be moderately higher in organic farming than in inorganic farming. This was clear from the income per rupee expenditure of each crops such as 1.65 in organic *Sali* paddy while 1.58 in inorganic *Sali* paddy, 1.71 in organic rape and mustard and 1.62 in inorganic rape and mustard, 2.15 in organic potato while 1.57 in inorganic potato, 4.29 in organic ginger and 3.96 in inorganic ginger and lastly 2.65 in organic turmeric and 2.20 in inorganic turmeric. Absence of premium prices for organic produces, difficulty in the process of certification of products and inaccessibility to market information were the serious setbacks reported by the organic farmers of the region.

Impact of Tenancy System on Resource Use and Production of Major Crops in Karbi-Anglong District of Assam

Brota Sing Bey

Agricultural productivity and production of Assam is less in compare to other state of the country. Increasing the productivity per unit of cultivable land has been the main priority of all concerned. Since the population growth rate of the state has been increasing at a faster rate than in compare to Agricultural production. So, the agricultural production could not keep up with the increasing population growth rate. Consequently, the state agriculture faced the problem of how to increase the productivity per unit of input use. Consequently, efforts have been made for accomplish efficiency in resource use. Though, the productivity and resource use of tenancy are affected by various elements such as the size of the holdings, tenancy system, tenurial status of land, etc. it was observed that apart from own farm operating system, tenancy system also exists in the Karbi Anglong district of Assam because the land owners do not cultivate all of their available land due to lack of family labour and some other reasons. The present paper attempts to study the nature and extent of existing tenancy systems, examine the production and resource use efficiency of major crops in owned and tenant farms and to identify the problems faced by owned and tenant farmers. The study was conducted in Karbi Anglong district of Assam with 84 respondents. The primary data were collected by personal interview method. Most of the respondents were between the age group of 15 to 60 years with most of them having primary level of education. From the study It was found that 62 percent of the sample tenant farmers had rented less than 50 percent of their own land which was considered to be the tenant group I and 38 percent of the sample tenant farmers has rented more than 50 percent of their own land which was considered to be tenant group II. The cropping intensity was found to be higher in the tenant farmers than in compare to the owned farmers and the cropping intensity of tenant group I was found to be higher in compare to the tenant group II. There was a difference in resource use in rice cultivation under Total tenant

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and owned, Tenant's leased in and Tenant's own land and Tenant group I and Tenant group II which was supported by t-test. Similarly, there was a difference in resource use in sugarcane and tomato cultivation under Total tenant and Owned and Tenant group I and Tenant group II, respectively. The change in some inputs like seed, fertilizers etc were found to be significant and positive. In the resource use efficiency of rice, the return to scale was found to be higher in tenant farmers compared to Owned farmers. In the resource use efficiency of sugarcane, the return to scale was found to be higher in Owned farmers than in compare to the Total tenant. Similarly, In the resource use efficiency of tomato, the return to scale was found to be higher in owned farmers than in compare to the Total tenant. The gross return obtained from rice by Total tenant and owned farms were ₹ 56855.24 and ₹ 45544.00, respectively. Similarly, for Sugarcane and Tomato, the gross return for Total tenant and Owned farms was found to be ₹ 583128.16 and ₹ 628011.63 and ₹ 176146.84 and ₹ 173706.04, respectively. It was found that the lack of irrigation facility and the hired labour charges and lack of proper knowledge about the disease and pest management was found to be the common problems in both the tenant and owned farmers. The study concluded that There is still scope for the farmers to increase the quantity of input use where the resource use has been under-utilized and the scope to decrease the quantity of input use where there is over-utilization of the resources by the farmers. The recommendation for advisory services and training on various insect, pest and disease management issue for better management practice by the farmers in the major crops.

Interzonal variation of agriculture in Brahmaputra valley zones of Assam

Dhiman Hazarika

The present study was conducted in the four agroclimatic zones of the Brahmaputra Valley viz., Upper Brahmaputra Valley Zone, Central Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone and North Bank Plains Zone with the objective of finding the zonal variation in agriculture. The main objectives included identification of the major farming systems in the study area, finding the interzonal variation in resource use, finding the variation of farm income across the zones according to the farming systems and finally identification of the constraint faced by the farmers. The study employed multistage random sampling technique and a total number of 200 sample farmers were selected for the study from the 20 ADO circles in the four agroclimatic zones.

The findings revealed that there were numerous farming systems practised by the farmers in the study area. However, only three of them emerged to be the major ones. The three most adopted farming systems were „crop“, „crop+dairy“ and „crop+dairy+poultry“. Between the three, crop farming system was the most popular and was adopted by 34.50 percent of the sample farmers. It was followed by crop+dairy+poultry farming system adopted by 19.5 percent sample farmers and finally, crop+dairy farming system adopted by 18.5 percent of the sample farmers in the Brahmaputra Valley. The resource use pattern was found out for the three major farming systems and it revealed that there was considerable variation in level of resource utilization across the agroclimatic zones with some zones using more inputs in crop, dairy and poultry than the rest. On examining the income variation across the agroclimatic zones it was found that crop enterprises contributed the most to farm income. It was followed by dairy and poultry enterprises respectively. Also, farm income increased with the incorporation of dairy and poultry enterprises in their farming system. Upper Brahmaputra Valley zone reported the highest net income per farm out of all the four zones in the Brahmaputra Valley. Finally, the constraints faced by the farmers in the study area were found out and evaluated. Major constraint faced under

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crop cultivation was lack of finance which meant that farmers lacked the required capital to efficiently perform agricultural activity. Most dairy farmers faced a shortage of skilled labourers in their farms. Under poultry farming early chick mortality was the most common problem to be identified across the zones.

Study on Farm Household Income in Jorhat district of Assam

Dibya Jyoti Kalita

The present study was conducted in Jorhat District of Assam to study the existing sources of income, their contribution to the total household income and factors affecting the household income. The study employed multistage random sampling technique and a total number of 120 sample farmers were selected for the study from the eight selected villages of the two ADO circles of Jorhat, i.e. Titabar and Selenghat.

The findings revealed the two most prevalent farming systems in the study area, which were 'Crop + Livestock' and 'Crop + Livestock + Fishery'. Between the two, 'Crop + Livestock' was most dominant. Only 25 percent of the farmers had Fishery as a component in the farming system. It was also found that there were mainly two sources of farm household income, namely on farm and off farm. The on farm sources included income from crop, livestock and fishery. However, off farm sources included wage earner, business and service. It was found that, the contribution of on farm sources was more than that of off farm to the total household income, i.e. 84 % from the on farm and 16 % from the off farm, respectively. The on farm income was found to be increasing across the farm size. The contribution of Sali rice was the highest to the total income from crops (around 56%), followed by vegetables. On the other hand, marginal farmers received highest on farm income from the Livestock (around 53%). Income from Sali rice was found to be the highest among the crop (around 39%) and Dairy contributes the highest to the total income from livestock (around 42%). The contribution of service sector was found to be the highest to the total off farm income (around 79%). The study revealed that most of the respondent farmers were following mono cropping and the unit size of the livestock was very less, so measures should be taken to intensify the cropping pattern and broadening the unit size of livestock.

A regression analysis was done to work out the factors affecting farmer's income. Out of the seven selected independent variables, four were found to be significant, namely education level of the respondents, size of land holding, Extension contact and number of income sources. It means that the income of the farm household could be enhanced through improving those four variables. The relationship of the seven

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variables was found to be positive with the income of the households. It was also estimated that the independent variables are 86 percent responsible for the changes in the dependent variable (income of the farm household).

Impact of Agriclinic and Agribusiness Centres (ACABC) in agripreneurs' income in Assam- A case study in Jorhat district

Gagana M D

Agricultural development is a precondition of our national prosperity as it is the main source of earning livelihood of the people. Agriculture will continue to be central part to all strategies of planned socio-economic development of the country. In the years to come, the increase in agricultural production will mainly come from the growth in productivity which will invite intervention of agricultural extension activities in providing farmers information, training and support for adopting improved production technologies. In this background, the scheme of "Agriclinic and Agribusiness Centres" was launched on 9th April, 2002. The fundamental objective of this scheme is to strengthen the transfer of technology and extension services and also provide self-employment opportunities to technically trained persons. The present study aimed at analyzing this fundamental objective of self employment opportunities and more particularly, the impact of the Agriclinic and Agribusiness Centres on agripreneurs' income.

The study revealed that about 735 candidates are trained in Assam and 227 of them have established ventures. The ventures are established in 19 activities in Assam, among which more units are established under Veterinary clinics followed by Dairy/poultry/piggery/goatary, and so on. Under the ACABC, to provide finance support for the establishment of ventures, there are 93 number of projects was sanctioned and 25 are still in pending in Assam. From the four Case studies, it was concluded that there is positive impact of Agriclinic and Agribusiness Centres on motivation to start new ventures, knowledge & skill, and business, marketing & financial management. Out of 4 case studies, three were shown positive impact on increase in agripreneurs' income as their income has significantly increased after training. But, in one Case study although every management is ideal but due to weather uncertainty his income has decreased. It was concluded that, the more competition in the market, Pest attack / disease infestation problem, Lack of financial support, too much of

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risk and lack of skilled man power were the major problems that are confronted by the agripreneurs. And hence, there is need of some protective measures or strategies to overcome these problems like, contract farming, insurance on crop or other enterprise, providing on the job training, etc. and the government support is also needed like increase in credit facilities, availability of inputs at low cost, measure to minimize price fluctuations, etc.

Dynamics of Hill Agriculture with special reference to Shifting Cultivation in Dima Hasao District of Assam

Hamjana Hojai

The present study was undertaken in Dima Hasao, one of the hilly districts in the state of Assam. In an attempt to understand the dynamics of hill agriculture in the district, it was found that the availability of operational holding per holder had decreased by 77.32 percent from the year 1970 to 2000. Another decrease of 36.23 percent was observed from the year 2000 to 2010 with the availability of 0.69 ha per holder in 2010. Cropping Intensity (C.I.) showed an increasing trend between 1999-00 (C.I. value of 129 percent) till 2010-11 (C.I. value of 200.50 percent), with a steep increase between the year 2008-09 and 2009-10. This could be attributed to the success of a few projects going on under the National Watershed Development Project for Rainfed Areas (NWDPR) during the time. This increase was followed by a decreasing trend between 2011-12 (C.I. value of 192.46 percent) and 2018-19 (C.I. value of 132.63 percent). A significant increase was observed in the area covered under cereals, pulses, oilseeds, fruits, vegetables, condiments and spices, sugar and rubber from 1999-00 to 2018-19. Also, there was significant growth in fertiliser (total) consumption with Compound Growth Rate (CGR) of 20.08 percent and a very high Co-efficient of Variation (CV) of 227.58 percent. Shifting cultivation is a dominant land use practice in Dima Hasao and in an attempt to identify the existing crop mix in the study area, it was found that they could be divided into four crop mix groups based on the crops grown under shifting cultivation. Out of them, Crop Mix III (Cereals + Vegetables + Spices + Oilseeds + Tubers) had the highest occurrence with 58.75 percent of respondents following it. The analysis of the resource use pattern under shifting cultivation revealed that human labour (owned) was the most extensively used resource, contributing up to 70.84 percent (Crop mix III) to the total cost of production. Seed costs contributed up to 33.37 percent, farm tools contributed up to 6.66 percent (Crop mix IV) and farm hut contributed only up to 0.75 percent (Crop mix I) to the total cost of production. The ratio of return over

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variable costs in shifting cultivation ranged from 1.78 to 2.03 in the four crop mix groups with the highest ratio (2.03) in Crop mix IV (Vegetables + Spices). Employment generation in shifting cultivation (year-round) ranged from 183.06 to 224.63 mandays (per ha) with an average of 205.19 mandays (per ha) while the average annual net income from shifting cultivation in Dima Hasao was found to be Rs. 31,193.13 per ha.

An Economic Perspective of Farmer Producer Company (FPC) — The Case of Satbhani Potato Producer Company Ltd

Imran Hussain

Farmer Producer Companies (FPCs) are the institutions that can be geared up towards protecting small farmers from the ill-effects of liberalization and to incentivize them to participate in modern competitive markets. The producer company aims to empower and improve the bargaining power as well as the quality of life of small and marginal farmers. The present study entitled “An Economic Perspective of Farmer Producer Company (FPC) - The Case of Satbhani Potato Producer Company Ltd.” was conducted under Biswanath district of Assam. The study intended to examine the structure, organisational pattern, and performance of Satbhani Potato Producer Company Ltd. The study compared the economics of potato production for both FPC and non-FPC farmers of the study area. Further, the factors influencing the performance of FPC farmers were examined under the study by employing multiple linear regression. The study reveals that the Satbhani Potato Producer Company Ltd. was found functioning as per the structure provided by the Department of agriculture and cooperation, Government of India under policy and process guidelines for farmer producer organisations. The various financial test ratio *viz.*, current ratio, net capital ratio, return on asset, return on equity and debt-equity ratio were calculated for Satbhani Potato Producer Company Ltd. for the financial year 2017-18 and 2018-19. The current ratio, net capital ratio, return on asset, return on equity and debt-equity ratio for the year 2017-18 were 2.21, 2.69, 0.05, 0.09, 0.59 respectively, while the ratios for the same for the year 2018-19 were 1.86, 3.13, 0.10, 0.14, 0.46 respectively indicating the satisfactory performance of the Satbhani Potato Producer Company Ltd. The costs and returns were examined to study the economics of potato production. The findings of the study revealed that FPC farmers were incurring relatively lower costs per hectare of potato production than non-FPC farmers. The per hectare cost of potato production was worked out as ₹ 181312.96 for FPC farmers and ₹ 195293.22 for non-FPC farmers on

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overall farm basis. For both FPC and non-FPC farms, the total cost of production per hectare was found to be increasing with the increase in the size of the farms. The overall productivity of potato was found higher in the case of FPC farmers (235.82 quintals/ha) as compared to non-FPC farmers (215.54 quintals/ha). In the case of FPC farmers, the productivity of small farmers was recorded as highest (248 quintals/ha) and it was lowest in the large farmer's category. In the case of non-FPC farmers, the highest productivity was found in medium farmers (226.05 quintals/ha) and lowest in large farmers (215.54 quintals/ha). The price received per quintal of potato was more in FPC farmers (₹ 1400) as compared to non-FPC farmers (₹ 1250). As a result, the overall gross income and net income per hectare were found higher in FPC farmers than those of non-FPC farmers. The overall gross income per hectare was ₹ 330166.66 and ₹261895.80 for FPC and non-FPC farmers respectively, while the overall net income was worked out as ₹148854.32 for FPC farmers and ₹ 66602.56 for non-FPC farmers. The overall benefit-cost ratio of FPC farmers was found higher (1.82) as compared to non-FPC farmers (1.38). The factors that were found significant in influencing the performance of FPC farmers were level of education, family labour, hired labour, family size, adoption of recommended production practices, and farm training attended during past years. The R² and adjusted R² for the estimated regression model were 0.8873 and 0.8709 respectively.

Management of Integrated Farming Systems under Kalong Kapili NGO in Kamrup (Metro) District of Assam

Jharna Choudhury

Integrated Farming System is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirement of farm household while preserving the resource base and maintaining high environmental quality. A total of 120 farmers of Kalong-Kapili NGO from Kamrup (Metro) district of Assam were randomly selected for the study, comprising of 24, 20, 13, 20, 24 and 18 farmers from fish cum pig, fish cum poultry, fish cum duck, fish cum dairy, fish cum rice and fish cum horticulture integrated farming systems, respectively. Till June 2019, 10,400 farmers were associated with the NGO out of which 6700, 2600 and 1100 farmers were from Kamrup (Metro), Nagaon and Karbi Anglong districts, respectively. More than half (52.50%) of the farmers were middle aged (30-45 years) and almost three fourth (76.67) of them studied up to matriculation level. Total operational holding was found highest (2.02 ha per farm) in case of fish cum dairy farmers, followed by fish cum horticulture (1.91 ha) and fish cum pig (1.63 ha) farmers, respectively. Utilization of inputs such as fish seed, piglets, birds, lime, organic manure, inorganic fertilizers, labour etc. was also analyzed in the study and it was found that all the farmers had been following scientific culture practices fully or partially. Both cost and income concepts were thoroughly analyzed and per hectare net income of Rs. 7,87,609.42, Rs. 2,30,600.03, Rs. 6,38,078.99, Rs. 7,13,500.24, Rs. 1,35,564.98 and Rs. 5,05,360.32, and benefit-cost ratios of 2.42, 1.51, 2.16, 2.13, 1.83 and 2.94 were found for fish cum pig, fish cum poultry, fish cum duck, fish cum dairy, fish cum rice and fish cum horticulture integrated farming systems, respectively. In fish cum poultry integration, requirement of poultry feed and its cost was extremely high and hence the return from poultry alone was in negative; but, due to its integration with fish, benefit-cost ratio of 1.51 was achieved. In fish cum dairy integration involvement of labour was maximum than the other integrated farming systems. Problems such as non availability of good quality fish seeds, fluctuating marketing conditions and prices, financial problems etc. were some of the common problems identified for the farmers of all the integrated farming systems.

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A study on economics of *khuti* systems of buffalo rearing in eastern districts of Assam

Lochan Jyoti Saikia

Khuti system of buffalo rearing is a traditional technique of Assam. Buffaloes are allowed to graze freely in open wetland areas or forest fields from morning till evening and taken back to the temporary camps. The present study entitled “To study the economics of *khuti* system of buffalo rearing in eastern districts of Assam” intended to study the extent of seasonality of production of milk. The present further worked out the cost and returns of *khuti* system of buffalo rearing and the problems faced by the buffalo rearers in production of milk.

From the findings of the study it was found that milk production is not uniform throughout the year due to certain factors like temperature and relative humidity. Farming activities of the *khuti* becomes difficult during the rainy seasons (from June to September) due to flooding in their low land areas. The milk yield was found to be highest in April and December. Minimum milk production per *khuti* was found during the month of July.

The cost of *khuti* has a positive relationship with the herd-size. The total cost per *khuti* of large rearers was found to be ₹286080.00 followed by medium (₹148998.47) and small rearers (₹90340.69). For overall sample, total cost per *khuti* was ₹169865.10.

Returns from all the sources per *khuti* were found to be highest for large rearers followed by medium and small rearers which were ₹754733.33, ₹207472.00 and ₹168050.00, respectively, and for the overall sample it was ₹257071.00. The net income per *khuti* for all the categories were ₹468653.33, ₹58473.53 and ₹77712.88 for large, medium and small rearers, respectively. For the overall sample, it was recorded as ₹87205.91. The cost-benefit ratio of small, medium and large categories of buffalo rearers were 1:1.86, 1:1.39 and 1:2.63, respectively, and it was 1:1.51 for the overall sample.

Major problems faced by the buffalo rearers in the study area were low productivity of the Assamese buffalo, lack of technical knowledge of milk production, lack of proper feed especially during rainy seasons due to flood in low land areas near

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river banks, the interference of middlemen for the marketing of buffalo milk, disease infestation especially during rainy seasons and seasonal hazard. Besides these, other problems faced by the rearers were – the high price of medicine and veterinary charges, lack in good storage facilities and lack of credit facilities.

An economic analysis of production and marketing of rubber in Karbi Anglong district of Assam

Olivina Katharpi

An economic analysis of production and marketing of rubber was conducted in Karbi Anglong district of Assam. The present study was undertaken with a view to study the status of the rubber cultivation in the district, the costs and returns of the rubber cultivation and its marketing channel and the problems associated with it. Primary data were collected from 120 respondents with pre tested schedule. Secondary data were also collected from Rubber Board and various published sources. The data collected was subjected to tabular analysis and various financial feasibility analysis by using Net Present Value, Benefit Cost Ratio, Internal Rate of Return and Pay Back Period.

The result revealed that the area and production increased over the years for the state with a per cent change of 44.64 and 22.58, respectively in the year 2016-17 over 2013-14. The area and production of rubber was also seen to increase in the Karbi Anglong district over the years. But the productivity of rubber is seen to decrease in the state as well as the district. In Karbi Anglong, per hectare total cost of establishment (initial and 7th year) was Rs.62,674.37 and Rs. 59717.84 in marginal, Rs.66337.49 and Rs. 52237.51 in small, Rs.72,080.15 and 1,30,966.10 in semi medium, Rs.72,728.36 and Rs.1,35,517.69 in medium and Rs.74,089.20 and Rs.1,38,327.13 in large plantations. The per hectare maintenance cost for gestation period (six years) was Rs.69,169.34, Rs.126,579.96, Rs.133,254.75, Rs.134,199.77, Rs.135,432.38 for marginal, small, semi-medium, medium and large, respectively. The yield of rubber cultivation was calculated both for rubber sheet and rubber scrap. The marketing channel was found to be same for both the rubber sheet and rubber scrap. The highest marketing efficiency was found in channel I (Producers-Dealers-Consumers). High initial investment cost, high labour cost, wind breakage are some of the major problems reported in the cultivation of rubber in the district. As investment in rubber plantation was found to be financially feasible, the farmers can take up the enterprise for their economic upliftment.

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A study on the economic aspects of the small tea growers in Dibrugarh district

Pahari Saikia

The present study entitled “**A Study on the economic aspects of small tea growers in Dibrugarh district**” was conducted with the objectives to study the pattern of resources, returns and efficiency of resources in tea production. Random cum proportionate sampling was followed for selection of estates. A total of 120 sample estates were selected from two development blocks, i.e., Barbaruah and Khowang Development Blocks. The small tea growers were classified into mini, mid-size and mega estates according to the land holding size of 0-11 bigha, 11-30 bigha and above 30 bigha, respectively. The results of the study revealed that total operational holding of the sample estates was 19.58 bigha of which 18.38 bigha of land was under tea cultivation and only 1.20 bigha of land was used to produce other crops or kept fallow. The land used for cultivation of tea for mini, mid-size and mega estates were 5.23 bigha, 18.38 bigha and 49.45 bigha, respectively, which showed that as the size of the holding increased, the proportion of land under tea cultivation also increased. The types of resources used were manure, fertilizers (urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP)), plant protection chemicals and labour which include the mandays of male and female labour and machine hour. It was found that sample estates were mostly dependent on fertilizers than on organic manures. Due to limited knowledge of plant protection measures, arbitrary doses of chemicals were applied rather than the recommended doses. Both male and female mandays increased per estate and decreased per bigha with increase in the size of estates from mini followed by mid-size and mega estates. However, the demand for female labour was comparatively high in all the estates due to their lower wages and involvement in major operation of plucking and weeding, implying a better livelihood for the rural women. Higher machine labour was used by mega estates indicating adoption of modern technologies was maximum in this category as compared to mini and mid-size estates. It was observed that total cost of cultivation for mini, mid-size and mega estates was ₹ 14,779.86, ₹ 13,942.89 and ₹ 13,478.83, respectively, which varied directly with the

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land size of small tea growers. It was found that highest per cent of the total variable cost composed of the costs of fertilizers which alone contributed 48.94 per cent of total cost followed by labour. This indicated that tea cultivation is both fertilizer and labour intensive. The examination of farm management efficiency parameters of tea cultivation indicated that all the size categories the benefit-cost ratio was greater than unity which further indicated that the benefits outweighs the costs in the estates. Both gross and net returns in tea estate increased with the increase in the size of estates. The four significant variables positively influencing tea yield were land, fertilizer, female and male labour with elasticity co-efficient 1.001, 0.031, 0.117 and 0.108, respectively. Among all the variable inputs, the influence of seedling, FYM and machine labour on output was seen to be non-significant. It was observed that 90.6 per cent was technically efficient and the remaining of 9.4 per cent technically inefficient. It was observed that low price realization of tea leaves, lack of workers in the peak plucking season, lack of technical knowledge, incidence of insects, pests and diseases and high price fluctuation of green tea leaves were the common problems faced by the small tea growers in the study area.

Production and marketing of Sugarcane in Golaghat district of Assam

Partha Pratim Baruah

The present study was conducted in Golaghat district of Assam to study the production, costs, returns, income, and marketing pattern of Sugarcane. The study employed multistage random sampling technique and a total number of 120 sample farmers were selected for the study. In addition to that, 15 numbers of intermediaries were also selected to examine the marketing of sugarcane.

The findings revealed that the area & production of sugarcane in Assam had increased significantly with a CGR of 1.37 & 1.03 respectively from the years 2007-2008 to 2017-2018. The productivity showed a declining trend with a CGR of -0.33 and the major reasons for it being heavy monsoon rainfall, high incidence of insect pests etc. In case of Golaghat district, it was found that there was a positive increase in area with a CGR of 15.58 from the years 2007-2008 to 2017-2018. But the production and productivity were declining with CGR of -2.79 & -2.97. In the Golaghat district, all sugarcane growers sold sugarcane in the form of jaggery and hence the return was from jaggery only. The cost incurred for the sugarcane and Jaggery production per ha was 156114.81 for marginal farmers, 153247.11 for small farmers, 151744.41 for medium farmers. The net returns per ha obtained was 71314.53, 72283.43 and 74384.39 for marginal, small, medium farmers respectively. And the return per rupee was highest in case of medium (1.49), small (1.47) and marginal (1.46) farmers.

And also it was found that there were 3 marketing channels present in the study area, among them marketing efficiency was more in case of Channel –I followed by Channel –II and Channel –III. The findings also showed that the major constraints faced in production of sugarcane were lack of information on government facilities followed by unavailability of labour, financial problem and lack of suitable varieties. With respect to marketing, price fluctuation was the major problem followed by presence of middleman, long distance to markets and lack of transportation.

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An Economic Analysis on Contribution of Women in Farm Business – A study in Dhemaji District

Priyanka Chutia

The study entitled ‘**An Economic analysis on contribution of women in farm business- A study in Dhemaji district**’ was conducted with the following objectives: 1. Study the contribution of women in farm and non-farm activities in the study area 2. Work out the gender differential in labour utilization in farming and allied activities 3. Working out the physical and economic conditions under which a farm women works and to explore their potential in enhancing the farm family income. Elicit the opinion of the farm women to overcome the problem of unemployment during off season Dhemaji district of Assam was selected purposively in carrying out the present investigation. A multistage random sampling method was adopted in selection of 120 respondents which constituted the sample for the study. From the selected district two blocks Dhemaji and Machhowa were selected purposively. From each selected block three villages were taken randomly thus making a total of six villages. The major tool used for collection of primary data in the study was a pretested schedule by personal interview method. For the purpose of achieving the specific objectives of the study data collected were subjected to the statistical analysis. For this purpose tabular presentation method with averages, frequency and percentages were employed. Transplanting and harvesting accounted for the highest proportion of women labour utilized in crop cultivation. During transplanting, on an average women workers devoted 37.24, 33.75, 49.43 and 44.28 mandays in marginal, small, medium and large households, respectively. In harvesting operation, the sample women devoted 32.95, 33.74, 48.11 and 47.93 mandays in the marginal, small, medium and large farm households, respectively. In livestock management the highest women labour was utilized in cleaning shed/utensils, milking, preparation of food/feed and watering animals in the pooled sample. The average mandays devoted by women in cleaning sheds or utensil was 45.97, 71.44, 61.18 mandays for the small, medium and large households, respectively. The average mandays devoted by women in milking was 64.16, 39.64, 49.94, and 28.31 for marginal, small, medium and large farm households, respectively. Preparation of feed is another

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important task done mainly by women in which the devotion of women on an average was 26.13, 37.30, 50.68 and 59.77 respectively. The average mandays devoted by farm women in the non-farm sector was highest in the handloom industry with an average mandays of 113.83, 95.92, 69.06 and 49.56 for marginal, small, medium and large farm households, respectively. Across the size groups the total male family labour utilized were 119.90, 134.31, 182.92, 177.32 mandays in the marginal, small, medium and large farm households, respectively. The total female labour utilized were 88.74, 97.22, 142.99 and 118.66 mandays in the marginal, small, medium and large farm households, respectively. In livestock management, total male labour utilized were 92.05, 127.81, 88.99 and 66.13 mandays against 149.18, 192.46, 194.69 and 160.78 mandays of female family labour in the marginal, small, medium and large farm households, respectively. The total male labour utilized in non-farm activities were 73.48, 85.40, 115.11 and 123.21 mandays against 151.07, 181.95, 156.26 and 147.87 mandays from female family labour in marginal, small, medium and large farm households, respectively. Activity wise participation of women in craftwork was much higher than men and the average mandays devoted by them were 113.83, 95.92, 69.06 and 49.56 for the marginal, small medium and large farm households, respectively. In the study area most of the households lived in pucca or semi pucca houses. Economically weaker households received housing facilities through Pradhan Mantri Awas Yojana. Women generally worked throughout the day on field in peak agricultural season from March-April to November-December in the study area. They spent their time doing farm related works in their own field as well as in the neighbouring fields. Few women were engaged as hired labours having smaller land holdings. On an average about 86.49 per cent of income was generated from the farming and allied sector and only 13.50 per cent was generated from the non-farm sector. It can be said that the livelihood pattern of the people of the study area was mainly dependent on agriculture and allied activities. It was found that the annual income per farm increase with the farm size which indicates a positive relationship with the size of land holdings.

Economics of cashew nut production in West Garo Hills district of Meghalaya

Saddam Hussain

Cashew nut is an important plantation crop in wasteland development programme due to its utility in soil water conservation and to build up balanced ecosystem. Due to improvement in health consciousness of people, cashew is getting importance not only in domestic markets but also in international markets. The present study is an attempt to examine the cost, returns and resource use efficiencies of Cashew nut cultivation by different categories of farmers.

The sampling design consists of four stages. In the first stage, the West Garo Hills district of Meghalaya was selected. In the second stage two blocks namely Dadenggre and Selsella were selected purposively. In the third stage, eight villages, namely, Amingokgre, Addinggre, Chibonggre, Daljagre, Dabakgre, Mronggre, Rongramgre and Makbilkolgre from the two blocks were selected purposively. In the final stage, proportionate number of farmers from each village were selected randomly to constitute a total sample of 120 farmers. The selected farmers were categorized as small (1- 2 ha), medium (2-4 ha) and large (> 4 ha).

The findings revealed that majority of the cashew nut growers were literate (78.62 per cent) with the educational status of (35.96 per cent) up to primary school, (28.47 per cent) up to secondary and (18.00 per cent) up to degree level education. The remaining (21.38 per cent) of cashew nut growers were observed to be illiterate. The average size of the family cashew nut growers was 6.11 members and land holding of the farmer was 3.10 hectares, out of which 2.97 hectares was operational and remaining 0.13 hectare was under permanent fallow. Out of operational land, the area under irrigation was 1.92 per cent and remaining area was unirrigated (98.08 per cent).

The study further revealed that the per hectare establishment cost of cashew nut on a small, medium and large farm in the year 2020 were ₹111816.80, ₹108736.84 and ₹106478.95 respectively. The average maintenance per hectare cost of small farm was estimated to be ₹35362.18, ₹36310.18, ₹36883.46, ₹37769.95, in medium farms ₹36101.19, ₹37122.29, ₹37805.73, ₹38796.76, large farms ₹38957.98, ₹40096.15, ₹41294.84, and ₹41893.20 in 8th, 11th, 14th and 17th year respectively. Benefit-Cost

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ratios were calculated as 2.44, 2.42 and 2.38 for the small, medium and large farms. It is observed that the Benefit-Cost ratio is more than unity, so it is feasible and economically viable.

The factors that found significant in cashew nut production were hired human labour, family labour, manures and fertilizers in all size of farms. But age of the farmers was not significant. It showed that hired human labour, family labour, manures and fertilizers have a positive impact towards the income from cashew nut. The ratio of MVP to MC was positive and greater than unity and it is significant in case of inputs like labour, manures and fertilizers. Its significance indicated the possibility of additional use of these inputs to achieve the optimum level. The adjusted R² for the estimated regression model were 0.8463, 0.7541 and 0.8677 for the small, medium and large farm respectively. The present study serve as a useful reference guide to the people involved in the cultivation and resource uses to the crop as well as a guideline for similar studies that may be undertaken in other parts of the country.

Economics of Production and Marketing of King Chilli in UBVZ of Assam

Saradi Sondhya Baruah

India is gifted with diversified chilli varieties. Among the important chilli varieties of India, King Chilli (*Capsicum sinense* Jacq.) is well known for its distinct pungency and aroma which had its origin in north-east India. King Chilli got its name and fame after it was crowned as the “World’s Hottest Chilli” by the Guinness World Record in September, 2006. The title of hottest chilli created international demand for the chilli. Since then efforts were made to extend chilli cultivation in the region to increase production to meet the rising demand. So, the present study entitled “Economics of Production and Marketing of King Chilli in UBVZ of Assam” was undertaken to depict the overview of production and marketing situation prevailing in the study area.

For the study two districts, namely Jorhat and Sivasagar were selected under Upper Brahmaputra Valley Zone of Assam. Primary data was collected for the analysis following multistage stratified random sampling technique. A total of 120 farmers were selected as the ultimate sample in the ratio of 4 Marginal:3 Small:2 Medium: 1 Large.

The study revealed that return per rupee invested was 5.6 for marginal farms, 5.9 for small farms, 6.3 for medium farms and 6.2 for large farms. Thus, return per rupee showed increasing trend with the increase in the size of farm. For studying the marketing channels a total of 29 marketing agents were personally interviewed. Different channels were identified in different harvesting period. Highest efficiency was found in marketing the products directly from producer to consumer which was calculated by using Acharya’s formula. Various production and marketing constraints faced by the respondents were also examined through Garrett’s ranking technique. Attack of pest and disease was found as important constraint faced by the farmers during production period while in marketing the products, wide price fluctuation was considered as the highest constraints. Hence, the study was taken up to study the economics of King Chilli in the region.

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Major Advisor : Dr. Riaz Abdul Halim

Estimation of Risk Frontiers in Rice Cultivation under Flood Prone Situation of North Bank Plain Zone of Assam

Shivangee Acharya

The present study was carried out in the North Bank Plain Zone (NBPZ) of Assam during February- March 2020. The mentioned zone was purposively selected to study the effect of risk rising from chronic flood hazards in the region. As the occurrence of flood in the production process was unavoidable, the use of modern inputs was also dramatically low. The perceived risk inherent in the production process was the primary reason for hesitance in use of fertilizers, HYV seeds, modern practices, etc. That gradually led to low production and low productivity of rice in the study region. Rice was predominant in the region as the prevalent climate and hydrology did not provide favourable situation for cultivation of other crops in a commercial basis.

A multistage random sampling technique was used for the selection of sample farms. The sample farms were the core units of observation in the study. A sample of 90 farmers were randomly selected for primary data collection in the present investigation. The sampled farms were then grouped into small, marginal, semi-medium and large based on operational landholding and into group A and B depending on the percentage of crop area affected by flood.

Demographic situation was analyzed through tabular method. As the traditional production function fails to capture the risk considerations of the production process and also does not imply the nature of risk associated with a certain factor, i.e. if it is increasing or decreasing, hence, estimation was done through the Just and Pope (1979) model to analyze the product-factor relationship under uncertainty environment. The effect of factors on the yield was studied through the Cobb-Douglas production function. To study the inefficiency effects, the stochastic production frontier function developed upon by Battese and Coelli (1995) was used. The analysis was carried out through the FRONTIER 4.1 software.

The study area was predominant with marginal and small farms characterized by a low literacy rate. The youth of the area was primarily involved in agriculture

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directly or indirectly. The use of modern inputs was low; fertilizer had insignificant effect on the yield of marginal farms, but affected the yield of small and semi-medium farms in a significant way which indicated that by increasing the amount of fertilizer used, the yield could be increased too. Fertilizer also had a risk decreasing effect on the yield, which showed that it reduced the variability in the rice yield of the 8 farmers. Abundance of labour in the farms lead to overuse of the same. This implied that there existed disguised unemployment amongst the youth of the region. Most of the young population was involved in rice cultivation directly or indirectly. Literacy was found to be important in reducing risk in agriculture in an uncertain environment, and significantly reduced the variability of yield and risk in the production process.

A number of risk management strategies were developed by the farmers to reduce the loss arising from the flood hazard or for minimization of risk under such condition. These strategies were either *ex-ante*, *ex-post* or executed in the period of flood occurrence. Percentage analysis was carried out to determine which strategy was the most prevalent in the area amongst the farmers. The present study showed that risk played a major role in use or non-use of modern inputs and adoption of modern cultivation practices. The production of rice in the region could be improved by structuring effective policies, constructing proper planning for flood loss mitigation and developing practices and inputs that are in line with safeguarding the interests of the farmers in flood affected regions.

Comparative economics of potato cultivation using tuber and True Potato Seed (TPS) in Tripura

Sonia Das

The present study was conducted in Unakoti District of Tripura to study the status of TPS potato, costs and returns of potato cultivation, resource use efficiency and constraints associated with TPS cultivation. The study employed multistage random sampling technique and a total 120 sample farmers were selected for the study. For analyzing the data, various statistical tools like percentage, compound growth rate, Cobb-Douglas production function, Garrett's ranking technique and cost concepts were used.

The findings revealed that the area under TPS potato in Tripura had increased significantly with a CGR of 10.34 from years 2007-2008 to 2017-18 and its percentage share to total potato area of the state had increased from 25.17 percent to 38.09 percent from 2007-08 to 2017-18. Productivity of TPS potato in the study area showed an increasing trend with a CGR of 2.35 and more than 50 percent area under potato cultivation was covered with TPS potato.

In the costs and returns calculation it was found out that the cost incurred for tuber potato was more as compared to TPS potato mainly due to high seed cost but returns were more in case of TPS potato. The study found out that return per rupee for TPS potato was 6.15 and tuber potato was 1.79 means profit was almost more than 3 times in case of TPS potato.

The study indicated that resource use efficiency of most of the resources for both tuber and TPS potato was found to be less than unity means the resources were underutilized. Hence, in order to obtain more production, expenditures on those resources should be increased.

The findings also revealed that lack of capital, less availability of implements, unavailability of seed at proper time of planting, lack of storage structures, unavailability of regulated market were the major constraints faced by the farmers in TPS cultivation. Government should take effective measures through various programmes to cover all the farmers for encouraging them to adopt new and innovative technologies for potato cultivation to achieve increased level of farm income for both tuber potato and TPS potato farms.

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An economic analysis of production and marketing of orange in Kamrup Metro district of Assam

Sunil Pator

Orange is commercially the most important sub-tropical fruit and one of the most widely cultivated fruit crops. The present study is an attempt to analyse the cost of cultivation of orange farmers, the economics of orange cultivation vis-à-vis competing crop and the marketing channel of orange in Kamrup Metro district of Assam. It will serve as a useful reference guide to the people involved in the cultivation and marketing of this crop as well as a guideline for similar studies that may be undertaken in other parts of the country. The present study is carried out with the following specific objectives: Find out the cost of cultivation of orange in study area; Study the economics of orange cultivation vis-à-vis competing crop; Study marketing of orange in study area. The sampling design consisted of four stages. In the first stage, the Kamrup Metro district of Assam was selected purposively. In the second stage two revenue circles namely Sonapur and Chandrapur were selected purposively. In the third stage, a total of six villages namely Kalangpur N.C, Dondoral N.C, Barkashrong N.C, Chandrapur Bagicha, Niz Panbari, Hingimari Bagicha from the two blocks were selected purposively. In the final stage, 32, 19, 25, 14, 15 and 15 farmers from Kalangpur N.C, Dondoral N.C, Barkashrong N.C, Chandrapur Bagicha, Niz Panbari, Hingimari Bagicha villages were selected randomly to constitute a total sample of 120 farmers. The selected farmers were categorized as small (those having less than 2 ha), medium (those having 2-4 ha) and large (those having more than 4 ha).

The findings revealed that the per hectare establishment cost of orange on a small, medium and a large farm in the year 2019 were ₹129357.60, ₹137160.60 and ₹139772.60, respectively. The average maintenance per hectare cost of small farm was estimated to be ₹55265.75, ₹55622.92, ₹57530.97, ₹64107.23 in medium farms ₹64528.75, ₹65050.25, ₹66645.25, ₹66882.75, large farms ₹73058.75, ₹73966.75, ₹75866.95, ₹76987.08 in 10th, 15th, 20th and 22nd year respectively. Benefit-cost ratios were calculated as 1.38, 1.45 and 1.50 for the small, medium and large farms. The

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average cost per hectare cost for arecanut farm was found to be ₹ 22555.93, ₹ 22297.81, ₹ 22429.49, and ₹ 24992.51 on 8th, 10th, 12th, and 13th year age plants. The net present value and benefit-cost ratio were found to be ₹ 261218.20 and 3.32, respectively. The study of marketing of orange revealed that orange producers sold their products through three marketing channels viz., Channel-I (Producer – Pre-harvest contractor – Retailer – Consumer), Channel-II (Producer- Village Trader – Retailer - Consumer) and Channel-III (Producer- Retailer – Consumer). Among these channels, channel-III was found the most important channel in the study area. The market efficiency was 4.58 in channel-III.

Disaggregated regional growth and disparity analysis of public sector banks in India with special reference to Assam

Swathy Parvathy

The banking sector in India has undergone remarkable changes during post-nationalisation period. From a purely profit-oriented private owned and urban biased sector, it had grown into a development-oriented and social justice based public sector banking industry now-a-days. The fundamental objective of bank nationalisation was to convert the banking of classes into banking of masses. The present study aimed at analyzing this fundamental objective of bank nationalisation and more particularly whether the wide disparity in banking development in terms of branch expansion, deposit mobilization and credit disbursement that existed prior to nationalisation remained even after 45 years of nationalisation or not. The study revealed that the number of bank branches, amount of deposit mobilized and credit disbursement increased in 2016 over 1972. But the imbalances among the regions and states remained the same even there was a reduction in the gap between them. Bank branch expansion could reduce the locational imbalances up to a particular level. But the credit disbursement showed much variation among regions in 2016 as well. The credit-deposit ratio of the regions and states indicated the discrimination to the north-eastern parts of the country in case of the credit disbursement.

All the agro-climatic zones in Assam showed an increasing trend in the number of bank branches, the amount of deposit mobilized and the amount of credit disbursed. But the trend did not support the policies adopted by the Government to eliminate gradually the existing gap among the zones. The credit-deposit ratio of the state, as well as the zones, had not increased much from 1973. Elasticity value of zones showed that every zone was under highly deposit potential area category. Growth in case of accounts and amount of credit disbursed in priority sector was not much enough to improve the economic status of the farmers. The number of accounts showed higher growth compared to the growth of the amount advanced to the sector. Imbalances in the banking facility in the priority sector remained the same in 2016 also.

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Major Advisor : Dr. Nilotpal Borthakur

It could be found out from the study of the public sector banking that during 1972-2016 banking development in India went in favour of desired policy lines. But the regional and state wise disparities in terms of banking services still exist. Analysis indicated that in major banking services (expansion of bank branches, mobilization of deposits and disbursement of credit especially to weaker sections of society) some healthy trends had been observed during these 45 years which might have helped significantly, if continued in the future by giving emphasis to North-Eastern region, in minimizing the widening banking disparities.

A study on crop diversification and its impact on agricultural production in Biswanath district

Trailukya Das

Crop diversification is an important strategy for overall agriculture development in the country. Crop diversification is the growing of more than two crops in a farm with not more than 50% of the return comes from a single enterprise. The study aimed at analyzing the nature and extent of crop diversification, finding the factors affecting crop diversification and to study the impact of crop diversification on crop production.

The necessary primary data were collected from 120 selected farmers of the district. Herfindahl index was calculated to study the nature and extent of crop diversification. Herfindahl index was transformed by subtracting it from 1 to avoid confusion to compare it with other indices. Multiple regression analysis was carried out to study the factors influencing and simple regression analysis was carried out to study the impact of crop diversification on crop production. Again, multiple regression analysis was carried out to study the impact of other factors on crop production along with crop diversification.

The transformed Herfindahl index value for the sample population was 0.696. Among the 120 respondent the highest transformed H.I. value was 0.851 and the lowest was 0.295. Across farm size, large farms shows highest diversification with transformed H.I. value 0.75 and marginal farms with transformed H.I. value 0.661 shows the least diversification. The transformed H.I. value for small farms was 0.682 and for medium farms was 0.712.

From results of multiple regression analysis the major factors found to have influence in crop diversification were landholdings, education of the farmer, availability of irrigation facility, cropping intensity, use of labour man days, and net income from crop production.

From the simple regression analysis, it revealed that there is direct positive relationship among crop diversification and crop production. With increase in crop diversification, crop production also increases. For all the farm size groups it was found that crop diversification has significantly influence on crop production. In all the cases

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(marginal farms, small farms, medium farms, large farms) the R² value are found to be on lower side i.e., less than 0.39. This means that there are other factors, which influence crop production.

To study the impact of other factors on crop diversification along with crop diversification multiple regression analysis was carried out. The results of regression analysis revealed that size of landholding, irrigation facility, cropping intensity, net income and crop diversification had significant influence on crop production. The adjusted R² value for the analysis done across all farm category was 0.9083, which indicate the level of impact of significant factors (size of landholding, irrigation facility, cropping intensity, net income from farm and crop diversification) on crop production.

Assessment of women participation in Assam Agriculture

Trishna Chutia

Indian women play a focal role in different agricultural activities along with their day-to-day household activities. The present study is an attempt to assess the level of women participation in agriculture, the women involvement in farm decision making along with estimation of women contribution to agricultural income in the state of Assam. The study also tried to identify the factors affecting women's participation in agriculture. The study area was in two districts of Assam *viz.*, Golaghat and Nagaon. A multi-stage random sampling technique was used to select the sample unit. A sample of 180 households was selected from Golaghat, and Sarupothar block of Golaghat district and Kothiatoli and Barhumpur block of Nagaon district.

Various activities performed in different crops were considered to study the women participation. The most important activities of rice cultivation, in which women actively participated were transplanting and harvesting in both the districts of the state. Similarly, for other crops *viz.*, sugarcane, mustard, potato, tomato and pumpkin, the most important activities that showed women participation were inter-culture activities, harvesting and post-harvest management

Decision making by women under organizational decisions was highest in leasing in & out of land (12.86%) in Golaghat district while decision making by women was highest in purchasing and selling of land (6.82%) in Nagaon district. With respect to production decision, highest decision by Women was for decision on area to put under different crop in both Golaghat (8.29%) and Nagaon (5.56%) districts. Storage of crop produce involved solo decision making by women in both Golaghat (49.14%) and Nagaon (31.06%).

The most profitable crop for both the district was pumpkin followed by tomato and sugarcane. The least profitable crop was found to be mustard for both the district with least return over cost. Contribution of women to net income was 36.84 per cent and 20.74 per cent in Golaghat and Nagaon district, respectively.

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Among different factors, poor economic status (48.89%) and lack of alternative employment avenue (58.89%) were the most influencing factor while preference for job (24.45%) and lack of training (40%) were equally the most hindering factor in Golaghat and Nagaon district, respectively.

The study revealed that women played an important role in different activities of important crops. However, women face some constraints while participating in agriculture. Intensive extension services, training, focus on income generating activities like off-season vegetable farming, nursery management and impetus on proper planning on women empowerment approaches etc. would help to increase their participation.

A study on financial management of Muktai Dairy Farm

Vishal Kacharu Kahandal

Muktai Dairy Plant was established in 7th February, 2007 just as chilling centre with a capacity of 10000 liters/day. At present they are processing and packing around 18000 liters of milk per day with the plant capacity of 30000 liters per day. The organizational structure of dairy farm had four departments which are Processing, Finance, Marketing and Human Resource departments. Processing department was considered as the prime department of the farm which involves Manager, Operator/Supervisor and plant workers.

The farm processes a number of milk and milk products which are very popular at different parts of Maharashtra. Shivneri milk is the main product of the farm with 34.66 lakh liters of production with a product share of 69.45 per cent. Shivneri chass has the lowest share (0.06%) due to seasonal demand and nature of production. Ghee, paneer and curd are the other products manufactured at the farm. Among the various investments, the investment on buying machinery and equipment was the maximum, having share of 71.21 per cent, with total amount of Rs. 363.10 lakhs. The other fixed expenses were incurred for acquisition of land, construction of building, vehicle, generator, fencing, furniture, water supply structure, license fee and lab equipments. Amount paid to the permanent workers of the farm was Rs.13.20 lakhs per year. Casual workers were mostly hired on the basis of daily wages as per the workforce requirement and the amount spent on casual workers was Rs.13.02 lakhs per year. The total variable cost worked out was Rs. 1469.94 lakhs, out of which the cost of purchasing of raw material was the prime cost accounting for Rs. 1231.68 lakhs. The processing costs for Shivneri milk, Muktai milk, Shivneri Ghee, Shivneri Paneer, Shivneri Curd and Shivneri Chass were accounted for Rs. 30.34/lit, Rs. 30.34/lit, Rs. 257.85/kg, Rs. 160.10/kg, Rs. 31.96/kg and Rs. 11.32/lit., respectively. The average productions of Shivneri milk, Muktai milk, Ghee, Paneer, Curd and Chass in the farm were 3466.13K lit, 1152.71K lit, 39.35K Kg, 3.08K Kg, 19.20K Kg and 9.66K lit. per year. Total net income of

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Muktai dairy farm was Rs. 274.58 lakhs per year. Similarly, total processing cost and gross income were found as Rs. 1514.75 lakhs and Rs. 1789.33 lakhs per year, respectively.

Net Present Worth, Benefit-Cost Ratio and Internal Rate of Return were found as Rs. 28,13,42,191.70, 1.15 and 112.97 per cent, respectively. This clearly indicates a sound financial position of Muktai Dairy Farm and hence the liabilities of the farm could be met easily during any unexpected closure in future.

Performance of Agri-Supply Chains: A study on Fresh Vegetable Distribution System in Jorhat district of Assam

Allah Mohammad Riaz

Supply chain is the network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services in the hand of ultimate customer. Supply chain management (SCM) of vegetable is complex as compared to other SCMs due to the perishable nature of the produce, and high fluctuations in demand and prices. A total of 150 samples comprising of 45 vegetable farmers, 30 assemblers, 30 wholesalers and 45 retailers were randomly selected from Jorhat district of Assam for the study. Different marketing activities such as cleaning and washing, grading, storing and packing were by and large followed by most of the respondents. All the traders, except the farmers, were lacking awareness on pesticides and chemical use standards set by the government. Precautionary measures such as washing, use of Indigenous Technical Knowledge (ITK), organic treatment and packaging were used by the channel players to improve the shelf life of fresh vegetables. Majority of the channel players were satisfied with the services offered by the transport operators in shipping of fresh vegetables. Most of the time, the fresh vegetables were damaged during transit due to long waiting time of loading and unloading. Prolonged storage time, poor storage facilities, inferior quality, and rough handling of vegetables were the main reasons for quality loss of vegetables in the marketing channels. Vegetable prices were mainly determined by the demand-supply forces. On an average, the respondent farmers had spent Rs. 64,404.00/farm/year and in return had earned Rs. 1,77,996.00/farm/year, which help them in earning a profit of Rs. 1,13,592.00/farm/year. Profit earned by farmers per kg of brinjal, ridge gourd, spine gourd, pointed gourd, broccoli etc. were comparatively more than the other vegetables. Four prominent marketing channels viz. channel I (Producer – Assembler – Wholesaler – Retailer – Consumer), channel II (Producer – Wholesaler – Retailer – Consumer), channel III (Producer – Retailer – Consumer) and channel IV (Producer –

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Consumer) were identified for marketing of vegetables in Jorhat district, out of which channel IV was the most efficient channel. Fluctuating price of vegetables, transportation difficulties, storage problem and non availability of market information were the common problems faced by majority of the respondents of all groups.

Impact of the Celebrity Endorsement on the Buying Behaviour of the Consumers in Jorhat District of Assam

Balaganesh T

The modern-day markets are very attractive in terms of the purchasing power and as well as equally competitive. The existence of a product is directly proportional to how far it reached and created awareness about the product to the consumers. So, the modern marketing strategy of the most business relies heavily on the advertising that can easily promote the products in a short period. Advertisement is a persuasive tool to convey a brand's message to target audience with an aim to persuade them towards buying that brand or product. It is the most influencing tool in the hands of the marketer to market his product. Meanwhile, the buying behaviour of the consumers decides the running of the business in the market. In this era, product endorsement from an authoritative figure is a key element in business advertising and marketing campaigns.

India is one of the places where the celebrities are idolized and they enjoy demigod status. Peoples admire the celebrity and hold them in high esteem. Celebrity endorsement has become a popular method of advertising in this era. In simple words, using the fame of celebrity to promote a product or service. McKinsey Global Institute (MGI), reported that the consumer market in India is developing at a speedy rate and prospective tempo, and the country's consumer market is the fifth largest in the world by 2025 which is currently valued at US\$ 511 billion.

The present study was an attempt to examine the impact of the celebrity endorsement on the buying behaviour of the consumers and conducted in Jorhat district of Assam. Data was collected through a questionnaire from 150 persons. The results showed that the celebrity endorsement had a positive impact on bringing awareness about the product but their influence on buying behaviour was minimal. The effective media for advertising was internet or social media which is becoming more popular in the modern era. The gender of the celebrity, beauty of the celebrity, physical attractiveness of the celebrity had no impact or they had a very minimal impact on influencing the consumers. The consumers had a positive attitude towards a celebrity endorsed product at the same time they expect them to be of good quality.

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Consumer preference towards Ayurvedic product in Assam

Debasis Kalita

The present study examined the awareness of consumer towards different brands of ayurvedic product, factors influencing brand preference of consumers and level of consumer satisfaction towards ayurvedic products.

The study was conducted in the Jorhat district of Assam. A random sampling technique was used for the purpose of selecting 80 consumers from 8 retail stores for detailed investigation. Necessary information pertaining to the objectives of the present enquiry were collected during 2020-21 from the selected consumers through pre tested structured schedules following survey method. Tabular analysis was used in verifying different aspects of the study to achieve the desired objectives.

The results of the study revealed that majority of the respondent were of the age group between 35-45 years with graduate level education and most of them were service holder. The income level of maximum respondent was between “30000-45000” income level categories. Most of the respondents belong to nuclear family with family size of below 5 members.

Majority of the respondents were aware of Patanjali brand which was followed by Himalaya and Dabur. Shopkeepers/retailers were the major source for getting information about the brands followed by news paper and television. Majority of the respondents were planned buyer and the respondent purchased products of all the categories whenever necessary.

Most preferred brands of ayurvedic food product, baby product, health care products were Dabur and Patanjali while for cosmetic products Himalaya and Biotique were the most preferred brand. Brand image was the main factor that influenced the consumers to prefer a particular brand for ayurvedic products. Better quality also plays an important role in influencing the consumers to prefer and stick to a particular brand of their choice. The other important factors that influence brand preference of ayurvedic product were flavour, quality, eco friendly, chemical free, preservative free, long relief, more nutritious, reasonable price of the products etc. Packaging design were comparatively less important factors that influence brand preference.

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Maximum numbers of respondent were highly satisfied with different products under broad categories viz, ayurvedic food products, health care products, baby products and cosmetic products. The major factors responsible for consumer satisfaction towards ayurvedic food product were brand image followed by better quality and health factor. In case of ayurvedic health care product, brand image, better quality and traditional based were the major factors while brand image followed by better quality, herbal ingredient were the factors responsible for ayurvedic baby product. With regards to consumer satisfaction towards ayurvedic cosmetic product brand image followed by better quality and long relief were found to be the major factors. The major reasons for consumer dissatisfaction towards ayurvedic product were non availability, higher price and less awareness.

Business analysis of Community Supported Agriculture (CSA) in Assam

Julfikur Rahman

Community Supported Agriculture (CSA) is a system that connects the producers and consumers within the food system more closely by allowing the consumer to subscribe to the harvest of a certain farm or group of farms. It is a strategy to improve local agricultural economy and is a unique concept regarding the process of buying and selling. A total of 120 samples comprising of 30 CSA farmers from Biswanath, 30 non CSA farmers from Biswanath and 60 consumers from Biswanath and Kamrup (Metro) districts were selected for the study. The consumers were divided into 4 groups based on their income for better interpretation of the data. All the CSA farmers were associated with organic vegetable cultivation and they sold their produce to seven different customer groups consisting of the outlet customers, registered members, farm-gate customers, restaurants, grocery stores, educational institutions and processors. Price of the vegetables sold by the CSA was more than the normal markets due to its organic nature and customers were accepted the vegetables satisfactorily. Total profit earned by the CSA in 2018-19 was Rs. 3,39,070.00 with benefit-cost ratio of 1.56. Non CSA farmers had sold their produce mainly through four marketing channels, out of which 65 per cent produce were moved through the direct channel of Producer – Consumer. Total profit earned by the non CSA farmers was Rs. 6,91,590.00 and their benefit-cost ratio was lesser (1.41) in comparison to the organic farmers of the CSA model. Eight factors such as availability of organic produce, diversity of products, convenient delivery locations, proper grading and standardization, good packaging etc. had influenced the consumers to purchase the produce of the CSA team. On an average a consumer required 3-12 kg vegetables per week. Consumers had identified price differences of Rs. 15-40 per kg between the vegetables sold by the CSA and non CSA farmers. More financial involvement among members, difficulty in development of customer base, requirement of constant grade produce, requirement of more labour, and differences in opinion of members were the main problems of the CSA farmers. Less bargaining power, higher price of the products, non availability of home delivery service at many places and availability of lesser number of products were the problems faced by the

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consumers. Looking at increasing awareness of the people on healthy and hygienic foods, CSA has great scope to be popularized throughout Assam as well as in the whole North-Eastern region.

Post-harvest Management of Medicinal Plants in Assam: A Case Study of Assam Prakritik Udyog

Nabajit Barman

Medicinal plants, also called medicinal herbs, have been discovered and used in traditional medicine practices since prehistoric times. With its vast tract of hills and forests, Assam is the homeland of wonderful and precious medicinal herbs and plants such as Sarpagandha (*Rauvolfia serpentina*), Pippali (*Piper longum*), Amlakhi (*Embllica officinalis*), Hilikha (*Terminalia chebula*), Bhomora (*Terminalia bellerica*), Arjuna (*Terminalia arjuna*). About 50% of India's entire plant biodiversity is contributed by the North Eastern States viz., Manipur, Mizoram, Sikkim, Tripura including Assam. Most of the medicinal plants used by local people and tribes of the state of Assam are indigenous and are not known to the vast world of phytochemical science and research. Proper and optimum utilization of those resources will help in employment generation and economic development of the rural poor of the region.

Assam Prakritik Udyog (APU) is a herbal products manufacturer located in Tihu town of Nalbari District. The Company manufactures Skin care products, Home care products, Beauty Products, Medicine, Natural food Products etc. Assam Prakritik Udyog (APU) was founded by Mr Ghanashyam Medhi. The study was performed to know about APU and its organizational structure, examine the status of management of medicinal plants and their products, and problems faced by the entrepreneur. The study was conducted in period of six months i.e. from January to June, 2019. The area of the proposed study was Kamrup (Metro) and Nalbari District in Assam. The study was based on both primary and secondary data. The outcome of the study would give a picture of the status of post-harvest management of medicinal plants in the state.

The study has helped to find out that there were several units in Assam which process medicinal plants and produce herbal products. However, these were not very well-structured and well-known as compared to the leading herbal brands. Assam Prakritik Udyog produced various personal care products by processing medicinal plants. As many as 53 Products were produced by Assam Prakritik Udyog by processing medicinal plants. The unit was run by the proprietor with the help of 9 employees. Three marketing channels were identified for the Assam Prakritik Udyog for their products.

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The unit was running at a profit as its annual return covered the cost incurred per annum. The consumers preferred their products as those were priced low and offered effective quality. However, the consumers stated that the packaging quality of the products was not up to the mark and the products were not easily available. There was good relation between the proprietor and the employees which had resulted in good management of the organization. However; the product packaging, promotional methods, hygiene and infrastructure of the organization can be improved.

Medicinal and Aromatic Plants based Cottage Industry offers immense potential for economic activity, by providing income-generating opportunities to a large section of the rural population of the state. So the State and the Central Government should formulate policies for conservation and sustainable use of such important natural resources.

Supply chain and value addition in flower marketing – A case study in Sukleshwar Ghat flower market of Guwahati

Nilakhi Sarma

The study entitled “Supply chain and value addition in flower marketing-A case study in Sukleshwar Ghat flower market of Guwahati” was carried out to study the arrival of different flowers in the market, extent of value addition done by the traders as well as the profitability of traders in flower marketing. Total 80 numbers of registered traders were found in the market out of which 40 traders were selected randomly for the study. Moreover, selected traders were classified into three groups according to their monthly income. For analyzing the data, statistical tools like tabular analysis, percentage, average methods were used.

The result from the study showed that different types of flowers like rose, gerbera, gladiolus, tuberose, marigold, lotus, orchid, etc were arrived in the market throughout the year. The flowers were arrived in the market through three different marketing channels. In case of Income group-I (<Rs25000) maximum numbers of flowers were arrived from floriculture hub of Assam, Hajo as the traders under this group could not afford to purchase flowers from outside sources because of their limited income. In case of Income group-II (Rs.25000 to Rs.50000) and Income group III (>Rs50000) maximum flowers were arrived from Kolkata and Bangalore. The arrival of total quantity of flowers was the highest in case of Income group-I because of more numbers of traders under this income group. Sukleshwar Ghat flower market was mostly dominated by traders under Income Group-I (income below Rs25000). But the average annual arrival per trader was reverse from the total annual arrival of flowers among the three Income Groups. Moreover, the study revealed that in case of Income group-I the highest arrival of flowers obtained in the month of July (1, 70,180 no.s) with an average of 7090 no.s (9.1 per cent) per trader .Whereas, in case of Income Group-II and Income Group-III, the highest arrival of flowers were obtained in the month of February with total arrival of 1, 37,600 no.s and 1, 18,700 no.s ,respectively. This was because of higher demand for flowers for celebration of number of ceremonial activities like

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wedding ceremonies, valentine day etc. in that month. The involvement of traders under Income Group II and Income Group-III were found more in value added activities like garland making, bouquet preparation, car decoration, making of wedding garland etc. for various occasions. Annual arrival of marigold was the highest in the market irrespective of all income groups with 8, 025, 90 numbers. Marigold was highly demanded throughout the year for different religious activities. Marigold was offered by devotees in nearby temples. Apart from marigold, rose, gerbera, gladiolus were found as major flowers in the market which were mostly used for value addition. Rose was extensively used for various value additions like preparation of bouquet, wedding garland, wedding head piece, car decoration, etc. Likewise, gladiolus and gerbera were also used in preparation of different value added product like bouquet, car decoration, etc. The profitability of traders directly related with the extent of value addition done by them.

Economic Analysis of Sugarcane Industry in Haridwar District of Uttarakhand

Nishant Choudhary

In India, sugarcane is an industrial crop with an area of about 4 million hectares and production to the tune of 348.4 million tonnes. The present study was conducted to examine the economic analysis of sugarcane jaggery in Haridwar district of Uttarakhand. It is one among the major sugarcane and sugar-producing states in the country and ranks ninth in area (88165 ha), seventh in production (63.48 lakh tonnes) and seventh with respect to productivity (72 tonnes per ha.). Sugarcane is cultivated extensively in three districts (Haridwar, Udham Singh Nagar and Dehradun) of the state. Among them, Haridwar District ranks first in the cultivation of sugarcane with an area of 55890 hectares and production of about 40,24,080 tonnes (Cane Development and Sugar Industry Department, 2018-19).

The result shows that as many as 2,006 Jaggery processing units are in the District of Haridwar alone out of 2506 jaggery processing units in the state. Therefore, the maximum jaggery is produced in Haridwar district followed by Udham Singh Nagar and Dehradun districts of Uttarakhand. The main products of jaggery processing units are jaggery, jaggery powder and *khandsari*. There are 230 units which produce *khandsari* in the state out of which 180 units are present in Haridwar district and 50 in Udham Singh Nagar district of Uttarakhand. The productivity of sugarcane was 52.20 tonne in 2009-10 and it increased to 72.00 tonne in 2018-19. The CGR (Compound Growth Rate) calculated for the 2009-10 to 2018-19 for the area of sugarcane was -2.50 per cent but the production and productivity of sugarcane in the state were positive with the CGR being 0.094 per cent and 2.44 per cent, respectively. The CV (coefficient of variation) recorded for the area, production and productivity of sugarcane of last ten years was 10.40 per cent, 7.58 per cent and 8.85 per cent respectively. The increase in the productivity of sugarcane cultivation between 2009-10 and 2018-19 was mainly because of the introduction of new technical methods of sowing like trench method and introduction of high yielding variety namely CO-0238. The CGR of the jaggery units in the state during last five years (2014-15 to 2018-19) was recorded as 4.73 per cent and

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the CGR for the production of jaggery in state was 4.71 per cent during the same period. The variations in number of jaggery units and jaggery produced per season in last five years were relatively stable as measured by coefficient of variation 8.12 per cent and 8.11 per cent respectively. A jaggery enterprise named “Organic Kishan Sahayta Kendra” with an area of one Acre has undertaken for the study. The findings revealed that the Net Present worth (NPW) was Rs. 91,85,385, Internal Rate of Return (IRR), Benefit Cost Return (BCR) and Pay Back Period (PBP) of the enterprise were 89.25 per cent, 1.09 and 1.095 years respectively. Basically, the enterprise faced two types of problems those were in production and marketing of jaggery. In production of jaggery the most common problems highlighted were high initial cost, non-availability of labour, high cost of inputs, low recovery etc while in marketing of jaggery, problems such as price fluctuation and low prices, long distance to markets and lack of market information, cash payment to sugarcane farmers, difficulty in getting credit from bank etc. were observed.

Organizational structure and management of Dream Dragon Fruit Farm of Nagaland

Pithunglo L Kiron

Dragon Fruit is a climbing cacti and needs support for growth and development. It is a new introduction in India and also known as “The wondrous fruit of the 21st Century” due to its nutraceutical properties. The study was conducted in Dream Dragon Fruit Farm located at Shitovi village of Dimapur district in Nagaland state of India. A total of 15 wholesalers, 20 retailers and 45 consumers were interviewed randomly to fulfill the objectives of the study.

The farm has been commercially established in 5 ha land area and it has six (6) varieties of dragon fruit, i.e. white fleshed dragon fruit (*Hylocereus undatus*), pink/purple fleshed dragon fruit (*Pysical graffiti*), red fleshed dragon fruit (*Hylocereus costaricensis*), yellow skin dragon fruit (*Hylocereus megalanthus*), orange skin dragon fruit and Opuntia variety. The organizational structure of Dream Dragon fruit farm is characterized by the proprietor who is the head of the organization, followed by three departments: Website Manager who is assisted by Assistant Website Manager, Farm Manager/ Caretaker who is assisted by 3 assistants and 4 labours, and Accountant cum marketing supervisor.

In order to estimate the economics of Dream Dragon Fruit Farm investment feasibility analysis was performed. The Net Present Value was found positive (Rs. 2,08,29,478.00), which indicates worthy investment of the proprietor. Benefit Cost Ratio was also greater than 1 (2.04), which also favours the investment. Internal Rate of Return of 11.78 clearly indicates a sound financial position of Dream Dragon Fruit Farm and hence the liabilities of the farm could be met easily during any unexpected closure in future. Value addition of dragon fruit in the form of wine preparation has started recently in 2019; a total of Rs. 2,23,000.00 was spend in wine preparation and the farm had earned a profit of Rs. 77,000.00 by selling the finished product.

Three prominent marketing channels viz. channel I (Producer – Consumer), channel II (Producer – Wholesaler– Consumer), channel III (Producer – Wholesaler - Retailer – Consumer) were identified for marketing of dragon fruits, out of which channel I was found to be most preferred channel.

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Higher initial investment and high labour requirement during monsoon season were the main production problems faced by the farm. Problem of storage facility, perishable nature of the fruit and high labour costs are the major marketing problems faced by the channel players. Lack of modernized processing industry and high cost of processing were the severe problems associated with value addition of dragon fruit. Government intervention in establishment of cold storage and processing industry will surely enhance the prospect of dragon fruit farming in the North Eastern region.

Impact of organized retailing on consumer buying behaviour for vegetables in Kamrup (Metro) district of Assam

Prabal Pratim Kalita

The present project-work entitled “Title: Impact of organized retailing on consumer buying behaviour for vegetables in Kamrup (Metro) district of Assam” was carried out in Guwahati city during the study period to analyze the organized retailing of vegetables in Kamrup (metro), to study the effect of organized retailing on consumer’s buying behaviour and to identify the problems of organized retailing. Twenty organized retailers of vegetables were selected purposively on the basis of availability and accessibility. Hundred consumers of vegetables from the organized retailers were taken using simple random sampling to study the effect of organized retailing on consumer’s buying behaviour. The data were collected from respective organized retail outlets and analyzed to achieve the objectives of the proposed study. The result of the investigation showed that the organized retail outlets belong to the two categories – supermarket and hypermarket. The supermarkets were dominant in the vegetable retailing with 85% (17 nos), the rest 15% (3 nos) being the hypermarkets. The hypermarkets were selling more of the vegetables in quantity as well as the price. Various aspects like sourcing, warehousing, transport management, manpower management, pricing of the vegetables, etc. done by the organized retail outlets were studied and presented in the project report. The marketing strategies as well as technological facilities used by the outlets were also studied. To examine the effect of organized retailing on consumer’s buying behaviour, the age, gender, income, etc. of the consumers were studied. Various factors influencing the consumers to visit the retail store, buying behaviour of the consumers as well as factors influencing the buying of the vegetables were studied in the present study. The present study found out that ease of shopping in the organized outlet, quality, income, etc. were the main factors affecting the consumer’s buying behaviour. The problems faced by the retailers and consumers in organized retailing were identified. Presence of more unorganized retailers and the price of the vegetables in the organized retail outlet were the main problems of organized retailin.

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Production and marketing management of flower cultivation in Hajo

Priyanka Bora

The study entitled “Production and marketing management of flower cultivation in Hajo”. Floriculture or flower farming is the discipline of horticulture concerned with growing and marketing of flowers and foliage plant. In Assam earlier only Malakar people from Kamrup District are engaged in flower cultivation so that they can supply raw flower in various temple like Kamakhya, Umananda temple etc . Now the scenario has changed in Assam .Floriculture is emerging as a commercial activity in Assam too. The present field survey was an attempt to examine the study the production management strategies of flower growers , examine the marketing channels of the flowers and estimate the marketing efficiency , and the last one is to identify the constraints in flower cultivation in Hajo with selected flowers such as Marigold, Gerbera, Tuberose and Gladiolus. The study was carried out in Kulhati and Muamari village in Kamrup District of Assam. A multistage random sampling technique was followed to select the ultimate sample unit. A sample of 30 households was selected and categorized into three different categories, viz. marginal, small and medium based on their operational holding.

The study revealed that sources of input for farmers of Hajo was KVK, HRS, Agri clinic, local trader etc. Under RKVY and NFSM scheme, farmers can purchase power tiller, seed at 50% subsidized price. Farmer also got Urea at Rs 8 with subsidized price. In case of marigold gross income was Rs. 603893 and net income was Rs. 420648 over total cost of Rs.183245 for all farms. Total cost, gross income and net income for all farms in case of tuberose were Rs. 248535, Rs.829371 and Rs. 580835, respectively. From gladiolus for all farms the gross income was Rs. 558009 and net income was Rs. 679779 over total cost of Rs. 305330. In case of gerbera gross income was Rs. 969780 and net income was Rs. 674641 over total cost was Rs. 295139 for all farms. . The benefit cost ratios (based on net return) over total cost were **2.6 , 2.3, 2.32** and **2.22** Marigold, Gerbera, Tuberose and Gladiolus, respectively. Highest amount of flowers (marketed surplus) were Transacted through Channel II and Channel III. Marketing efficiency for flower transaction was highest in Channel I because producer

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directly sold product to ultimate customers. Problem related to production was highest in Hajo as there was no proper organized market for sale of flowers. In marketing, the most important problem faced by the farmers was price instability because price fluctuation happens in the market within the same day. They get lower price when there is heavy arrival from Kolkata to the local markets.

Consumer Preference towards Online Shopping in Jorhat District of Assam

Rahmatullah Shahin

Online shopping is a modern way of marketing a product or service. In India it was first started in 1999-2000. However, due to ease, simplicity, convenience, security etc in trading and delivery system, it has been gaining tremendous popularity among all categories of stake holders. Diversity in taste, security, perceived privacy, perceived after-sales service, perceived marketing mix, perceived reputation and consumer's attitude affect the adoption of online shopping. But, the marketers faces problem in getting response from the customers as there is no face to face interaction between buyers and sellers in case of online shopping. This study was taken up to understand the background of online shopping, consumer preference towards online shopping, impact of online shopping on traditional retailer and the problems of online shopping perceived by the consumers in Jorhat district of Assam. The sample for the present investigation was selected using random sampling procedure.

E-commerce was introduced about 40 years ago in its earliest form. Boston Computer Exchange, which was launched in 1982, became the world's first ecommerce company. Presently numerous agencies like Flipkart, Amazon, Myntra, Snapdeal, Paytm, e-Bay, Zivame, ZopNow, Jabong, Shop Clues, Rediff, Nykaa and many others are performing online marketing all over the world.

Under the present study, 72 percent of respondents were found to involve in online shopping. More than 85 percent of user respondent reported that they preferred online shopping because it was easy to get product through online marketing while 74.07 percent of respondents viewed that they preferred online shopping as they could shop at any time through online marketing. Highest proportion of online customer (83.33 %) were found in the age group of 'above 20 years to 30 years'. There was not much difference in likings and involvement in online shopping over the gender of the customers. Literate people were found more involved in online shopping. Students were most prominent online users for shopping different goods and services. More than 88 per cent of students were found to perform online shopping. The least prominent group

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was wage earner group. Maximum number (73.15%) of online customers used online shopping for purchasing of cloths. The least preferred items through online was baby products followed by medical items. The major services provided online were flight ticketing followed by bus and railway ticketing. The most popular platforms in the study area are Flipkart, Amazon, Myntra, Snapdeal, Zomato, Swiggy, Nykaa and Cluvia. More than 98.00 per cent of online customers used smart phone for online shopping. The use of internet café for online marketing was very less because of security reason. The most frequently used payment mode was cash on delivery followed by debit card. Majority of customers in the study area did not write the review about the product or services they have purchased. The frequency of online shopping was highly varied from customer to customer. More than 50 percent of the online buyers spent less than Rs. 1000.00 in single online purchase.

The major problems faced by the customers during online marketing were difference between displayed product and actual product, time consuming and complicated registration, delay in delivery of product, selling of inferior quality product, missing of personal observation, feel and touch on product before purchasing, etc. which acted as hindrance of online marketing.

Presently, though there is no significance impact of online marketing on the business and income of traditional retailers, but looking at the growing popularity of online marketing, it is not unwise to predict the negative effect of online marketing on the sales and profit of traditional retailing business. Hence, rational policy measures are needed for the development of on line marketing as well as protecting of the interest of traditional retailers. Traditional retailers also must equip their retailing business to compete with online mode of marketing.

Investment Analysis of Dairy Farming in Assam

Raj Kallol Dutta

India being a major agrarian economy has a deep connection with dairy farming since Vedic era. Dairy farming is an important secondary source of income that provides employment and nutritive food for millions of families. The project work was carried out in the state of Assam as the state's economy continues to be an agrarian economy and the dairy sector plays a major role in the income generation for both the rural and semi-urban population. Out of all the variable costs under the study it shows that the cost incurred for cattle feed and labour were the main capital intensive costs. The farms under study have also proven to be all viable and profitable in terms of their production and the existing price of production. Returns on dairy farming across various groups prove to be all positive, and among all the farm enterprise, the farms rearing jersey breed cattle proves to be the most cost effective. The results have also clarified that problems faced by the dairy farmers mainly consist of problems such as lack of veterinary health aid, water scarcity and low price of milk, unavailability of local feed retailers, inadequate infrastructure and high price of feed. Lack of knowledge, extension works and management skills are still much needed among the farmers and given the right attention to these extension work and management skills, dairy farming may go long way in enhancing the income of the dairy farmers.

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Department : Agri-Business Management

Major Advisor : Dr. R. A. Halim

Study on Management of Agribusiness Startups

Sahryar Tehzib Ahmed Choudhury

The present project-work entitled “Study on Management of Agribusiness Startups” was carried out in Guwahati city during the study period to identify and examine the organizational structure, management aspects, and constraints associated with the selected startups. Two startup organizations were selected purposively on the basis of availability and accessibility. The data were collected from respective startups and analyzed to achieve the objectives of the proposed study. The selected Startups were *Jeev Anksh Eco Product Private Limited* and *Innotech Interventions Private Limited*. The result of the investigation shows that the Startups were well-structured with organizational hierarchy. The roles and responsibilities of the managers and staff were studied and presented in the project report. To examine the management aspects of the enterprises' various parameters of production and marketing were determined and estimated. The study also provides information regarding the profitability of the startups. It was found that the top management of *Jeev Anksh Eco Product Private Limited* comprised of Managing director, Additional director (marketing), Additional director (finance), and Assistant manager. The enterprise dealt in organic food products which generated a total return of Rs. 2,38,08,500 per year against the total cost of Rs. 1,82,94,480 with a profit of Rs. 55,14,020. The startup used two partial marketing channels for marketing the products in cities like Kolkata and Mumbai. In the second startup *Innotech Interventions Private Limited*, the top management comprised of Founder director, Chief Technical Officer, and Director, Chief Executive Officer and Director, and Project Scientist (Mushroom Project). The enterprise produces and marketed Vitamin D fortified Mushroom “*Protemouth*” which generated a total return of Rs. 3,40,500 per year against a total cost of Rs. 1,93,550 with a profit of Rs. 1,46,950. The startup used two marketing channels for marketing the products in different districts of Assam. Both the startups used publicity and personal selling as promotional strategies. They faced different constraints in the production, marketing, and management activities which were thoroughly studied in the project work.

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Department : Agri-Business Management

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Rice Distribution System Through Co-operative Societies and Fair Price Shops in Jorhat district of Assam

Tabarak Hussain

The Public Distribution System (PDS) evolved as a system of management of scarcity and for distribution of food grains at affordable prices. Over the years, PDS has become an important part of Government's policy for management of food economy in the country. Poor households spend nearly 80 percent of their income on food. Therefore an effective way of enhancing real income and ensuring food security to poor households is an assured delivery of adequate quantities of food grains and other essential commodities at favourable prices which are lower than the market prices. In India this has been attempted through the Public Distribution System (PDS). The project work was carried out in Jorhat District of Assam. A total of 120 consumers were selected for the study and 20 Fair Price shops and 10 co-operative societies were selected for the study. The study revealed that out of the total population of Jorhat district, Public Distribution System accounts for 52 % of the total population, where AAY scheme covers 16.53 % and PHH scheme covers 83.47% of the total PDS population. The Study also revealed that the consumers are satisfied with the quality, quantity, price as well as the functioning of the public distribution system in the concerned area. The study highlighted certain loopholes in the system which indicates the failure of the government to pay the outstanding dues to the authorities involved in the distribution of commodities in the public distribution system. Though the system is able to feed the current PDS population but it fails to standardize the process of the distribution system.

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Value Chain Management of Naga King Chilli of Nagaland

Tumei Konyak

Agro-climatic condition of India gives scope for growing 63 different spices, making India the “Land of spices” (with 48% India’s share in world trade of spices). Naga King chilli (*Capsicum chinense* sacq) also known as ‘Raja Merja’ or ‘Raja Mircha’ is one of the world’s hottest chilli (has also entering in "Guinness book of world records”) and is widely known for its distinct taste, aroma and its pungency, widely grown Northeast part of India. Nagaland having favorable topography and climatic condition, has about 7739 million tons of production of Naga king chilli in 1385 hectare area (GON, 2015-16) and has also obtained G.I rights for Naga king chilli in 2008 from G.O.N under Registration and Protection Act, 1999. So, Present Study on “value chain management of Naga king chilli in Nagaland” was carried out to identify and map the different value chain of Naga king chilli, to analyze the resource management in different value chains of Naga king chilli and to examine the problems faced by value chain players in the region. The study was executed in Mon district of Nagaland during the year of 2020 and Tizit block was selected for the study, under which two villages (*viz.* Nokyan village and Loakho Village) were studied and the data’s collected were from both primary and secondary means. A total of 100 respondents were selected randomly for the study, comprising of 50 farmers, 20 Intermediaries and 30 customers. The value chain players identified from the study area were Naga king chilli growers (all small farmers), Wholesalers (Local & Distant), Retailer/vendors (Local & Distant) and customers. Data’s related to perception and attitude of end users were collected from Customers of Tizit block, also four market channels were identified in the study area. The growers practiced organic cultivation and profit earned by chain players per kg of NK Chillies is comparatively higher than other normal Chillies in the study area. The total number of working days required for production & cultivation of NK chilli was 183 days/ha/year, respectively. And the total number of labors required were 90/ha/annually. Some precautionary measures for picking, grading, washing and cleaning of Chillies, use of Indigenous Technical Knowledge (ITK) and packaging are

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used by the channel players to improve the shelf life of the chilli. Pest attack and Wide fluctuation in price were the major problems faced by farmers for production and marketing of Naga King Chillies, respectively. Major problems faced by other value chain players in the study region were Wide fluctuation in price, Availability/ Supply Shortage, Handling and storage problems, Perishable nature of Chilli, etc. Some of the policies suggested were, Contract agreement between farmers and buyers to sustain the supply flow. Initiating post-harvest handling practices for the tribal farmer, Proper/scientific storages, Forming Cooperatives/FPO's, Trainings could be initiated through KVK, NGO'S, state departments, etc. Hence, this study was undertaken to understand the value chain management in Naga king chilli in the region.

Study on Vishaka Dairy Products and Consumers' Perception in North Coastal Districts of Andhra Pradesh

Yedla Divya Dinkar

The project work was carried out for a period of three months from March-May, 2019 in the State of Andhra Pradesh to in connection with the “Study on Vishaka Dairy Products and Consumers' Perception in North Coastal Districts of Andhra Pradesh”.

For this study, a total of 100 numbers of consumers were drawn from the selected territory of North Coastal Districts of Andhra Pradesh, representing an equal number of samples from each region *viz.*, Srikakulam, Vizianagaram, Visakhapatnam, and East Godavari. The simple random sampling design was followed for the study. Data relating to the perception of the consumer were collected from consumers with the help of a structured pre-tested schedule and questionnaire through personal interview method and secondary data were collected from the record books and reports of the milk Union. The milk products produced by the Union were smart milk, cream, ghee, plain curd, sweet curd, and paneer. The consumers' perception towards different products of the union was found good during the study and it significantly differed from all the other brands available in the territory under consideration and well-received among the masses, indicating higher potential in coming years because of the trending brand loyalty.

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Major Advisor : Dr. A. K. Das

Growth and yield of tomato crop under modified microclimatic condition in Jorhat

Amlanika Kalita

The present investigation was carried out during *rabi*, 2019-20 at the Experimental Farm, Dept. of Horticulture, Assam Agricultural University, Jorhat to study the effect of modified microclimates on growth, development and yield of tomato. The variety – *Arka Rakshak* was grown in split plot design with 4 dates of planting (P1 - 25th October, P2 - 14th Nov , P3 - 3rd December and P4 - 8th January) in main plots and three mulching treatments (M0 - non mulch, M1 – rice straw mulch and M2 - black polythene) in sub-plots, following recommended agronomic practices . Microclimatic parameters like daily soil temperature (5 cm and 10 cm depth) and soil moisture content at 15 days interval from two depths (0 -15cm and 15 - 30 cm) and different components of photo-synthetically active radiation (PAR), viz., incident (IPAR), reflected (RPAR) and transmitted (TPAR) were recorded at 10 days interval starting from 30 days after planting (DAP) using line quantum sensor (Model LQM-70-10) at local noon time (11:30 AM). Crop growth parameters viz., plant height, leaf area index and dry matter accumulation, phenological observations and yield attributing characters and fruit yield were recorded. Agro-climatic indices viz., growing degree day (GDD), heliothermal unit (HTU) and phenothermal index (PTI) were computed for attaining different phenological events and heat use efficiency (HUE) were estimated for both biomass and grain yield of the varieties sown on different dates. The range for weekly mean maximum and minimum temperature throughout the crop growing period was found within 21.7 to 31.7°C and 8.4°C to 20.8°C with their respective averages of 26.7°C and 14.5°C. Thus, the daily maximum temperature never exceeded 34.6°C, but increasing daily maximum temperature above 30°C after mid March (11 SMW) was detrimental to the crop as the optimum temp is for the crop is 18 to 24°C. Similarly, the lower average daily minimum temperature (<10°C) during 49th to 5th SMW affected growth of the crop. The average soil moisture content in upper 30 cm soil profile in experimental plots recorded up to mid March, 2020 was highest in the second date of planting (80.81 mm), followed by first (79.7 mm), third (76.44 mm) and fourth (72.15 mm) dates of planting.

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Major Advisor : Dr. Prasanta Neog

As compared to non mulch treatment, the increase in weekly morning and evening soil temperatures under black polythene was up to 1.63 and 2.47 °C, respectively, while under rice straw mulch the increase in the soil temperature was to some extent lower. Incident PAR (iPAR) during the crop growth season varied from 531 to 1431 $\mu\text{mol s}^{-1}\text{ m}^{-2}$ with the mean value of 1140.4 $\mu\text{mol s}^{-1}\text{ m}^{-2}$. The reflected PAR varied from 41 (P1M2) to 285 (P1M2) $\mu\text{mol m}^{-2}\text{ sec}^{-1}$ in different planting dates and mulching treatments. In all dates of planting and mulching treatments, the lowest transmitted PAR was recorded at 90 to 100 DAP (in case of P1 to P3) when the crop was with full canopy coverage, thereafter it increased with the advancement of the age of the crop. The crop took 36 to 57, 45 to 71, 87 to 115 and 120 to 180 days for attaining first flower appearance, first fruiting, first fruit maturity and end of fruit harvest, respectively under different planting dates and mulching treatments. The plant height of crop varied from 63.4 to 102.5 cm, irrespective of dates of planting and mulching treatments. The maximum leaf area index recorded were significantly affected by both planting dates and mulching treatments, which ranged from 1.85 to 3.26 irrespective of planting dates and mulching treatments. The biomass production at maturity was the highest in the second date of planting (284.7 g/plant) and it decreased gradually with delay in planting. The total biomass production was highest under black polythene mulch (263 g/plant), followed by rice straw mulch (28.1 g/plant) and non-mulched treatment (149.9 g/plant). The fruit yield of tomato cultivar planted under different planting dates and mulching treatments ranged between 76.6 and 392.6 q ha⁻¹ with an overall mean of 234.9 q ha⁻¹. The crop planted on 14th November was found to be the most suitable planting date because it facilitated optimum weather conditions with improved soil hydrothermal and radiation (PAR) regimes during the crop season. Mulching with black polythene was found to be more suitable compared to non mulched condition for crop growth and fruit yield due to increase of soil temperature particularly during 49th to 5th SMW by up to 1.84 under black polythene. Irrespective of mulching treatments and planting dates, the GDD accumulation to attain end of the fruit harvest was reduced from 2140 to 1463 °C day, when planting was delayed from 25th October to 3rd December, but it again increased to 1687 °C day when planting was further delayed to 8th January. Regardless of dates of planting and mulching treatments, Heliothermal units (HTU) and Day temperature accumulated to attain end of the harvest stage varied from 7152 to 12300 °C hr and 2502 to 3526 °C, respectively. The PTI at different phenological stages varied from 9.61 to 17.25 °C day⁻¹ in regardless of planting dates and mulching treatments. The HUE for total biomass production and fruit yield ranged from 2.9 to 4.6 kg ha⁻¹ °C⁻¹ and 1.3 to 5.2 kg ha⁻¹ °C⁻¹, respectively. The RUE under different dates of planting and mulching treatment varied from 0.48 to 1.64 g MJ⁻¹ and 0.30 to 1.10 g MJ⁻¹ with the mean value of 1.04 and 0.68 g MJ⁻¹ for total biomass production and fruit yield, respectively. Regression studies showed that there were linear significant relationships between total biomass, fruit yield and max LAI with iPAR and RUE in the tomato variety. Correlation studies between fruit yield, and thermal indices (Thermal time,

HTU, Day temperature, HUE and PTI) confirmed the existence of significant and positive correlation between them. The regression model developed indicated that fruit yield can be predicted with high determining factor ($R^2 = 0.99$) from thermal time accumulation during planting to first flower appearance, HTU from the first maturity to end of harvest and heat use efficiency for biomass production.

Effect of weather parameters on growth and yield of Greengram [*Vigna radiata* (L.)] under the agroclimatic conditions at Jorhat

Mangshatabam Annie

A field experiment was carried out during *kharif*, 2018 at the Instructional-Cum-Research (ICR) Farm of Assam Agricultural University, Jorhat to study crop-weather relationships of *Kharif* green gram grown under different micro-climatic environments: MR-I: 25th Aug, MR-II: 10th Sep and MR-III: 25th Sep with three varieties: SG-16, SG-20 and IPBM-02-3, following a split plot (in number) design with four replications. Weekly mean maximum and minimum temperatures, morning and evening relative humidities, duration of bright sunshine hours and pan evaporation ranged from 25.6 to 34.5°C, 11.1 to 25.8°C, 89 to 99%, 59 to 83%, 1.3 to 8.2 Hours and 1.3 to 3.4 mm respectively. Rainfall during the crop growth season was found to be nearly evenly distributed, barring few weeks when there was no rainfall. Biometric observations, *viz.* leaf area index, plant height, total biomass production, no of pod per plant, no of seeds per pod, Test weight and seed yield were recorded periodically. Meteorological variables showed a near normal distribution during the crop growth period. Total accumulated agro-climatic indices showed a gradual decrease in the three successive micro-climatic regimes irrespective of varieties. Early-sown (MR-I) crop took less number of days from sowing to maturity as compared to late sown crop (MR-II & MR-III). Total biomass differed significantly both in varieties and microclimatic regimes in all the crop growth stages. Highest biomass was found in MR-I and the lowest in MR-III. Similarly, leaf area index (LAI) also differed significantly under microclimatic regimes and varieties at 45 DAS and 60 DAS. Most of the agro-climatic indices and meteorological parameters yielded higher correlation coefficients with final yield irrespective of varieties and microclimatic regimes for all growth stages. Highest correlation coefficient of seed yield (0.965) was obtained against accumulated growing degree days (AGDD) corresponding to physiological maturity stage. Among the mean meteorological parameters, the highest correlation coefficients was found in rainfall, DTRF (0.957), corresponding to the Vegetative stages. A few predictive models

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involving both accumulated indices and mean parameters were also developed combined over both varieties and microclimatic regimes corresponding to some selected crop growth stages. From the stepwise regression analysis, the most efficient model was found for the accumulated bright sunshine hours (ABSH) and accumulated rainfall (ADRF) corresponding to Pod Initiation stage. Among the mean meteorological parameters, the best model was found for the maximum temperature (MAXT) corresponding to the physiological maturity stages. Lower per cent variations (PCV) were indicative of the fact that the predicted models are very effective under agro-climatic conditions of Jorhat.

Simulation modelling of Winter Rice (*Oryza sativa* L) using DSSAT model in Agroclimatic condition of Jorhat

Nikhil Shrishail Paschapur

The Field experiment was conducted at the Instructional-Cum-Research (ICR) farm of Assam Agricultural University, Jorhat during *Kharif*, 2019 to calibrate and validate the CERES-Rice model for winter rice (*Sali* rice) and to estimate its yield variability under changing climatic scenario at Jorhat. The experiment consisted of three different micro-climatic environments *viz.*, D1 (26th June), D2 (11th July) and D3 (26th July) with three varieties *viz.*, Mahsuri, Swarna sub-1 and TTB-404 following split plot (in number) design with four replications. Biometric observation, *viz.* total biomass production, leaf area index, plant height, number of effective tillers, number of grains per panicle, grain yield and straw yield were recorded phenophase wise. Early transplanted (D1) crop took more number of days from transplanting to maturity as compared to late transplanting (D2 and D3). The overall days required to maturity were relatively highest in D1 in all the three varieties *i.e.*, 122, 126 and 121 and lowest in the D3 *i.e.*, 116, 121 and 117 for Mahsuri, Swarna Sub-1 and TTB-404, respectively. Total dry matter production (TDM) differed significantly in both varieties and growing environments irrespective of crop stages. Highest TDM was found in D1 and lowest in D3, the dry matter production per plant was found at-par in Swarna Sub-1 (48.6 g) and TTB-404 (48.5g) and minimum in Mahsuri (43.8 g). Further, Leaf Area Index (LAI) was observed maximum during panicle emergence to 50% flowering stage and statistically significant variation in maximum LAI exists among three varieties and microclimatic regimes. Additionally, grain yield was significantly influenced by different growing environments and varieties. Among the three microclimatic regimes, D1 was significantly different from D2 and D3 with CD value 17.38. The highest grain yield was recorded in Swarna Sub-1 (3912kg/ha) followed by TTB-404 (3866kg/ha) and lowest in Mahsuri (3782kg/ha). The interaction between microclimatic regimes and varieties were found significant for grain yield with CD value 10.01kg/ha. The interaction between varieties and microclimatic regimes also showed significant

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differences for straw yield with CD value 144.08kg/ha. Correlation between grain yield and phasic mean meteorological parameters showed substantial impact of weather parameters on grain yield of *Sali* rice. Among the three different models involving phasic mean meteorological parameters, the best model for grain yield prediction comprises rainfall during PE to 50% flowering stage as the most important variable with R² of 0.88.

Effect of elevated CO₂ and temperature on growth and yield of winter rice under Jorhat condition

Parishmita Das

A pot experiment was conducted during *kharif*, 2018 to assess the effect of elevated CO₂ and temperature under different transplanting dates on growth and yield of rice variety Ranjit. The treatment composed of three CO₂-temperature levels [T₀: ambient temperature & ambient CO₂, T₁: elevated temperature (ambient +1°C) & elevated CO₂ (ambient+25% of ambient) and T₂: elevated temperature (ambient +2°C) & elevated CO₂ (ambient + 50% of ambient)] and three dates of transplanting (D₁: 25th June, D₂: 10th July and D₃: 25th July). The experiment was conducted in three CO₂ Temperature Gradient Tunnels (CTGTs) following factorial CRD with 4 replications. Occurrence of different phenological stages like tiller initiation, panicle initiation and flowering was earlier under elevated CO₂-Temperature condition which significantly differed with the ambient condition. On the other hand, days to tillering increased whereas days to panicle initiation, flowering and physiological maturity reduced with delay in transplanting. The crop duration was reduced by about 15 days and 8 days under T₂ and T₁ respectively compared to T₀ and by about 10 days and 5 days in D₃ and D₂ respectively compared to D₁. Reduction in the duration of vegetative phase was found to be more distinct than the reproductive and ripening phases. Accumulated agro-climatic indices *viz.*, AMaxT, AMinT, AMeanT and AGDD showed a gradual decline with delay in date of transplanting from 25th June onwards during vegetative, reproductive and maturity stages irrespective of CO₂-Temperature treatments. Similarly, accumulated agro-climatic indices decreased under elevated CO₂-Temperature during vegetative stage but increased during reproductive and ripening phases of the crop. Plant height and tiller number was recorded highest under T₂ followed by T₁ compared to T₀, which decreased with delay in transplanting. Both plant height and number of tillers differed significantly in CO₂-temperature treatment as well as dates of transplanting. Number of panicles hill⁻¹, panicle length, number of filled grains panicle⁻¹ and 1000-grain weight were significantly influenced by elevated CO₂-temperature levels and date of transplanting. Number of panicles was greater but filled grains panicle⁻¹ slightly

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reduced under T₂. With respect to dates of transplanting, D₂ recorded higher number of panicles hill⁻¹ (17.9) and higher filled grains panicle⁻¹ (156.6). Higher grain yield (55.9g hill⁻¹) attributed to higher number of panicles hill⁻¹ and filled grains panicle⁻¹ was observed under T₂ which was at par with T₁ and it was statistically significant over ambient. Grain yield significantly reduced (40.6g hill⁻¹) when transplanting was delayed after 10th July. Similarly, straw yield and above ground biomass at harvest were significantly increased with CO₂-temperature elevation but reduced with delay in transplanting. Though the interaction effect of CO₂-temperature and dates of transplanting on rice yield was not statistically significant, the results revealed that the growth and yield of rice variety Ranjit was found to be better under elevated CO₂-temperature levels when transplanted on 10th July.

Impact of thermal and radiation regimes on growth and yield of Potato (*Solanum tuberosum*) under varying microenvironments

Raktim Jyoti Saikia

A field experiment was conducted during *rabi*, 2018-19 in the Instructional-Cum-Research (ICR) Farm of Assam Agricultural University, Jorhat to study the impact of thermal and radiation regimes on growth and yield of Potato under varying microenvironments. The cultivar *Kufri Jyoti* was grown in split plot design with four dates of planting (P₁ - 10th Nov, P₂ - 20th Nov, P₃ - 30th Nov and P₄ - 10th Dec) in main plots and mulches (M₀ - non mulch, M₁ - water hyacinth and M₂ - black polythene) in sub-plots, following recommended agronomic practices. Microclimatic parameters like soil temperature (daily), soil moisture and photosynthetically active radiation (PAR) were recorded periodically. Occurrences of different phenological events along with periodic LAI, plant biomass, yield attributing characters and tuber yield were recorded. Phenophase-wise agroclimatic indices *viz.*, growing degree days (GDD), heliothermal unit (HTU), day temperature, phenothermal index (PTI) and heat use efficiency (HUE) were computed following established procedure. The weekly maximum and minimum temperature throughout the crop growth period ranged from 21.3 to 27.2°C and 8.1 to 16.1°C, respectively. A total of 110.7 mm rainfall from 16 rainy days was received during the growing period and weekly average BSSH ranged from 1.5 to 7.7 hr. The maximum soil moisture depth (mm) was recorded under water hyacinth (85.7 mm) followed by non-mulched (81.2 mm) and lowest under black polythene mulch (79.7 mm). Among different dates of plantings P₁ recorded highest (83.3mm) soil moisture depth, followed by P₄ (82.0 mm), P₂ (81.8 mm) and P₃ (81.5 mm). The weekly mean morning and evening soil temperature ranged from 13.6 to 19.3°C and 19.6 to 28.6°C, respectively under different planting dates and mulching treatments. Irrespective of planting dates, soil temperatures under black polythene was higher in morning and evening by 0.8 to 1.9°C and 1.5 to 2.8°C, respectively, while soil temperatures under water hyacinth were 0.3°C to 0.9°C higher in the morning and 0.5 to 2.2°C lower in the

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evening as compared to non mulched treatment. No considerable difference in incident PAR was observed among mulching treatments. However, it varied considerably when measured at different days in all planting dates. Irrespective of planting dates the reflected PAR increased in later growth period of the crop with the onset of senescence. The lowest ($65 \mu \text{ mol s}^{-1} \text{ m}^{-2}$) RPAR values under black polythene treatment were attributed to greater absorption by black surface. The transmitted PAR was lowest, when measured on 55 DAP with full coverage of canopy, after that it increased again with maturity of the crop. PAR interception was highest on 55 DAP (74.8 %) in all the planting dates and mulching treatments. Among the mulching treatments, crops under water hyacinth recorded highest (80.6%) interception of PAR. The duration of the crop was highest under first date of planting (100.33 days) followed by second (96.7 days), third (90 days) and fourth (87.6 days) date of planting. The maximum leaf area index (LAI) was observed under water hyacinth (2.77) followed by black polythene (2.44) and non-mulched (2.14) treatment. Maximum partitioning of photosynthates towards tuber was found in case of water hyacinth (386.77 g m^{-2}) and lowest in non-mulched (241.63 g m^{-2}). Highest average total dry matter accumulation was obtained in P₁ (465.2 g m^{-2}) followed by P₂ (431.6 g m^{-2}), P₃ (309.6 g m^{-2}) and P₄ (284.8 g m^{-2}). The tuber yield was found to be highest on P₁ (135.6 q ha^{-1}) followed by P₂ (118.3 q ha^{-1}), P₃ (86.3 q ha^{-1}) and P₄ (60.0 q ha^{-1}). The RUE for tuber yield was highest under water hyacinth (2.35 g MJ^{-1}) followed by black polythene (2.03 g MJ^{-1}) and non-mulched (1.67 g MJ^{-1}) condition. From correlation study it was observed that tuber yield, biomass accumulation and LAI were found significant and positively correlated with PAR interception and RUE as well as with AGDD, AHTU, HUE and PTI. The predictive model have been developed by using stepwise regression to predict tuber yield from radiation and thermal indices with higher R² value of 0.96 and 0.99, respectively.

Dry and Wet spell Analysis for Crop Planning in Upper Brahmaputra Valley Zone (UBVZ) of Assam

Sangeeta Hazarika

The present research work was carried out for five districts under Upper Brahmaputra Valley Zone of Assam (UBVZ) to find out the probabilities of occurrence of dry and wet spells and onset and withdrawal of rainy season to suggest suitable crop planning in the region. Long term rainfall data were collected from Department of Agrometeorology, AAU, Jorhat and IMD, Pune for all the districts. The probability analysis was carried out by using Markov chain model which calculates the initial, conditional and consecutive probability of occurrence of dry and wet spell and onset and withdrawal of rainy season were determined by using forward and backward accumulation method, result pertaining to which was used for crop planning in different growing season over the region. The highest annual rainfall was recorded in Dibrugarh district (2590.2mm) followed by Tinsukia (2475.7mm), Sivasagar (2022.0 mm), Jorhat (1923.5mm) and lowest in Golaghat (1648.2mm). Seasonal rainfall analysis indicated that, monsoon season receives the highest amount of rainfall with least CV and the winter records the lowest rainfall with a higher CV in all the districts.

From the result of initial probability, it was found that there was higher chances of occurrence of wet spell of minimum 10mm of threshold limit from 12th SMW (19th – 25th March) to 41st (8th – 14th Oct) and 42nd SMW(15th – 21st Oct) in all the districts. The consecutive probability of occurrence of wet spell of two weeks is more than 50% from 13th (26th march – 1st April) and 15th SMW (9th – 15th April) onwards in Sivasagar and Golaghat, respectively whereas the such condition occurs from 12th SMW in rest of the three districts. There was higher chances of getting wet spell of three consecutive weeks of more than 40mm rainfall at different periods in Jorhat (26th – 28th SMW), Sivasagar (25th – 28th), Dibrugarh (23rd – 31st) and Tinsukia(22nd – 29th , 31st , 32nd SMW), which may lead to flood like condition in the districts. So, water harvesting of the excess moisture as well as provision of drainage in the crop field is suggested during the aforesaid period. The probabilities of occurrence of dry spell were higher before 12th

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SMW and after 42nd SMW, but during monsoon season it was found to be very less which indicates that *Kharif* crops can be grown without any supplemental irrigation.

Considering forward accumulation from 9th SMW there was accumulation of 75 mm and 200 mm of rainfall within 13th – 15th SMW and 16th – 19th SMW, respectively in all the districts which indicates that sowing of summer crops can be started within these weeks. Considering forward accumulation from 22nd SMW it was found that within 23rd – 24th SMW and 25th – 26th SMW, there was accumulation of 75mm and 200 mm rainfall, respectively in the districts. The mean week for end of rainy season was found to be within 34th – 37th SMW (20th Aug – 16th Sept) for 300mm rainfall and 31st to 35th SMW (30th Aug – 2nd Sept) for 500 mm rainfall for all the districts. It indicates that delayed sowing of rice crop may be done latest by the week on which rainy season ends after backward accumulation of 500 mm of rainfall. On the other hand sowing of short duration crops with low water requirements may be done latest by the week on which there will be backward accumulation of 300mm of rainfall.

Sowing of summer crops such as greengram, blackgram, ahu rice were suggested to complete within 12th SMW onwards for all the districts. Nursery bed preparation for *Sali* rice can be started as early as 18th SMW in the district of Jorhat, Dibrugarh and Tinsukia. Sowing of *Kharif* greengram blackgram could be started after 34th SMW and *Rabi* crops and sowing of vegetables could be started after 40th SMW.

Evaluation of Pan Coefficient Methods for Estimating Reference Crop Evapotranspiration at Jorhat

Saurabh Sharma

Pan coefficient is an important parameter for computation of reference crop evapotranspiration (ET_o) from pan evaporation (E_{pan}). In this study the five empirical approaches proposed by Snyder (1992), Cuenca (1989), Orang (1998), Allen and Pruitt (1991), Pereira *et al.* (1995) were used to estimate pan coefficient (K_{pe}) by using weather parameter of Jorhat over 20 years (1996 to 2016). K_{pe} values obtained from the empirical methods, on regression did not reveal a good fit line with that of the pan coefficient (PMK_p) values calculated from FAO Penman-Monteith method which is considered as one of the most accepted methods worldwide. However Snyder method gave best pan coefficient value among all empirical approaches with coefficient of determination (R^2) value of 0.16, root mean square error (RMSE) value of 0.35, mean absolute deviation (MAD) value of 0.33, correlation coefficient (r) value of 0.42 and percent error (PE) value of 34.29 on monthly basis.

Reference Evapotranspiration (ET_o) estimated by multiplying E_{pan} values by K_{pe} values obtained by empirical methods were compared with the reference evapotranspiration values estimated by Penman-Monteith method ($PM ET_o$). On comparison of ET_o values from all empirical methods with $PM ET_o$ values, evaluation statistics revealed that ET_o estimated from Snyder method was closer to $PM ET_o$, with R^2 value of 0.36, RMSE value of 0.71 mm, MAD value of 0.69 mm, r value of 0.57 and PE value of 24.68% on mean monthly data. Hence Snyder method is assumed to be the best method for calculating ET_o using pan coefficient and pan evaporation data.

The line graphs drawn among daily ET_o of all empirical methods and daily $PM ET_o$ revealed that ET_o from Snyder method was closer to $PM ET_o$ than ET_o of other empirical methods.

Based on visual comparison as well as from statistical criteria ET_o computed from Snyder method gave closer agreement with $PM ET_o$ for daily and monthly estimates as compared to other approaches.

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Moreover the model developed (Equation I) between Epan and PM ETo revealed a strong correlation between the two variables with R^2 value of 0.938.

Another model obtained from regression line fitted with mean daily PM ETo on mean daily EToe from Snyder method showed a good correlation between the two variables (Equation II) with coefficient of determination (R^2) value of 0.893.

ETo estimated by all the three above mentioned approaches *viz.* Snyder equation, Equation I and Equation II were ultimately validated with PM ETo for the mean daily ETo of individual year 2017 and 2018 and pooled data of two years (2017-18) respectively. On comparison of different EToe values with PM ETo values, evaluation statistics revealed that equation II was the best approach among all the three approaches with lowest RMSE, MAD and PE values for all above mentioned time period.

With available Kpe data estimated by Snyder method, EToe (Snyder) can easily be estimated by multiplying pan evaporation data and then model II can be used to get better value of reference evapotranspiration.

On the other hand reference evapotranspiration can also be estimated with only the available pan evaporation data by equation I for this region.

Quantification of thermal and radiation regimes on growth and yield of aromatic rice in Jorhat district of Assam

Silpa Rajkhowa

A field experiment was carried out during *Kharif*, 2019 in the Instructional-cum-Research (ICR) Farm of Assam Agricultural University for quantification of thermal and radiation regimes on growth and yield of aromatic *Joha* rice under different microclimates. The experiment was laid out in factorial RBD with four dates of sowings (D1-30th May, D2-15th June, D3-30th June and D4-15th July) and two varieties viz., *Keteki Joha* and *Kola kon Joha* grown following recommended agronomic practices. Occurrences of different phenological events of both the cultivars were recorded. Crop growth parameters viz., leaf area index (LAI) and biomass production, grain yield and yield attributing characters were recorded. Incident Photosynthetically Active Radiation (IPAR), reflected PAR (RPAR) and transmitted PAR (TPAR) were recorded at seven days interval from 30 DAT, while intercepted PAR (iPAR) and radiation use efficiency (RUE) for both the varieties were estimated from those data. Moreover, diurnal variation of IPAR, RPAR and TPAR were recorded at one-hour interval during maximum tillering and 50% flowering stages of the crop sown on different dates. Agro-climatic indices viz., growing degree day (GDD), heliothermal unit (HTU) and phenothermal index (PTI) were computed for attaining different phenological events and heat use efficiency (HUE) were estimated for both biomass and grain yield of the varieties sown on different dates. During a day, iPAR formed a parabolic shape with the maximum interception at 11:30 am in both maximum tillering and 50% flowering stages. The incident PAR recorded during the crop growing period varied from 1267 to 1622 $\mu\text{ mol sec}^{-1}\text{ m}^{-2}$ and 1271 to 1644 $\mu\text{ mol sec}^{-1}\text{ m}^{-2}$, in *Keteki Joha* and *Kola kon Joha*, respectively. RPAR and TPAR showed variation for different dates and varieties. The higher RPAR (82 $\mu\text{ mol sec}^{-1}\text{ m}^{-2}$) and TPAR (588 $\mu\text{ mol sec}^{-1}\text{ m}^{-2}$) was recorded in *Kola kon Joha* compared to *Keteki Joha* with RPAR and TPAR of 68 and 513 $\mu\text{ mol sec}^{-1}\text{ m}^{-2}$, respectively. The higher iPAR was recorded in *Keteki Joha* (61.49%) as compared to *Kola kon Joha* (55.64%). Period of vegetative growth in both

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the cultivars was influenced by sowing dates and the highest vegetative period was recorded in the first date of sowing, which reduced gradually with successive delay in sowings. Irrespective of varieties and sowing dates, the crop attained maximum tillering (panicle initiation) and 50% flowering stage when it was exposed to the day length of around 12 and 11 hours, respectively. The maximum LAI was recorded highest in the first sowing and it reduced successively in delayed sowings in both the varieties. Irrespective of dates of sowing higher LAI was recorded in *Keteki Joha* (2.58) as compared to *Kola kon Joha* (2.20). The above ground biomass production was found highest at first dates of sowing (D1) compared to the last date of sowing (D4). Like LAI, *Keteki Joha* produced higher biomass (21.65 g hill⁻¹) compared to *Kola kon Joha* (16.66 g hill⁻¹). Grain yield in *Keteki Joha* and *Kola kon Joha* ranged from 1.45 to 2.90 t ha⁻¹ and 0.90 to 2.02 t ha⁻¹, respectively. The significant reduction in grain yield in later sowing dates (D3 and D4) attributed due to lower LAI, iPAR, biomass production and biomass partitioning to the grain as compared to the early sown dates. Thermal time accumulation at physiological maturity was relatively higher in *Keteki Joha* (2176.05 oC day) than in *Kola kon Joha* (2077.15 oC day). The accumulated GDD for attaining any phenological events decreased in both the varieties as sowing was delayed. Similar to GDD, HTU accumulation at physiological maturity was found be higher in *Keteki Joha* (11138.41oC hr). The mean value of PTI computed for different phenological stages showed a decreasing trend from transplanting to physiological maturity which varied from 12.66 to 19.10 oC day⁻¹ (*Keteki Joha*) and 13.22 to 19.47 oC day⁻¹ (*Kola kon Joha*) under different dates of sowing. The HUE for biomass and grain was found to be highest at second date of sowing in both the varieties compared to other dates of sowing and between the varieties *Keteki Joha* computed the highest as compared to *Kola kon Joha* for both biomass 2.47 kg ha⁻¹ oC⁻¹ and 1.97 kg ha⁻¹ oC⁻¹, respectively and grain yield 1.00 kg ha⁻¹ oC⁻¹ and 0.70 kg ha⁻¹ oC⁻¹, respectively. RUE for biomass and grain yield were computed, which was found to be highest in the second date of sowing in both the varieties. Between the varieties, *Keteki Joha* recorded the higher RUE than the *Kola kon Joha* for both biomass (0.75 g MJ⁻¹ for *Keteki Joha* and 0.69 g MJ⁻¹ for *Kola kon Joha*) and grain yield (0.30 g MJ⁻¹ for *Keteki Joha* and 0.22 g MJ⁻¹ for *Kola kon Joha*). The correlation study showed that grain yield had a significant correlation with biomass, LAI, and different meteorological parameters, PAR interception (both average and maximum), RUE and thermal indices like GDD, HTU, PTI and HUE. The predictive model for grain yield using meteorological parameters, radiation indices and thermal indices explain the relationship with a high coefficient of determination (R²) with values more than 86.

Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice (*Oryza sativa* L.)

Abhinandan Chetia

A field experiment was conducted at Instructional cum Research (ICR) Farm, Assam Agricultural University, Jorhat during autumn season of 2019 to study the “Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice (*Oryza sativa* L.)”. The experiment consisted of four irrigation levels *viz.*, I1 : 1.20 ETc (drip at 120% ETc), I2 : 1.00ETc (drip at 100% ETc), I3 : 0.8 ETc (drip at 80% ETc) and I4 : 0.60% ETc (drip at 60% ETc) and four fertilizer levels *viz.* F1 : 100% recommended dose of N and K through drip, F2 : 75% recommended dose of N and K through drip, F3 : 50% recommended dose of N and K through drip and F4 : No fertilizer. The experiment was laid out in Randomised Block Design with three replications. The soil of the experimental site was sandy loam in texture with available N, P₂O₅, K₂O and OC of 299.3 kg/ha, 20.03 kg/ha, 120.39 kg/ha and 0.71% respectively with pH 5.9. The rice variety Inglongkiri was sown on 20th March, 2019 and harvested on 7th July, 2019. The results revealed that irrigation level I1 : 120% Etc (drip at 120% ETc) recorded significantly maximum plant height at PI and maturity stages ; and I2 : 100% ETc (drip at 100% ETc) recorded the highest dry matter accumulation and plant population at tillering, PI and maturity. The maximum values with respect to yield attributing characters, grain and straw yields, harvest index, plant water content; N, P, K uptake and irrigation water use were recorded under irrigation level I1 followed by I2. Different fertilizer levels brought about significant differences in dry matter accumulation at PI and maturity, grain yield, straw yield and in N, P, K uptake. The highest values for these parameters were recorded under application of 100% N and K through drip (F1) followed by at par results with F2 (75% N and K). The treatment F2 recorded slightly better result with respects to RWC and soil moisture content at all the growth stages, NPK content in grain.

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With regard to combined effect of treatments I1F1 recorded the highest grain and straw yields of 35.93 q/ha and 80.95 q/ha respectively. This combination of treatment also recorded the highest nutrient uptake of N, P₂O₅ and K₂O.

In terms of economics, the treatment combination I1F1 (drip at 120% ET_c and 100% N K fertigation) was the best with respects to gross return (Rs 71,961.00), net return (Rs 21,747.00) and B:C (1.43) followed by the treatment combination of I1F2 (drip at 120% ET_c and 75% recommended dose of N K).

Zinc fortification in maize *Zea mays* through soil and foliar application

Anupriya Yadav

A field experiment entitled „Zinc fortification in maize (*Zea mays*) through soil and foliar application“ was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *summer* season of 2019 to find out the effect of zinc on growth, yield and uptake of zinc through soil and foliar application. The experiment consisted of nine treatments *viz.*, 0 kg/ha ZnSO₄ (Control), 10 kg/ha ZnSO₄ soil application, 20 kg/ha ZnSO₄ soil application, 0.5% ZnSO₄ foliar spray at 25 DAS, 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS, 10 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS, 10 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS, 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS. The treatments were laid out in Randomized Block Design (RBD) and replicated thrice. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.4), medium in organic carbon (0.64%), low in available N (198.04 kg/ha), medium in available P₂O₅ (24.98kg/ha), low in available K₂O (187.30 kg/ha) and low in available zinc (0.56 mg/kg).

The highest plant height was recorded in the combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS. The Leaf Area Index (LAI) and yield attributing characters like weight and length of the cob with and without husk, girth of cob, number of grain rows per cob, number of grains per row, number of grains per cob and grain weight per cob as well as grain yield (43.05 q/ha), cob yield (64.49 q/ha) and stover yield (88.99 q/ha) were recorded the highest in the combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS which was at par with the combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS. The highest N, K and Zn content and uptake were obtained in the combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS. The P content in grain and stover were found to be non significant owing to different treatments but combined

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application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS recorded higher P uptake than control. Significantly higher available N, P₂O₅ and K₂O (kg/ha) in the soil after harvest were recorded under 0 kg/ha ZnSO₄ (Control) over rest of the treatments. The combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 45 DAS recorded highest available Zn which was at par with combined application of 20 kg/ha ZnSO₄ soil application + 0.5% ZnSO₄ foliar spray at 25 DAS and 20 kg/ha ZnSO₄ soil application . The highest gross return (Rs.117680), net return (Rs.88128) and B: C ratio (2.98) was obtained with the combined application of 20 kg/ha ZnSO₄ in soil + 0.5% ZnSO₄ as foliar spray at 25 DAS and 45 DAS.

Nutrient and weed management in buckwheat (*Fagopyrum esculentum*) after *sali* rice

Bamon Timung

An experiment entitled “Nutrient and weed management in buckwheat (*Fagopyrum esculentum*) after *sali* rice” was conducted at Instructional-cum-Research farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018-19 to study the effect of nutrient and weed management practices on buckwheat after *sali* rice harvest. The experiment was laid out in factorial randomized block design with three replications. The treatment consisted of four nutrient management practices *viz.*, control, application of 20-10-10 kg/ha N-P₂O₅-K₂O, respectively, application of 20-10-10 kg/ha N-P₂O₅-K₂O, respectively + 1.25t/ha vermicompost and application of 20-10-10 kg/ha N-P₂O₅-K₂O, respectively + 2.5t/ha vermicompost and three weed management treatments *viz.*, control, pre-emergence application of pendimethalin @ 0.75 kg/ha and pre-emergence application of pendimethalin @ 0.75 kg/ha + dryland weeder at 40 DAS. The soil of the experiment site was sandy loam in texture, acidic in reaction (pH: 5.6) medium in organic C (0.58 %), available N (259.56 kg/ha), P₂O₅ (20.40 kg/ha) and available K₂O (161.23 kg/ha). The weeds of the experimental field were *Eleusine indica*, *Panicum repens*, *Paspalum compressus*, *Digitaria setigera*, *Cynodon dactylon* among the grasses; *Cyperus rotundus* among the sedge; and *Ageratum houstonianum*, *Commelina benghalensis*, *Polygonum plebeium*, *Mimosa pudica* and *Acmella ciliata* among the broad leaved.

The density and dry weight of weeds in rainfed buckwheat were found to be significantly lesser with application of 20-10-10 kg/ha N-P₂O₅-K₂O, respectively + 2.5t/ha vermicompost compared to other treatments. As a result, the uptake of N, P and K by weeds was found to be significantly lesser with N₃. The growth parameters like plant height, number of primary branches/plant and yield attributing characters *viz.*, number of cyme/plant, number of seeds/cyme were found to be significantly higher in N₃. The highest seed yield (1249.99 kg/ha), stover yield (2046.76 kg/ha) was thus recorded with this treatment.

In respect of weed management, pre-emergence application of pendimethalin @ 0.75 kg/ha + dryland weeder operation at 40 DAS was found to significantly lower the

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density and dry weight, N,P and K content and uptake of weeds in rainfed buckwheat. Thus, the growth and yield attributing characters of rainfed buckwheat improved with this treatment which recorded the highest seed (1080.55 kg/ha) and stover (1824.02 kg/ha) yields.

The nutrient as well as weed management interacted significantly and the combination of the two above-mentioned treatments was the best treatment combination with the seed yield of 1333.32 kg/ha and stover yield of 2079.16 kg/ha. This treatment combination was also found to be the best with a gross return of Rs. 47,705.72, net return of Rs. 26,032.58 and B: C ratio of 1.20.

Conservation irrigation and integrated nutrient management of late sown *toria* in rice fallows of Assam

Bhakti Priya Dutta

A field experiment entitled “Conservation irrigation and integrated nutrient management of late sown *toria* in rice fallows” was conducted at the Instructional-cum-Research Farm of Assam Agricultural University, Jorhat during *rabi* season (December-March) of 2017-18. The *toria* variety used for the investigation was *Jeuti* (JT-90-1). The treatments consisted of five levels of conservation irrigation *viz.*, I₀-Rain-fed, I₁-Mulching with rice straw @5t/ha, I₂- One irrigation at 50% flowering, I₃ - One irrigation at 50% flowering + mulching with rice straw @5t/ha and I₄- Two Irrigations at 50% flowering and at pod development stages and three levels of integrated nutrient management practices *viz.*, N₁- Recommended dose of fertilizers (RDF), N₂ - 50% N of RDF + 50% N as FYM and N₃ - 75% N of RDF + 25% N as FYM + Bio-fertilizer (Consortium of *Azotobacter* and PSB), laid out in a split-plot design with conservation irrigation in the main plots and integrated nutrient management practices in the sub-plots and were replicated thrice. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.3), medium in organic carbon (0.48%), available N (271.24 kg/ha), available P₂O₅ (22.95 kg/ha) and available K₂O (155.67 kg/ha). The bulk density, field capacity, permanent wilting point and water holding capacity of the soil were 1.48 g/cc, 24.46%, 11.23% and 36.38%, respectively.

Results revealed that application of two irrigations at 50% flowering and at pod development stages resulted in higher growth in terms of plant height, dry weight and number of branches per plant as well as yield attributing characters like number of siliquae per plant and number of seeds per siliqua. The effects of these were reflected in resulting to higher yield of seed, stover and oil. However in all such cases, this treatment was found to be statistically at par with that of one irrigation at 50% flowering + mulching with rice straw@ 5 t/ha. The maximum values of N, P and K uptake, consumptive use and total water use were observed under two irrigations at 50% flowering and at pod development stages, followed by one irrigation at 50% flowering +

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mulching with rice straw @ 5 t/ha. Also, higher gross and net return and B: C ratio were found under the treatment of two irrigations at 50% flowering and at pod development stages which was closely followed by one irrigation at 50% flowering + mulching with rice straw @ 5 t/ha.

Different integrated nutrient management practices brought about significant differences in growth parameters, yield attributing characters, seed, stover and oil yield, consumptive and total water use, water use efficiency and N, P and K uptake. The highest values in all such aspects as well total return and B: C ratio were recorded under application of 75% N of RDF + 25% N as FYM + Bio-fertilizer.

The treatment combination of two irrigations at 50% flowering and pod development stages and 75% N of RDF + 25% N as FYM + Bio-fertilizer produced the highest seed, stover and oil yield which was closely followed by one irrigation at 50% flowering+ mulching with rice straw @5t/ha along with 75% N of RDF + 25% N as FYM + Bio-fertilizer.

Effect of sowing dates and planting geometry on summer baby corn

Dibya Jiban Panda

A field experiment entitled “Effect of sowing dates and planting geometry on summer baby corn” was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during summer season of 2018 with a view to find out a suitable date of sowing and a suitable planting geometry for baby corn. The experiment was laid out in a split-plot design with three replications. The treatments consisted of four date of sowing *viz.*, 20th February (D₁), 2nd March (D₂), 12th March (D₃), 22nd March (D₄) in main plot and four planting geometry practices *viz.*, 40 cm x 20 cm (S₁), 40 cm x 25 cm (S₂), 45 cm x 20 cm (S₃), 45 cm x 25 cm (S₄), in sub-plot. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.06), medium in organic carbon (0.74%), available N (232.21 kg/ha), available P₂O₅ (25.36 kg/ha), available K₂O (168.72 kg/ha) and the bulk density 1.36 g/cc. During the crop season, total rainfall received was 617.5 mm.

Results revealed that sowing on 2nd March resulted in higher growth parameters in terms of plant height and leaf area index as well as yield attributing characters like number of cob per plant, weight and length of cob with and without husk and cob girth. The effect of these reflected in resulting higher cob yield with and without husk and green fodder yield. However, in all such cases, this treatment was found to be at par with 12th March sowing. Similar effects of these treatments were also observed in respect to N, P and K uptake.

Experimental findings revealed that spacing 40 cm x 20 cm and 45 cm x 20 cm had significantly higher plant height and leaf area index as compared to 40 cm x 25 cm and 45 cm x 25 cm at 45 DAS and at harvest. Spacing had non-significant effect on days taken for baby corn initiation. Wider spacing of 45 cm x 25 cm had significantly more number of cobs per plant, weight of cob and length of cob with as well as without husk and baby corn girth. However, yield of cob with as well as without husk and fodder yield was found to be higher under spacing 45 cm x 20 cm. Total N,P and K uptake was also found to be higher under 45 cm x 20 cm spacing than rest of the planting geometry

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treatments. Planting geometry had non- significant effect on available N, P₂O₅ and K₂O (kg/ha) status of soil after harvest.

In terms of economics, among all the dates of sowing, the 2nd March sowing resulted higher gross (1,72,327.69 ₹/ha) and net return (1,38,831.44 ₹/ha) and B:C ratio (4.15) which was closely followed by 12th March sowing. Among all the spacing, higher gross return (1,62,763.61 ₹/ha), net return (1,29,209.61 ₹/ha) and B:C ratio (3.85) was recorded from 45 cm x 20 cm spacing compared to other treatments.

Effect of fertility levels and mulching on growth and yield of *rabi* baby corn

Dulla Pushpa

A field experiment entitled “*Effect of fertility levels and mulching on growth and yield of rabi baby corn*” was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2017-18 with a view to evaluate the effect of different fertility levels and mulching on growth and yield of *rabi* baby corn. The experiment was laid out in a factorial RBD with three replications. The treatments consisted of two different factors, *viz.*, four fertility levels [60-30-30 kg N-P₂O₅-K₂O ha⁻¹ (F₁), 80-40-40 kg N-P₂O₅-K₂O ha⁻¹ (F₂), 100-50-50 kg N-P₂O₅-K₂O ha⁻¹ (F₃) and 120-60-60 kg N-P₂O₅-K₂O ha⁻¹ (F₄)] and three mulching practices [without mulch (M₀), mulching with paddy straw of 4 cm thickness (M₁) and mulching with paddy straw of 8 cm thickness (M₂)]. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.6), medium in organic carbon (0.65%) and low in available N (236.63 kg ha⁻¹), P₂O₅ (22.28 kg ha⁻¹) and K₂O (126.71 kg ha⁻¹).

Experimental findings revealed that among the fertility levels, 120-60-60 kg N-P₂O₅-K₂O ha⁻¹ (F₄) produced higher plant growth parameters [like plant height, number of green leaves plant⁻¹, dry matter accumulation, LAI], yield attributes [like length and girth of cob with and without husk, weight of cob without husk] and available P₂O₅ in soil after harvest of baby corn which were statistically comparable with F₃ but significantly superior over F₂ and F₁. Significantly higher number of cobs per plant, cob yield with (92.89 q ha⁻¹) and without (19.45 q ha⁻¹) husk, green fodder yield (38.80 t ha⁻¹), total NPK uptake, available N and K₂O in soil after harvest of baby corn were observed at F₄ (120-60-60 kg N-P₂O₅-K₂O ha⁻¹) over rest of the treatments.

Among the mulching practices, M₂ recorded highest plant height, green leaves per plant, dry matter accumulation, LAI, length and weight of cob (with and without husk), green fodder yield, total K uptake and available K₂O in soil after harvest of baby corn which was statistically *at par* with M₁. The levels of mulching recorded significant increase in girth of cob with and without husk, number of cobs per plant, yield of cob with and without husk, total uptake of N and P and available N and P₂O₅ content in soil

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after harvest of baby corn. At all intervals, the soil moisture values were found to be highest under mulching with paddy straw of 8 cm thickness (M_2).

The interaction effect of fertility levels and mulching were found to be significant in case of number of cobs per plant, weight of cob without husk and yield of cob (with and without husk). The maximum number of cobs per plant (3.98) were obtained at F_4 (120-60-60 kg N- P_2O_5 - K_2O ha⁻¹) in combination with M_2 (mulching with paddy straw of 8 cm thickness) level of mulching. In case of cob weight without husk, highest value was recorded at F_3 (100-50-50 kg N- P_2O_5 - K_2O ha⁻¹) in combination with M_2 (14.86 g cob⁻¹). In M_2 level of mulching, yield of cob with and without husk increased with increasing levels of fertilizer.

In terms of economics, the highest gross return (₹ 211507.93 ha⁻¹), net return (₹ 164521.80 ha⁻¹) and net return per rupee invested (3.50) were observed at F_4 (120-60-60 kg N- P_2O_5 - K_2O ha⁻¹) level of fertilizer in combination with M_2 (mulching with paddy straw of 8 cm thickness) level of mulching and lowest at F_1 (60-30-30 kg N- P_2O_5 - K_2O ha⁻¹) level of fertilizer in combination with M_0 (control) level of mulching.

Performance of quality protein maize (*Zea mays* L.) under different crop management practices

Gargi Kashyap

An agronomic experiment entitled “*Performance of quality protein maize (Zea mays L.) under different crop management practices*” was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018 to find out the performance of QPM under different dates and a suitable row spacing for QPM cultivation in Assam condition. The experiment consisted of three different dates *viz.*, 15th November (D1), 25th November (D2) and 5th December (D3) and four different row spacings *viz.*, 50cm x 25cm (S1), 55cm x 25cm (S2), 60cm x 25cm (S3) and 65cm x 25cm (S4). The treatments were laid out in split plot design and replicated thrice with different dates in the main plots and row spacings in the sub-plots. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.10), medium in organic carbon (0.64%), low in available N (227.72 kg/ha), low in available P₂O₅ (21.07kg/ha) and medium in K₂O (198.51 kg/ha). Experimental findings revealed that among the three different dates allotted, 15th November (D1) sown crop recorded highest plant height, total number of functional leaves, LAI and CGR values and less GDD than late sown other two dates and less days recorded in terms of total days for tasseling, silking and harvesting. Yield attributing characters were also recorded highest under 15th November crop *viz.*, number of cobs/plant(1.07), cob weight with husk (230.36g) and without husk (190.38g), cob length with husk (24.56 cm) and without husk (15.40 cm), cob girth (16.72 cm), number of rows/cob (16.72), number of grains/rows (31.53) and weight of 1000 grains (313.43g). The highest grain yield (45.01q/ha), stover yield (78.03q/ha) and harvest index (36.68%) were found under 15th November. The highest nutrient content in grains, stover and protein content in grains were recorded and also found highest under 15th November crop. Different row spacings showed significant effect on plant height, which was recorded the highest under 60cm x 25cm (S3). The number of functional leaves, LAI and CGR as well as yield attributing characters like number of cobs/plant, length and weight of the cob with and without husk, cob girth, number of rows/cob,

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number of grains/row and 1000 grain weight as well as grain yield (44.41q/ha) and stover yield (79.23q/ha) were recorded the highest with the spacing of 60cm x 25cm (S3). The highest nutrient content and nutrient drained from soil was obtained under row spacing of 60cm x 25cm (S3). In terms of economics, the highest gross returns (Rs. 1,16,158.14), net return (Rs. 91,742.89) and highest B:C ratio (3.76) was obtained from 15th November sown crop. Among the different row spacings 60cm x 25cm (S3) resulted in the highest gross return (Rs. 1,20,419.56) and net return (Rs. 96,052.56) and highest B: C ratio (3.94).

Estimation of crop water footprint in Jorhat district of Assam

Grefy Morang

A research project entitled “Estimation of crop water footprint in Jorhat district of Assam” was carried out during 2017-18 in Jorhat district. In this study, the water footprint of 18 different major crops of the district namely summer rice, autumn rice, winter rice, rapeseed, blackgram, greengram, summer maize, sugarcane, potato, pea, tomato, cauliflower, cabbage, chilli, kingchilli, banana, Assam lemon and tea were assessed. The work was carried out with the objectives to estimate water footprint of crop production system in Jorhat district and to quantify the Green, Blue and Grey water components of total crop water footprint. In the present study, the ET_{green} and ET_{blue} of water footprint was calculated using CROPWAT 8.0 model. After that WF_{green}, WF_{blue} and WF_{grey} components of water footprint for major crop grown in Jorhat were calculated for per ton production of each crop. Finally the Blue, Green and Grey components for total production of each crop in one year period were estimated.

The result revealed that actual crop evapotranspiration and rainfall pattern had played a vital role in WF_{green} and WF_{blue} analysis. WF_{green} in cubic meter per ton was found to be the highest in winter rice and lowest in tomato among all the crops. WF_{blue} was recorded highest for tea. WF_{green} was found high in all the cereals except summer maize. Winter rice recorded the highest green water footprint among cereals. It was recorded highest in chilli and lowest in tomato among the vegetables. The value of WF_{blue} was recorded the highest in pea and lowest in tomato. WF_{blue} was found to be the highest in tea and lowest in banana among the commercial crops.

Thus, from the present investigation it could be concluded that winter rice recorded the highest total process water footprint value 537.92 million cubic meter (MCM) which was 47 per cent of total fresh water consumption. Whereas, summer maize, chilli and king chilli were found to be as low as 0.45 MCM, 0.54 MCM and 0.56 MCM, respectively. It had been observed that blue, green and grey water footprint (total water footprint) of tea for per ton production was the highest (10160.71 m³/t). Thus, a total of 1117.33 million cubic meter of process WF was obtained for accomplishment of

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crop production system in the Jorhat district of Assam. The respective values of total process WFgreen, WFblue and WFGrey components were estimated to be 62.80 per cent (701.7 MCM), 7.57 per cent (84.48 MCM) and 29.63per cent (331.15 MCM) of total process water foot print value.

Agronomic bio-fortification of fodder maize (*Zea mays* L.) with boron and zinc

Himangshu Deka

A field experiment entitled “Agronomic bio-fortification of fodder maize (*Zea mays* L.) with boron and zinc” was conducted during the *summer* season of 2019 at the ICR farm of Assam Agricultural University, Jorhat, with a view to evaluate the response of fodder maize to boron and zinc bio-fortification. The experiment was laid out in a randomized block design with 10 treatments and replicated thrice. The treatments consisted of soil and foliar applications of zinc and boron *viz.*, Absolute control [T1], Recommended dose of fertilizers [T2], RDF + Zn (10 kg/ha) [T3], RDF+ Zn (20 kg/ha) [T4], RDF + B (1% Borax as foliar application) [T5], RDF + B (1.5% Borax as foliar application) [T6], RDF + Zn (10 kg/ha) + B (1% Borax as foliar application) [T7], RDF + Zn (10 kg/ha) + B (1.5% Borax as foliar application) [T8], RDF+ Zn (20 kg/ha) + B (1% Borax as foliar application) [T9], RDF + Zn (20 kg/ha)+ B (1.5% Borax as foliar application) [T10]. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.9), medium in OC (0.64%), low in available N (196.26 kg/ha), medium in available P₂O₅ (25.34 kg/ha) and available K₂O (155.23 kg/ha) and low in available zinc (0.62 mg/kg) and boron (0.56 mg/kg).

The results revealed that the growth and yield attributing characters, quality parameters and NPK content and uptake by the fodder maize were significantly higher with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10]. The green fodder yield and dry fodder yield were significantly influenced by the application of zinc and boron. The highest value (287.23 q/ha) was recorded with the treatment T10 [RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application)]. Among the different treatments, application of RDF+ Zn (20 kg/ha) [T4] recorded the highest Zn content (39.12 mg/kg) and the lowest one (18.67 q/ha) was recorded with the treatment T1 [Absolute control]. Similarly, the highest B content (47.34 mg/kg) was recorded with the application of RDF + B (1.5% Borax as foliar application) [T6]. In case of zinc and boron uptake by the plant, the highest value was observed with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10].

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Among different treatments higher monetary return (Rs.45956.80) was realized with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10] whereas, the B: C (2.11) ratio was highest with the application of Recommended dose of fertilizer (RDF) [T2].

Effect of Plant Growth-promoting Rhizobacteria and Weed Management in Direct-seeded Upland Rice

Jimni Phukan

A field experiment entitled “Effect of Plant Growth-promoting Rhizobacteria and Weed Management in Direct-seeded Upland Rice” was carried out at Instructional-cum-Research Farm (ICR), Assam Agricultural University, Jorhat during *autumn* season of 2018 with a view to study the effect of plant growth-promoting rhizobacteria and weed management practices on weed, crop growth and yield of direct seeded upland rice.

The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of three PGPR inoculations *viz.*, *Bacillus cereus* (P₁), *Pseudomonas fluorescens* (P₂) and no inoculation (P₃) and four weed management practices *viz.*, Pretilachlor @ 0.75 kg/ha (W₁), Pretilachlor @ 0.75 kg/ha followed by 1 hand weeding at 30 DAS (W₂), three hand weedings at 15, 30 & 45 DAS (W₃) and weedy check (W₄). The soil of the experimental site was sandy loam, acidic in reaction (pH: 5.5), medium in organic carbon (0.54%), low in available N (191.0 kg/ha), P₂O₅ (22.28 kg/ha) and K₂O (107.05 kg/ha). The weed flora of the experimental field comprised of *Eleusine indica*, *Digitaria setigera*, *Cynodon dactylon*, *Cyperus difformis*, *Cyperus rotundus*, *Ageratum houstonianum*, *Commelina diffusa*, *Oldenlandia corymbosa*, *Spermacoce articularis*, *Cleome rutidosperma*, *Mimosa pudica* and *Acmella ciliata*.

The density and dry weight of weeds were lowest with *Pseudomonas fluorescens* among PGPR treatments. The plant height, number of tillers, plant dry matter accumulation, panicle length, number of panicles and number of grains were significantly improved due to *Pseudomonas fluorescens*. The highest grain and straw yield of rice were recorded with *Pseudomonas fluorescens*. Bacterial populations in soil, phosphomonoesterase and dehydrogenase activity were enhanced by *Pseudomonas fluorescens* but fungal population in soil was increased by *Bacillus cereus*.

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Single application of Pretilachlor @ 0.75 kg/ha or application of Pretilachlor @ 0.75 kg/ha followed by 1 hand weeding at 30 DAS resulted least density and dry weight of weeds at initial stages but in later stages of crop growth, lowest values were recorded in three hand weedings done at 15, 30 & 45 DAS. Better growth and yield attributing characters of rice with three hand weedings at 15, 30 & 45 DAS resulted in the highest grain and straw yields. Higher microbial count in soil and enzymatic activity were recorded in weedy check and three hand weedings at 15, 30 & 45 DAS.

The combination of *Pseudomonas fluorescens* with either three hand weedings at 15, 30 & 45 DAS or Pretilachlor @ 0.75 kg/ha followed by 1 hand weeding at 30 DAS was found to be superior with grain and straw yield. Similar trend was also achieved in gross and net returns. The benefit : cost ratio was highest with the combination of *Pseudomonas fluorescens* with Pretilachlor pre-emergence @ 0.75 kg/ha followed by 1 hand weeding at 30 DAS.

Effect of Phosphate Solubilising Bacteria (PSB) on fodder productivity of cowpea in acid soil

Jishnu Pratim Mudoi

A field experiment entitled “Effect of Phosphate Solubilizing Bacteria (PSB) on fodder productivity of cowpea in acid soil” was carried out during the *kharif* season of 2018-19 at the Instructional-cum-Research Farm, Assam Agricultural University, Jorhat to find out the performance of PSB on growth, productivity and quality of fodder cowpea. The experiment consisted of twelve treatments *viz.*, control (T1), application of recommended dose of fertilizers according to all India trial which were 20:60:30 kg/ha of N:P₂O₅: K₂O (T2) respectively, application of PSB (12PF-1) + N and K full (T3), application of PSB (47PF-1) + N and K full (T4), application of PSB (48PF-3) + N and K full (T5), application of PSB (48PF-4) + N and K full (T6), application of PSB(131PF-1) + N and K full (T7), application of PSB (99PF-1) + N and K full (T8), application of PSB (26PB-2) + N and K full (T9), application of PSB (68PB-3) + N and K full (T10), application of PSB (103PB-1) + N and K full (T11) and application of PSB (136PB-1) + N and K full (T12) and along with it, from 3rd treatment onwards, only half of the required phosphorus was supplied through inorganic fertilizer. The name of cowpea variety was „BL-2” (Bundel Lobia -2). This variety was developed in IGFRI, Jhansi through single plant selection from IL-978. The treatments were laid out in Randomized Block Design (RBD) and replicated thrice. The soil of the experimental site was clayey loam in texture, acidic in reaction (pH 5.1), medium in organic carbon (0.51%), low in available N (239.12 kg/ha), medium in available P₂O₅ (18.4kg/ha), medium in available K₂O (158.23 kg/ha). Experimental findings revealed that in case of the growth parameters such as highest plant height, no. of leaves per plant, length of root per plant and Leaf Area Index (LAI), significant results were found at 40 DAS, 60 DAS and at harvest compared to the other treatments with treatment T11 [application of PSB (103PB-1) + N and K full] recording highest values and being at par with application of PSB (136PB-1) + N and K full. Root weight per plant was significantly affected at all the stages of observation, i.e., at 20 DAS, 40 DAS, 60 DAS and at harvest with the highest recorded data observed in case of application of PSB (103PB-1) + N

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and K full (T11) which was at par with treatment T12 [application of PSB (136PB-1) + N and K full] . No. of root nodules and their weight per plant showed significant affect at 20 DAS, 40 DAS and at 60 DAS with the highest data being recorded in case of treatment T11 [PSB (103PB-1) + N and K full] followed by treatment T12 [application of PSB (136PB-1) + N and K full] with which it was statistically at par. CGR values increased at an increasing rate from 20-40 DAS to 40-60 DAS and thereafter the rate decreased from 40- 60 DAS to 60-Harvest with highest CGR values being observed in treatment T11 [application of PSB (103PB-1) + N and K full]. RGR values were highest between 20 DAS to 40 DAS and thereafter declined till harvest with highest data being recorded with application of PSB (103PB-1) + N and K full (T11). Green forage yield and dry matter yield were also significantly affected by the application of PSB with highest data being recorded in treatment T11 [application of PSB (103PB-1) + N and K full] which were 35.2 t/ha and 8.28 t/ha respectively and it was followed by treatment T12 [application of PSB (136PB-1) + N and K full] with which it was statistically at par . Crude protein yield was also influenced significantly and treatment T11 [application of PSB (103PB-1) + N and K full] recorded highest data (1.13 t/ha) which was at par with application of PSB (136PB-1) + N and K full (T12). The uptakes of N& P and were found to be significantly affected as well with treatment T11 recording highest N-uptake (23.56 kg/ha) as well as P – uptake (11.32 kg/ha). The primary nutrient status of the soil also increased after the harvest of the crop with significant results seen in case of available N and available P₂O₅ in soil. Treatment T11 recorded highest available N (254.35 kg/ha) and available P₂O₅ (29.94 kg/ha) of the soil which were at par with treatment T12 [application of PSB (136PB-1) + N and K full]. Among different treatments, higher gross return (₹ 70400.00), net return (₹ 49102) and B: C ratio (₹ 2.31) were realized with the application of [PSB (103PB-1) + N and K full [T11].

Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation

Keisham Dony Devi

A field experiment entitled “Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation” was conducted during the *rabi* season of 2019-20 at the research farm of Assam Agricultural University, Jorhat, with a view to evaluate the performance of early maturing mustard varieties and the effect of integrated nutrient management in rapeseed and mustard in rice fallow situation. The experiment was laid out in a split-plot design with four (4) rapeseed and mustard varieties in the main plot and five (5) integrated nutrient management (INM) practices in the sub-plots and replicated thrice. The varieties (V) viz., PM 26 (V1), PM 27 (V2), NRCHB-101 (V3) and TS-36 (V4) and INM practices viz., control (No N-P-K) (F1), 50% of the recommended dose (RD) of NPK + vermicompost mixture @ 1t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) in equal splits applied at basal and 30 DAS (F2), vermicompost @ 2t/ha enriched with biofertilizers (Azotobacter + PSB) incubated @ 0.2% w/w for 15 days (F3), FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4) and recommended NPK @ 40-35-15 kg/ha (F5) was sown on 23rd Nov 2019 and harvested on 24th Feb 2020 for *toria* and 6th March 2020 for mustard. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.99), high in OC (0.98%), low in available N (219.17 kg/ha) and available P₂O₅ (17.47 kg/ha) and medium in available K₂O (281.8 kg/ha). The field capacity of the soil was 21.26 %.

The results revealed that the growth and yield attributing characters, the seed oil content (40.31%), oil yield (475.65 kg/ha) and NPK content of seed and stover as well as uptake by the crop were significantly higher in PM 27 (V2). Among four varieties, the highest seed and stover yield was produced by mustard variety PM 27 (V2) and it was *at par* with NRCHB 101 (V3). Application of recommended NPK @ 40-35-15

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kg/ha (F5) was significantly superior over all other treatments and *at par* with 50% RD of NPK + VC @ 1t/ha incubated with biofertilizer in equal splits as basal and at 30 DAS (F2) in terms of the growth and yield attributing characters, seed and stover yield and NPK content and uptake. The highest oil content (40.15%) and oil yield (483.86 kg/ha) and available N, P₂O₅, K₂O in soil after harvest was recorded in application of recommended NPK @ 40-35-15 kg/ha (F5).

The highest Agronomic efficiency (AE) (kg/kg), Nutrient use efficiency (NUE) (kg/kg), Physiological efficiency (PE) (kg/kg) and Apparent recovery efficiency (ARE) (%) of rapeseed and mustard was obtained in INM treatment of FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4).

Among the varieties, PM 27 (V2) produced the highest net returns of ₹ 40,965.11/ha with a B:C ratio of 2.34 followed by NRCHB 101(V3) which produced a net returns of ₹ 38644.91/ha and B:C ratio of 2.22. In INM practice, a net returns of ₹ 45,325.00/ha with the highest B:C ratio of 2.74 could be recorded in recommended NPK @ 40-35-15 kg/ha (F5) followed by application of FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4) producing a B:C ratio of 2.59 with net returns of ₹ 39,629.63/ha.

From the interaction effect of variety and INM practice, it may be concluded that after the harvest of *kharif* rice in Assam, the sowing of mustard variety PM 27 or NRC HB 101 with recommended NPK @ 40-35-15 kg/ha may be followed. At the same time, considering the importance of INM practice, instead of chemical fertilizer alone, the best INM practice (50% RD of NPK + VC @ 1t/ha incubated with biofertilizers in equal splits as basal and at 30 DAS) may be applied in mustard cultivation for better results under rice fallow situation.

Irrigation scheduling in rapeseed using Can evaporimeter

Krishna Bharadwaj

A field experiment entitled “Irrigation scheduling in rapeseed using Can evaporimeter” was carried out at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018-19 to determine the suitable depth and schedule of irrigation in rapeseed (toria) based on Can evaporimeter and to find out the water requirement of rapeseed by scheduling irrigation with Can evaporimeter. The experiment was laid out in factorial randomized block design and replicated thrice. The treatments consisted of 3 depths of irrigation *viz.*, irrigation of 4 cm depth (I1), irrigation of 5 cm depth (I2) and irrigation of 6 cm depth (I3) and 3 irrigation schedules *viz.* irrigation at 4 cm evaporation from Can evaporimeter (D1), irrigation at 5 cm evaporation from Can evaporimeter (D2) and irrigation at 6 cm evaporation from Can evaporimeter (D3). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.2), medium in organic carbon (0.70%), low in alkaline KMnO₄ extractable N (243.7kg/ha), medium in Brays I P₂O₅ (24.9kg/ha) and low in 1 N ammonium acetate extractable K₂O (151.6kg/ha). The toria variety “TS-38” was sown on 15th October, 2018 and harvested on 16th January, 2019. The total amount of rainfall received during the crop growth period was 69.8 mm.

Experimental findings revealed that irrigation of 6 cm depth (I3) recorded the highest values for all growth characters in terms of plant height, dry matter accumulation, Leaf Area Index (LAI), Specific Leaf Area (SLA) and Crop Growth Rate (CGR) and Relative Growth Rate (RGR). Similarly, the yield attributing characters *viz.*, branches/plant, number of siliquae/plant, number of seeds/siliqua and nutrient (NPK) uptake of rapeseed was observed to be highest under irrigation of 6 cm depth (I3). However, 6 cm irrigation (I3) recorded lower Specific Leaf Weight (SLW). The highest seed and stover yield (1104 kg/ha and 2052 kg/ha, respectively) was found under irrigation of 6 cm depth (I3) which was statistically at par with irrigation of 5 cm depth (I2) [1042 kg/ha and 1942 kg/ha, respectively]. On the other hand, the test weight and harvest index (HI) were found to be non-significant under different treatment

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combinations. Likewise, irrigation of 6 cm depth (I3) also recorded the highest oil yield (465.9 kg/ha), highest water use (205.6 mm), crop WUE (89.9 kg/ha cm) and nutrient (NPK) uptake.

Scheduling of irrigation at 4 cm evaporation from Can evaporimeter (D1) resulted in better growth parameters of the crop *viz.*, plant height, dry matter accumulation, LAI, SLA, CGR and RGR. On the other hand, irrigation at 6 cm evaporation from Can evaporimeter (D3) recorded better SLW. Irrigation at 4 cm evaporation from Can evaporimeter (D1) also recorded the highest yield attributing characters *viz.*, number of branches/plant, number of siliquae/plant and number of seeds/siliqua. The highest seed and stover yield was found under irrigation at 4 cm evaporation from Can evaporimeter (D1) [1173 kg/ha and 2152 kg/ha, respectively]. Similarly, irrigation at 4 cm evaporation from Can evaporimeter (D1) also recorded the highest oil yield (484.9 kg/ha), highest water use (216.3 mm), crop WUE (97.3 kg/ha cm) and nutrient (NPK) uptake. The highest field WUE (57.2 kg/ha cm) was recorded under irrigation scheduling at 5 cm evaporation from Can evaporimeter (D2).

Irrigation of 6 cm depth at 4 cm evaporation from Can evaporimeter (I3D1) recorded the highest dry matter accumulation, siliquae/plant, seed yield and stover yield. It was closely followed by 5 cm irrigation at 4 cm evaporation from Can evaporimeter (I2D1), 4 cm irrigation at 4 cm evaporation from Can evaporimeter (I1D1), 6 cm irrigation at 5 cm evaporation from Can evaporimeter (I3D2) and 5 cm irrigation at 5 cm evaporation from Can evaporimeter (I2D2). However, I1D1 required less irrigation than I2D1 and I3D1 and recorded higher crop WUE and field WUE. In terms of economics, the highest gross return (41510.00/ha), net return (14322.00) and benefit-cost ratio (1.53) were obtained by application of 6 cm irrigation at 4 cm evaporation from Can evaporimeter (I3D1) and closely followed by application of 5 cm irrigation at 4 cm evaporation from Can evaporimeter (I2D1) with gross return, net return and benefit – cost ratio of 41125.00/ha, 14237.00 /ha] and 1.52, respectively.

Effect of date of sowing and row spacing on growth and yield of baby corn (*Zea mays L.*) during *rabi* season

Lipika Talukdar

A field experiment entitle “Effect of dates of sowing and row spacing on growth and yield of baby corn (*Zea mays L.*) during *rabi* season” was carried out at the Instrutional-cum-Research farm. Assam Agricultural University, Jorhat in the year of 2017-18. The experiment was laid out in split-plot design and replicated thrice. The treatment consist of two different factors, *viz.*, four dates of sowing 31stOctober (D₁), 10th November (D₂), 20th November (D₃) and 30th November (D₄) and three row spacing 60 cm x 20 cm (S₁), 45 cm x 20 cm (S₂) and 30 cm x 20 cm (S₃). The baby corn Cv. G-5414 was sown with application of recommended those of 90:60:60 N, P₂O₅, and K₂O kg ha⁻¹. The soil of the experimental site was sandy loom in texture, acidic in reaction (pH 5.4), medium in organic carbon (0.52 %), low in available Nitrogen (190.24 kg ha⁻¹) and available P₂O₅ (20.03 kg ha⁻¹) and medium in available K₂O (160.03 kg ha⁻¹).

Experimental findings revealed that almost all the growth and yield attributes such as plant height, number of leaves per plant, leaf area index, dry matter accumulation per plant, number of cobs per plant, cob length, cob girth, cob weight were significantly influenced by different dates of sowing. In most of cases early sowing on 31st October and 10th November were statistically at par and shown their superiority over late sowing on 20th November and 30th November sown crop. The dates of sowing show significant difference on harvest duration of baby corn. The highest harvest duration was found in 31st October sown crop which was statistically at par with 10th November sown crop. Crops sown on 31st October recorded 4.72, 18.05 and 24.60 per cent higher cob yield with husk and green fodder yield by 12.52, 14.72 and 26.68 per cent higher respectively over 10th November, 20th November and 30th November sowing. The 31st October sown crop recorded significantly higher total N, P and K uptake by crop over 10th, 20th, 30th November sown crop. Crop sown on 30th November significantly recorded higher available N, P₂O and K₂O (Kg ha⁻¹) in the soil after harvest over rest of the dates of sowing.

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Results showed that at 50, 75 DAS and at tasseling and at harvest spacing 30 cm x 20 cm recorded significantly higher plant height over those of 45 cm x 20 cm and 60 cm x 20 cm spacing. Spacing of 60 cm x 20 cm recorded highest harvest duration which were significantly higher than those of other spacing. Wider spacing of 60 cm x 20 cm had significantly higher number of cobs plant⁻¹, weight of cob and length of cob and cob girth, however, the lowest values were found at 30 cm x 20 cm spacing. Yield of cob with husk, without husk and fodder yield was found to be the higher under spacing 45 cm x 20 cm (88.24 q ha⁻¹, 20.79 q ha⁻¹ and 363.34 q ha⁻¹ respectively). Cob yield with husk obtained under 45 cm x 20 cm spacing increased by 8.40, 17.57 per cent over other spacing viz. 60 cm x 20 cm and 30 cm x 20 cm respectively. Total N, P and K uptake was also found to be higher under 45 cm x 20 cm spacing than rest of the spacing treatments.

In terms of economics, higher gross return (Rs. 2,07,011.11,) net return (Rs.1,60,224.11/ha) with BCR (3.42) were recorded by the 31st October sown crop than other dates of sowing. Among different spacing the highest gross return (Rs.2,02,627.50/ha), net return (Rs.1,52,486.10/ha) and benefit-cost ratio (3.04) was recorded from the spacing 45cm x 20cm than other spacing.

Crop diversification in organic rice ecosystem

Merajul Hussain

A field experiment entitled “Crop diversification in organic rice ecosystem” was conducted at the organic block, Instructional-cum-Research farm of Assam Agricultural University, Jorhat during *kharif* and *rabi* seasons, 2019-20 to evaluate the effect of crop diversification in organic rice ecosystem. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The main crop was scented rice (*kon joha*) with different diversified modules. The experiment consisted of eight different treatments *viz.*, sole rice (T1), rice + swamp taro intercropping (4:2) (T2), rice + buffalo spinach intercropping (4:2) (T3), T2 + pumpkin in bund (T4), T2 + marigold in bund (T5), T3 + pumpkin in bund (T6), T3 + marigold in bund (T7) and rice – lathyrus (relay) (T8). The soil of the experimental site was clay loam in texture with pH 5.28, organic carbon (0.82%), CEC {6.48 c mole (p+)/ Kg}, medium in available nitrogen (272.45 kg/ha), available P205 (28.11 kg/ha) and low in available K2O (132.38 kg/ha). The total rainfall received during the crop season was 2014.1 mm. The mean maximum and minimum temperature during the whole crop growing period ranged from 20.7 to 34.8 0C and 8.4 to 26.9 0C, respectively.

Most of the rice growth and yield attributes *viz.*, plant height, number of tillers/hill, number of effective tillers/hill, number of panicles/m², weight of panicle, no. of filled grains/panicle, test weight, grain yield (18.46 q/ha) and straw yield (45.41 q/ha) were found to be highest in sole cropping of rice. However, the growth and yield attributes of component crops were not influenced significantly under different crop diversification modules. Accumulated GDD during each phenophases of rice was recorded and found that the *kon jon* variety require a total GDD of 2026 0C days.

Though crop diversification failed to exert much impact on growth and yield attributes of rice, it had positive influence on multiple cropping index, rice equivalent yield and diversity index which, ultimately resulted in increase in total system productivity. Quality of rice grain *i.e.* kernal length (6.77 mm), kernal breadth (2.32 mm), protein content (7.35%) and milling recovery (61.97%) were significantly improved under crop diversification and found best in rice + swamp taro intercropping + pumpkin in bund. It was *at par* with rice + swamp taro intercropping + marigold in

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bund. Soil bulk density, organic carbon, CEC and biological properties were significantly improved under crop diversification and recorded the best in rice + swamp taro intercropping + pumpkin in bund which was *at par* with rice + swamp taro intercropping + marigold in bund. A highest B:C ratio of 3.10 was recorded in rice + swamp taro intercropping + marigold in bund and was closely followed by rice + swamp taro intercropping + pumpkin in bund (2.94). The study revealed that crop diversification module, rice + swamp taro intercropping + marigold in bund was the best option in respect of profitability, rice equivalent yield, multiple cropping index, diversity index, quality of grain, physico-chemical and biological properties of soil.

Integrated nutrient management in summer maize (*Zea mays*)

Minakshi Bezboruah

A field experiment entitled “Integrated nutrient management in summer maize (*Zea mays*)” was carried out at Instructional-cum- Research (ICR) Farm, Assam Agricultural University, Jorhat during the year 2019 to find out the effect of INM practice to the growth and yield of summer maize and to study the post-harvest nutrient status of soil as affected by different INM practices. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The treatments consisted of both soil and foliar application of fertilizers viz., T1 [60-40-40 kg/ha NPK (RDF)], T2 [RDF + *Azospirillum* + PSB], T3 [RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS], T4 [75% N of RDF + 25% of N replaced by vermicompost], T5 [75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB], T6 [75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS], T7 [50% N of RDF+ 50% of N replaced by vermicompost], T8 [50% N of + 50% of N replaced by vermicompost + *Azospirillum* + PSB], T9 [50% N of RDF + 50% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS]. The soil of the experimental site was sandy loam in texture, acidic in reaction, medium in organic carbon (0.72%), low in available N (156.19 kg/ha) and medium in available P₂O₅ (23.78 kg/ha), and K₂O (161.50 kg/ha). N was applied in two split doses one at knee high stage and second application was before tasseling. The maize seeds of the variety VMH-53 was sown on 15th of March (2019) and harvested by two picking on 10th June and 15th June. Experimental findings revealed that INM practices influenced both the growth and yield attributing characters. Application of RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) recorded highest values for all the growth attributing parameters. Similarly, the yield attributing characters like weight of cob with and without husk, length of cob, number of rows per cob, grain per row, grain per cob, weight of grain per cob and nutrient (NPK) uptake was observed to be highest under RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) which was *at par* with 75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB +

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2 sprays of vermiwash at 25&40 DAS. Likewise, the highest grain and stover yield being 43.04 q/ha and 89.66 q/ha respectively was produced from RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) which was *at par* with the grain yield 41.81 q/ha and stover yield 87.42 q/ha obtained from 75% N of RDF+ 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS (T6). However, the protein content in maize and nutrient content in soil after harvest was found to be non-significant. In terms of economics, the highest gross return (₹ 96765), net return (₹ 77705) and the B:C ratio (4.08) was recorded from the treatment RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) and which was nearly followed by the treatment 75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T6).

Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem

Nayan Jyoti Bordoloi

An experiment entitled “Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem” was conducted at instructional-cum-research farm, Assam Agricultural University, Jorhat during the *rabi* season of 2017-18 with the objective to evaluate efficient proportion of intercrops under organic management system in rice fallow land and to monitor soil physico-chemical properties as influenced by different intercrops. The experiment was laid out in randomised block design with 3 replications. The experiment was consisted of nine different treatment combinations namely T1 [Sole buckwheat]; T2 [Sole lathyrus as grain]; T3 [Sole lathyrus as fodder];T4 [Buckwheat + Lathyrus as grain (1:1)]; T5 [Buckwheat + Lathyrus as fodder (1:1)]; T6 [Buckwheat + Lathyrus as grain (2:1)]; T7 [Buckwheat + Lathyrus as fodder (2:1)]; T8 [Buckwheat + Lathyrus as grain(2:2)] and T9 [Buckwheat + Lathyrus as fodder (2:2)]. The soil was sandy loam with high in organic C (0.77 %). The initial nutrient content of the soil were, N (296.56 kg/ha), P₂O₅ (34.88 kg/ha) and K₂O (148.32 kg/ha). The present investigation revealed that the yield of buckwheat, lathyrus grain and lathyrus fodder was highest in respective sole treatments and decreased with increasing share of intercrops [1,088.71kg/ha (for buckwheat)], 465.34kg/ha (for lathyrus grain), 6023.60 kg/ha (for lathyrus fodder)]. Among different intercropping systems highest buckwheat equivalent yield was obtained in buckwheat + lathyrus as grain at a ratio of 2:2. In terms of intercropping advantage measured by land equivalent ratio (LER), three intercropping viz T8 [Buckwheat + Lathyrus as grain(2:2)]; T9 [Buckwheat + Lathyrus as fodder (2:2)] and T5 [Buckwheat + Lathyrus as fodder (1:1)] showed superior performance over the sole croppings. However, intercropping of buckwheat + lathyrus as grain in 2:2 ratio recorded highest LER values over the other intercropping systems indicating intercrop advantage. Intercropping of buckwheat + lathyrus as grain at 2:2 row proportion proved to be the best since it recorded highest K value (3.32) indicating better complementary effect. Overall soil health as measured by soil available N, P and K content and organic carbon after harvest of test crops was not affected much due to

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sole and intercropping systems. Among different treatments, the highest cost of cultivation (₹ 25,100.00) was recorded in sole buckwheat. Among the intercroppings, the highest gross return (₹ 77,237.75.00), net return (₹ 55,024.75.00) and B:C (2.48) were obtained in buckwheat + lathyrus as (G) in 2:2. This study showed that among the sole cropping treatments, buckwheat was found to be the best crop under rice fallow land organic ecosystem. As a whole intercropping of buckwheat with lathyrus as grain in 2:2 ratio found to be the best in respect of buckwheat equivalent yield, biological efficiency and economic point of view. Since the findings are based on one year experimentation, further validation in farmers field will be helpful for generating best technology under fallow land organic ecosystem.

Relative performance of niger varieties to graded levels of fertilizer under rainfed condition

Nikita Kaman

During the *rabi* season of 2019-20, a field experiment entitled “Relative performance of niger varieties to graded levels of fertilizer under rainfed condition” was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat with a view to study the effect of varieties and graded levels of NPK on growth, yield and quality of niger and also the nutrient uptake by the crop and its availability in soil before and after the crop. The experiment was laid out in a factorial randomized block design (RBD), with three replications. The treatments consisted of four varieties *viz.*, V1: NG-1, V2: GA-10, V3: JNS-9 and V4: NB-1 and four levels of NPK *viz.*, F1: 10-5-5 kg NP₂O₅-K₂O/ha, F2: 20-10-10 kg N-P₂O₅-K₂O/ha, F3: 30-15-15 kg N-P₂O₅-K₂O/ha and F4: 40-20-20 kg N-P₂O₅-K₂O/ha. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.43), medium in organic carbon (0.56%), available N (283.14 kg/ha) and available K₂O (156.55 kg/ha) while low in available P₂O₅ (18.67 kg/ha). Experimental findings revealed that different varieties significantly influenced the growth parameters, yield attributing characters, seed and stover yield, oil content, oil yield and uptake of N, P and K by niger. The variety NB-1 gave significantly higher values in almost all the growth characters (*viz.*, plant height, number of leaves per plant, leaf area index, number of branches per plant and dry matter production per plant) under study except chlorophyll content of leaves, which was higher in the variety GA-10. On the other hand, the variety GA-10 gave significantly higher values in respect of yield attributing characters like number of capitula per plant, number of seeds per capitulum and 1000-seed weight which were at par with JNS-9. Significantly higher seed yield was obtained in GA-10 (491.87 kg/ha) which was at par with JNS-9 (470.24 kg/ha), whereas, the stover yield was the highest in NB-1 (2866.84 kg/ha). Harvest index was significantly higher in GA-10 (16.44%) and was at par with JNS-9 (15.90%) and NG-1 (15.50%). The variety GA-10 also produced significantly higher oil content of seed (38.76%), oil yield (191.96 kg/ha), protein content of seed (16.65%) and N, P and K content and total uptake. The iodine value and saponification

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value of oil and available N, P and K content in soil after harvest of the crop was non-significant. Application of 40-20-20 kg N-P₂O₅-K₂O/ha, 30-15-15 kg N-P₂O₅-K₂O/ha and 20-10-10 kg N-P₂O₅-K₂O/ha gave statistically at par values in respect of all growth parameters studied *viz.*, plant height, number of leaves per plant, leaf area index, number of branches per plant, dry matter production per plant and chlorophyll content of leaves. Among the levels of NPK, 40-20-20 kg N-P₂O₅-K₂O /ha proved superior in terms of yield attributing characters like capitula per plant, number of seeds per capitulum, and seed (534.15 kg/ha) and stover yield (2981.05 kg/ha), oil yield (204.12 kg/ha) and uptake of N, P, and K by niger while number of seeds/capitulum was statistically at par with 30-15-15 kg N-P₂O₅-K₂O /ha. However, the oil content was the highest at 30-15-15 kg N-P₂O₅-K₂O/ha (39.36%). No treatment differences were observed in respect of 1000-seed weight, harvest index, iodine value and saponification value of oil and available N, P and K content in soil after harvest of the crop due to levels of NPK. The highest interaction effect was recorded under the treatment combination- V2F4 (40-20-20 kg N-P₂O₅-K₂O /ha was applied to GA-10) in respect of number of capitula per plant (35.64), seed yield (623.90 kg/ha) and uptake of N and K by seed over rest of the treatment combinations. However, in regards to oil content the highest interaction effect was recorded when 30-15-15 kg N-P₂O₅-K₂O /ha (F3) was applied to variety GA-10 (V2). From the economic analysis, it has been found that the highest gross return (₹ 37,434.00/ha), net return (₹ 22,413.00/ha) and B-C ratio (2.49) were recorded in treatment combination of V2F4 *i.e.* when highest fertility level of NPK *i.e.* 40-20-20 kg NP₂O₅-K₂O /ha was applied to the variety GA-10.

Performance of late sown toria in rice fallows under integrated nutrient management practices

Priyanki Bora

A field experiment entitled “Performance of late sown toria in rice fallows under integrated nutrient management practices” was carried out at Instructional-cum-Research Farm, Assam Agricultural University, during the *rabi* season of 2017-18 and 2018-19. The experiment was laid out in Randomized Block Design and replicated thrice and consisted of ten treatments. The treatments were 100% Recommended dose of fertilizer (RDF) (40-35-15 kg N-P₂O₅-K₂O/ha + 10 kg borax/ha) (T₁), 100% RDF + vermicompost @ 2t/ ha (T₂), 100% RDF + vermicompost @ 2 t/ ha + 20 kg S/ha (T₃), 100% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha (T₄), 100% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha + seed treatment with biofertilizer consortia (T₅), 75% RDF (T₆), 75% RDF + vermicompost @ 2t/ ha (T₇), 75% RDF + vermicompost @ 2 t/ha + 20 kg S/ha (T₈), 75% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha (T₉), 75% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha + seed treatment with biofertilizer consortia (T₁₀). The soils of the experimental sites were sandy loam in texture, acidic in reaction (pH 5.2 and 5.5), medium in organic carbon (0.51 and 0.54%), available N (315.51 and 328.71 kg/ha), available K₂O (137.5 and 138.42 kg/ha) and available Zn (0.79 and 0.95 mg/kg) while low in available P₂O₅ (17.80 and 20.45 kg/ha), available S (16.12 and 19.83 kg/ha) and available B (0.21 and 0.25 mg/kg) in both the years, respectively.

Experimental findings revealed that application of 100% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha + seed treatment with biofertilizer consortia (T₅) resulted in significantly higher growth parameters *viz.*, plant height, numbers of leaves per plant, leaf area index, dry matter production per plant and number of primary and secondary branches per plant and the highest yield attributing characters *viz.* length of siliqua, number of siliquae per plant, number of seeds per siliqua in both the years. The highest seed yield (945.21 and 1025.21 kg/ha in the year 2017-18 and 2018-19, respectively) and stover yield (2236.98 and 2292.54 kg/ha in 2017-18 and 2018-19, respectively) were also recorded in T₅. However, oil content was significantly higher in treatment having 75% RDF + vermicompost @ 2 t/ha + 20 kg S/ha + 4 kg Zn/ha +

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seed treatment with biofertilizer consortia (T₁₀) but protein content and oil yield of toria in both the years were significantly higher under the treatment T₅. Similar effects of this treatment were also observed in respect of N, P, K, S, Zn and B-content in seed and stover and their uptake by seed and stover as well as total uptake as well as in terms of available N, P₂O₅, K₂O, S, Zn and B in soil after the harvest of the crop in both the years.

The highest gross return (₹ 61438.65/ha in 2017-18 and ₹ 66638.65/ha in 2018-19) and net return (₹ 28040.55/ha during 2017-18 and ₹ 33240/ha during 2018-19) were also the highest in T₅. However, the highest B: C ratio of 2.78 during 2017-18 and 2.91 during 2018-19 were recorded in treatment having 100% RDF (T₁).

Nutrient and weed management in rainfed toria by organic methods

Prostuti Bora

An experiment entitled “Nutrient and weed management in rainfed toria by organic methods” was conducted at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2019-2020 to study the effect of nutrient management (NM) and weed management (WM) by organic methods on growth and yield of toria. The experiment was laid out in randomized block design (factorial) with three replications. The treatments consisted of three nutrient management treatments *viz.*, control (N0), application of vermicompost 2.5 t/ha (N1) and application of vermicompost 5.0 t/ha (N2) and three weed management treatments *viz.*, control (W0), hand weeding at 30 DAS (W1) and dryland weeder operation at 30 DAS (W2). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.1), medium in organic carbon (0.58%), available N (270.86 kg/ha), P₂O₅ (21.87 kg/ha) and K₂O (169.82 kg/ha). The weeds of the experimental fields were *Cynodon dactylon*, *Eleusine indica*, *Paspalum conjugatum*, *Panicum repens*, *Axonopus compressus* among grasses ; *Cyperus rotundus* the sedge and *Commelina benghalensis*, *Ageratum houstonianum*, *Mimosa pudica*, *Acmella euliginesa*, *Gynura bicolor*, *Oxalis corniculata*, *Alternanthera philoxeroides* and *Chenopodium album* among the broad leaved weeds. The density and dry weight of weeds in rainfed toria were found to be significantly lesser with application of 5.0 t/ha vermicompost compared with other treatments. As a result, the content and uptake of N, P and K by weeds were found to be significantly lesser with N2. The growth parameters like plant height, number of primary branches/plant, number of secondary branches/plant and yield attributing characters *viz.*, number of siliquae/plant, number of seeds/siliqua were found to be significantly improved in N2. The highest seed yield (929.26 kg/ha), stover yield (1997.95 kg/ha) was recorded with this treatment. The oil content, oil yield, N, P and K content and uptake also increased with N2. In respect of weed management, dryland weeder operation at 30 DAS (W2) was found to significantly lower the density and dry weight. N, P and K content and uptake of weeds in rainfed toria. The growth and yield

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attributing characters of rainfed toria improved significantly with this treatment which recorded the highest seed (755.67 kg/ha) and stover (1750.18 kg/ha) yields. Oil content, oil yield, N, P and K content and uptake also increased with W2. NM interacted significantly with WM in respect of seed and stover yields of toria. The combination of N2W2 was found to be superior with 1038.28 kg/ha and 2217.17 kg/ha seed and stover yield. The treatment combination N2W2 resulted in higher gross return (Rs. 67,082.69 /ha), net return (Rs. 43,379.69 /ha) and the benefit: cost ratio (1.83).

Studies on potato crop as affected by planting date and nutrient management

Rajibul Hoque Mullah

A field experiment entitled —Studies on potato crop as affected by planting date and nutrient management was conducted during the *rabi* season of 2018-19 at the ICR farm of Assam Agricultural University, Jorhat, with a view to study the growth and productivity of potato crop as influenced by planting date and nutrient management. The experiment was laid out in a randomized block design (factorial) with three replications. The treatments consisted of four dates of planting *viz.*, November 15(D1), November 25(D2), December 5(D3), December 15(D4) and three nutrient management treatments *viz.*, recommended N-P₂O₅-K₂O dose (120-100-100 kg/ha)[N1], 2/3rd of recommended N through chemical fertilizer + 1/3rd of recommended N through organic source (vermicompost)[N2], 3/4th of recommended N through chemical fertilizer + 1/4th of recommended N through organic source (vermicompost)[N3]. (Recommended P & K was applied through chemical fertilizer after adjusting with organic source). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.1), medium in organic carbon (0.68%), available N (265.40 kg/ha), P₂O₅ (25.37 kg/ha) and K₂O (169.82 kg/ha).

The results revealed that the growth and yield attributing characters and N, P and K uptake by the potato crop were significantly higher with the planting on D1 (November 15) as compared to that in other dates of planting. Planting on D1 (November 15) produced the highest number of tubers per plant (10.34) which was significantly higher than that in D2 followed by D3 and D4. Tuber yield per plant was highest (196.17g) on D1 (November 15) as compared to that in other dates of planting. Planting on D1 (November 15) produced the highest tuber yield (182.67 q/ha) which was significantly higher than that in D2 followed by D3 and D4. The highest N, P and K uptake was found with the planting on D1 (November 15). Higher monetary return as well as B: C ratio was realized with the planting on D1 (November 15) as compared to that in other dates of planting.

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The highest plant height, number of leaves/plant, leaf area index, dry matter accumulation were recorded with the nutrient management treatment N2 (2/3rd of recommended N through chemical fertilizer + 1/3rd of recommended N through vermicompost) as compared to that in other treatments. Nutrient management treatment N2 significantly increased the number of tubers per plant (9.22), tuber yield per plant (181.27 g) and total tuber yield (168.45 q/ha) as compared to that in other treatments. Nutrient management treatment N2 significantly increased the N, P and K content and uptake. Higher monetary return as well as higher B: C ratio was recorded with the treatment of N2 as compared to that in other treatments.

Response of rainfed late sown toria in rice fallows as influenced by application of sulphur and boron and sulphur

Rekhankona Pegu

During the *rabi* seasons of 2018-19 and 2019-20, a field experiment entitled “Response of rainfed late-sown *toria* in rice fallows as influenced by application of sulphur and boron” was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat with a view to study the effect of sulphur and boron on growth, yield, quality of *toria* and the nutrient uptake by crop and its availability in soil. The *toria* crop variety used for investigation was Jeuti (JT-90-1). The experiment comprised of 5 levels of sulphur *viz.*, S0 : 0 kg S/ha, S1 : 10 kg S/ha, S2 : 20 kg S/ha, S3: 30 kg S/ha and S4 : 40 kg S/ha through gypsum and 3 levels of boron *viz.*, B0 : 0 kg B/ha, B1 : 1 kg B/ha and B2 : 2 kg B/ha through borax was laid out in a factorial randomized block design (RBD), with three replications. The soils of the experimental site was sandy loam in texture, acidic in reaction (pH 5.29 and 5.3), medium in organic carbon (0.53 and 0.52%), available N (313.6 and 325.55 kg/ha) and available K₂O (136.55 and 138.39 kg/ha) and low in available P₂O₅ (18.87 and 20.23 kg/ha), available S (15.59 and 19.15 kg/ha) and available B (0.215 and 0.243 mg/kg). Experimental findings revealed that levels of sulphur influenced growth parameters, yield attributing characters, seed and stover yields, oil content, oil yield, uptake of N, P, K, S and B by *toria* crop in both the years. Application of 30 kg S/ha (S3) gave significantly higher values in almost all the characters under study. The highest seed (979.97 kg/ha in 2018-19 and 928.33 kg/ha in 2019-20) and stover yields (2181.77 kg/ha in 2018-19 and 2052.89 kg/ha in 2019-20) were obtained by application of 30 kg S/ha (S3). As regard to oil content, oil yield, N, P, K, S and B content and uptake, the values were significantly higher with 30 kg S/ha. Available N, P, K, S and B content in soil after harvest of the crop were non-significant in both the years. The highest net return (₹ 36142.05 in 2018-19 and ₹ 32785.45 in 2019-20) and B-C ratio (2.31 in 2018-19 and 2.19 in 2019-20) were obtained when 30 kg S/ha was applied. Among the levels of boron, 2 kg B/ha (B2)

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proved superior in terms of growth parameters, yield attributing characters, seed and stover yield, oil content, oil yield, uptake of N, P, K, S and B by *toria* crop in both the years. Significantly higher seed (846.37kg/ha in 2018-19 and 807.15 kg/ha in 2019-20) and stover yields (1881.52 kg/ha in 2018-19 and 1812.47 kg/ha in 2019-20) were obtained in 2 kg B/ha (B2) which was statistically at par with 1 kg B/ha (B1) for seed (830.78 kg/ha in 2018-19 and 800.95 kg/ha in 2019-20) and for stover yields (1852.44 kg/ha in 2018-19 and 1798.67 kg/ha in 2019-20). In regards to oil content, oil yield, N, P, S and B content and uptake, the values were significantly higher with 2 kg boron/ha. No treatment differences were observed in respect of available N, P, K, S and B content in soil after harvest of the crop for two years of study. The highest net return (₹ 34444.70 in 2018-19 and ₹ 32505.75 in 2019-20) and B-C ratio (2.76 in 2018-19 and 2.66 in 2019-20) were obtained due to application of 1 kg B/ha.

The highest interaction effect was recorded under combined application of 30 kg S and 2 kg B/ha treatment (S3B2) for both the years in respect of number of seeds per siliqua, seed yield (1035.77 kg/ha in 2018-19 and 986.36 kg/ha in 2019-20), stover yield (2276.02 kg/ha in 2018-19 and 2123.00 kg/ha in 2019-20), oil content (39.03% in 2018-19 and 38.36% in 2019-20), oil yield (404.11 kg/ha in 2018-19 and 367.45 kg/ha in 2019-20), uptake of N, P, S and B by seed, stover and total uptake by crop over rest of the treatment combinations. From the economic analysis, it has been found that the highest net returns (₹ 37469.05 in 2018-19 and ₹ 34257.40 in 2019-20) were recorded when 30 kg S/ha was applied in combination with 2 kg B/ha (S3B2).Whereas, the B-C ratio (2.30 in 2018-19 and 2.17 in 2019-20) were the highest in S3B1 (30 kg S and 1 kg B/ha).

Effect of irrigation schedule and sulphur fertilization on productivity of Indian mustard (*Brassica juncea* L.)

Shantonu Paul

An experiment entitled “Effect of irrigation schedule and sulphur fertilization on productivity of Indian mustard (*Brassica juncea* L.)” was carried out during *rabi* season of 2019-20, at the Instructional-cum-Research Farm of the Assam Agricultural University, Jorhat to find out the appropriate irrigation schedule and sulphur requirement of Indian mustard. The treatments comprised of six irrigation schedules *viz.*, I0- Rainfed, I1- Irrigation at 25-30 DAS, I2- Irrigation at Flowering (F), I3 - Irrigation at 25-30 DAS + F, I4 - Irrigation at 25-30 DAS + Siliquae formation (SF) and I5- Irrigation at 25-30 DAS + F + SF and three levels of sulphur fertilization *viz.*, S0 - No application (Control), S1 - 20kg ha⁻¹ and S2 - 40 kg ha⁻¹. The experiment was laid out in a split-plot design with irrigation schedules in main plot and levels of sulphur in sub plots and each treatment was replicated thrice. The soils of the experimental site was sandy loam in texture, acidic in reaction (pH- 5.45), medium in organic carbon (0.59%), available N (282.24 kg ha⁻¹), and available K₂O (184.60 kg ha⁻¹) and low in available P₂O₅ (18.75 kg ha⁻¹) and available S (15.2 kg ha⁻¹). The mustard var. NRCHB-101 was sown on 13.11.2019 and harvested on 22.02.2020. During the crop period, total rainfall received was 36.4 mm against the total evaporation of 123.7 mm, resulting in deficit of rainfall by 87.3mm.

The results revealed that three irrigations at 25-30 DAS + F + SF (I5) and two irrigations either at 25-30 DAS + F (I3) or at 25-30 DAS + siliquae formation (I4) produced statistically at par values in plant height at harvest, dry matter production at 50 DAS, 75 DAS, crop growth rate during 25-50 DAS and 50-75 DAS and branches plant⁻¹ of Indian mustard over the treatments with one irrigation and rainfed. The yield attributes *viz.*, number of siliquae plant⁻¹, length of siliqua and number of seeds siliqua⁻¹ as well as seed, stover and oil yields with lower harvest index due to the said irrigation schedules were also at par and significantly higher over rest of the treatments. They produced significantly higher oil yields with higher oil content over other treatments.

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The irrigation schedule I5 resulted in higher evapo-transpiration and total water use followed by I3 and I4, but crop and field water use efficiencies were markedly lowest under three irrigations at 25-30 DAS + F + SF (I5). The per cent content of N, protein, P, K and S in both seed and stover (except K content in stover) due to I5, I3 and I4 were at par and significantly higher over other treatments. But, the uptake of N by seed and stover and the total uptake was significantly higher under I5 over I3 and I4, the latter two being at par but significantly higher over other irrigation regimes. While, the uptake of P, K and S by both seed and stover as well as their total uptake (except total P and K uptake) due to I5 and I3 were at par and significantly higher over other treatments. However, different irrigation schedules did not show any impact on weed density and dry matter and content and uptake of N, P, K and S by weeds. The soil organic carbon content and pH and N, P₂O₅, K₂O and S status of soil after the crop harvest were also remained unaffected by irrigation schedules. Economic analysis revealed that the cost of cultivation, gross and net return increased with increasing levels of irrigation and thus, the highest values were recorded under I5. But, the B/C ratios due to I5 followed by I3 and I4 were closure to each other and considerably higher over other treatments.

The highest plant height at 60 DAS and at harvest, dry matter accumulation at 50 DAS, 75 DAS, crop growth rate during 25-50 DAS, 50-75 DAS and 75-harvest and number of branches plant⁻¹ were recorded under 40 kg S ha⁻¹ which were at par with 20 kg S ha⁻¹ and significantly higher over control. Similar trend of results was also recorded on yield attributes *viz.*, siliquae plant⁻¹, length of siliqua and seeds siliqua⁻¹ as well as seed and stover yields, seed oil content and oil yield, in addition to content and uptake of nutrients N, P, K and S by seed and stover. The evapotranspiration and total water use though did not show much variations comparatively higher crop and field water use efficiencies were recorded with 40 kg S ha⁻¹ and 20 kg S ha⁻¹ over the control. However, different levels of S did not influence weed density, dry weight and content (except S content by weed at 60 DAS, which has no impact on its uptake) and uptake of nutrients N, P, K and S by weeds. The soil organic carbon, pH and N, P₂O₅, K₂O and S status of soil after the crop harvest were also not influenced by different levels of S application. Though, the cost of cultivation increased with increasing levels of S, the gross and net return also increased due to 40 kg S ha⁻¹ followed by 20 kg S ha⁻¹ with higher but closure B/C ratios.

Nutrient management in rapeseed through organic sources

Sonam Lhamu

An experiment on “**Nutrient management in rapeseed through organic sources**” was carried out in the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat to study the effect of different organic sources of nutrients on growth and yield of rapeseed during the *rabi* season of 2018-19. The treatments consisted of eleven levels of organic sources of nutrients *viz.*, T1 – FYM @ 10 t/ha, T2 – Vermicompost @ 5 t/ha, T3 – Poultry Manure @ 5 t/ha, T4 – FYM @ 5 t/ha + vermicompost @ 2.5 t/ha, T5 – FYM @ 5 t/ha + poultry manure @ 2.5 t/ha, T6 – Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha, T7 – FYM @ 5 t/ha + vermicompost @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T8 – FYM @ 5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T9 – Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T10 – FYM @ 5 t/ha + vermicompost @ 1.25 t/ha + poultry manure @ 1.25 t/ha + mustard oil cake @ 1 t/ha including one T0 – Control. The treatments were laid out in a randomized block design with three replications. The soil of the experimental site was sandy loam in texture, with bulk density 1.48 g/cm³, field capacity 24.45%, PWP 11.20%, water holding capacity 35.35%, organic carbon 0.53%, acidic in reaction (pH-5.1) and medium in available nitrogen (274.20 kg/ha), phosphorus (26.95 kg/ha) and potassium (192.00 kg/ha). A *toria* variety TS-67 was sown following all recommended practices of the crop.

Results revealed that the growth parameters *viz.*, plant height and dry weight of plants recorded at 30 DAS, 60 DAS and at harvest, plant population per unit area and number of primary, secondary as well as total branches per plant, the yield attributes *viz.*, number of siliquae/plant, seeds/silqua and seed and stover yield of rapeseed were significantly higher with the application of vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha followed by FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha over most of the other organic sources of nutrients and control. The increase in seed yield due to the said treatments were 330.7% and 307.2%, respectively over the control and on an average 45.5% and 37.5%, respectively over

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other organic sources of nutrients. The oil yield due to the said treatments was also significantly higher by 346.2% and 324.6%, respectively over the control. Significantly higher N, P and K contents and their uptake by both seed and stover of rapeseed under the said treatments were recorded over other organic sources of nutrients and the control.

Application of FYM, poultry manure and vermicompost either alone or in combination with mustard oil cake significantly reduced the weed population/m² over other organic sources of nutrients and the control but increased the N, P and K contents in weeds over the control. However, due to the lower dry weight of weeds, significantly lower uptake of such nutrients by weeds were recorded with the treatment FYM 5 t/ha + vermicompost 2.5 t/ha + mustard oil cake 1t/ha (T7) followed by vermicompost 2.5 t/ha + poultry manure 2.5 t/ha (T6) compared to other organic sources of nutrients and control.

Application of organic nutrient sources also considerably increased the soil moisture contents recorded from two different depths viz., 0-20 cm and 20-40 cm of the profile at flowering and siliquae development stages over the control.

The highest cost of cultivation and gross return was recorded with the treatment vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (T9) followed by the treatment FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (T8). The highest B: C ratio (3.600) was recorded with the treatment FYM 10 t/ha (T1), but the highest additional net profit of Rs. 39180 was recorded under FYM 5 t/ha + poultry manure 2.5 t/ha (T5) over the control (T0).

Performance of direct seeded sali rice under two different crop establishment methods and weed management practices

Vigneshwaran M

A field experiment entitled “Performance of direct seeded sali rice under two different crop establishment methods and weed management practices” was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the sali season of 2018-19 with a view to study the growth and yield behavior of direct seeded sali rice under two different crop establishment methods and to find out the appropriate weed management practices for direct seeded sali rice. The experiment was laid out in a factorial RBD with three replications. The treatments consisted of two methods of sowing i.e., dry seeding (M1) and wet seeding (M2) and seven different weed management practices viz., two hand weeding at 20 & 40 DAS (W1), pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha (W2), pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS (W3), pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha (W4), pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS (W5), weed free check (W6) and weedy check (W7). The experimental field was infested with different types of grasses viz., *Panicum repens*, *Leersia hexandra* and *Eragrostis unioides*, sedges viz., *Cyperus rotundus* L., *Fimbristylis littoralis*, and broad leaved weeds viz., *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Ludwigia decurrens* and *Acmella ciliate*. The method of sowing brought significant influences on weed density and weed dry weight in all the growth stages. The wet seeding proved statistically superior in regards to growth attributes i.e. number of tillers/m² and plant height at all growth stages compared to dry seeding. Similarly, wet seeding recorded significantly highest yield attributes i.e. number of panicles/m² (160.11), panicle length (26.32 cm), number of filled grains/panicle (118.83) of sali rice followed by dry seeding. The wet seeding also recorded significantly highest grain yield (31.27 q/ha) and straw yield (49.04 q/ha). Higher uptake of nitrogen, phosphorus and potassium in grain, straw and total uptake by sali rice and lower uptake by weeds were

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recorded in wet seeding. Among the different weed management practices, weed free plot recorded the lowest weed density and weed dry matter, highest weed control efficiency and highest weed control index at all growth stages as well as recorded the highest growth characters, yield attributes, grain yield and straw yield. Results indicated that apart from the weed free plot, pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS and pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS shown the lowest weed density, dry weight, highest WCI, highest WCE at 45, 60 DAS and at harvest stage as well as it recorded the highest yield attributes, grain yield and straw yield. At 30 and 60 DAS, lowest uptake of nutrients by weeds were recorded in weed free check followed by two hand weedings at 20 & 40 DAS. At harvest, lowest uptake by weeds were recorded in weed free check followed by pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS. Significantly higher uptake of nitrogen, phosphorus and potassium in grain, straw and total uptake by Sali rice was recorded in weed free check followed by pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS and pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS. The treatment combination of wet seeding (M2) combined with the weed free check recorded the highest grain yield (41.33 q/ha) and straw yield (59.33 q/ha) and it was statistically at par with the treatment combination of wet seeding along with preemergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS. An economic analysis showed that treatment combination of wet seeding combined with pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS (M2W3) recorded the highest net return (Rs. 63,089/ha) and benefit cost ratio (1.76).

Effects of Manganese on some rice genotypes in acid soil of Assam

Aisina Yomso

Rice (*Oryza sativa* L.) is the staple food for about 50% of the world's population and particularly more important in an agricultural country like India. The extent of acid soils in Northeastern hill (NEH) region is about 21 million ha (Mha) including Assam (4.7 Mha) where the concentration of Mn is 2-20 ppm. Manganese, being one of the micronutrients plays vital role in physiology and biochemistry of crop plants modulating growth and development depending upon its concentration in plants. So, a pot experiment was carried out (January 2019-June 2019) to study the effects of Mn (0, 10, 20, 30 ppm Mn in the form of MnSO₄.H₂O as foliar spray (misting) at vegetative stage i.e.70 days after sowing) on physio-biochemical parameters, and thereby to evaluate the Manganese use efficiency (MnUE) of ten rice genotypes (Kanaklata, Mulagabharu, Kapilee, Disang, Kolong, Joymoti, Jyoti Prasad, Luit, Lachit and Chilarai) cultivated in Assam. The relationships amongst the yield and yield attributing parameters of the rice genotypes under Mn treatments were also studied. Results obtained during the investigation revealed the variations in responses of rice crop genotypes to doses of Mn in terms of physiological, biochemical and yield parameters of the crop. The lower dose of Mn (10ppm) as MnSO₄.H₂O increased significantly the SLW (4.72-11.12%), plant height (3.56-35.16%), shoot biomass (7.77-21.64%), tiller numbers (2.89-22.67%), total chlorophyll contents in leaf tissues (10.29-27.17%), NR activity (13.62-35.39%), carbohydrate contents (3.72-9.04%), cell membrane stability (29.70-37.06%), panicle length (16.29-37.46%), panicle weight (10.54-19.50%), panicle number per plant (4.54-13.63%), number of seeds per panicle (18.38-36.48%), test weight (7.21-29.15%), high density (HD) grains (5.59-30.45%), economic yield (14.40-28.03%), biological yield (32.58-47.70%), harvest index (3.2-7.90%), lower intercellular Mn (16.66-75.67%), lower exchangeable Mn (13.91-56.98%), and MnUE (0.021-0.160%) was increased upto 20ppm Mn as MnSO₄.H₂O. However, the highest dose of Mn (30ppm) as MnSO₄.H₂O affected adversely all the physiological attributes in the study. Among the ten genotypes, Kanaklata performed the

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best followed by Chilarai in the experiment. The physiological characteristics supporting the holistic performance of the variety Kanaklata are higher SLW (99.92 cm), Shoot biomass (29.03 g), tiller numbers (5.95 nos.), total chlorophyll (1.92 mg/gf.w.), carbohydrate content (9.05mg/gd.w.), higher cell membrane stability (29.804%), lower intercellular ions (17.85 ppm), lower exchangeable ions (13.91 ppm), 7 panicle weight (5.99 g), panicle number per plant (6.87 nos.), number of seeds per panicle (70.67 nos.), economic yield (13.85 g/plant), biological yield (46.09 g/plant) and harvest index (47.40%).

The correlation studies revealed that seed yield in Kanaklata was correlated positively with panicle length (0.999**), panicle weight (1.000**), panicle number per plant (0.990**), seed per panicle (0.972*), test weight (0.992**), HD grains (0.966**) and HI 0.981**). In case of Manganese treatments, 10ppm Mn as MnSO₄H₂O was correlated positively with panicle weight (0.823**), panicle number per plant (0.975**), HD grains (0.704*), HI (0.951**) and MnUE (0.719*). In case of 20ppm Mn as MnSO₄H₂O was correlated positively with panicle number per plant (0.959**), HI (0.928**), and MnUE (0.786**). However for the treatment 30ppm Mn (as MnSO₄H₂O), economic yield was correlated positively with panicle number per plant (0.913**), harvest index (0.902**), and manganese use efficiency (0.866**) only. It is concluded that yield and yield attributes including MnUE are influenced by Mn upto a certain limit (i.e.20ppm Mn) in rice crop. In the study, the rice genotype Kanaklata was found the best in terms of all physiological and biochemical attributes including MnUE, which was dose responsive to Mn misted on foliage at maximum tillering to heading stage (70 days after sowing).

Regulation of vase life and quality of gerbera (*Gerbera jamesonii*) by postharvest chemical application

Anirban Saikia

Scientific approaches in the field of modern floriculture have been progressed commercially due to intense efforts made by various researchers. The increasing business potential of this field inspired many government and non-government organizations to review the prospects of Indian floriculture both in domestic and export market. Production and subsequent marketing of cut flowers are the most important aspects associated with this commercial approach. Gerbera (*Gerbera jamesonii*) is an important commercial cut flower grown throughout the world. Floral characteristics of this flower, such as colour, floral diameter, stem length, and vigour make it a very important commercially potential cut flower. However, very short vase life of gerbera is the major constraint and therefore the improvement of vase life is an urgent research need. To address the problem, an investigation was carried out in the department of Crop Physiology, AAU, Jorhat-13 to evaluate the effects of different pulsing treatments and holding solutions on vase life of gerbera. In one experiment, after harvest gerbera was pulsed with different concentrations of salicylic acid (50,100,150 ppm), benzyl adenine (50,100,150 ppm) and nano-silver (5,10,15 ppm) for 1 hour. It was observed that moisture content, fresh and dry weights, amount of water uptake, transpirational water loss, scape bending, chlorophyll content, carbohydrate content and vase life were affected positively by the pulsing treatments. Among all the pulsing treatments, 10 ppm nano-silver was found to be the best in enhancing the vase life and quality of the cut flower. In another experiment, cut gerbera flowers were treated with different concentrations of salicylic acid (50, 100, 150 ppm), benzyl adenine (50, 100, 150 ppm) combined with 10 ppm nano-silver as holding solutions. Recorded data revealed that different physiological characters such as moisture content, fresh and dry weights, amount of water uptake, transpirational water loss, scape bending, chlorophyll content, carbohydrate content and vase life of the cut flower were altered positively by the holding solutions. Among the different treatments, salicylic acid 100 ppm + 10 ppm

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NS+4% sucrose exhibited the longest vase life (13.30 days) of cut gerbera flower, which was found to be the best. Results of the two experiments confirmed that holding treatments had more positive effects compared to the pulsing agents with respect to quality and vase life.

Tolerance of summer greengram genotypes against water-logging condition

Bhaskar Saikia

A study was carried out in the Department of Crop Physiology and Stress Physiology premises, F.A., Assam Agricultural University to evaluate the physiological performance of some greengram genotypes as influenced by waterlogging condition of varying duration imposed at different stages of growth. Initially, a total of forty genotypes of greengram were evaluated for their ability to germinate and seedling growth under simulated waterlogged situation in petri-plates. Out of these genotypes, five were selected for further evaluation; they are NVL-855, KM 2355, AKM 12-28, Pratap and Sadiya Local. These five genotypes were further evaluated for their germination, seedling growth and final yield by growing them in pots filled with soil and FYM where inorganic nutrients were also supplied as per recommendation for greengram. The pots were kept under natural condition. Waterlogging conditions were created in the pots for specified length of time at vegetative and reproductive stages of the crop.

When the waterlogging condition was imposed during vegetative and reproductive stage, the growth and development of the genotypes were found to be affected adversely. Longer the period of waterlogging, more severe was the affect on growth and development of the plant. Genotypes were found to show similar response to the waterlogging when plants were exposed to waterlogging at vegetative as well as reproductive stage. However, the impact of waterlogging introduced at reproductive stage was found to be more severe on the yield. The values for the traits namely leaf chlorophyll, leaf area, plant height, nitrate reductase activity, seeds/pod, pods/plant, root length, number of root nodules/plant, test weight, total biomass of the plant and harvest index were found to decline under waterlogged condition. Whereas, lipid peroxidase and superoxide dismutase activity showed higher values under waterlogged condition.

The performance of the genotype namely Sadiya Local was found to be the best from the point of view of seed yield as influenced by waterlogging. The better performance of this genotype appeared to be related to higher values for the traits namely

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germination percentage, leaf chlorophyll, nitrate reductase activity, superoxide dismutase activity, number of pods/plant and harvest index.

The genotype Sadiya Local showed a decline of 29.82% only in terms of seed yield/plant when the plants were exposed to 12 days of waterlogging at vegetative stage and 38.59% when exposed to 12 days of waterlogging at reproductive stage. The harvest index value were lowered by 12.5% and 20.87% under the waterlogging stress introduced at the vegetative and reproductive stages respectively.

The results of the present study revealed that waterlogging has detrimental effects on the growth of summer greengram at all stages of crop growth. But the effects of waterlogging was more detrimental when imposed at reproductive stage compared to early seedling stage, since, it was found to result in a reduction of the harvest index by 28-30% in comparison to 12-15% that resulted from waterlogging stress imposed at early vegetative stage. Among the five genotypes studied, Sadiya Local and AKM 12-28 can be considered to be tolerant to waterlogging followed by Pratap.

Effect of jatropha leaf extract and seed oil on okra (*Abelmoschus esculentus* L.)

Mr. Jeffrey Malsawmzuala

Jatropha curcas is a woody shrub that is projected to be one of the best sources for bio-diesel as it can be grown in diverse climatic conditions. However, it is also known to exhibit allelopathic and phytotoxic effects to nearby plants. The seed oil is known to be a potent source for biopesticide formulations due to its toxicity but its possible allelopathic effects on the recipient crop has not been properly explored. A series of experiments were conducted during July 2018 to October 2018 to test the possible allelopathic effects of jatropha leaf extract and seed oil on okra (*Abelmoschus esculentus* L.). In two separate experiments, aqueous extracts of jatropha leaf at 2.5%, 5.0%, 10.0% and 15.0% (W/V) concentrations and jatropha seed oil at 1.0%, 2.5%, 5.0%, 7.5% and 10.0% (V/V) concentrations were bio-assayed against germination and seedling growth of okra. In both the cases, germination percentage, germination index, root and shoot length, fresh and dry weights of root and shoot and vigour index were found to be significantly reduced by both the leaf extract and seed oil. Seed oil exhibited higher inhibitory effects than aqueous leaf extract. Two other separate pot culture experiments were conducted with both aqueous leaf extract and seed oil of jatropha at the same range of concentrations as employed in the above mentioned experiments to evaluate growth and yield of okra. In both the cases, significant reduction in plant height, leaf number, leaf area, root volume, dry weights of root and shoot, total leaf chlorophyll content, fresh and dry weights of pods were recorded. Different growth parameters of the crop were found to respond differentially to aqueous leaf extract and seed oil of jatropha. Higher reduction of pod fresh weight (yield) was recorded in aqueous leaf extract (25.37% inhibition over control) in comparison to seed oil (12.18% inhibition over control) at their highest applied concentrations. All inhibitory effects of both aqueous leaf extract and seed oil were found to be concentration dependent. In conclusion, seed oil was found to be more inhibitory in laboratory bioassay while final yield of okra was reduced more by the aqueous leaf extract of jatropha.

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Physiological effect of high temperature stress on some *sali* rice genotypes

Kabita Saikia

Plants are sensitive to high temperature during critical stages such as flowering and seed development. With the increase in daily maximum temperature averaged over flowering period above about 36⁰C, rice yield generally declined because of spikelet sterility induced by high temperatures. Rice crop exposure to the spells of high temperature results in grain yield diminish due to spikelet sterility, reduction in source and sink activities, assimilate partitioning. Identifying genotypic variation through field screening for high temperature tolerance is required for initiating successful breeding programme to develop rice cultivars capable of higher yields under projected climatic change conditions. In view of the importance of high temperature tolerance in rice, an experiment was carried out to study “Physiological effect of high temperature stress on some *sali* rice genotypes” during kharif, 2017 at Regional Agricultural Research Station, AAU, Titabarin split-plot design with conditions (control and high temperature) as main-plot treatment and 33 rice genotypes as sub-plot treatment including N22 as heat tolerant check variety. Heat stress was imposed in the field immediately after PI stage by enclosing the field grown crop with a make shift locally fabricated polythene tent (<92% transmittance), duly supported by bomboo sticks. The polythene cover was removed at the time of harvest. Enclosing the field crop during reproductive phase with polythene sheet had resulted in significant increase in maximum temperature. Another set of same varieties was grown in ambient condition. The increase in maximum temperature was 1-3.5⁰C over the ambient temperature and minimum temperature had increased by 0.5-1.5⁰C.

Elevated temperature had no significant effect on mean days to flowering and days to maturity for all the genotypes. However, significant differences were observed between varieties. Among the genotypes IET 26774, IET 26776, IET 26778, 175-2K, S-458, N22 were less affected in morphological traits under high temperature stress. The number of filled grains per panicle is an important yield determining character which was significantly affected by high temperature stress. The sterility percentage were

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minimum (2-7%) for 175-2K, S-458, IET 26778 due to heat stress. Yield attributes such as panicle weight, harvest index, test weight, panicle number m^{-2} , grain number panicle⁻¹, spikelet number panicle⁻¹ and grain yield were significantly reduced under high temperature stress. Dry matter heat susceptibility index(DMHSI) varied between a minimum of 6.76 (N22) to a maximum of 41.52 (IET 26777). IET 26757, IET 26759, IET26760, IET 26778, IET 26776, 175-2K, S-458 and N22 are the entries with DMHSI value <15 indicating relative tolerance to heat stress. The grain yield heat susceptibility index(GYHSI) was lowest 11.24 in 175-2K. Amongst the remaining varieties IET 26757, IET 26778, S-458 and N22 performed relatively better with < 15 GYHSI. Exposure to high temperature caused marked reduction in 1000 grain weight. The interaction between genotypes and treatment was found to be highly significant. Minimum reduction in test wt. were observed in IET 26776, 175-2K and S-458 (between 7-9%) which were less than the check var. N22(11%). The values for the traits namely leaf chlorophyll, starch content, nitrate reductase activity were found to decline under high temperature stress condition. Whereas, nitrogen content in leaf showed higher values under high temperature stress condition. The desirable traits of maintenance of low profile of the pace of reduction of chlorophyll content, starch content, NR activity, leaf N content of the varieties viz. IET 26766, IET 26771, IET 26774, IET 26775, 175-2K, S-458 and N22 during high temperature stress condition. The varieties 175-2K, S-458, IET 26778 reflected the inherent capabilities to tolerate high temperature stress with less reduction in grain yield and yield components, grain sterility percentage and other biochemical parameters, could be used as a donor in various breeding programmes also could be adopted in farmer's field to increase the economic yield.

Physiological basis of aluminium tolerance in rice (*Oryza sativa* L.)

Ms. Ph. Fakiha

The investigation was carried out to evaluate the performance of some rice (*Oryza sativa* L.) genotypes under different levels of aluminium during November 2017 to December 2018 in the Stress Physiology Laboratory, Department of Crop Physiology, Assam Agricultural University, Jorhat-13. In first experiment, 149 rice genotypes collected from different North-Eastern States were screened for aluminium tolerance with two different aluminium levels of 60 μM Al and 100 μM Al using Yoshida solution along with a control. Out of 149 genotypes, seven genotypes *viz.*, Alubari Dhan, Dewri, Ayangleima, Marin Chatpi, Rene Nepung Aam, Rongabetguti and Rajamani were found to be promising in terms of Al tolerance and these were further evaluated in second experiment for mechanism of responses of Al. In the second experiment the screened rice genotypes were grown in pots in three different levels of Al *viz.*, 100 μM Al (T₁), 200 μM Al (T₂), and 300 μM Al (T₃) along with a control (T₀) to study the mechanism of the morpho-physiological and biochemical traits contributing to rice growth and development under higher levels of aluminium.

Results obtained during the investigation revealed that higher levels of Al significantly influenced on number of leaves, specific leaf weight, leaf area index, membrane stability index, total leaf chlorophyll content, in-vivo leaf nitrate reductase activity, SOD, root volume, root length, root dry weight, plant height and yield attributes in all the genotypes. However, among the seven genotypes Rajamani and Rene Nepung Aam showed less reduction in root length, photosynthetic rate and total chlorophyll. These two genotypes also showed the lowest per cent reduction in grain yield and yield attributes over control. This could be correlated with the increase in superoxide dismutase and proline content in the leaf with proportional decrement of MDA. The genotype Rajamani and Rene Nepung Aam accumulated less amount of aluminium in its root biomass as compared to other genotypes which indicates that this genotype has a better tolerance mechanism by excluding aluminium from the root system thereby contributing better growth and development. Considering the studied

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morpho-physiological, biochemical and yield related attributes, Rajamani and Rene Nepung Aam genotypes may be considered as the most promising genotypes among all seven genotypes under higher levels of AI in the present investigation.

Phenotyping of some cultivated and wild banana germplasm of NE India under rainfed and irrigated conditions of Assam

Nishita Pathak

Banana (*Musa* spp.) is a tropical fruit crop which belongs to the family 'Musaceae'. Banana is a mesophytic plant and requires heavy feeding of nutrients and soil moisture for good growth and development. The major effect of moisture shortage in banana is that it reduces the photosynthetic capacity of the banana plants as the crop sensitivity is reflected by reduced greenness of foliage. Under Assam situation, highest moisture deficit occurs during November to January. A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2019-2020. Fifteen germplasm of banana viz., Athiya, Savari, Jahaji, Digjowa, Ludum, Assamese Malbhog, Naga Malbhog, GobinTulchi, Banria, Agnisagar, Balha Kual, Nagaland-1, Nagaland-2, Arunachal Pradesh-1 and Arunachal Pradesh-2 were taken to assess the extent of variation in phenotypic characters and contribution of phenotypic traits on yield performance under rainfed and irrigated conditions. Various parameters were recorded at 7th, 8th and 9th months after planting. Moisture stress progressively reduced the values of relative leaf water content, chlorophyll content (a, b, total), specific leaf weight leaf area, total leaf production, functional leaves, stomatal conductance, root biomass, pseudostem height, pseudostem girth, fruit length, fruit circumference, weight of 2nd hand, number of hands per bunch, number of fingers per hand, weight of finger, volume of finger, shelf life, duration of fruit filling, pulp-peel ratio, bunch weight and fruit yield while the contents of proline in leaf tissue and lipid peroxidation increased under moisture deficit. The individual germplasm under irrigated condition showed better results as compared to that of rainfed condition. In our study, under both rainfed and irrigated conditions the germplasm Jahaji (36.24 kg/ha; 38.47 kg/ha) was found to be highest yielder followed by Athiya (34.15 kg/ha; 35.66 kg/ha) and Digjowa (31.78 kg/ha; 33.21 kg/ha) whereas the germplasm Arunachal Pradesh-1 (24.99 kg/ha; 26.54 kg/ha) was found to be the lowest performer in

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this regard. As compared to irrigated condition, under rainfed condition the reduction in values of various parameters in the germplasm Jahaji (G3) which was found to be superior in our study were observed *viz.*, RLWC (6.48 per cent), Chlorophyll 'a' (3.92 per cent), Chlorophyll 'b' (7.64 per cent), total chlorophyll (11.68 per cent), total leaf production (8.08 per cent), functional leaves (17.04 per cent), leaf area (10.70 per cent), root biomass (2.28 per cent), fruit length (8.10 per cent), fruit circumference (16.73 per cent), weight of second hand (27.62 per cent), number of hands per bunch (14.63 per cent), number of fingers per hand (10.13 per cent), volume of finger (36.24 per cent), weight of finger (1.43 per cent) and fruit yield (5.80 per cent). In the case of the lowest producer i.e. lowest yielder Arunachal Pradesh-1 (G14), the corresponding reductions under rainfed condition were 7.49 per cent RLWC, 7.59 per cent Chlorophyll 'a', 15.65 per cent Chlorophyll 'b', 18.89 per cent total chlorophyll, 5.47 per cent total leaf production, 20.84 per cent functional leaves, 15.66 per cent leaf area, 9.26 per cent root biomass, 29.74 per cent fruit length, 15.34 per cent fruit circumference, 58.36 per cent weight of second hand, 28.57 per cent number of hands per bunch, 10.03 per cent number of fingers per hand, 41.54 per cent volume of finger, 2.95 per cent weight of finger and 5.84 per cent fruit yield. From the correlation study, it was found that the banana yield was positively and significantly correlated with the parameters *viz.*, number of fingers per hand ($r = 0.9898$), weight of 2nd hand ($r = 0.9847$), weight of finger ($r = 0.9834$), total leaf production ($r = 0.9780$), fruit length ($r = 0.9774$) and leaf area ($r = 0.9470$).

In our study, the germplasm Jahaji (G3) which was found to be superior from yield point of view both under rainfed and irrigated conditions also recorded higher values for these parameters *viz.*, RLWC, proline content, chlorophyll 'a', chlorophyll 'b', total leaf chlorophyll, total leaf production, number of functional leaves per plant, leaf area, root biomass, fruit length, fruit circumference, weight of second hand, number of hands per bunch, number of fingers per hand, volume of finger, weight of finger, bunch weight and fruit yield.

Physiological performance of lentil genotypes under late sown condition in rice fallow as influenced by rhizobacteria (*Pseudomonas fluorescens*)

Reshme Moirengjam

A field experiment of lentil grown under moisture stress was carried out in *rabi* season of 2018-19 in Instructional Cum Research (ICR) farm premises and Department of Crop Physiology of Assam Agricultural University. The main objectives of the study were to evaluate the performance of the lentil genotypes under late sown (delayed by 20 days beyond recommended date of sowing) condition as compared to the timely (recommended date) sown condition and to assess the influence of applied Rhizobacterium, *Pseudomonas fluorescens* on the physiological performance of these genotypes under the two situations, timely sown and late sown condition. The eight lentil genotypes were KLS 218, HUL 57, PL 406, DPL 62, DPL 15, Borpeta local, IPL 316 and IPL 81 under timely sown and late sown condition. These eight genotypes were grown in field condition under recommended sowing date (timely sowing) on 15th November 2018 and late sowing on 5th December 2018 treated with liquid culture of rhizobacterium (*Pseudomonas fluorescens*) collected from Department of Plant Pathology, Jorhat that had a uniform population of 2×10^9 CFU/ml which was initially inoculated as seed treatment (2% of *Pseudomonas fluorescens*) followed by foliar spray at 30 DAS (2% of *Pseudomonas fluorescens*) under both timely sowing and late sowing condition; along with vermicompost and inorganic fertilizers supplied as per recommended for lentil.

During the initial crop growth stages under recommended date of sowing the soil moisture content was quite optimum (20.90% in mid-October to mid-November) but it gradually declined (16.07% in December and 14.36% in January) due to lack of rainfall which reduced the values of the overall physiological, biochemical and yield attributing traits of late sown lentil when compared to timely sown condition with as well as without the application of *Pseudomonas*.

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Promotive effect of the treatment with rhizobacteria *Pseudomonas fluorescens* (seed inoculations as well as foliar spray) could be seen on the physiological performance of the lentil genotypes under both timely and late sown condition.

Plants under late sown condition showed reduction in the values of the parameters like plant height, above ground biomass, root biomass, whole plant biomass, root nodule count, total chlorophyll content, membrane stability index, *in-vivo* nitrate reductase activity, number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield and harvest index whereas an increment in parameters like root volume, root surface area, lipid peroxidation, super oxide dismutase activity were observed. When the soil moisture content depleted during the late sown phase, plants responded with an increase in root growth parameters like root volume, root surface area for the purpose of efficient moisture extraction from deeper soil layers in order to supply water for maintenance of cellular functioning, cellular turgidity, structural stability and supply of various minerals and assimilates to all parts of the plant.

The genotypes DPL 62 and DPL 15 showed higher values in terms of plant characteristics like plant height, above ground biomass, whole plant biomass, root nodule count, root volume, root surface area, total chlorophyll content, membrane stability index, *in-vivo* nitrate reductase activity, SOD activity, pods per plant, test weight and low lipid peroxidation which contributed in producing high seed yield, stover yield and harvest index.

From the yield analysis, under timely sown condition genotype DPL 62 showed the highest seed yield of 9.92q/ha under no *Pseudomonas* and 10.94q/ha in *Pseudomonas* treated condition. In case of late sown situation the seed yield was found to be lesser but DPL 62 showed the highest yield of 9.59q/ha under no *Pseudomonas* and 10.55q/ha in *Pseudomonas* treated condition. Likewise for the parameter harvest index in timely sown condition DPL 62 showed the highest value of 34.49% under no *Pseudomonas* and 36.20% under *Pseudomonas* treatment. In case of late sown condition there was a decline in the harvest index but genotype DPL 62 showed the highest harvest index of 34.30% under no *Pseudomonas* and 35.99% under *Pseudomonas* treatment.

Other genotypes like KLS 218, DPL 15 and HUL 57 also responded well with a high yield upon application of rhizobacteria (*Pseudomonas fluorescens*) treatment.

A positive and significant correlation between above ground biomass and seed yield ($r = 0.198$ for timely sown and $r = 0.226$ for late sown); total chlorophyll content and seed yield ($r = 0.869$ for timely sown and $r = 0.890$ for late sown); pod number and seed yield ($r = 0.612$ for timely sown and $r = 0.646$ for late sown); test weight and seed yield ($r = 0.556$ for timely sown and $r = 0.500$ for late sown) were contributory factors of yield production in lentil. The results of the present study revealed that soil moisture deficit during early vegetative stage arising out of non-receipt of rainfall as well as delayed date of sowing were found to have detrimental effects on growth of plants at all stages

that led to reduction in seed yield by adversely affecting the physiological performance and harvest index however the inoculation of rhizobacteria (*Pseudomonas fluorescens*) as seed and foliar spray helped in mitigating the negative effects faced by plants in late sowing as compared to timely sowing. Late sowing had resulted in 5.2% and 2% reduction on an average in seed yield and harvest index respectively when compared to timely sowing. The genotype DPL 62 showed a reduction of 3% only in seed yield and 0.65% reduction in harvest index in late sowing as compared to timely sowing. Under timely sown condition the genotype DPL 62 showed the highest benefit cost ratio (2.14 under no *Pseudomonas* and 2.03 under *Pseudomonas* treatment) and the lowest benefit cost ratio was observed in the genotype Borpeta local (1.28 under no *Pseudomonas* and 1.17 under *Pseudomonas* treatment) and IPL 81 (1.17 under *Pseudomonas* treatment). Similarly, in case of late sown condition genotype DPL 62 showed the highest benefit cost ratio (2.04 under no *Pseudomonas* and 1.93 under *Pseudomonas* treatment) and the lowest was observed in Borpeta local (1.20 under no *Pseudomonas* and 0.99 under *Pseudomonas* treatment).

Among the eight genotypes studied, genotype DPL 62 could maintain its performance under depleted soil moisture in late sown condition followed by DPL 15 and KLS 218.

Effects of some Organic Nutrients on Physiology of Scented Rice (*Oryza sativa* L.)

Stutipriya Hazarika

Rice is widely grown as staple food for half of the world's population. In the post independence period, the most important challenge in India has been to produce enough food for the growing population. Hence, high yielding varieties are being used with infusion of irrigation water, fertilizers, or pesticides. This combination of high yielding production technology has helped the country develop a food surplus as well as contributing to concerns of soil health, environmental pollution, pesticide toxicity, and sustainability of agricultural production. Scientist and policy planners are, therefore reassessing agricultural practices which relied more on biological inputs rather than heavy usage of chemical fertilizers and pesticides. Organic farming can provide quality food without adversely affecting the soil health and environment. India has tremendous potential to become a major exporter of organic rice in the international market. Assam is also known to be the centres of its origin along with wide range of rice cultivars. Among all cultivars, aromatic rice, more particularly joha group of this region enjoys the top position. The joha rice is known for its unique aroma, superfine kernel, good cooking qualities and excellent palatability.

It is now established that organic farming can improve the quality of scented rice. Assam can earn good revenue by promoting joha rice to the national and global markets as it fetches high premium price for its high standard quality traits. The information about the effects of the organic inputs on scented rice is very limited in Assam. Considering the importance of organic farming and to generate comprehensive scientific research data, the present investigation was conducted. The study was carried out on growth physiology, nutrients uptake pattern. Yield and quality parameters under the influence of organic nutrient scented on scented joha rice under Assam condition.

The eight treatment combinations of organic inputs were laid out in RBD with 3 replications. Organic nutrients combination were taken as treatment such as T₁. Enrich compost (5 t/ha) + Biofertilizer consortium as root dip (4kg/ha seedling), T₂. Green manure (2.5 t/ha) + azolla (20kg/ha) + Biofertilizer consortium (4kg/ha seedling) as root

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dip + Rock phosphate (17 kg/ha), T₃. Green manure(5t/ha)+Azolla(20kg/ha) +Biofertilizer consortium (4 kg/ha seedling) as root dip + Rock phosphate (17 kg/ha), T₄. Vermicompost (2.5t/ha)+ Azolla(20 kg/ha) +Biofertiliser consortium as root dip (4kg/ha seedling) +rock phosphate(17 kg/ha), T₅. Vermicompost(5t/ha)+ Azolla (20kg/ha)+Biofertilizer consortium(4 kg/ha seedling) as root dip +rock phosphate(17 kg/ha), T₆. Green manure (2.5t/ha)+ Vermicompost(2.5t/ha)+Consortium(4kg/ha seedling) as root dip 4+Rock phosphate (17kg/ha)+Azolla(20 kg/ha), T₇. Vermicompost(2.5t/ha)+ Neem cake (300kg/ha)+Half basal and half top dressed +Biofertilizer consortium(4kg/ha seedling) as root dip and T₈. Control.

The experiment was conducted at organic block of Regional Agricultural Research Station (RARS) in the kharif season of 2017 and 2018. The organic inputs under study was produced under strict organic guidelines of Assam Agricultural University, Jorhat. The seeds of Keteki joha was collected from organic block of RARS, Titabar, Assam. The plant protection measures also carried out by organic standards. In the control plot, no external organic inputs were added, may be treated as organic with native fertility and biological make up. Seed treatment will be carried out by soaking the seeds 12 hours in a solution of pseudomonas flourosence @ 10 g/litre of water/kg of seed. For both the years, dhaincha as green manure crops was grown using 50 kg ha⁻¹ in the month of May in separate plot till 60 days. After harvesting, it was weighed, chopped and incorporated as per treatments one week before transplanting of rice. Enriched compost was prepared by taking ordinary compost prime with microbial consortia @ 1%, mixed with 1% rock phosphate (17 kg per 100 kg compost and cure for 15-20 days. Enriched compost, vermicompost was applied one week before transplanting of rice . Before transplanting root dip treatment was carried out with bio fertilizer Consortium @ 10 g/kg of seed. Consortium is a specific formulation of Azospirillum, Azotobacter, Phosphorus solubilizing bacteria (PSB) and Rhizobium. Azolla was applied 7 days after transplanting of rice as per the treatment. After formation of a thick mat, the azolla was incorporated with soil.

The results revealed that application of different treatment significantly increased the plant height, tiller number hill⁻¹, flag leaf area in treatment T₆. The highest value recorded in case of the plant height , tiller no hill-1, flag leaf area in the treatment T₆ were 78.5 cm, 12.1, 35.33 cm². The different growth parameters significantly recorded highest CGR of (24.0 g/m²/day), RGR of (61.39 g/g/day), SLW of (8.56 g/dm²) , NAR of (48.4 mg/cm²/day) , LAI of (4.32), dry matter partitioning of (1320.06 g m⁻²) at treatment T₆. The biochemical parameters chlorophyll content (3.12 mg/g/f.wt) and nitrate reductase activity (2.80 u mole NO₂⁻ formed g⁻¹ f.w.hr⁻¹) which were significantly higher over all other organic inputs . The quality parameters TSP (8.13%) ,Starch (64.6%) ,TSS (0.95%) increased significantly in treatment T₆. The Nitrogen (54.05 kg/ha), Phosphorus (6.77 kg/ha) , Potassium (99.05 kg/ha) uptake by the plant were significantly increased in treatment T₆ compared to control. Application of T₆ exhibited the highest grain yield and yield attributing characters such as panicle m²,

1000 grain weight, grain per panicle over all other organic inputs applied. The highest yield of (38.05 q/ha) and yield attributing characters panicle m² of (304.3 m²), grain/panicle of (84.43) and 1000 grain weight of (23.62 g) were recorded in treatment T₆. The highest straw yield were recorded in the T₇ (73.97 q/ha) and the highest harvest index of (33.60 q/ha) were recorded in the treatment T₆. Though the cost of cultivation was highest in treatment T₁ due to high value of enriched compost and among different organic inputs, High benefit cost ratio was found to be highest in treatment T₆.

Impact of high temperature and carbon dioxide on plant growth and beneficial rhizospheric microbes of rice

Supriya Sarma Rajkhowa

The rise of CO₂ (600 μmol mol⁻¹ CO₂ by the middle of 21st century) and temperature (1.8 and 4.0 °C by the end of the present century) will effectively influence the productivity of crop plants. In the present investigation, the responses of local genotypes of rice were studied in Carbon dioxide Temperature Gradient Tunnel (CTGT), to simulate elevated CO₂ concentration and temperature. Similarly, response of beneficial rhizospheric microbes to elevated CO₂ and temperature were also studied. Six genotypes of rice were studied viz., Inglongkiri, Dehangi, Banglami, Sokinglong, Maibee and Bash under field condition and CTGTs. In CTGTs interactive treatments of CO₂ and temperature was induced at range of 390ppm+2°C (CTGT-I), 600 ppm+4°C (CTGT-II), 750ppm+6°C (CTGT-III) and in field condition as ambient. The results revealed that CTGT-II had a greater impact on various morpho-physiological parameters whereas CTGT-III showed a declining trend in maximum physiological and yield attributing characters indicating the deleterious effect of high temperature and CO₂. In CTGT-II some soil parameters viz., electrical conductivity, soil organic carbon and rhizospheric root carbon rate were recorded to increase while soil pH and microbial biomass nitrogen significantly decreased from ambient to CTGT-III. The microbial population rate increases with increased concentrations of CO₂ and temperature. For this study, experiment was conducted before treatments were induced i.e. initial and after the treatments were applied as final. The activity of the microbes raises in the final stage than the initial indicating the population growth of the microbes. Moreover, beneficial microbes *Trichoderma* spp. and *Pseudomonas fluorescens* also got increased with increasing CO₂ and temperature.

The genotypes Inglongkiri, Banglami and Dehangi showed higher values in terms of physiological characteristics like leaf area, leaf area index, leaf area duration, leaf weight ratio, relative leaf water content, plant height, photosynthetic rate, stomatal

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conductance, root biomass, root volume, tiller numbers, panicle numbers, panicle length, grains per panicle, grain weight which contributed in producing high grain yield. These genotypes also showed higher values in terms of soil chemical characters such as soil pH, electrical conductivity, organic carbon, rhizospheric root carbon, microbial biomass carbon and nitrogen.

A positive and significant correlation between grain yield and soil microbial biomass carbon was observed in Inlongkiri, Dehangi, Banglami and Bash but negative correlation was observed in Sokinglong and Maibee. The correlation coefficient was also analyzed between yield and soil microbial biomass nitrogen. It was observed that Soil microbial biomass nitrogen of selected rice genotypes with interactive effects were found to be positively related with the yield production in rice.

Study on growth and yield of green gram (*Vigna radiata* L. Wilczek) under high level of CO₂

Tarique Aziz

An experiment was carried out in the stress physiology laboratory, Department of Crop Physiology of Assam agricultural University under Open Top Chamber during the *rabi* season of 2019 with six genotypes of green gram *viz.* SML1827, SML832, SML1831, PM1533, Pusa M-19-31, Pant M-5. Three different levels of CO₂ concentration of 390ppm, 600ppm and 750ppm along with an ambient were maintained to assess the response of growth, physiological and yield parameters of green gram. The results obtained for this experiment showed that CO₂ has a greater effect on crop growth and development process. However some genotypes response differently at various level of CO₂. Results indicated that the increase in CO₂ concentration up to 600ppm caused progressive increase in some growth parameters *viz.* leaf area, leaf area index, leaf area duration, plant height, number of branches per plant, length of pod, number of effective root nodules and total biomass of plant which ultimately linked with the increase of yield, however at 750 ppm opposite trend was recorded and most of these parameters were reduced. Similar trend was also found in case of physiological parameters like photosynthesis, internal CO₂ and stomatal conductance. But chlorophyll content, nitrate reductase activity and leaf nitrogen was significantly decrease due to higher level of CO₂ but reduction of these parameters were less in genotype Pant M-5 under 600 ppm of CO₂. Highest reduction of these parameters were recorded in SML 1827 under 750 ppm of CO₂. All yield and yield attributing character *viz.* number of pods per plant, number of seeds per pod, length of pod, seed yield per plant, thousand seed weight were significantly increased under elevated levels of CO₂ (600 ppm). All these parameters were recorded higher in the genotype Pant M 5, followed by, Pusa M-19-31 under the treatment 600 ppm where lowest was recorded in SML 1827 in treatment 750 ppm CO₂. Highest harvest index was recorded in Pant M-5 under 600 ppm CO₂ and the lowest was recorded in genotype PM 1533 under 750ppm. From the above study it can be concluded that, the genotype Pant M-5 and Pusa M-19-31 were found to be the high

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yielder whereas genotype SML 1827 showed lowest yield. These two responsive genotypes viz. (Pant M-5 and Pusa M-19-31) invariably maintained good plant biomass due to higher photosynthetic rate, nitrate reductase activity and chlorophyll stability index under high level of CO₂. These two genotypes (Pant M-5 and Pusa M-19-31) were promising lines within the six genotypes under the varying level of CO₂. These genotypes may be advocated for breeding and seed production programme in near future under changing climatic condition.

Biology of *Callosobruchus chinensis* (L.) on Green gram, *Vigna radiata* (L.) and Black gram, *Vigna mungo* (L.) in two different seasons

Abhilasa Kousik Borthakur

Field and laboratory experiments were conducted in the Instructional cum Research farm, Department of Agronomy, Assam Agricultural University, Jorhat and Department of Entomology, Assam Agricultural University, Jorhat during 2018-19 to examine the biology of *Callosobruchus chinensis* (L.) in two different seasons viz., summer and winter considering green gram (variety-Pratap) and blackgram (variety-KU301) as host plants. Ovipositional preference of *Callosobruchus chinensis* (L.) was also evaluated on four different host plants viz., green gram (variety-Pratap), black gram (variety-KU301), chickpea (variety-JG16) and cowpea (variety-Green fall).

The data on biology of *C. chinensis* (L.) revealed that the insect had a comparatively shorter developmental period in the summer season (April-May) than in the winter season (October-November). In green gram, the fecundity of the insect during summer season was 4.96 ± 0.13 number of eggs while in winter it was 3.60 ± 0.19 number of eggs. The incubation period was found to be 4.92 ± 0.14 days and 6.24 ± 0.13 days during summer and winter respectively. The insect took 17.50 ± 0.12 days to complete its larval period during summer and 23.57 ± 0.18 days during winter. The pupal period was recorded to be 7.53 ± 0.09 days during summer and 9.41 ± 0.07 days during winter. Thus the total developmental period was worked out and noted to be 29.95 ± 0.21 days during summer and 39.22 ± 0.22 days during winter. The longevity of the male was upto 7.73 ± 0.23 days during summer while in winter it survived upto 10.36 ± 0.21 days. The longevity of the female was recorded as 6.70 ± 0.21 days and 8.10 ± 0.27 days during summer and winter respectively.

In black gram the mean fecundity was recorded as 3.10 ± 0.12 in summer and 1.57 ± 0.11 in winter. The incubation period was recorded as 5.46 ± 0.12 days and 7.37 ± 0.15 days during summer and winter respectively. The larval period was completed in 18.28 ± 0.08 days during summer and 24.50 ± 0.12 days in winter. The pupal

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period was 8.17 ± 0.07 days and 10.12 ± 0.12 days during summer and winter respectively. The developmental period was completed in 31.91 ± 0.15 days during summer while it took 42.08 ± 0.21 days during winter. The male longevity was 8.90 ± 0.23 days during summer while 9.40 ± 0.29 days during winter. The longevity of the female was 7.40 ± 0.26 days and 6.80 ± 0.20 days during summer and winter respectively.

The data on ovipositional preference revealed that green gram was the most preferred host for egg laying with a mean of 17.40 eggs per four pods, followed by chickpea (14.33), cowpea (11.50) and black gram (8.50). Hatchability percentage was maximum in green gram (90.55%) followed by chickpea (86.24%), black gram (82.86%) and cowpea (81.80%).

Maximum adult emergence was observed in green gram (79.16%) and minimum adult emergence was observed in black gram (64.82%). Adult emergence in chickpea was 75.53% and in cowpea it was 76.55%.

The data on morphological parameters of the pods revealed that cowpea had the maximum pod length (14.13cm), trichome number/mm² (14.16) and pod wall thickness (0.73mm).

Correlation analysis between ovipositional parameters and morphological parameters of pods revealed that eggs laid, hatchability percentage and adult emergence had a negative correlation with trichome number/mm² and pod wall thickness, whereas pod length showed a positive correlation with eggs laid, hatchability percentage and adult emergence percentage.

Data on growth parameters revealed that the maximum percentage of reproductive success was shown in green gram (65.52%) followed by Cowpea (55.91%), chickpea (54.56%) and black gram (42.32%). Total developmental period was highest in black gram (33.12 days) followed by chickpea (32.12 days), green gram (31.05 days) and least in cowpea (28.13 days). Growth Index was lowest in black gram (1.96) while the highest was found in cowpea (2.73) followed by green gram (2.56) and chickpea (2.35).

Correlation between Growth Index and growth parameters showed that Growth Index was negatively correlated to developmental period and positively correlated to adult emergence and number of eggs laid. A significantly high positive correlation between Growth Index and percentage adult emergence was exhibited by cowpea and chickpea.

Loss assessment and prey preference of coccinellid (*Coccinella transversalis* Fabricius) to different instars of aphids (*Aphis gossypii*) in tomato (*Solanum lycopersicon* L.)

Ankita Baruah

The experiment on ‘Loss assessment and prey preference of coccinellid to different instars of aphids in tomato’ was carried out during 2017-19 at Experimental Farm, Deptt. of Horticulture and at Insectary and PG Laboratory, Deptt. of Entomology, Assam Agricultural University, Jorhat.

During field investigation the diversity indices of different insect pests and natural enemies were observed and it was found that the species richness was highest in the fruiting stage which was 2.158 and 2.221 for the years 2017-18 and 2018-19. Species diversity data was also high in fruiting stage 1.640 and 0.623 for both the years 2017-18 and 2018-19 and hence it suffered heavy infestation of insect pests with a rich population. The species evenness was highest in the vegetative stage 0.726 and 0.243 for both the years 2017-18 and 2018-19. The per cent relative abundance was also observed during the cropping season for both the years. The average percent relative abundance was highest in *Aphis gossypii* (49.28 %) and lowest in *Agrotis ipsilon* (0.23%) among the insect pests. Among the natural enemies the relative abundance was found to be highest in *Nesidiocoris tenuis* (3.55 %) which was a new species of zoophytophagous bug which was reported for the first time from Assam. Among the coccinellid predators *C. transversalis* was the dominant one with 1.51 per cent relative abundance. *H. armigera*, *A. gossypii*, *B. tabaci*., *L. trifolii* were found to be the major pests in tomato. The insect pests population of these major insects were compared in protected and unprotected plots of tomato and it showed that the insect infestation was significantly highest in the unprotected plots than in the protected plots for both 2017-18 and 2018-19. The yield gained and damaged fruits were also compared in protected and unprotected plots of tomato and it showed that the yield was significantly highest in the protected plots than in the unprotected plots for both 2017-18 and 2018-19 and the

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damaged fruits were more in the unprotected plots than the protected plots. The yield gained and damaged fruits was found to be 288.3 ± 5.90 q/ha for protected, 72.6 ± 1.29 for unprotected and 57.0 ± 0.90 q/ha for protected, 122.5 ± 1.37 q/ha for unprotected for the year 2017-18. The yield gained and damaged fruits for the year 2018-19 was 329.1 ± 7.22 q/ha for protected, 87.5 ± 1.51 q/ha for unprotected and 47.0 ± 0.98 q/ha for protected and 112.0 ± 1.35 q/ha for unprotected. The yield loss was 74.81 percent for the year 2017-18 and 73.41 percent for the year 2018-19. The average yield loss was found as 74.11 per cent for the year 2018-19.

During the laboratory experiment, when the prey consumption of *C. transversalis* was observed to 3rd instar *A. gossypii* in different densities viz- 150,100,80,60,40 it was found that the smaller instar coccinellids (2nd instar) had no significant difference in aphid consumption when aphid density was 80,100 and 150. In case of 3rd ,4th instar and adult *C. transversalis* when the density was more their rate of consumption was high($131.60 \pm 1.64, 139.80 \pm 1.10, 144 \pm 0.9$). When different instars of aphids were provided to the *C. transversalis*, it was found that 2nd instar prefers the smaller sized *A. gossypii* (1st and 2nd instar). The 3rd ,4th and adult *C. transversalis* preferred larger sized *A. gossypii* i.e 3rd and 4th. Based on biomass experiment it was found that consumption was dependent on the size of the aphids not the biomass. The highest mean consumption by adult, 4th instar, 3rd instar and 2nd instar *C. transversalis* were 0.2951 mg, 0.2865 mg, 0.2690 mg and 0.0614 mg respectively. When Manly's preference index was calculated by providing all the *C. transversalis* instars to all the instars of *A. gossypii* then it was found that the 2nd instar *C. transversalis* preferred 1st and 2nd instar *A. gossypii*, 3rd and 4th instar *C. transversalis* preferred 3rd and 4th instar *A. gossypii* and the adult *C. transversalis* showed a highly marked preference to 2nd, 3rd and 4th instar *A. gossypii*.

This study will help in estimating the proportion of predator prey density for artificial release of predators in protected cultivations which will make the biological control more profitable.

Bioassay of some plant extracts against banana pseudo stem weevils *Odoiporus longicollis* Oliver (Coleoptera: Curculionidae)

Annabhatula Sasidhar

Laboratory experiments were conducted in the Department of Entomology, Assam Agricultural University, Jorhat during 2019-20 to evaluate the bioassay of some plant extracts against banana pseudo stem weevil, *Odoiporus longicollis* Oliver, (Coleoptera: Curculionidae). The results revealed that Solvent (chloroform) plant extracts were found to be superior in terms of adult mortality of *Odoiporus longicollis* as compared to aqueous plant extracts. The solvent (chloroform) and aqueous plant leaf extracts of *Lantana camara* were found having more insecticidal properties recording the highest mortality of 56.66 at 10 and 53.33 percent at 15 percent concentration at 72 hours after treatment (HAT) and the most effective LC50 values were found to be 9.741 and 15.791 % respectively at 72 HAT for solvent and aqueous plant extracts. From the present work on bioassay, the order of toxicity to *Odoiporus longicollis* with respect to LC50 values among solvent plant leaf extracts were Imidacloprid (0.424) > *Lantana camara* (14.454%) > *Azadirachta indica* (20.481%) > *Clerodendron infortunatum* (22.694) > *Melia azaderach* (23.752%) > *Xanthium strumarium* (32.507 %), imidacloprid (0.315 %) > *L.camara* (11.65%) > *A.indica* (13.604 > *C.infortunatum* (15.82%) > *M.azaderach* (19.457%) > *X.strumarium* (30.19%), imidacloprid (0.273%) > *L.camara* (9.741%) > *A.indica* (11.509%) > *C.infortunatum* (13.875%) > *M.azadercah* (17.829%) > *X. strumarium* (21.082%) at 24, 48 and 72 hours after treatment and in case of aqueous leaf extracts imidacloprid (0.424 %) > *L. camara* (21.863%) > *A.indica* (23.373%) > *C.infortunatum* (31.137%) > *M.azadercah* (42.811%) > *X.strumarium* (75.881%), imidacloprid (0.315%) > *L. camara* (17.829%) > *A.indica* (21.661%) > *C.infortunatum* (27.21%) > *M.azadercah* (34.687%) > *X.strumarium* (58.708%), imidacloprid (0.273%) > *L. camara* (15.791%) > *A.indica* (18.789%) > *C.infortunatum* (23.756%) > *M.azadercah* (27.127%) > *X.strumarium* (39.02%) for 24, 48 and 72 hours after treatment.

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The order of toxicity for both solvent and aqueous plant extracts were Imidacloprid > *Lantana camara* > *Azadirachta indica* > *Clerodendron infortunatum* > *Melia azaderach* > *Xanthium strumarium*.

Based on LC50 values the solvent extracts were selected for experiments on repellency of plant extracts against banana pseudo stem weevil. Based on the data on screening of plant extracts for their repellency against *Odoiporus longicollis*, solvent plant leaf extracts of *Lantana camara* and *Azadirachta indica* (chloroform) was found to be the most effective with the lowest settlement response of banana pseudo stem weevils at 0.33, 1.33 and 1.66 and 2.33 at 24 HAR and 48 HAR (Hours after release). Similarly, *C. infortunatum*, *M. azaderach* and *X. strumarium* showcased 3.33, 4.33, 4.66 and 4.00, 4.33, 5.33 at 24 and 48 HAR.

Similarly, *L. camara* and *A. indica* showcased lesser feeding and weight loss of pseudo stems in comparison to other plant extract treated pseudo stem against banana pseudo stem weevil with values of 1.14, 2.74 percent and 2.91, 6.02 percent at 48 HAR. *C. infortunatum*, *M. azaderach* and *X. strumarium* demonstrated 5.52, 7.11, 8.37 percent and 10.86, 12.28, 13.84 percent

Present investigation conclusively proves that plant extracts can be used for mortality, repellency and also as an anti-feedant against insect pest, banana pseudo stem weevil, *Odoiporus longicollis*, rearing a path for incorporation and utilisation of newer botanical pesticides in banana pest management systems.

Studies on predator-prey and host-parasitoid relationship involving sucking pests and it's entomophages in mulberry ecosystem

Arindam Khanikar

Studies on sucking pests and their natural enemies in mulberry crop were carried out during 2018-2020 at Assam Agricultural University, Jorhat. Four species of sucking pests viz., *Paracoccus marginatus*, *Maconellicoccus hirsutus*, *Pseudodendrothrips mori* and *Aleurodicus dispersus* were prevalent in the mulberry plantation. Among the four species of sucking pests the most abundant was *Paracoccus marginatus*. Three species of coccinellid predators viz., *Coccinella septempunctata*, *Coccinella transversalis* and *Micraspis discolor*, one species of lepidopteran predator viz., *Spalgis epius* were found associated with *Paracoccus marginatus*. Among these natural enemies *Spalgis epius* was relatively most abundant. The appearance and peak activity of the three coccinellids predators *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolor* and one lepidopteran predator *Spalgis epius* were synchronized with that of *Paracoccus marginatus*. The feeding potential of the first instar larvae of the two coccinellids predators *Coccinella transversalis* and *Coccinella septempunctata* were less voracious than the latter instars. The voracity increases in the succeeding instars. The first instar larvae of *Coccinella transversalis* consumed an average of 3.40 no of *Paracoccus marginatus* adult in 24 hours. An adult female of *Coccinella transversalis* consumed an average of 7.04 no of *Paracoccus marginatus* adult in 24 hours. Likewise the fourth instar larvae of *C. septempunctata* consumed an average of 5.10 no of prey in 24 hours. The first and fourth instar of *S.epius* larvae consumed an average of 3.74 and 6.00 no of adult stage of *Paracoccus marginatus* in 24 hours. Studies on functional response revealed the feeding potential of both the predators increase with the increased prey density and showed a positive density dependent pattern of prey consumption. The prey density showed significantly strong relationship with the feeding potential of I instar ($r=0.98, 0.98$), II instar ($r=0.98, .0.98$)

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III instar ($r=0.99, 0.98$), IV instar ($r=0.99, 0.99$), Adult female ($r=0.99, 0.99$) and Adult male ($r=0.99, 0.99$) of *C. transversalis* and *C. septempunctata* respectively. All the developmental stages of the *C. transversalis* and *C. septempunctata* exhibited Holling's Type III functional response which is characterised by the typical sigmoid response curve.

Bioassay of some plant extracts against banana leaf and fruit scarring beetle (*Nodostoma subcostatum* Jacoby, Coleoptera: Chrysomelidae)

Baishali Boruah

Laboratory experiments were conducted in the Department of Entomology, Assam Agricultural University, Jorhat during 2018-20 to evaluate the efficacy of some aqueous and solvent plant extracts against banana leaf and fruit scarring beetle (*Nodostoma subcostatum*, Jacoby Coleoptera: Chrysomelidae) under laboratory condition. The results revealed that the chloroform plant extracts were found to be superior in terms of adult mortality of *N. subcostatum* as compared to aqueous plant extracts. The chloroform plant extract of *Polygonum hydropiper* L. was found having more insecticidal properties recording the highest of 90.00% mortality of adult *N. subcostatum* at 10.00% concentration at 72 hours after treatment (HAT). While, aqueous plant extract of *P. hydropiper* was found to be having insecticidal properties recording the highest of 83.33% of adult mortality of *N. subcostatum* at 10.00% concentration at 72 hours after treatment (HAT).

Among, all the aqueous plant extracts, *Polygonum hydropiper* L. was found to be most effective against *N. subcostatum* followed by *Terminalia chebula* Retz., *Melia azedarach* L. and *Carica papaya* L. and the lowest mortality was recorded in *Melastoma malabathricum* L. In case of chloroform plant extract, *P. hydropiper* was found to be most effective against *N. subcostatum* followed by *T. chebula*, *M. azedarach* and *C. papaya* and the lowest mortality was recorded in *M. malabathricum*. The order of toxicity with respect to LC50 value of aqueous plant extracts was *P. hydropiper* > *T. chebula* > *M. azedarach* > *C. papaya* > *M. malabathricum*. The order of toxicity with respect to chloroform extracts was *P. hydropiper* > *T. chebula* > *M. azedarach* > *C. papaya* > *M. malabathricum*.

Based on the data on screening of plant extracts for their efficacy against *N. subcostatum*, plant extract of *P. hydropiper* (chloroform) was found to be the most effective with the lowest LC50 value of 0.357% and *M. malabathricum* (aqueous) was found to be least effective with the highest LC50 value of 10.253%.

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Plant extracts can be used as an alternative to chemical pesticides. Thus, Present investigation exploring toxicity of five plant extracts paved a path in their possible incorporation and utilization in banana IPM programme.

Avifaunal diversity in Rice Agro ecosystem

Chiranjeeb Sonowal Borah

The present study on avifaunal diversity of rice agro ecosystem was conducted in the Upper Brahmaputra Valley Zone (UBVZ) and North Bank Plain zone (NBPZ) of Assam in the year 2018-20. The various population indices like species richness, species diversity, species density, relative abundance and population density was calculated through line transect method in all the locations of the zone comprising all the crop stages. The average population of predatory and depredatory birds among all the six locations was found to be 72.8 % and 27.1 % respectively. Among all the six locations, the highest population was recorded from Baligaon, NBPZ with 1998 recorded individuals while the lowest population was recorded from ICR Farm AAU, UBVZ with 1210 individuals. In case of cropping stages, the highest population was recorded from harvesting stage while the lowest was recorded from sowing stage.

The species richness of 15 species was found to be highest in the harvesting stages and lowest of 8 species in the sowing stages among all the recorded locations. Similarly, the highest species diversity of 2.272 was recorded from harvesting stage in Batghoria while the lowest of 1.736 was recorded from ICR Farm in sowing stage. In case of similarity index, the panicle initiation stage at Batghoria showed lowest similarity of 0.171 while the sowing stage at Baligaon showed the highest similarity of 0.306.

The highest number of individual recorded species belonged to the Ardeidae family with 427 individuals which were mainly dominated by Cattle Egret, Little Egret and Pond Heron species with while the lowest individuals were recorded from Oriolidae family comprising the Black Hooded Oriole with 10 individuals. The average number of bird families recorded from each of the six locations was 18 families. The percentage of predatory birds was found to be highest in ICR Farm with 76% population under UBVZ and lowest in Baligaon under NBPZ with 69 % population. Similarly, the relative abundance of 10.06 was found to be highest in the sowing stages and lowest of 7.09 in the harvesting stages across all the locations.

The estimation of damage caused by depredatory birds of rice was carried out in Boro and Sali rice at Upper Temera, UBVZ and Batghoria, NBPZ respectively. The

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damage estimation was carried out by following the quadrature method of damage estimation and it was found that the grain yield loss was higher in sali rice with 27.4 % loss as compared to Boro rice with 21.58 %. The major damage was caused by Baya Weaver and Munia in both the cropping seasons. The weight loss in both the seasons was also prominent and sali rice showed more weight loss as compared to the boro rice. More damage was recorded in the sali rice at grain filling stage as compared to the boro rice at harvesting stage.

Influence of coloured light emitting diodes on specific behaviours of *Sitophilus oryzae* (L.) and *Callosobruchus chinensis* (L.)

Jabanika Hazarika

It has been estimated that between one quarter and one-third of the world grain crop is lost each year during storage. The Rice weevil, *Sitophilus oryzae* and Pulse beetle, *Callosobruchus chinensis* are two of the most damaging coleopteran primary grain and seed feeders that attack whole and undamaged grain. Management of these insects is very important for reducing the post harvest loss of cereals and pulses.

The present study was carried out to study the orientation of *S. oryzae* and *C. chinensis* towards various coloured LEDs in grain storage. The coloured LEDs were Green, Yellow, Infrared, Blue, Ultraviolet and Red respectively with White being the control. The result showed that in multi-choice test, when food was kept only in the small square shaped containers, preference of *S. oryzae* and *C. chinensis* at 1, 3, 6 and 24 hours after release was highest in Red (11.07 to 11.80%) and Green (13.13 to 13.80%) respectively, while lowest preference of *S. oryzae* was recorded in Ultraviolet (6.20 to 6.73%) and *C. chinensis* in White (control) (7.20 to 9.67%). Data recorded at different time intervals when only the mother container was provided with food showed Blue (11.80 to 12.60% and 12.13 to 13.73%) to be the most preferred treatment for both the insect while the least preferred LED of *S. oryzae* was Infrared (7.27 to 8.20%) and for *C. chinensis*, lowest preference was recorded from Red LEDs (6.13 to 8.40%). Highest preference was found in Blue (11.53 to 11.93%) and Ultraviolet (13.20 to 14.20%) for *S. oryzae* and *C. chinensis* respectively at different time intervals when food was kept both in the mother container and square-shaped containers and *S. oryzae* showed lowest preference towards Infrared LEDs (6.93 to 8.07%) while in case of *C. chinensis*, Red (6.67 to 7.93%) was found to be the least preferred treatment.

In the multi-choice test, the variation in the sex ratio of adult *C. chinensis* according to their orientation to the different coloured LEDs at 6 and 24 hours after the release was also worked out. When food was kept only in square shaped containers, male preference was highest in Green (4.53% and 4.33%), likewise, female preference

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was also highest in Green (8.80% and 8.80%) at 6 and 24 hours after release. The sex ratio (male: female) of *C. chinensis* oriented to different coloured LEDs showed that movement of female was highest towards Green (1:1.94 and 1:2.03) across different time intervals. At 6 hours after release when food was kept only in the mother container male showed highest preference towards Blue LEDs (4.40%) while at 24 hours after release highest preference of male was observed in Ultraviolet (5.27%). In case of adult female preference was highest in Blue (8.40% and 9.00%) across different time intervals and orientation of female was also highest towards Blue (1:1.90 and 1:2.14). Highest preference of male was observed in Ultraviolet (5.00% and 5.00%) at different time intervals when food was kept both in square shaped containers and the mother container. In this condition, adult female showed highest preference towards Blue LEDs (8.53% and 8.60%) and the sex ratio (male: female) was also highest in Blue (1:2.15 and 1:2.03).

The present study revealed that *S. oryzae* and *C. chinensis* reacted differently to different coloured LEDs during the storage of rice and green gram.

Evaluation of Two Native Entomopathogenic Nematodes against Termite (*Odontotermes obesus*) and Cutworm (*Agrotis ipsilon*)

K. Sindhura Bhairavi

Laboratory experiments were carried out in the Soil Arthropod Pests Laboratory, Department of Entomology, Assam Agricultural University (AAU), Jorhat during 2018-20 to evaluate the infectivity of two native Entomopathogenic Nematodes (EPNs), *Heterorhabditis bacteriophora* and *Steinernema aciari* against termite, *Odontotermes obesus* and potato cutworm, *Agrotis ipsilon*. Different concentrations of Infective Juveniles (IJs) of both the EPN species were tested along with untreated control. Both *O. obesus* workers and *A. ipsilon* larvae were found susceptible to the two native EPN species at different concentrations and time intervals.

Experimental results indicated that both *H. bacteriophora* and *S. aciari* were able to cause mortality at 24 hours in case of the workers of *O. obesus*. At 24 hours, *H. bacteriophora* induced 10, 30 and 40 per cent mortality at inoculation rates of 200, 250 and 300 IJs/termite respectively whereas *S. aciari* caused 10 and 30 per cent mortality at inoculation rates of 250 and 300 IJs/termite respectively. However, both the EPN species were able to register at least 50 per cent mortality at 48 hours at inoculation rates of 150 and 200 IJs/termite in case of *H. bacteriophora* whereas *S. aciari* exhibited 60 per cent mortality at 250 IJs/termite. Complete mortality of the workers was achieved by *H. bacteriophora* at an inoculation rate of 300 IJs/termite at 72 hours and by *S. aciari* at inoculation rates of 250 and 300 IJs/termite at 96 hours. The mortality of the workers seems to be increasing with an increase in concentration and time of exposure and the LD50 and LT50 values of both the EPN species showed variable differences. In case of *H. bacteriophora*, the highest and lowest LD50 values were 693.194 and 13.054 IJs/termite at 24 and 96 hours respectively. The highest LT50 value was 72.817 hours at 10 IJs/termite while the lowest value was 26.639 hours at 300 IJs/termite. With respect to *S. aciari*, the highest LD50 obtained was 2997.000 IJs/termite at 24 hours and the

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lowest value was 42.040 IJs/termite at 96 hours. The highest and lowest LT50 values for *S. aciari* were 99.616 and 31.761 hours at 10 and 300 IJs/termite respectively. Based on the mortality rates observed as well as considering the lower values of LD50 and LT50, *H. bacteriophora* was found to be more virulent against the workers of *O. obesus* than *S. aciari*.

While studying the infectivity of both the EPN species against *A. ipsilon*, it was recorded that none of them showed any mortality of larvae up to 48 hours and the mortality was observed at 72 hours after exposure only. After 72 hours, *H. bacteriophora* recorded 10, 10, 20 and 30 per cent mortality at inoculation rates of 150, 200, 250 and 300 IJs/cutworm respectively. In case of *S. aciari*, mortality rates of 10, 20 and 20 per cent were observed at inoculation rates of 200, 250 and 300 IJs/cutworm respectively at 72 hours. However, after 96 hours, both the EPN species were able to surpass the 50 per cent mortality level. *H. bacteriophora* caused 60 per cent mortality at 250 IJs/cutworm whereas *S. aciari* showed 50 per cent mortality at inoculation rates of 250 and 300 IJs/cutworm. Complete mortality of the larvae was achieved by *H. bacteriophora* and *S. aciari* at an inoculation rate of 300 IJs/cutworm at 144 and 168 hours respectively. Comparatively lower LD50 values were registered in case of *H. bacteriophora* than *S. aciari*. The highest and lowest LD50 values of *H. bacteriophora* were 1314.790 and 35.711 IJs/cutworm at 72 and 168 hours respectively. As regards to *S. aciari*, the highest and lowest LD50 values were 2649.610 and 71.192 IJs/cutworm at 72 and 168 hours respectively. Similarly, the LT50 values of *S. aciari* were higher than *H. bacteriophora*. The highest LT50 value for *H. bacteriophora* was 156.655 hours at 10 IJs/cutworm while the lowest was 83.050 hours at 300 IJs/cutworm. The highest and lowest LT50 values of *S. aciari* were 173.144 and 97.921 hours at 10 and 300 IJs/cutworm respectively. Considering mortality rates as well LD50 and LT50 estimated, it can be inferred that *A. ipsilon* larvae were more vulnerable to *H. bacteriophora* than *S. aciari*.

Comparative biology of *Callosobruchus chinensis* (L.) under different colour cues

Komedity Chamua

The high prevalence of storage pests is one of the principal causes of food insufficiency in India. For all those pests, food stores are excellent breeding grounds. Among the different storage pests, the genus *Callosobruchus* predominately infests the stored products. In recent years, the use of botanicals, biological control agents, irradiations and different physical control measures in storage are gaining importance over the chemical control because of their low residual toxicity, next to nil hazards to human health, bio-friendliness, less expensive nature and target specificity. Insects are extremely responsive to lights. Different aspects of light like photoperiod, frequency, wavelength, intensity etc. may have some influence on growth, metabolism, development and reproduction of the insect pests. Therefore, keeping above in view, the present investigation was carried out in the laboratory-II of AICRP on PHET under the Department of Agricultural Engineering, AAU, Jorhat-13, during the year 2018-2020 where efforts were made to find out the potency of physical means to study the biology of *C. chinensis* on different colour cues and thus examining the relative gradation of colour cues preference by *C. chinensis*.

During the investigation, it was observed that Green LED was found to be highly preferred for egg laying by pulse bruchid with the significantly highest numbers of eggs (93.60 ± 0.83 eggs/female and 74.00 ± 2.31 eggs/female) and lowest on White (56.27 ± 2.11 eggs/female and 36.00 ± 1.16 eggs/female) during both season I and season II respectively. Incubation period was maximum on UV (6.67 ± 0.33 days) and minimum on Green (4.30 ± 0.12 days) in season I while during season II, White (9.30 ± 0.15 days) recorded highest incubation period and lowest incubation days observed on Green (5.40 ± 0.20 days). In season I, the larval duration was prolonged on UV (21.47 ± 0.30 days) and hastened on Yellow (13.60 ± 0.55 days) and in season II, Blue (27.93 ± 0.77 days) recorded maximum larval duration and Green (20.53 ± 0.42 days) recorded minimum larval duration. The longer pupal period was recorded on Blue (8.57 ± 0.26 days and 11.07 ± 0.19 days) and shorter pupal period was recorded on Yellow

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(5.00 ± 0.15 days and 6.17 ± 0.09 days) in both season I and season II respectively. The adult emergence was maximum from Green ($89.13 \pm 0.28\%$ and $86.56 \pm 0.47\%$) and minimum from White ($53.31 \pm 0.33\%$ and $55.92 \pm 0.22\%$) in both season I and II respectively. The adults lived longer on Yellow (Male- 11.87 ± 0.62 days, Female- 12.53 ± 0.62 days) and shorter on White (Male- 5.27 ± 0.58 days) and Blue 6 (Female- 6.47 ± 0.42 days) during season I, while the longevity of adults during season II was longer on Yellow (Male- 12.73 ± 0.54 days, Female- 13.10 ± 0.44 days) and shorter on Blue (Male- 6.13 ± 0.03 days, Female- 6.70 ± 0.25 days). In both the seasons, females lived longer than the males. The average total life cycle in season I was maximum under UV (44.15 ± 0.78 days) and minimum under Green (33.76 ± 0.70 days) while during season II, it was maximum on White (53.73 ± 0.25 days) and minimum on Green (45.25 ± 0.38 days). It can be concluded from the present investigation that short wavelengths of lights like Blue, Ultraviolet and polychromatic light like White could be used for the management of *C. chinensis*. It was observed that exposure to short wavelengths of light significantly reduced fecundity, prolonged the duration of immature stages, decreased adult emergence and delayed the life span of both the sexes of *C. chinensis*. Based upon these findings, there is scope for formulating strategies for control/management measures of *C. chinensis*.

Diversity of insect forager complex and foraging behaviour of honeybee, *Apis cerana* in ber and papaya

Liza Shyam

The experiment on diversity of insect forager complex and foraging behaviour of honeybee, *Apis cerana* in ber and papaya was carried out during 2017-18 at the Experimental Farm, Deptt. of Horticulture and in the Apiculture Laboratory, Deptt. of Entomology, Assam Agricultural University, Jorhat.

Among the different insect foragers of ber, *A. cerana* was the dominant forager comprising of 50.66% followed by *Vespa magnifica* (10.30%), *A. mellifera* (6.42%), *Musca domestica* (4.70%), *Calliphora* sp. (4.48%), *Eristalinus* sp. (4.27%), *Monomorium indicum* (3.94%), *Athyma perius* (3.50%), *Polistes hebraeus* (3.49%), *Pelopidas* sp. (3.45%), *Pieris rapae* (2.33%) and *Coccinella septempunctata* (2.24%) in the year 2017. The subsequent study during 2018 also showed similar pattern of results. Out of the different insect foragers of papaya, *A. cerana* was the dominant forager comprising of 49.64% followed by *A. mellifera* (10.30%), *Papilio polytes* (7.32%), *Pieris rapae* (5.32%), *Pelopidas* sp. (5.28%), *Monomorium indicum* (4.75%), *Musca domestica* (4.28%), *Coccinella septempunctata* (3.72%), *Vespa magnifica* (3.50%) and *Polistes hebraeus* (3.46%) in the year 2017. The subsequent study in the next year also showed the similar pattern of results.

The study on the foraging behaviour of *A. cerana* revealed that 0900-1000 hours was the peak period of visit on ber and papaya flower. In ber, the number of *A. cerana* per square meter per minute was recorded to be maximum (10.05 ± 0.62) during 0900-1000 hours and minimum (3.18 ± 0.37) during 1500-1600 hours. The maximum frequency of flower visit per minute was found to be 21.85 ± 1.31 during 0900-1000 hours and minimum 3.70 ± 0.99 during 1300-1400 hours of the day. The maximum time spent per flower was 6.60 ± 0.44 seconds during 0900-1000 hours while the minimum was 2.74 ± 0.45 seconds during 1300-1400 hours of the day. The number of flower visited per trip was found to be maximum (265.45 ± 2.46) during 0900-1000 hours and

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minimum (133.45 ± 3.24) during 1300-1400 hours of the day. The pollen load per trip was maximum (5.20 ± 0.54 mg) during 0900-1000 hours and minimum (2.24 ± 0.33 mg) during 1500-1600 hours of the day. Likewise in papaya, the number of *A. cerana* per square meter per minute was recorded to be maximum (5.42 ± 0.68) during 0900-1000 hours and minimum (2.46 ± 0.37) during 1500-1600 hours. The maximum frequency of flower visit per minute was found to be 9.21 ± 0.31 during 0900-1000 hours and minimum 2.56 ± 0.35 during 1300-1400 hours of the day. The maximum time spent per flower was 4.77 ± 1.34 seconds during 0900-1000 hours while the minimum was 2.66 ± 0.37 seconds during 1300-1400 hours of the day. The number of flower visited per trip was found to be maximum (265.65 ± 2.44) during 0900-1000 hours and minimum (134.15 ± 3.01) during 1300-1400 hours of the day. The pollen load per trip was maximum (5.46 ± 0.56 mg) during 0900-1000 hours and minimum (2.19 ± 0.15 mg) during 1500-1600 hours of the day.

The various meteorological factors influenced the foraging activities of *A. cerana* of which temperature and bright sunshine hours showed positive correlation with foraging behaviour. On the other hand, relative humidity and rainfall showed negative correlation with the foraging behaviour of *A. cerana*.

Nutritional composition of some commonly available aquatic edible insects of Assam

Mintu Sarma

Nutritional composition of five commonly available edible aquatic insects of Assam viz., *Diplonychus rusticus* (Water bug), *Cybister* sp. (Diving beetle), *Lethocerus indicus* (Giant water bug), *Laccotrephes* sp. (Water scorpion) and *Ranatra* sp. (Water stick) were assessed on the basis of their proximate and elemental composition as well as the antioxidant and anti-nutritional properties. Proximate analysis revealed that *Laccotrephes* sp. contained the highest (9.19%) amount of moisture which showed statistical parity with *D. rusticus* (9.06%) and the lowest (3.38%) was recorded in *L. indicus*. The carbohydrate content of the studied species ranged from 2.74 to 3.68 per cent where the maximum (3.68%) was registered in *Cybister* sp. which was *at par* with *Ranatra* sp. (3.52%). In case of crude protein, the highest (57.67%) was registered in *D. rusticus* and it was found to be significantly superior over rest of the species. The protein contents recorded in *Ranatra* sp., *Laccotrephes* sp., *Cybister* sp. and *L. indicus* were 56.56, 54.75, 51.42 and 50.03 per cent, respectively. The highest (28.95%) crude fat content was registered in *Cybister* sp. (28.95%) whereas, the lowest (8.67%) was recorded in *Ranatra* sp. (8.67%). The crude fibre contents varied from 2.48 to 12.68 per cent and the *Cybister* sp. registered maximum fibre. The highest (4.74%) ash content was recorded in *D. rusticus* whereas the lowest (2.39%) was recorded in *L. indicus*.

While analysing the energy content (kcal/100g) of all the five species, the maximum energy content (506.38) was estimated in *Cybister* sp. followed by *D. rusticus* (499.20) and *L. indicus* (474.85). *Laccotrephes* sp. recorded the lowest energy content (331.98) which was found *at par* with *Ranatra* sp. (337.75).

Altogether 10 minerals as elemental composition of all the five species was also estimated. Maximum sodium content (28.62 mg/100g) was estimated in *D. rusticus* followed by *L. indicus* (26.22) and *Cybister* sp. (22.49) and least in *Ranatra* sp. (19.74). Both phosphorus and potassium content were estimated to be maximum (153.32 and 34.60 mg/100g, respectively) in *Cybister* sp. whereas the lowest was recorded in *Laccotrephes* sp. (76.34) and *Ranatra* sp. (22.00), respectively. The highest calcium

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content was recorded in *Laccotrephes* sp. (56.15 mg/100g) followed by *L. indicus* (48.30) and *D. rusticus* (40.13). Likewise, the highest magnesium content was registered in *D. rusticus* (45.20 mg/100g) followed by *Laccotrephes* sp. (43.20) whereas, the least was found in *Ranatra* sp. (33.60). The sulphur content recorded in all the five species ranged from 16.89 to 26.45 mg/100g and the *Laccotrephes* sp. registered maximum (26.45) and also found significantly superior over rest of the four species. Highest iron content was recorded in *Ranatra* sp. (112.10) followed by *D. rusticus* (99.02) and *Laccotrephes* sp. (90.40). Contrary to above, three other minerals viz., zinc, manganese and copper were comparatively found in trace amounts.

Analysis of the antioxidant properties of the studied species revealed the highest phenol content in *Cybister* sp. (363.80 mg catechol equivalent/100g) which is significantly superior over rest of the species (range: 117.39-245.67 mg catechol equivalent/100g). The highest (50.82 mg quercetin equivalent/100g) flavonoid content was registered in *Cybister* sp. followed by *Laccotrephes* sp. (41.69) and *D. rusticus* (37.34). However, *Ranatra* sp. possessed the highest antioxidant activity (91.47% DPPH inhibition) and the least was recorded in *Laccotrephes* sp. (80.82% DPPH inhibition). Anti-nutritional properties based on tannin, phytic acid and oxalic acid content recorded in all the five species were found within the acceptable limit.

Methods of Extraction of Mucin from Giant African Snail, *Achatina fulica* (Stylommatophora: Achatinidae)

Partha Pratim Gyanudoy Das

The Giant African Snail, *Achatina fulica* Bowdich, a native species of East Africa is one of the most important pestiferous land snails in the world. Like other species of land snails, *A. fulica* are also known to release mucin for locomotion. Being a biological hydrogel, mucin also serves as a lubricant to protect epithelia against shear induced damage from mechanical and physical forces. Of late, snail mucin has received global attention as a novel candidate in pharmaceutical studies because of its immense medicinal and cosmetic values. Pertinent to above, a maiden attempt was made to standardize extraction of mucin from *A. fulica* by using solvents and mechanical means during 2017-19 in the Soil Arthropod Pests Laboratory, Department of Entomology, AAU, Jorhat.

Experimental findings indicated that, in case of medium sized snails, out of the six solvents tested, dichloromethane registered the highest (2.79 ml) mucin and it was found to be significantly superior to rest of the solvents including the control. The mean amounts of mucin recorded in acetone and ethanol were 1.97 and 1.92 ml, respectively which were statistically *at par*. Likewise, the amount of mucin recorded in case of methanol was found to be 1.35 ml which was significantly superior to hexane (0.62 ml) and petroleum ether (0.59 ml). Mucin registered in case of distilled water (control) was found to be 1.05 ml. The order performance of the solvents tested was dichloromethane>acetone> ethanol> methanol> hexane> petroleum ether. Considering the amounts of mucin extracted based on concentration, the mean maximum (1.93 ml) amount of mucin was recorded at the highest concentration (3 ml) out of the five concentrations tested for the purpose. The mean amount of mucin registered in case of 2 ml concentration was found to be 1.78 ml which was statistically *at par* with 3 ml concentration (1.93ml). However, comparatively less amount of mucin was extracted at lower concentrations (0.5, 1 and 1.5 ml).

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Similarly, in case of large sized snails, dichloromethane registered the highest (2.94 ml) amount of mucin and it was found to be significantly superior to rest of the solvents including the control. Mucin recorded in acetone and ethanol were 2.52 and 2.57 ml, respectively and they were statistically *at par*. Likewise, the amount of mucin recorded in case of methanol was 2.10 ml which showed significant superiority over hexane (1.23 ml) and petroleum ether (1.15 ml). Least (0.81 ml) amount of mucin was extracted in distilled water. Perusal of data reflected the following order of performance of solvents: dichloromethane> ethanol> acetone> methanol> hexane> petroleum ether. Based on concentration wise comparison, the maximum (2.72 ml) amount of mucin was recorded at the highest concentration (3 ml) out of the five concentrations tested. The amount of mucin registered in case of 2 ml concentration was found to be 2.12 ml which was statistically significant over rest of the concentrations. However, the amount of mucin recorded in case of 1.5 ml concentration was 1.76 ml which showed statistical parity with mucin recorded in 1 ml concentration (1.51 ml). The lowest (1.40 ml) amount of mucin was registered in case of 0.5 ml concentration.

By applying mechanical means of mucin extraction from medium sized snail, highest (2.05ml) amount of mucin could be extracted when smoke emanating from incense stick was applied on the snails for 15 minutes. It was found to be significantly superior to rest of the mechanical methods. Mucin registered by applying electrical shock (10 V) was 0.5 ml which was *at par* with the mucin (0.47 ml) extracted by stroking of the snail foot by a pasteur pipette. However, the lowest (0.11ml) mucin extraction was recorded when the snails were allowed to move over the rough tiles for 30 minutes. Similar trend of result was observed in case of large sized snails also, where the highest amount of mucin (3.02 ml) was recorded in smoking method followed by application of electric shock (1.30 ml) and stroking by a pasteur pipette (0.80 ml). Mucin extraction was recorded to be lowest (0.23 ml) when the snails were allowed to move over rough tiles.

Pests scenario of tea, *Camellia sinensis* (L.) O. Kuntze, and management of red spider mite, *Oligonychus coffeae* Nietner by newer acaricidal molecules

Parthiban. M

The present investigation was carried out in the Experimental Tea Plantation, Department of Tea Husbandry and Technology, AAU, Jorhat as well as in the Acarology laboratory, Department of Entomology, AAU, Jorhat during March 2019 to February 2020 to record Pests scenario of tea and management of red spider mite *Oligonychus coffeae* Nietner by newer acaricidal molecules. Among the non- insect pest four mites species viz, red spider mite, scarlet mite, pink mite and yellow mite, occurrences were recorded in different periods of the year. The incidence of 33 insect species belonging to 7 orders and 27 families, were recorded Species abundance was observed as Lepidoptera (16 species) followed by Hemiptera (14 species), Orthoptera (2 species) and Diptera (1 species). Among the pest red spider mites, Tea mosquito bug, leafhopper complex and thrips were observed as important sucking pests, while leaf roller, tea tortrix and flush worm were observed as significant chewing pests. Among the leaf hoppers infestation two new rice leaf hopper species such as *Recilia dorsalis* (Zig Zag Leaf hoppers) and *Nephotettix virescens* (Green leafhopper blue biotype) and lepidopteran brush footed butterfly *Charaxes* spp. also newly recorded in Experimental tea plantation AAU. The incidence of maximum number of red spider mites was observed to be 54.78 per leaf during the 3rd week of Oct, the population trend continues up to December and reaches second maximum during 3rd week of December with 40.67 mites per leaf. No mites were recorded from the 2nd week of July to the first week of August, then the population trend started to build slowly from the 4th week of August. Correlation between weather parameters and incidence of red spider mite showed significantly positive correlation with morning relative humidity ($r = 0.713$). Whereas the red spider mite population had a negative correlation with Maximum temperature (r

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= - 0.499), Minimum temperature ($r = -0.681$), Evening relative humidity ($r = -0.590$) and total rainfall ($r = -0.548$). The incidence of tea mosquito bug was maximum during Nov – Dec with the highest population indices record of 70.00 infested shoots per bush, the second maximum population indices were recorded during the 4th week of Nov at the rate of 63.6 infested shoots per bush. Zero population indices were recorded during the 3rd week of July to 2nd week of August. The population indices in the rest of the months range from less than 10 infested shoots per bush. Correlation between weather parameters and population indices of tea mosquito bug showed population indices was significantly positive correlated with morning relative humidity ($r = 0.531$). Whereas the tea mosquito bug population indices were negative correlation with Maximum temperature ($r = -0.418$), Minimum temperature ($r = -0.529$), Evening relative humidity ($r = -0.318$) and total rainfall (-0.480). Efficacy of newer acaricide against active stages of red spider mite during two rounds of spray showed the treatments T6 (Fenazaquin 20% EC 100 g *a.i.* ha⁻¹), T7 (Rebufenpyrad 20% EC 200 g *a.i.* ha⁻¹) recorded cent percent reduction in mite population and it was at par with T3 (Rebufenpyrad 20% EC 100 g *a.i.* ha⁻¹), T5 (Fenpyroximate 5% EC @ 30 g *a.i.* ha⁻¹) that recorded 0.04 and 0.77 mites per leaf respectively. Whereas T4 (Propargite 57% EC 612 150 g *a.i.* ha⁻¹) recorded 3.23 mites per leaf. T1 (Rebufenpyrad 20% EC @ 50 g *a.i.* ha⁻¹) recorded 8.70 mites per leaf, T2 (Rebufenpyrad 20% EC 75 g *a.i.* ha⁻¹) recorded 2.59 mites per leaf indicting an increasing trend of mite population over the previous data counted. Efficacy newer acaricides against eggs of red spider mite during two rounds of spray showed the treatments T6, (Fenazaquin 20% EC @ 100 g *a.i.* ha⁻¹) recorded 6.17 eggs per leaf and it was at par with T7, (Rebufenpyrad 20% EC @ 200 g *a.i.* ha⁻¹), T5, (Fenpyroximate 5% EC @ 30 g *a.i.* ha⁻¹) and T3, (Rebufenpyrad 20% EC @ 100 g *a.i.* ha⁻¹) recorded 8.34, 9.00 and 15.83 eggs per leaf respectively. The least ovicidal activity was recorded in T1, (Rebufenpyrad 20% EC @ 50 g *a.i.* ha⁻¹) and T4, (Propargite 57% EC @ 612 g *a.i.* ha⁻¹) with 32.00 and 29.17 eggs per leaf. Effect of acaricides against the natural enemies of tea pests was recorded at different days after spray. Among the treatments T5 (Fenpyroximate 5% EC @ 30 g *a.i.* ha⁻¹) and T6 (Fenazaquin 20% EC @ 100 g *a.i.* ha⁻¹) recorded mortality against hymenopteran natural enemies. Whereas T4 (Propargite 57% EC @ 612 g *a.i.* ha⁻¹) recorded mortality against grub of coccinellide beetle *Stethorus punctillum*. Effect of acaricides on predatory mites, *Amblyseius* sp evaluated under laboratory showed that among the treatments T5, (Fenpyroximate 5% EC @ 30 g *a.i.* ha⁻¹), T6 (Fenazaquin 20% EC @ 100 g *a.i.* ha⁻¹) and T7 (Rebufenpyrad 20% EC @ 200 g *a.i.* ha⁻¹) recorded cent percent mortality. Whereas the least mortality was recorded in T1, (Rebufenpyrad 20% EC @ 50 g *a.i.* ha⁻¹) with 6.67 predators per leaf.

Bio efficacy of certain entomopathogenic fungus against major insect pests of *Brassica campestris* var. *toria*

Prabhu Prasanna Pradhan

Field experiment was conducted in Instructional-Cum-Research (ICR) farm, Assam Agricultural University, Jorhat during *rabi* 2018-19 to evaluate the bio-efficacy of certain entomopathogenic fungus against major insect pests of *Brassica campestris* var. *toria*.

Seasonal incidence of insect pests and natural enemies revealed that mustard aphid, *Lipaphis erysimi*, sawfly, *Athalia lugens proxima* and flea beetle, *Phyllotreta cruciferae* appeared during 51st SMW (Standard Meteorological Week) and was active till 9th SMW. Highest population of aphid and flea beetle were observed during 6th SMW, whereas maximum number of mustard sawflies were observed during 4th SMW. Moreover, the predator, *Coccinella transversalis* and the hymenopteran parasitoid, *Diaeretiella rapae* were observed during 4th SMW and active till 9th SMW.

Correlation coefficient between different weather parameters and population of major insect pests revealed that aphid had a positive correlation with maximum temperature ($r = 0.502$), minimum temperature ($r = 0.456$) and rainfall ($r = 0.038$), whereas aphid had shown a negative impact with evening relative humidity ($r = -0.251$), but a significant negative correlation was observed with morning relative humidity ($r = -0.606$). Flea beetle showed a positive correlation with maximum temperature ($r = 0.510$) and minimum temperature ($r = 0.120$) but showed a negative correlation with morning relative humidity ($r = -0.523$), evening relative humidity ($r = -0.484$) and rainfall ($r = -0.206$). Sawfly exerted a negative correlation with morning relative humidity ($r = -0.328$), evening relative humidity ($r = -0.525$) and with rainfall ($r = -0.552$). A significant negative correlation was also observed with minimum temperature ($r = -0.625$) but had a positive correlation with maximum temperature ($r = 0.461$). In case of natural enemies, *C. transversalis* showed a significant positive correlation with minimum temperature ($r = 0.669$) but had a negative correlation with morning relative humidity (r

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= -0.453) and evening relative humidity ($r = -0.058$). Similarly, *D. rapae* had a significant positive correlation with minimum temperature ($r = 0.682$) but a negative correlation was observed with morning relative humidity ($r = -0.447$) and evening relative humidity ($r = -0.047$). relationship of aphid and natural enemies showed that aphid had significant positive correlation with ladybird beetle population ($r = 0.710$) and *D. rapae* population ($r = 0.670$).

All the treatments were found to be significantly superior over control (untreated). Results of efficacy of entomopathogenic fungus against mustard aphid and sawfly revealed that, lowest mean population (0.39 aphids/10 cm twig and 0 sawfly) was observed in dimethoate 30 EC @ 2 ml/lit treated plots after 3rd spray followed by *Lecanicillium lecanii* (NBAIR) (2.22 aphids/10 cm twig and 0.29 sawflies/plant) and highest population was observed in Azadirachtin @ 2 ml/lit treated plot (18.18 aphids/10 cm twig and 2.99 sawflies/plant), but in case of flea beetle, lowest mean population (0.02 flea beetle/plant) was observed in dimethoate 30 EC @ 2 ml/lit treated plots followed by *L. lecanii* (NBAIR) (0.09 flea beetle/plant) and highest was observed in *Metarhizium anisopliae* (AAU-culture) treated plot (2.95 flea beetle/plant).

The efficacy of treatments against *C. transversalis* revealed that after 3rd spray, highest mean population was observed in Azadirachtin @ 2 ml/lit treated plots (2.05 beetle/plant) followed by *L. lecanii* (AAU-culture) (1.71 beetle/plant), whereas highest mean population of *D. rapae* was observed in Azadirachtin @ 2 ml/lit treated plots (2.40 *D. rapae*/plant) followed by *M. anisopliae* (AAU-culture) (2.01 *D. rapae*/plant).

Management of *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) - a stored grain pest of *Flemingia macrophylla* (Willd.) and *Flemingia semialata* (Roxb.)

Preetipuja Kashyap

Laboratory experiments were conducted in the Insect Physiology Laboratory of Department of Entomology, Assam Agricultural University, Jorhat during 2018-19 to study the comparative biology of *Callosobruchus chinensis* on *Flemingia macrophylla*, *Flemingia semialata*, *Vigna radiata* and *Cicer arietinum* seeds and to evaluate the efficacy of some bio-pesticides viz., citronella oil, lemongrass oil, patchouli oil, neem oil, mustard oil, *Vitex negundo* leaf powder, *Leucas indica* leaf powder and *Beauveria bassiana* formulation. The plant oils were evaluated at different doses viz., 2.5, 5, 10, 15 and 20 ml per kg seeds. Whereas, leaf powders and *Beauveria bassiana* formulation were applied at 0.5, 1, 5, 10 and 15 g per kg seed.

The developmental parameters during the months of June-July and Nov-Dec showed that the total developmental period was highest in *F. semialata* (32.60±0.50 days, 46.4±0.50 days) and lowest in *V. radiata* (25.40±0.24 days, 39.2±0.37 days) in both the seasons respectively.

Fecundity was observed to be highest in chickpea (84.2±1.28) and lowest in *F. semialata* (67.6±0.51). The highest seed infestation percentage recorded in *V. radiata* (76.81±0.88) and lowest in *F. semialata* (65.30±3.21).

While evaluating the plant oils, citronella oil was found to be superior over rest of the plant oils, registered the highest percent of mortality i.e. 100% mortality at 72 hours after treatment (HAT) followed by lemongrass oil (at 96 HAT), patchouli oil (at 144 HAT), neem oil (at 168 HAT) and mustard oil (98% mortality at 168 HAT).

Among the leaf powders (*Vitex negundo*, *Leucas indica*) and *Beauveria bassiana* formulation, *B. bassiana* showed highest mortality (100%) at 120 HAT at the dose of 15g/kg seed. However, *L. indica* leaf powder showed 100% mortality at 144 HAT followed by *V. negundo* leaf powder (96% mortality at 168 HAT) at the dose of 15g/kg seed.

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The highest oviposition inhibition (100%) was observed in case of citronella oil, lemongrass oil and patchouli oil, followed by neem oil (95.37%) and mustard oil (74.38%). Among the leaf powders (*V. negundo*, *L. indica*) and *B. bassiana* formulation, *B. bassiana* exhibited 100% inhibition followed by *Leucas indica* leaf powder (81.91%) and *V. negundo* leaf powder (79.73%).

Similarly, highest hatching inhibition (100%) was observed in case of citronella oil, lemongrass oil and patchouli oil, followed by neem oil (94.69%) and mustard oil (84.15%). Among the powder formulations, *B. bassiana* exhibited 100% inhibition followed by *L. indica* leaf powder (75.54%) and *V. negundo* leaf powder (49.29%).

Botanicals for Tea Insect Pest Management

Ritushree Mahanta

The experiment on bioefficacy of *Annona squamosa* (L.) (Family: Annonaceae), *Adhatoda vasica* (L.) (Family: Acanthaceae), *Cascabela thevetia* (L.) Lippold (Family: Apocynaceae), *Datura stramonium* (L.) (Family: Solanaceae) and *Lawsonia inermis* (L.) (Family: Lythraceae) leaf extracts conducted at Department of Entomology, Assam Agricultural University, Jorhat during 2018-20 revealed a dose- and time-dependent mortality of red spider mite (RSM), *Oligonychus coffeae* Nietner (Tetranychidae: Acarina) and tea mosquito bug (TMB), *Helopeltis theivora* Waterhouse (Miridae: Hemiptera) attacking tea plantation. The leaves of the selected insecticidal plants were collected from the Jorhat district of Assam; which were later macerated and extracted with standard procedure in distilled water on weight/volume basis for preparation of desired concentrations through serial dilution method viz., 0.1%, 0.5%, 0.75%, 1.0%, 2.5%, 5.0%, 7.5%, 10.0%. Neem Seed Kernel Extract (NSKE) 0.15% EC 2.5 ml/litre of water as standard check along with a control (water) were also taken for toxicity comparison. The treatments were replicated thrice and the data on adult mortality were recorded at 6, 12, 24, 48 and 72 hours after treatment (HAT). Moreover, plant extracts at different concentrations were also tested for ovicidal activity against *O. coffeae*. Tea leaves were also tested for any change in biochemical properties of tea leaves after application of botanicals to control *H. theivora* and *O. coffeae* at Phytochemistry Laboratory, Department of Biochemistry & Agricultural Chemistry, AAU, Jorhat during 2018-20. Best three plant extracts showing lowest LC₅₀ values against the test insects were considered for biochemical investigation and data were recorded at 1, 3, 5 and 10 days after spraying (DAS) of botanicals with three replications.

The results on bioefficacy revealed the strong acaricidal properties of *D. stramonium* recording 90.00% mortality of *O. coffeae* adults, while *L. inermis* has been found to be having strong insecticidal properties against *H. theivora* adults recording 80.00% mortality at 72 hours after treatment (HAT). The water extract of *D. stramonium* had the highest ovicidal properties causing complete inhibition of hatching of *O. coffeae* eggs even upto 5.00% concentration as against 91.32% hatching in the

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control, which was followed by *A. vasica* recording 25.93% hatching at 5.00% concentration as compared to 93.03% hatching in the control.

The order of toxicity of botanicals against *O. coffeae* in terms of LC₅₀ values was *D. stramonium* (0.270%)>*A. vasica* (1.979%) >*L. inermis* (2.085%) > *C. thevetia* (3.740%) > *A. squamosa* (3.942%); while the order of toxicity in case of *H. theivora* was found to be *L. inermis* (1.052%)>*D. stramonium* (2.228%) >*C. thevetia* (2.296%) >*A. vasica* (2.644%) >*A. squamosa* (4.534%).

The best three botanicals based on their LC₅₀ values viz., *Lawsonia inermis* (1.052%), *Datura stramonium* (2.228%) and *Cascabela thevetia* (2.296%) for *H. theivora* and for *O. coffeae* the botanicals viz., *Datura stramonium* (0.270%), *Adhatoda vasica* (1.979%) and *Lawsonia inermis* (2.085%) were tested for biochemical parameters including chlorophyll a & b, carotenoids, reducing sugar and polyphenols along with healthy leaf sample and found that the reducing sugar content in TMB and RSM infested tea leaves decreased upon application of *D. stramonium* leaf water extracts to 1.592 mg/100g and 3.477 mg/100g, respectively at 10 DAS as compared to control (6.566 mg/100g & 5.487 mg/100g respectively). Whereas, the polyphenol content in TMB and RSM infested tea leaves decreased upon application of treatment with *L. inermis* and *D. stramonium* leaf water extracts to 3.967 mg/100g and 3.247 mg/100g, respectively on 10 DAS as compared to the control (8.470 mg/100g & 6.773 mg/100g respectively). The chlorophyll a, chlorophyll b and carotenoids contents in both TMB and RSM infested tea leaves was found to have decreased upon application of *D. stramonium* leaf extracts.

Brood rearing and foraging activity of stingless bee (*Tetragonula iridipennis* Smith) in cucumber (*Cucumis sativus* Linnaeus) under protected condition

Sourav Sen

Investigations on brood rearing and foraging activities of stingless bee (*Tetragonula iridipennis* Smith) in cucumber (*Cucumis sativus* Linnaeus) were carried out in the Department of Entomology and Horticulture Experimental Farm, Assam Agricultural University, Jorhat during 2019-2021. Three stingless bee colonies, maintained in wooden hives with specifications 15504 cc, 14364 cc and 6664 cc were selected to study the brood rearing activity in the apiary of the department. The brood, pollen and honey areas were measured by using a 5×5 cm sq. paper grid. The determination of foraging activities and effect of stingless bee pollination on cucumber was done by installing 15504 cc hive (approx. 700-1000 bees) at 25% flowering of the crop under protected condition during summer, 2020 and winter, 2020-2021. In 15504 cc hive, the highest brood (204.52±1.90 cm sq.), pollen (138.53±3.98 cm sq.) and honey (90.8±2.14 cm sq.) areas were observed during February, 2020 whereas the lowest brood (62.78±3.92 cm sq.), pollen (74.62±2.40 cm sq.) and honey (68.92±2.17 cm sq.) areas were observed during April, 2020, October, 2019 and July 2020. The maximum and minimum brood areas during February, 2020 and April, 2020 were also recorded in 14364 cc (163.15±1.10 and 46.95±3.07 cm sq.) and 6664 cc (137.99±1.45 and 48.10±3.46 cm sq.) hives. The highest pollen areas in 14364 cc (127.91±1.08 cm sq.) and 6664 cc (123.40±0.57 cm sq.) hives were observed during February and January, 2020 whereas the lowest pollen areas in 14364 cc (74.54±2.72 cm sq.) and 6664 cc (78.27±1.79 cm sq.) hives were observed during August 2020. The maximum and minimum honey area in 14364 cc (82.99±4.87 and 68.13±2.40 cm sq.) was observed during January 2020 and December, 2019. The highest and lowest honey area in 6664 cc (80.28±0.39 and 63.99±2.10 cm sq.) was recorded during June and July, 2020. A significant negative correlation was observed between brood, pollen and honey areas of

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15504 cc hive and maximum temperature; brood, pollen and honey areas and minimum temperature, brood, pollen and honey areas and evening relative humidity. Brood and pollen areas have also shown significant negative correlations with total rainfall and number of rainy days. Similar trend in the results of correlation studies was also observed in 14364 cc and 6664 cc hives at $p < 0.05$.

A total of 35 plant species belonging to 23 families were recorded as foraging sources of *T. iridipennis* within the campus. The family Asteraceae (20%) was found to be the dominant one as most preferred foraging source followed by Solanaceae (11.43%) and Brassicaceae, Rosaceae and Caryophyllaceae with 5.71 per cent abundance. In the prepared floral cycle of *T. iridipennis*, the maximum foraging plants were available during December (16%), January (16%) followed by February (13%). Furthermore, a very few foraging plants were available during August (4%) and September (4%). In the second experiment, study on foraging behaviour have shown *Apis cerana indica* was the most predominant pollinator (29.87%) under open pollination followed by *A. dorsata* (21.07%), *Xylocopa* sp. (10.69%) and *T. iridipennis* (9.12%). The foraging behaviour of *T. iridipennis* in summer, 2020 and winter, 2020-2021 revealed that the maximum number of *T. iridipennis* per flower per minute (1.06 ± 0.15 and 1.21 ± 0.16) was recorded in 0800-0900 hours and minimum number (0.51 ± 0.11 and 0.49 ± 0.08) was found in 1600-1700 hours of the day during summer, 2020 and winter 2020-21 respectively. The maximum and minimum time spent per flower was 11.57 ± 0.37 and 12.07 ± 0.99 seconds during 0800-0900 hours during summer and winter, 2020-21 whereas the minimum was 7.15 ± 0.83 seconds at 1600-1700 hours in summer, 2020 and 8.32 ± 0.71 seconds at 1500-1600 hours during winter, 2020-21. The maximum pollen loads carried by 10 individuals was 6.50 ± 0.67 mg and 7.15 ± 0.39 mg at 0800-0900 hours and minimum was found to be 2.93 ± 0.56 mg and 2.98 ± 0.45 mg at 1600-1700 hours of the day during summer and winter, 2020-21 months respectively. During summer and winter, maximum fruit length (18.08 ± 1.23 and 18.31 ± 1.24 cm), fruit girth (10.08 ± 0.59 and 10.14 ± 0.56 cm), fruit weight (202.62 ± 12.98 and 205.11 ± 8.85 g), fruit set (79.06 ± 8.60 and 83.85 ± 6.16 %) and fruit yield/ha (13.15 ± 6.68 and 14.65 ± 2.31 t) were recorded in stingless bee pollinated plot (SBP) whereas minimum (11.24 ± 0.79 and 10.71 ± 0.86 cm, 7.78 ± 0.53 cm and 7.70 ± 0.45 cm, 92.05 ± 6.81 and 90.38 ± 5.99 g, 34.14 ± 9.40 and 35.80 ± 8.04 % and 2.13 ± 0.68 and 2.39 ± 0.67 t) was observed in pollinator exclusion (PE). *T. iridipennis* pollinated cucumber plot produced 5 times more yield than pollinator exclusion plot. A significant positive correlation was observed between number of bees per flower per minute and average temperature and relative humidity during both the seasons whereas a positive significant correlation was found between pollen load per 10 bees per trip and average temperature during summer, 2020 only.

Haemocyte Morphology and Cellular Immune Response in Cabbage butterfly, *Pieris brassicae* (L.) against *Beauveria bassiana* (Bals.)Vuill.

Sravanthi Erla

Beauveria bassiana, an entomopathogenic fungus is the alternative biocontrol agent exploited against the major economic crop pests. *Pieris brassicae* (L.) is an emerging pest of the Brassicaceae family. In the present study, fungal isolate of *B. bassiana* viz, BBJ-S-1 was evaluated to study the virulence against 5th instar larvae of *P. brassicae* (Lepidoptera: Pieridae). The work was carried out in the Insect Physiology laboratory, Department of Entomology, Assam Agricultural University, Jorhat-13 during 2018-2020. Study on biology of *P. brassicae* resulted out the various life stages viz., egg, 1st, 2nd, 3rd, 4th, 5th instar larvae and pupa with the average 1.12 ± 0.04 , 4.25 ± 0.95 , 8.06 ± 0.79 , 15.10 ± 0.88 , 25.54 ± 0.97 , 36.50 ± 0.98 and 0.54 ± 0.06 , 0.37 ± 0.02 , 1.65 ± 0.19 , 3.28 ± 0.25 , 4.18 ± 0.36 , 4.82 ± 0.47 mm in body length and width respectively. The average developmental period of larval instars and pupa were found to be 17.73 and 7.72 days respectively. The wing expanse of male butterfly was ranged between 52.96 ± 1.00 mm and the female was 62.92 ± 1.01 mm. The total developmental period from egg to adult was recorded 39.13 ± 2.29 days. *B. bassiana* (1×10^7 conidia/ml) showed 84 per cent mortality rate of *P. brassicae*. Four types of haemocytes namely; prohaemocytes (PRs), plasmatocytes (PLs), granulocytes (GRs) and oenocytoids (OEs) were observed in the haemolymph of 5th instar larvae of *P. brassicae* (L.). PRs were smallest rounded with large nuclei, spindle or ovoid shaped PLs with round nuclei, rounded or ovoid GRs with round nuclei and largest rounded OEs with eccentric nuclei. The total haemocyte count (THC) ranged between 5145 to 5511 cells/mm³ in control and 5545 to 3033 cells/mm³ in treated insects. Differential haemocyte count (DHC) ranged as 5.01-5.71 (PRs), 34.16-36.65 (PLs), 54.32-54.98 (GRs), 4.92-5.14 per cent (OEs) in control where as in case of treated 0.77-5.73 (PRs), 34.26-39.24 (PLs), 54.87-59.71 (GRs), 1.16-5.17 per cent (OEs). PRs were reduced drastically while PLs and GRs were increased significantly in response to *B. bassiana*. Granulocytes and plasmatocytes of *B. bassiana* infected larvae showed morphological changes whereas no change was

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observed in control. Granulocytes showed fine pseudo-pod like cytoplasmic extensions and disintegration of the plasma membrane at 6 HAT accompanied by leakage of cell contents. In addition clumping of plasmatocytes and granulocytes, apposition of granulocytes, filopodial elongation, degranulation and vacuolation of GRs were observed. Cellular immune reactions viz., phagocytosis, encapsulation and nodule formation were observed against *B.bassiana*. The plasmatocytes and granulocytes were the principal cell types, which responded mostly during the defence. The 5th instar larvae treated with *B. bassiana* although transformed into pupa but died after 2 days without transforming into adult whereas in control the larvae transformed into pupa and further to the adult stage was recorded. *B. bassiana* can be a promising biocontrol agent to manage the *P. brassicae* in near future.

Evaluation of release methods of Trichogrammatids (Hymenoptera: Trichogrammatidae) against lepidopteran pests of cabbage

Tanbir Hazarika

A field experiment on release methods of Trichogrammatids (Hymenoptera : Trichogrammatidae) against lepidopteran pests of cabbage was carried out during *rabi* 2018-2019 at Experimental farm, Organic section, Department of Horticulture, Assam Agricultural University, Jorhat. The *Trichogramma pieridis* was released in the cabbage field using different methods for the effective biological suppression of the lepidopteran pests. The different treatments were trichocard stapled under the surface of leaves (T1), trichocard stapled under the surface of leaves + 20% honey solution (T2), trichocard covered with cup for protection from rain (T3), trichocard covered with cup for protection from rain +20% honey solution (T4), trichocard attached with stick at 50 cm distance (T5) and along with untreated control (T6). All the treatments brought about a significant reduction on the incidence of lepidopteran pests over untreated control. It was found that the plot treated with trichocard covered with cup for protection from rain + 20% honey solution (T4) registered the lowest population of pests. The second best treatment was found to be trichocard stapled under the surface of leaves + 20% honey solution (T2) followed by trichocard stapled under the surface of leaves (T1) trichocard covered with cup for protection from rain (T3) and trichocard attached with stick at 50 cm distance (T5) were found to be least effective in controlling the pests population. In the investigation a total of four lepidopteran pests belonging to three different families *ie* Plutellidae, Pieridae and Noctuidae have been found to attack the crop during different growth stages. Of lepidopteran insect pests diamondback moth, *Plutella xylostella* (L.), cabbage butterfly, *Pieris canidia* (L.) and cabbage looper, *Trichoplusia ni* (Huf) were considered as major pests of cabbage. Population of *Cotesia plutellae*, *Coccinella transversalis* and *Episyrphus belteatus* were also recorded as natural enemies in cabbage ecosystem. The correlation study of different weather parameters indicated that both maximum and minimum temperature showed negative correlation with the population build up of *P. xylostella* ($r=-0.31$, $r=-0.74$), *P. canidia* ($r=-0.83$, $r=-0.64$), *T. ni* ($r=-0.33$,

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$r=-0.74$), *C. plutellae* ($r=-0.60$, $r=-0.59$), *E. belteatus* ($r=-0.75$, $r=-0.59$) and *C. transversalis* ($r=-0.43$, $r=-0.72$), respectively. As regards to yield, the highest yield was recorded in treatment T4 with 37.0 q/ha. The second best yield was found in treatment T2 with 33.0 q/ha followed by treatment T1 with 22.2 q/ha, treatment T3 with 20.7 q/ha and treatment T5 with 17.0 q/ha during 2018-19, respectively.

Study on native plants as hosts of Lac insect, *Kerria chinensis* (Mahdihassan)

Tanjil Rahman

Field and laboratory experiments were conducted at Lac park and Lac laboratory, Department of Entomology, Assam Agricultural University, Jorhat-13 during May, 2018 to April, 2019 to screen out the native plants as preferred and non preferred hosts of *Kerria chinensis*. Eight native plants *i.e.*, *Flemingia semialata*, *Flemingia strobilifera*, *Indigofera teysmannii*, *Ficus religiosa*, *Zizyphus mauritiana*, *Litchi chinensis*, *Hibiscus rosa-sinensis*, *Cajanus cajan* were selected to study the productivity linked parameters and life cycle of the lac insect to find out their host preference. It was also aimed to find out the role of certain morphological and biochemical characteristics in respect of preference.

The productivity linked parameters were studied in two different seasons from May, 2018 to October, 2018(Season I) and October, 2018 to April, 2019(Season II). Among the eight investigated native plants, *F. semialata* recorded the best results in terms of duration of life cycle as well as productivity linked parameters. *F. semialata* recorded highest initial density of settlement (nos./sq.cm), final density of settlements (nos./sq.cm), female cell density at crop maturity (nos./sq.cm), cell size (mm), cell weight (mg), resin weight (mg), fecundity (nos. of crawlers /female cell), broodlac yield (kg) and broodlac ratio (broodlac yield at harvesting/inoculated broodlac).The life cycle of *K. chinensis* in *F. semialata* was completed in 164.52 days in season I and 171.92 days in season II.All the parameters showed better results in season II compared to season I.

The lac insect was found to thrive well in all the plants except in *I. teysmannii* where the insects died within 21 days of lac inoculation. The life cycle and productivity parameters recorded in all the hosts showed good results but varied significantly from host to host.

Study on morphological parameters revealed that the girth of the bark of the plants possesses significant negative correlation with the settlement density of crawlers as well as production of lac. However, trichome density of the bark was found to

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possess positive but non significant correlation with the settlement density of crawler s as well as production of lac.

Among the biochemical constituents, correlation studies revealed that phenol content of the bark registered a significant positive correlation with the production of lac. Flavanoid was found to possess a negative but non significant correlation whereas alkaloid content showed positive non significant correlation with the production of lac.

Effect of gamma irradiated rice seeds against certain insect pests of rice

Uddipana Shandilya

An experiment entitled “Effect of gamma irradiated rice seeds against certain insect pests of rice” was carried out at the Instructional-cum-Research (ICR) Farm and insectary cum screening house, Assam Agricultural University, Jorhat during Sali 2018 (M2 generation) and Sali 2019 (M3 generation) respectively, to screen out the most effective doses of gamma irradiation showing tolerance against insect pests as well as to study the biochemical and morphological characteristics of the irradiated plants imparting tolerance against rice insect pests. Seeds of popular rice variety Ranjit Sub-1 were taken for irradiation at NRL laboratory, New Delhi. Five different gamma irradiated doses 100Gy, 150Gy, 200Gy, 250Gy and 300Gy along with an unirradiated control and a check variety (Jaya) was taken as treatments and each treatment was replicated four times. The field experiment was laid out in a randomized block design and the entire experiment was conducted organically. Three insect pests of rice i.e. *Dicladispa armigera* (Olivier), *Cnaphalocrocis medinalis* (Guenee), and *Leptocorisa oratorius* (Fabricius) were taken for screening. Experimental findings revealed that among the gamma irradiated doses, 200Gy showed minimum infestation as well as incidence of *Dicladispa armigera* (Olivier) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) followed by 150Gy and 100Gy. Infestation by *D. armigera* was lowest at 200Gy (14.93±1.05%) and highest at 300Gy (25.81±1.18%). According to the Standard Evaluation System (SES), IRRI, the doses 100Gy, 150Gy and 200Gy were recorded as Moderately Resistant, 250Gy and 300Gy as Less Susceptible category against *D. armigera* infestation. Infestation by *C. medinalis* was lowest at 200Gy (14.84±0.98%) and highest at 300Gy (24.80±2.01%). The doses 100Gy, 150Gy and 200Gy were recorded as Moderately Resistant, 250Gy and 300Gy as Moderately Susceptible against *C. medinalis* infestation according to SES, IRRI. In case of grain infestation by *L. oratorius* none of the gamma irradiated doses were found to be tolerant. Biochemical characteristics of the rice plants like nitrogen, potassium, phenol and crude protein was

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found to have significant effect in imparting tolerance against rice insect pests. Nitrogen and crude protein was found to be positively correlated whereas potassium and phenol were negatively correlated with insect infestation. Morphological characters of rice plant like total leaves, total tillers and leaf width were found to have significant effect in insect infestation. Total leaves and total tillers were negatively correlated and leaf width was positively correlated with insect pest infestation. Highest yield among the gamma irradiated doses were found at 200Gy.

A study on extent of Farm Mechanization in North Bank Plains Zone of Assam

Abhishek Rajkhowa

The study entitled as ‘**A study on extent of farm mechanization in North Bank Plains Zone of Assam**’ was conducted with the following objectives:

1. To determine the extent of farm mechanization across different farm size groups
2. To explore the impact of farm mechanization on the farm production across different farm size groups
3. To identify the factors influencing the extent of farm mechanization across different farm size groups
4. Find out the constraints faced by the farmers in mechanization across different farm size groups

The present study was conducted in NBPZ of Assam. Sonitpur district and Udalguri district were selected randomly. Random sampling design was followed for selection of sub-divisions, ADO circles, AEA *Elekas* and villages for the study. A proportionate-cum-random sampling (probability proportionate to size) technique was followed for selection of 160 respondents which constituted the sample for the study. The head of each farm household was the respondent of the study. The major tool used for collection of primary data in the study was a pretested schedule by personal interview method. The study period was from February to April.

All together 17 independent variables, viz., Age, Education level, Family type, Family size, Social participation, Occupational status, Degree of information exposure, Size of operational land holding, Working capital availability, Gross annual income, Risk orientation, Scientific orientation, Economic orientation, Innovativeness, Labour availability, Credit seeking behavior and Cropping intensity. Farm mechanization was the dependent variable considered in the study. The statistical tools used for analysis and interpretation of data included frequency, percentage, mean, standard deviation and coefficient of variation.

Findings revealed that Majority of the respondents (46.25%) belonged to the middle aged category with 21.25 per cent of respondents being illiterate. Majority of the respondents (72.50%) belonged to single family type, had small family size (67.57%),

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had small category of land holding size (38.75%), had medium social participation (46.25%) and medium gross annual income (71.26%). Likewise, majority of the respondents (45.63%) belonged to the medium credit seeking behavior category, medium degree of information exposure (60%), medium level of working capital availability (66.88%), medium level of risk orientation (51.87%), medium level of scientific orientation (60%), medium level of economic motivation (65.62%), medium level of taking credit (45.63%), low level of innovativeness (41.25%), medium level of cropping intensity (77.50%) and low level of labour availability (74.37%).

As regards extent of farm mechanization, findings revealed that majority of marginal (64.86%), small(64.52%), medium(72%) and large(72.73%) farmers had ii medium level of farm mechanization. In Case of pooled sample majority (67.5%) of the respondents had medium level of farm mechanization. As regards impact of farm mechanization on farm production, four crops were selected viz., rice, mustard, cauliflower and watermelon. Findings revealed that across all farm categories the 't' value was found to be significant at 0.01 and 0.05 level. So in case of all farm categories farm mechanization showed significant impact on productivity of rice, mustard, cauliflower and watermelon. In case of cropping intensity also farm mechanization showed significant impact. The result of correlation analysis revealed that out of 17 independent variables, 6, 8 and 8 independent variables significantly correlated with the extent of farm mechanization of marginal, small and medium farmers respectively. In the pooled sample, 11 independent variables had significantly correlated with the extent of farm mechanization. Of these education level($r=0.573$), social participation($r=0.442$), occupational status($r=0.367$), working capital availability($r=-0.194$), scientific orientation($r=0.577$), economic motivation ($r=0.612$), innovativeness($r=0.353$) and cropping intensity($r=0.635$) had moderately strong coorelation with extent of farm mechanization. The result of regression analysis revealed that 3,3 and 4 independent variables had positive significant contribution towards extent of farm mechanization of marginal, small and medium farmers respectively. In case of pooled farmer respondents variables; education level, occupational status, scientific orientation, economic motivation, cropping intensity, social participation, working capital availability and innovativeness had positive significant contribution towards extent of farm mechanization. 'High initial cost', 'lack of finance' and 'lack of awareness about implements' were faced by both marginal and small farmers as three most important constraints in mechanization. 'High fuel cost', 'high maintenance cost' and 'high initial cost' were faced by medium and large farmers as three most important constraints in mechanization.

A study on effectiveness of advisory services rendered by Agro-Input Dealers in Jorhat District, Assam

Adrija Bora

The study entitled “A study on effectiveness of advisory services rendered by Agro-Input Dealers in Jorhat District, Assam” was carried out in Jorhat district. A total of 120 respondents were selected using simple random sampling technique out of which 30 were agro-input dealers and 90 were farmers. The data were collected by means of personal interview schedule. Appropriate statistical tools employed to analyze and interpretation of data.

The profile analysis of the farmers indicated that majority of the farmers were middle aged (66.67%) completed high school (40%) with 4 to 6 members family (72.22%) and 1-2 ha of cultivable land (46.67%). Majority of farmers (74.44%) had annual income ranging from Rs. 80158.09-198950.86 with medium farming experience (67.78%) but received less training (11.11%) with medium level of extension contact (90%), participation in extension activities (60%) and mass media participation (71.11%). Medium level of contact with agro input dealers was found for 66.67 per cent. Advisory services provided by agro input dealers to the farmers were found moderately effective (74.44%), followed by highly effective (13.33%) and less effective (12.22%).

In case of agro input dealers, majority of the input dealers were middle aged (76.67%), with education higher secondary (46.66%), 4 to 6 family members (60%), with average 11.77 years dealership experience and 10.8 years farming experiences. The average annual income Rs.3,42,100.00 and majority of them (46.67%) deals with fertilizer, pesticides and seeds and invested their owned fund(70%). Training and mass media were the source of information for majority agro input dealers. Majority of them had medium level of extension contact (83.33%) and participation in extension activities (56.67%). Knowledge of the agro input dealers about selected POP of major crops was found medium level (60%), followed by low (23.33%), and high (16.67%). And item wise analysis results revealed that in case of paddy 100 per cent of the respondents had

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correct knowledge on 'variety of crop', 'water management', 'weed management' and 'harvesting'. In case of okra, cabbage, pea and rapeseed crop 100 per cent of the respondents had correct knowledge on 'harvesting'. In case of brinjal and potato crop 100 per cent of the respondents had correct knowledge on 'water management', 'weed management' and 'harvesting'. And dealers had very less knowledge on 'fertilizer management' in all the crops.

'Language problem while talking with dealers', 'unavailability of inputs at times', 'Lack of updated information', 'Slow in solving problem', 'dealers do not give field visit on request' were most prominent problems reported by majority farmers. While for input dealers 'not able to meet company personnel at urgent times', 'Lack of time for field visits on farmer request', 'Insufficient feedback from farmers about performance of agro-advisory services' and 'Inadequate technical qualification of input dealers in agro-advisory services', 'communication with farmers', 'Lack of sufficient field experience' were the most prominent problems.

A study on the extent of diversification and level of livelihood security of farmers in the North Bank Plains Zone of Assam

Akhoy Jyoti Bharadwaj

The study entitled ‘A Study On The Extent Of Diversification And Level Of Livelihood Security Of Farmers In The North Bank Plains Zone Of Assam’ was conducted with the following objectives:

1. To find out the extent of diversification across different farm size groups
2. To find out the level of livelihood security of farmers across different farm size groups
3. To identify the factors influencing the extent of diversification and level of livelihood security across different farm size groups
4. To identify the constraints in diversification as perceived by the farmers across different farm size groups.

The present study was conducted in The North Bank Plains Zone Of Assam.

The North Bank Plains Zone consists of 6 districts. Out of these 2 districts was selected randomly *viz.*, Sonitpur and Lakhimpur. A random sampling was followed for the selection of sub-divisions, ADO circles, AEA *elekas* and villages. A sample of 160 farmers was selected from the 8 selected villages following a proportionate random sampling technique. The major tool used for collection of primary data in the study was a pretested schedule by personal interview method. The statistical tools used for analysis and interpretation of data included frequency, percentage, mean, standard deviation, coefficient of variation, t-test, multiple correlation coefficient and multiple regression analysis.

The two dependent variables included in the study were extent of diversification and level of livelihood security. All together 15 independent variables were included in the study.

Findings revealed that 23.12 per cent of the respondents were marginal farmers, 43.13 per cent small and 33.75 per cent medium farmers. Majority of the respondents

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were middle aged (50.62%) and literate (82.50%) with single type (71.87%) but large (51.25%) large size family and had medium (44.40%) credit seeking behaviour. Majority of the respondents (38.75%) had membership in one organization. Majority of the respondents had medium degree of information exposure (48.12%), medium farm mechanization (70/00%), medium scientific orientation (43.75%), medium risk orientation (54.37), medium economic motivation (56.87%), high innovativeness (37.50%) and medium management efficiency (60.63%). While, 54.05 per cent of the marginal farmers had less favourable attitude towards agricultural diversification, 68.12 per cent of small and 50.00 per cent of the medium farmers had moderately favourable attitude towards agricultural diversification.

In this study, the extent of diversification was measured in terms of crop diversification and enterprise diversification across different farm size groups. As regards crop diversification, in case of marginal farmers, majority of the respondents (59.46%) had medium crop diversification followed by 27.03 per cent of them with low and 13.51 per cent of them with high crop diversification. In case of small farmers, majority of the respondents (75.37%) had medium crop diversification followed by 13.04 per cent of them with high and 11.59 per cent of them with low crop diversification. Whereas among the medium farmers, majority of the respondents (53.70%) had medium crop diversification category followed by 33.33 per cent of them with high and 12.97 per cent of them with low crop diversification. In the pooled sample of farmers, majority of the respondents (64.37%) had medium crop diversification followed by 20.00 per cent of them with high and 15.63 per cent with low crop diversification.

As regards enterprise diversification, majority of the marginal farmers (64.86%) had medium enterprise diversification followed by 27.03 per cent with low and 8.11 per cent with high enterprise diversification. In case of small farmers, majority (66.67%) of the respondents had medium enterprise diversification followed by 17.39 per cent of them with low and 15.94 per cent with high enterprise diversification. Whereas among the medium farmers, majority (51.85%) of the respondents had medium enterprise diversification followed by 29.63 per cent with high and 18.52 per cent with low enterprise diversification. In the pooled sample of farmers, majority (61.25%) of the respondents had medium enterprise diversification followed by 20.00 per cent with low and 18.75 per cent with high enterprise diversification.

As regards livelihood security, majority of the marginal farmers (57.76%) had medium level of livelihood security followed by 32.43 per cent with low and 10.81 per cent with high level of livelihood security. In case of small farmers, majority (63.77%) of the respondents had medium level of livelihood security followed by 18.84 per cent of them with low and 17.39 per cent with high level of livelihood security. In case of medium farmers, majority (51.85%) of the respondents had medium level of livelihood security followed by 33.33 per cent with high and 14.82 per cent with low level of livelihood security. In the pooled sample of farmers, majority (58.13%) of the

respondents had medium level of livelihood security followed by 21.25 per cent with high and 20.62 per cent with low level of livelihood security.

Findings of correlation analysis of crop diversification reveal that, in case of marginal farmers, 9 independent variables and in case of both small and medium farmers 7 independent variables were significantly correlated with the extent of crop diversification. In the pooled sample of farmers, 10 independent variables were significantly correlated with the extent of crop diversification.

The findings of regression analysis of crop diversification revealed that, in case of marginal farmers out of 9 independent variables, only 3 variables were found to contribute significantly towards the extent of crop diversification. The variables *viz.* size of operational land holding, scientific orientation and innovativeness had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of R^2 (0.674) indicated that 9 independent variables selected for regression could predict 67.40 per cent of the variation in extent of crop diversification. In regards small farmers, out of 7 independent variables, only 4 variables were found to contribute significantly towards the extent of crop diversification. The variables *viz.* innovativeness and management efficiency were had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable size of operational land holding and risk orientation had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of R^2 (0.787) indicated that 7 independent variables selected for regression could predict 78.70 per cent of the variation in extent of crop diversification. In case of medium farmers, out of 7 independent variables, only 4 variables were found to contribute significantly towards the extent of crop diversification. The variables *viz.* size of operational land holding, scientific orientation and economic motivation had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable farm mechanization was positively and significantly correlated with extent of crop diversification at 0.05 level. The value of R^2 (0.787) indicated that that 7 independent variables selected for regression could predict 74.50 per cent of the variation in extent of crop diversification. In the pooled sample of farmers, out of 10 independent variables, 7 variables were found to contribute significantly towards the extent of crop diversification. The variables *viz.* size of operational land holding, scientific orientation, risk orientation, economic motivation, innovativeness and management efficiency had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable degree of information exposure had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of R^2 (0.813) indicated that 10 independent variables selected for regression could predict 81.30 per cent of the variation in extent of crop diversification.

Findings of correlation analysis of enterprise diversification reveal that, in case of both marginal and medium farmers, 8 independent variables and in case of small farmers 12 independent variables were significantly correlated with the extent of

enterprise diversification. In the pooled sample of farmers, 9 independent variables were significantly correlated with the extent of enterprise diversification.

The findings of regression analysis of enterprise diversification revealed that, in case of marginal farmers out of 8 independent variables, only 3 variables were found to contribute significantly towards the extent of enterprise diversification. The variables *viz.* size of operational land holding, innovativeness and management efficiency had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of R^2 (0.829) indicated that 8 independent variables selected for regression could predict 82.90 per cent of the variation in extent of enterprise diversification. In respect of small farmers, out of 12 independent variables, only 5 variables were found to contribute significantly towards the extent of enterprise diversification. The variables *viz.* education level and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level, whereas the variables size of operational land holding, social participation and innovativeness had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of R^2 (0.831) indicated that 12 independent variables selected for regression could predict 83.10 per cent of the variation in extent of enterprise diversification. In case medium farmers, out of 8 independent variables, only 4 variables were found to contribute significantly towards the extent of enterprise diversification. The variables *viz.* size of operational land holding, degree of information exposure and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level whereas the variable economic motivation had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of R^2 (0.745) indicated that 7 independent variables selected for regression could predict 74.50 per cent of the variation in extent of enterprise diversification. In the pooled sample of farmers, out of 9 independent variables, 6 variables were found to contribute significantly towards the extent of enterprise diversification. The variables *viz.*, age, degree of information exposure, innovativeness, management efficiency and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level whereas, the variable operational land had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of R^2 (0.813) indicated that 9 independent variables selected for regression could predict 81.30 per cent of the variation in extent of enterprise diversification.

Findings of correlation analysis of livelihood security revealed that in case of marginal farmers, 13 independent variables and in case of both small and medium farmers, 7 independent variables were significantly correlated with the level of livelihood security. In respect of pooled sample of farmers, 12 independent variables were significantly correlated with the level of livelihood security.

The findings of regression analysis of livelihood security revealed that, in case of marginal farmers out of 13 independent variables, 5 variables were found to contribute significantly towards the level of livelihood security. The variables social participation and innovativeness had positive and significant contribution towards level of livelihood security at 0.01 level whereas, the variables size of operational land holding, risk orientation and management efficiency had positive and significant contribution towards level of livelihood security at 0.05 level. The value of R^2 (0.929) indicated that 13 independent variables selected for regression could predict 92.90 per cent of the variation in level of livelihood security. As regards small farmers, the variables size of operational land holding, social participation, economic motivation, innovativeness and management efficiency had positive and significant contribution towards level of livelihood security at 0.01 level. The value of R^2 (0.849) indicated that 7 independent variables selected for regression could predict 84.90 per cent of the variation in level of livelihood security. In respect of medium farmers, out of 6 independent variables, 3 variables were found to contribute significantly towards the level of livelihood security. The variables social participation, economic motivation and innovativeness had positive and significant contribution towards level of livelihood security at 0.01 level. The value of R^2 (0.776) indicated that 6 independent variables selected for regression could predict 77.60 per cent of the variation in level of livelihood security. In the pooled sample of farmers, out of 12 independent variables, only 5 variables were found to contribute significantly towards the level of livelihood security. The variables social participation, economic motivation, innovativeness and management efficiency had positive and significant contribution towards level of livelihood security at 0.01 level whereas, the variable size of operational land holding had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of R^2 (0.873) indicated that 12 independent variables selected for regression could predict 81.30 per cent of the variation in level of livelihood security. “Lack of finance to start a new enterprise”, “high cost of labour” and “Lack of information regarding scientific cultivation of crops” were perceived by the marginal farmers as the three most important constraints in diversification. “Lack of finance to start a new enterprise”, “High cost of labour” and “High cost of animal feed” were perceived by both small and medium farmers as the three most important constraints in diversification.

A Study on the Entrepreneurial Behaviour of the Nursery Owners in Kamrup (Metro) and Kamrup Districts of Assam

Arup Bora

The study entitled “**A Study on the Entrepreneurial Behaviour of Nursery Owners in Kamrup (Metro) and Kamrup Districts of Assam**” was undertaken in Kamrup (Metro) and Kamrup Districts in Assam, primarily to assess the entrepreneurial attributes of the nursery owners, measure their entrepreneurial behaviour, study the relationship between the entrepreneurial attributes and the entrepreneurial behaviour and to study the constraints experienced by the nursery owners in managing their nursery enterprises.

A descriptive research design, following an *ex post facto* approach was utilized for the study. A multi-stage, purposive cum convenience sampling design was adopted for the study in order to select 50 (fifty) nurseries. Data has been collected during the month of March and April of 2019 with the help of a pretested, structured research schedule, using the personal interview method.

With respect to the entrepreneurial attributes of the nursery owners, the study revealed that majority of the respondents (54.00%) belonged to the middle aged category, with high level of formal education (62.00%) and low level of social participation (54.00%). Majority of the respondents (74.00%) were in the medium category with respect to their cosmopolitaness and belonged to the booming class with experience in nursery business ranging between 2 to 19 years (68.00%). Vast majority of the respondents (88.00%) belonged to the marginal category of land holding size, belonging to the medium income category (72.00%). Majority (60.00%) of the respondents had medium level of achievement motivation and risk orientation (62.00%).

The data for entrepreneurial behaviour revealed that majority (48.00%) of the respondents were prospective entrepreneurs, possessing a mix of both external and internal locus of control. While 32.00% of the respondents highlighting more of internal locus of control belonged to the category of entrepreneurial internals, the remainder (20.00%) were entrepreneurial externals, showing more external locus of control.

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Major Advisor : Dr. J. K. Sharma

The Pearson's product moment correlation coefficients between entrepreneurial behaviour and the selected independent variables of the study shows that seven variables, viz, education, social participation, cosmopolitaness, size of land holding, annual income, achievement motivation and risk orientation were positively and significantly correlated with entrepreneurial behaviour.

Linear multiple regression analysis highlighted that education, annual income, achievement motivation and risk orientation had a causal relationship with entrepreneurial behaviour as they were positively and significantly related with entrepreneurial behaviour.

With regard to personal constraints, majority (46.00%) of the respondents perceived work stress to manageable; absence of required knowledge and skill to be negligible (60.00%) and problem of lack of time to be negligible to manageable (80.00%). In so far as social constraints were concerned, majority (82.00%) of the respondents perceived family problems to be negligible to manageable and absence of social support to be negligible to manageable (84.00%). As far as the financial constraint category was concerned, majority (48.00%) of the respondents perceived that the constraint of paucity of capital was manageable, closely followed by 42.00% of them who perceived it to be a severe constraint. In the marketing constraint category, most of the respondents (82.00%) stated that the constraint of inability to find market was negligible to manageable. Under the human resource constraint category, 84.00% of the respondents perceived that the constraint of insufficient labour was negligible to manageable. Lack of skilled labour was stated to be manageable by 52.000% of the respondents. More than half (54.00%) of the respondents perceived lack of technical support to be a severe problem under the technical constraint category along with absence of required nursery infrastructure & equipment (60.00%) .

Facilitating the social participation of the nursery owners; organising stakeholder interfaces and buyer seller meets to promote cosmopolitaness; ensuring higher returns per unit area by adopting scientific nursery management practices; facilitating participation in state, national and international level expositions for strengthening forward linkages; organizing capacity building programmes on risk management, contingency planning, activity planning; facilitating credit linkages; availing advantages of government schemes and programmes and strengthening the internal locus of control of the nursery owners are the general recommendations of the study.

Resource Integration in *bari* system farming: A study in Jorhat district of Assam

Ashish Hazarika

Bari system farming is the best way to integrate resources, which were present in every house of the small and marginal farmers such as: crops, fruits, live-stock etc. Considering the importance of the resource integration the present study was entitled ‘Resource integration in *bari* system farming: A study in Jorhat district of Assam’. The objectives that are taken for the study are: □ To assess the level of food availability and agricultural productivity from the *bari* system farming □ To study quality of resources in terms of soil, water and tree in *bari* system farming. □ To study social acceptability of *bari* system farming. The study was carried out in Titabor sub-division of Jorhat district of Assam, from where 10 respondents were selected randomly from four villages. Data was collected from the randomly selected farmers. To study all these aspects of the *bari* system farming i.e., food availability, agriculture production and productivity, quality of resources, social acceptability of the components etc., an appropriate schedule was prepared and data was collected from all the selected respondents. For processing the data, statistical methods like frequency, mean, percentage, standard deviation, coefficient of variance, rank, regression analysis were used with the help of Microsoft excel and other concerned departments. The study revealed that majority of farmers were middle aged (35 to 50yrs.) and most of them are Schedule Tribe (Plain). Majority of farmers had land holding up to 1.76 ha. Majority of respondents had net annual income Rs.8199.52-Rs.26936.6. Average cultivable area of each family was 1.2 hectare of which only 0.4 hectare was for the horticultural area, 0.2 hectare for non-cultivable area. Area under the *bari* system farming, where of the majority had between 0.13 to 0.31hectare. Majority of the respondents with 67.5% were under the medium category level of resource integration. The integration between Vegetable and Livestock was found common with majority of the respondents.

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Department : Extension Education

Major Advisor : Dr. Sundar Barman

A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat

Chiranjeeta Dutta

The present study entitled “A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat” was undertaken with the following objectives:

1. To delineate the socioeconomic and personal profile of the visitors of ATIC.
2. To assess the effectiveness of ATIC of AAU, Jorhat.
3. To identify difficulties of the visitors if any, in availing ATIC services and their suggestive measures.

The study was conducted in Jorhat district of Assam to measure the effectiveness of ATIC located at Assam Agricultural University (AAU), Jorhat from the farmers’ point of view. Two villages from each direction (North, East, West and South) which are located within the radius of 50 km from ATIC were selected on random basis for the present study. Respondents from eight villages were selected purposively by using snowball sampling technique with the help of records available in ATIC register of AAU, Jorhat. Primary data was collected from 120 beneficiary farmers having regular and good contact with ATIC through personal interview technique. Effectiveness of ATIC was measured by the scores obtained from four different dimensions *viz.* attitude of the respondents, satisfaction level of respondents, respondent’s level of change/improvement in agriculture and allied practices, personal and economic empowerment of the respondents. The overall perceived effectiveness of ATIC was measured with the help of effectiveness index.

The study revealed that majority of the respondents belonged to the middle aged group (40.00%) of 36 to 55 years, from the OBC caste (56.67%), with educational qualification of High School passed (26.67%), were married (80.83%), belonged to joint family type (57.50%) having medium family size (55.00%) with 5 to 10 members. Majority of the respondents possessed marginal land holding (70.00%), had occupation

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Major Advisor : Dr. Debajit Borah

of only farming with no subsidiary occupation (40.00%). Majority of the respondents had medium annual family income (73.33%) ranged between Rs. 53,764.36 to Rs. 1,56,893.98 with no membership in any organization (44.17%).

It was observed from the study that majority of the respondents had medium level of overall attitude (68.33%), medium overall satisfaction level (71.67%), medium level of overall change/improvement in agriculture and allied practices (60.00%), medium level of overall personal and economic empowerment (60.83%), medium level of overall perceived effectiveness of ATIC (65.83%).

The study indicated that age and annual family income of the respondents had significant relationship with attitude of the respondents. Annual family income of the respondents had significant relationship with satisfaction level of respondents. Age, operational land holding and annual family income of the respondents had significant relationship with respondent's level of change/improvement in agriculture and allied practices. Age, operational land holding and annual family income of the respondents had significant relationship with personal and economic empowerment of the respondents. Annual family income of the respondents had significant relationship with overall perceived effectiveness of ATIC whereas, the variables *viz.*, age, size of family and operational land holding had no significant relationship with overall perceived effectiveness of ATIC.

The findings of the study showed that education, occupation and social participation of the respondents had significant association with attitude of the respondents. Social participation of the respondents had significant association with satisfaction level of respondents. Education, marital status, occupation and social participation of the respondents had significant association with respondent's level of change/improvement in agriculture and allied practices. Caste, education, occupation and social participation of the respondents had significant association with personal and economic empowerment of the respondents. Social participation of the respondents had significant association with overall perceived effectiveness of ATIC whereas, the variables *viz.*, caste, education, marital status, type of family and occupation had no significant association with overall perceived effectiveness of ATIC.

The three severe difficulties faced by the respondents in availing ATIC services were "lack of awareness about the services and facilities available at ATIC" (72.50%), followed by "more distance between ATIC and host village" (70.83%) and "lack of proper transportation facilities to ATIC" (45.00%).

A Study on the Effectiveness of Skill Training of Rural Youth (STRY) Programme Implemented by KVKs in Assam

Darpan Kr. Das

Economic uplift of a nation depends not only on agriculture but also on the active participation of youths in agriculture. It is imperative to train and develop the youths skillfully that may help transform agriculture into a lucrative entrepreneurial activity. So, introduction of effective skill training programmes in agriculture and allied sectors is of immense necessity for paving the way to a bright future of the youths. The study was conducted in five districts of Assam, viz., Dhemaji, Lakhimpur, Udalguri, Baksa and Dima Hasao in the year 2019 with a view to study the effectiveness of Skill Training of Rural Youth (STRY) programme implemented by the KVKs of Dhemaji, Lakhimpur, Udalguri, Baksa and Karbi Anglong respectively. The study was carried out with a total of 120 respondents by using purposive sampling technique and by taking 80 per cent of the trainees trained under each of the selected KVKs. The data were collected by means of personal interview schedule and through personal observation for critical skills. Statistical tools employed to analyze the data included frequency, percentage, mean, standard deviation, Pearson product moment correlation coefficient, 't' test and chi-square test. The findings revealed that majority (49.17%) of the respondents belonged to the age group of 22 to 32 years, with majority (86.67%) being male and most of them (39.17%) had education up to higher secondary level. Majority (69.17%) of the respondents were marginal farmers and annual income for highest percentage of respondents (75%) ranged between Rs. 40,408.02 to Rs. 2,25,988.64. It was found that majority (62.50%, 60.83%, 46.67% and 65.83%) of the respondents had medium level of achievement motivation, learning motivation, motivation to transfer learning and self-efficacy respectively, and 44.17 per cent had high level of economic motivation. The study further revealed that majority (62.50%) of the trained youths had medium level of training effectiveness. A positive and significant relationship was found between effectiveness of trained youths and their education, annual income, operational land holding, achievement motivation, learning motivation, economic

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motivation, motivation to transfer learning and self-efficacy. Guidelines and methodologies for training under STRY were suggested to be better specified. The guidelines and methodologies for training perceived as important by trainees included demonstration of skills, field visits, methods used for theory and practical sessions, and effective session plan for training sessions/skill teaching. Problems/constraints faced by trainees during and after the training included lack of Government support and benefits, lack of proper study materials and inadequate hands-on training. Suggestions expressed by trainees for improvement of training were provision of loans by Government to practice the skills, incorporation of more number of practical sessions and provision of raw materials needed to practice the skills acquired. The findings revealed that although the STRY programme has been implemented successfully by the concerned KVKs in Assam, there is ample scope to improve the STRY programme in the subsequent phases for the benefit of the rural youths by considering the suggestions given by the trainees.

A Study on the Extent of Adoption of Recommended Muga (*Antheraea assamensis*) Rearing Practices in Lakhimpur District of Assam

Jagat Jyoti Baruah

The present study was carried out in the Lakhimpur district of Assam with the objectives to study the extent of adoption of scientific Muga rearing practices along with the level of knowledge of Muga rearers on scientific Muga rearing practices and constraints faced by the Muga rearers. A total of 120 Muga rearers were selected as respondents by following simple random sampling technique. Appropriate statistical tools viz., frequency, percentage, mean, standard deviation, weightage mean score, correlation and multiple regression analysis were employed to analyze the data. The findings revealed that most of the respondents were in the age group of 36-56 years with educational qualification as high school passed. Moreover, majority of the respondents were from ST caste, belonged to the joint family of medium sized family i.e., 4 to 8 members. Majority of the respondents had annual income from Muga between Rs. 67,000 to Rs 2,93,000. Majority of the respondents were marginal farmers having land holding up to 1 ha and an area of upto 5 bigha under Muga cultivation. Majority of the respondent family's primary occupation is Muga and allied agriculture having farming experience between 10-20 years and majority of the respondents used family members as help in Muga rearing. Fellow farmers/ Progressive farmers was ranked first in regard to extension contact by Muga rearers. Almost two third of the respondents had not attended any training on Muga rearing. Majority of the respondents were having medium level social orientation. Although information sources utilization were found as regular in majority respondents but had low information source relevancy to Muga. Majority of respondents have medium level of marketing orientation, risk bearing ability and decision making ability. With regard to knowledge level on adoption of recommended cultivation practice majority of the respondents had medium level. The majority of the Muga rearers exhibited a medium level of extent of adoption of recommended scientific practices of Muga. Correlation coefficient revealed a positive and significant relationship between the extent of adoption and variables namely age,

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total annual income, annual income from Muga, total landholding, area under Muga, farm experience, extension contact, risk bearing ability, and negative and significant relationship between the extent of adoption and variables namely education and decision making ability. Moreover, correlation coefficient revealed a positive and significant relationship between the knowledge on adoption and variables namely age, land holding under Muga, experience and extension contact. Whereas, for regression analysis the variables which were found to be significant relationship with dependent variable were considered. The multiple regression analysis with fifteen predictors produced $R^2=0.714$. Thus, this signifies that fifteen variables taken together could explain 71.4 per cent of the total variation in respondent's extent of adoption. The findings suggested that the government should take proper initiatives to help the rearers, machinery and other facilities should be provided by the extension agencies, institutions, etc. Periodically, training should be provided to the rearers based on their needs, timely meetings and contact should be there between the rearers and experts to get information and solutions. Proper financial, technical, and other support should be provided to the rearers, proper training, information, inputs about the diseases and pest management, and their measures should be given. The proper market channel, government center for collection, and appropriate rates for their products should be there. Moreover, extension contact need to be frequent to aware and inspire them to adopt recommended scientific practices of Muga cultivation and rearing.

Training need assessment of agricultural input dealers in Upper Brahmaputra Valley Zone (UBVZ) of Assam

Lisha Bordoloi

Agricultural research and extension are two major factors of agricultural development. An efficient extension system is capable of timely dissemination of need based farm technology among farming communities which has great importance for achieving sustained growth in agriculture. The system of transfer of technology from research stations to the farming community has always played a crucial role in modernizing agriculture. Considering training as an important element for agricultural input dealers to increase their both theoretical as well as practical knowledge on agricultural technology the present study entitled 'Training need assessment of agricultural input dealers of Upper Brahmaputra Valley Zone (UBVZ) of Assam' was done. The study was conducted in Golaghat, Jorhat and Sivasagar districts of Assam under Upper Brahmaputra Valley Zone. A total of 121 agricultural input dealers as respondents (40% of total number of agricultural input dealers from each district) were selected by following the snowball sampling technique. Appropriate statistical tools like frequency, percentage, mean, standard deviation, coefficient of variance, t-test and chisquare analysis were used to analyze the data. The findings of the study with regard to the selected profile characteristics of the respondents indicated that 65.28 per cent of the input dealers were middle aged, 61.15per cent of the respondents had 'higher secondary level' of education, 61.16 per cent of the respondents had 'medium' experience in dealership, 52.89 per cent of the respondents sold one type of input, 61.98per cent of the agricultural input dealers had medium annual income, 60.33 per cent of the respondents had 'medium' level of extension contact, 75.21 per cent of the respondents had 'medium' information seeking behaviour, 78.51 per cent of the respondents had 'medium' level of cosmopolitaness, 67.78 per cent of the respondents had 'medium' level of risk orientation, 65.29 per cent of the respondents had 'medium' level of economic motivation and 57.02 per cent of the respondents had 'received'

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training. Most of the respondents (66.94%) had 'fair' level of advice provided to the farmers while dealing with agricultural inputs. Also, majority of the respondents (69.42%) had 'medium' level of training need.

Livelihood diversification of muga and non muga rearers- A comparative study in Majuli district of Assam

Manash Jyoti Borah

Muga is famous as golden silk, and it has the potentiality to provide substantial income to farmers. However, it was observed that in the same locality all farmers are not adopting muga as an income-generating portfolio of livelihood and livelihood diversification exist within muga rearers. Research gap exists in the area, and so the study was conducted to find out the livelihood diversification of muga rearers and muga non-rearers in a traditional muga belt of Majuli district of Assam. Total 75 muga rearers and 75 muga non-rearers were selected by proportionate random sampling technique. The data were collected using the personal interview schedule and through personal observation. Statistical tools employed to analyse the data included frequency, percentage, mean, standard deviation, chi-square test, t-test, Simpson Index of diversity (SID) and cross-tabulation.

The findings revealed that the majority (38.70%) of the respondents belonged to the age group of 36-44 years in case of muga rearers and 38.70 percent muga non-rearers belonged to 46-54 years of age group. Most of the muga rearers (32.00%) were up to middle school passed, and most of the muga non-rearers (30.70%) were higher secondary and above passed. Majority of the muga rearers (54.70%), as well as muga non-rearers (58.70%), belonged to scheduled tribe (ST). Most of the muga rearers (57.30%), as well as muga non-rearers (78.70%), were having the nuclear type of family. Majority of respondents (58.70%) were small farmers in case of muga rearers and marginal farmers in case of muga non-rearers (52.00%). The average monthly income for the highest percentage of respondents (60.00%) in case of muga rearers ranged between Rs. 14000-18375 and for muga non-rearers (46.70%) it was 8750-150083 Rs. It was found that majority of the respondents had a medium level of economic orientation both in the case of muga rearers (54.70%) and muga non-rearers

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(40.00%). Social participation was found as high in the case of muga rearers (64.00%) and medium in case of muga non-rearers (53.30%). The study further revealed that the average SID value of muga rearers was 0.67 and in the case of muga non-rearers, it was 0.75, which is on the higher side. Majority of muga rearers (62.70%) and much non-rearers (76.00%) were found to have high livelihood diversification.

The study revealed that livelihood diversification was high both in the case of muga rearers and muga non-rearers, but it was more in case of muga non-rearers. It reflected that muga gives a good income to the rearers, but still, it was not a dependable source of income. Less land in the surveyed area for somoni will hinder for extension of the portfolio. So, effort should be given to sustain the existing somoni. Since the surveyed area was a traditionally famous muga belt, it should be protected, and proper marketing with a brand name may be tried for muga. It will also open the scope for entrepreneurship. So, start-up programme in AAU incubation centre may try to see the viability of entrepreneurship development.

A Study on the factors influencing entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production

Manisha Barman

The present study entitled “A Study on the factors influencing Entrepreneurial Behaviour of the members of Farmer Producer Company with reference to commercial potato production” was carried out with the following objectives:

1. Assess the personal, socio-economic, psychological and communication characteristics of the members of Farmer Producer Company
2. Measure the Entrepreneurial Behaviour of the members of Farmer Producer Company with reference to Commercial Potato production
3. Explore the relationship of Entrepreneurial behaviour of the members of Farmer Producer Company with their selected personal, socio-economic, psychological and communication characteristics
4. Identify the constraints as perceived by the members of Farmer Producer Company in production and marketing of Potato

The study was undertaken in Nagaon and Biswanath districts of Assam which were selected purposively, as two Farmer Producer Companies dealing with commercial potato production were operating in these two districts. Two FPCs namely, Satbhani Potato Producer Company of Biswanath district and Sankar Azan Agro Producer Company of Nagaon district were selected purposively for the study. A sample of 120 farmer members of two FPCs was selected from the six selected villages following a proportionate random sampling technique. The primary data for the study were collected by the personal interview method with the help of a structured research schedule. The primary data for the study were collected during the month of February 2020 and November 2020. Keeping in view the objectives of the study, 18 independent variables and 1 dependent variable were included in the study. The independent variable included

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in the study were age, education level, family size, family type, potato farming experience, occupational status, size of operational land holding, area under potato cultivation, annual net farm income, social participation, scientific orientation, leadership ability, decision making ability, risk orientation, achievement motivation, economic motivation, degree of information exposure and exposure to training. The dependent variable included in the study was the entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production which was measured by using the scale developed by Rao (1985). The statistical techniques and tests used in the study for analysis and interpretation of the data were frequency, percentage, arithmetic mean, standard deviation, co-efficient of variation, multiple correlations, multiple regression and t-test for testing the significance of the coefficients for correlation and regression analysis. Findings revealed that majority of the respondents (50.00%) were in the middle aged group followed by 28.33 per cent of respondents in old aged group and 21.67 per cent of the respondents in young aged group. Most of the respondents (30.83%) had higher secondary/ PU level of education followed by 27.5 per cent respondents with high school level of education. Majority of the respondents (51.57%) had large family size and rest had small family size. Majority of the respondents (74.17%) belonged to the nuclear family and the rest 25.83 per cent belonged to the joint family. Majority of the respondents (53.33%) had medium term (10-20 years) experience of potato farming followed by 27.50 per cent respondents with long term experience (21 years and above). Majority of them (65.00%) had only cultivation as their occupation followed by 25.00 per cent of respondents had cultivation + business as occupation. Majority of the respondents (45.00%) belonged to the small farmer category followed by 26.67 per cent in semi-medium and 21.67 per cent of the respondents in marginal land holding category. Only 6.66 per cent of the respondents belonged to the medium land holding category. In case of area under potato cultivation, majority of the respondents (47.50%) were having a land area above 2 ha followed by 37.50 per cent respondents having land area from 0.3 to 2 ha. Majority of the respondents (61.67%) had medium annual net farm income ranging from Rs 41731.34 to Rs 109585.33 followed by 23.33 per cent respondents with low annual net farm income up to Rs 41731.33. In case of social participation, majority of the respondents (70.83%) were member of one organization, followed by 22.50 per cent respondents having membership with more than one organization/ institutions. Majority of the respondents (62.50%) had medium level of scientific orientation followed by 22.50 per cent respondents with low level of scientific orientation and 15.00 per cent respondents with high level of scientific orientation. Majority of the respondents (53.33%) had medium level of leadership ability followed by 24.17 percent respondents with low level of leadership ability and 22.50 per cent respondents with high level of leadership ability. Majority of the respondents (64.17%) had medium level of decision making ability followed by 23.33 percent respondents with low level of decision making ability and 12.50 per cent respondents with high level of decision making ability. Majority of the

respondents (65.00%) had medium level of risk orientation followed by 20.83 per cent respondents with low level of risk orientation and 14.17 per cent respondents with high level of risk orientation. Majority of the respondents (58.34%) had medium level of achievement motivation followed by 20.83 per cent respondents with both low level and high level of achievement motivation. Majority of the respondents (66.67%) had medium level of economic motivation followed by 18.33 per cent respondents with high level of economic motivation and 15.00 per cent respondents with low level of economic motivation. Among the personal cosmopolite sources of information, Input dealers were used in regular basis by majority (48.33%) of the respondents followed by NGO personnel (35.00%), Agril. Scientists/ KVK scientists (13.33%), ADO/Block Extension Personnel/SDAO/DAO (5.83%) and Agricultural Extension Assistant (4.17%) as their source of information. Among the personal localite sources of information, friends/ relatives/ neighbours or fellow farmers were used regularly by majority (22.50%) of the respondents followed by family members (20.00%) for getting information about the use of improved farming practices. Among the mass-media sources, farm publications were used regularly by majority (22.50%) of the respondents followed by mobile phones (20.83%), internet (17.50%), newspaper (15.00%), television (14.17%) and radio (11.67%) as their sources of information. Majority of the respondents (75.00%) had medium level of information exposure followed by 15.00 percent respondents with high level of information exposure and 10.00 percent respondents with low level of information exposure. Majority of the respondents (55.83%) had medium level of exposure to training followed by 23.34 percent respondents with high level of exposure to training and 20.83 percent respondents with low level of exposure to training. Findings revealed that majority (48.33%) of the respondents were prospective entrepreneurs, possessing a mix of both external and internal locus of control. While 31.67 per cent of the respondents highlighting more of internal locus of control belonged to the category of entrepreneurial internals, the remainder 20.00 per cent was entrepreneurial externals, showing more external locus of control. The mean value (2.27) indicated that on an average the sample tended to lean towards the prospective entrepreneur category, with the scores of individual respondents tending to cluster around the mean as depicted by the standard deviation value (0.83). Findings of correlation analysis indicated that out of the 18 selected independent variables, 12 independent variables were significantly correlated with the entrepreneurial behaviour of the members of FPC. Among the 12 independent variables, 10 variables *viz.*, education level (0.845), potato farming experience (0.351), scientific orientation (0.796), leadership ability (0.598), decision making ability (0.503), risk orientation (0.824), achievement motivation (0.833), economic motivation (0.677), degree of information exposure (0.763) and exposure to training (0.587) showed significant and positive relationship with the entrepreneurial behaviour of the members of FPC at 0.01 level of probability and 2 variables *viz.*, age (-0.566) and family size (-0.238) showed significant but negative relationship with the entrepreneurial behaviour

of the members of FPC at 0.01 level of probability. The variables which were found to have significant correlation with entrepreneurial behaviour of the members of FPC were further selected for multiple regression analysis with a view to determining the relative influence of those independent variables in predicting the dependent variable (entrepreneurial behaviour). The predicting power of multiple regressions was estimated with the help of coefficient of multiple determinations (R²) and adjusted R². Out of 12 independent variables, 7 variables, viz., education level (0.120), scientific orientation (0.032), leadership ability (0.113), risk orientation (0.260), economic motivation (0.378), degree of information exposure (0.354) and exposure to training (0.330) were found to contribute significantly towards variation in the entrepreneurial behaviour of the members of FPC. Two variables viz., education level and risk orientation showed significant contribution towards the entrepreneurial behaviour at 0.05 level of probability and five variables, viz., scientific orientation, leadership ability, economic motivation, degree of information exposure and exposure to training showed significant contribution towards entrepreneurial behaviour at 0.01 level of probability. The value of R² (0.837) indicated that 12 independent variables selected for the study were efficient in predicting the entrepreneurial behaviour of the members of FPC. The 12 independent variables fitted in the linear regression analysis could predict 83.70 per cent of the variation in the entrepreneurial behaviour of the members of FPC. Majority of the respondents (81.67%) perceived that 'Lack of credit facility' was the most important constraint (ranked first) faced by the members of FPC in production of potato. The other constraints faced by the members in order of importance were 'high cost of labour' (71.67%), 'non availability of good quality seeds' (68.33%), 'high cost of good quality inputs' (65.00%) and 'seeds and fertilizers are not provided in proper time' (62.50%) which were ranked 2nd, 3rd, 4th, and 5th, respectively. As regards marketing related problems, majority (76.67%) of the respondents perceived that 'problem of price variability' was the most important constraint faced by the members of FPC which was ranked first. The other constraints faced by the members in marketing of potato were 'lack of proper market place/ *mandis*' (72.50%), 'large number of middlemen in the marketing system' (68.33%), 'poor product handling and packaging' (48.33%), 'poor transportation and communication facility' (39.17%) and 'poor storage facility' (22.50%) which were assigned ranks from 2nd to 6th, respectively.

Paddy Farmers' Perspective Towards Sustainable Practices in Agriculture: A Study in Tinsukia District of Assam

Moukham Wakheth

The study entitled "Paddy Farmers' Perspective towards Sustainable Practices in Agriculture: A Study in Tinsukia District of Assam" was carried out with a total of 120 respondents by means of structured interview schedule followed by personal interview. A purposive cum random sampling technique was followed. The present research was conducted in the two sub-divisions of Tinsukia district. For analysing the data, various statistical tools like frequency distribution, percentage, mean, standard deviation, co-efficient of variation, rank and weighted mean score were used.

The findings revealed that 98.34 per cent of the respondents were male and 60.84 per cent of the respondents belonged to the age group of 39-59 years. 34.17 per cent of the respondents had education up to middle school level. It was found that nearly three fourth (75.83%) of the respondents had 4-6 family members. 53.33 per cent of the respondents were found to be engaged as family labour comprising 1-3 family members. The farm size was found to be highest in the year 2017-18 with 55.83 per cent of the respondents being small farmers having 1-2 ha of land. Annual income (non-farming + farming) of respondents (74.17%) ranged between Rs.37,947.00 to Rs.79,700.00. It was found that more than half (67.50%) of the respondents had 14-33 years of farming experience. The productivity of rice was highest 34.93-47.44 q/ha in the year 2018-19. Income from rice of respondents (81.66%) was Rs.10639.9 to Rs.41655.7 in the year 2017-18. It was found that all the respondents used traditional harvesting method and their cropping pattern was found to be monocropping. The net sown area was found to be highest in the year 2017-18 with 55.00 per cent being small farmer having 1-2 ha of land. Three-fourth (89.16%) of the respondents was found to grow 'ranjit' rice variety and 92.50 per cent of the respondents had reared cattle. The study further revealed that 79.17 per cent had no irrigation facility and 80.00 per cent of the respondents had no training exposure. More than half (65.00%) of the respondents

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had medium level of extension contact. 60.83 per cent of the respondents had medium exposure to sources of information. Majority (78.33%) of the respondents had no membership in social organization and 76.67 per cent of the respondents had medium level of self-confidence. 65.00 per cent of the respondents had not received any government assistance and 13.34 per cent of the respondents had availed loan from nationalized banks. More than half (63.33%) had used MOP and 26.66 per cent had used insecticides.

It was affirmed from the findings that ‘lack of sufficient irrigation’ (100.00%), ‘heavy floods during crop period’ (98.33%), ‘scarcity of labour during peak hours’ (97.50%), ‘non-availability of quality seed in time’ (91.66%) etc. were the major constraints faced by the farmers during paddy cultivation.

It was found that the paddy farmers followed few number of ITKs in paddy cultivation for control of insect/pests, diseases and storage purpose. Majority (100.00%) of the respondents followed ITKs like ‘leaf clipping of rice seedling before transplanting’, ‘application of bamboo (*Bambusa vulgaris*) perches in rice field’ (77.50%) and ‘application of Germany bon (*Eupatorium audoratum*) in rice field’ (75.83%) etc. With respect to sustainable paddy cultivation, the farmers followed the practices like ‘use of animal manure’ (78.34%), ‘manual weeding’ (62.50%), ‘use of organic fertilizer’ (50.83%) and ‘use of minimum tillage’ (9.16%) more than once in a calendar year.

As regards to farmers’ knowledge towards sustainable agricultural practices, it was found that all the respondents had knowledge on ‘biological control and weeding of rice farm’, followed by ‘animal manure and its application’ (98.33%) and ‘green manure and its application’ (98.33%). Moreover, it was revealed from the findings that more than three-fourth (75.83%) of the respondents had medium level of knowledge towards sustainable agricultural practices.

With respect to farmers’ attitude towards sustainable agricultural practices, it was observed that the attitude ‘soil and water are the sources of all life and should therefore be strictly conserved’ with WMS 4.70 ranked first, followed by the negative attitude ‘sustainable agriculture is not economically profitable’ with WMS 4.62 ranked second and ‘application of cow dung and compost increases soil fertility’ with WMS 4.55 ranked third. Moreover, it was revealed from the findings that majority (74.17%) of the respondents had moderately favourable attitude towards sustainable agricultural practices.

An Evaluative Study of Selected Training Programmes Conducted by KVKs of Upper Brahmaputra Valley Zone of Assam

Niberto Sangma

The present study was undertaken to evaluate the training programme “production and use of organic inputs” conducted by KVKs of UBZ of Assam with the following objectives:

1. To measure the effectiveness of the training course on “Production and Use of Organic Inputs”.
2. To study extent of application of learning on the selected training by the trainees in their farm situation and changes taken place.
3. To ascertain relationship, if any, between training effectiveness and socio personal, professional and psychological characteristics of the trainees.
4. To identify difficulties, if any, in application of learning and suggest measures to overcome those for improvement of the training programme.

The study was carried out in five district of Assam. Five KVKs of UBZ of Assam were selected purposively and a total number of 125 respondents were selected using random sampling technique. The data was collected by means of personal interview schedule. Statistical tools employed to analyse the data included frequency, percentage, mean, standard deviation, Karl Pearson’s correlation coefficient, weighted Mean Score and Chi-square test for independent and dependent variable.

The findings revealed that majority 66.40 per cent of the respondents belonged to (29 to 50) years of age group and 64.00 per cent of the respondents were male and the rest 36.00 per cent were female. A large majority 80.80 per cent of the respondents were married and most of them 67.20 per cent belonged to OBC category. It was found that majority 27.20 per cent of the respondents had passed high school, while 62.40 per cent of the respondents had small size of family and majority 69.60 per cent of the family type was nuclear. Most of the farmers 40.00 per cent had small land holding and 44.80 per cent choose their main occupation as cultivation. The gross annual income ranges between Rs. (63012 to 2,06508) and 56.00 per cent of the respondent’s source of income is farming. Majority 67.20 per cent of the respondents have medium level of extension

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contact and 69.60 per cent of the respondents had medium level of mass media exposure. In case of social participation it is observed that 38.40 per cent of the respondents have no membership in any organization. The findings also revealed that majority 82.40 per cent of the respondents have medium level of achievement motivation. The present study reveals that 78.40 per cent of the respondents had medium level of economic motivation while majority 79.20 per cent of the respondent had medium level of risk preference as well.

The result obtained from the study revealed the effectiveness of training programme, in terms of perceived usefulness, majority 79.20 per cent of the respondents had moderately useful of the training. In terms of knowledge gained, 72.80 per cent of the respondents had moderately gained knowledge and in terms of skill developed, majority 71.20 per cent of the respondents had developed medium level of skill.

The study shows that majority 94.40 per cent of the respondents had applied their learning (construction of vermi tank and application of vermicompost) in their actual field condition. While, 92.00 per cent of the respondents had mentioned that they had seen changes in slow perishability of vegetables. 90.40 per cent of the respondents had mention that they had seen changes in improvement of soil quality. The study shows that 68.00 per cent of the respondents had their problems in marketing of organic inputs, while 58.00 per cent of the respondents faced problems on lack of awareness in bio pesticides.

Majority 64.00 per cent of the respondents had suggested that there should be a regular market for selling their products and 38.40 per cent of the respondents had suggested that Govt. should provide infrastructural support in construction of concrete tanks either in subsidies or fully funded.

Preference of farm women towards sericulture as income generating activity- a study in Sivasagar district of Assam

Rekamoni Gogoi

The present study was carried out in Sivasagar district of Assam with the objectives to study profile characteristics of farm women and their level of participation in sericulture activities, assessing factors influencing in preferences for sericulture as income generating activity of farm women and to explore the problems faced by the women sericulture farmers. A total of 120 farm women were selected as respondents by following simple random sampling technique. Appropriate statistical tools *viz.* frequency, percentage, mean, standard deviation, co-efficient of variation, weightage mean score, correlation, chi-square test and multiple regression analysis were employed to analyse the data.

The findings revealed that majority of the respondents (51.67%) i.e. women silkworm rearer were belonged to middle age category i.e. 30-50 years, educated up to high school level (45.83%), having joint family (58.33%) and medium sized family with 5-7 family members (44.17%). Most of the women sericulture rearer were married (89.17%), in case of occupation sericulture + agriculture + wage earnings was the major source of income for majority of respondents(55.00%) and majority (55.83%) had annual family income up to Rs 70,000. In case of operational land holdings majority (84.16%) were under the category of marginal farmers with medium level of experience in sericulture (64.17) and majority of the respondents (63.33 %) had 15-30 numbers of host plants. Most of the respondents (56.67%) had medium level of social participation with medium level of relevancy (65.00%) to farm information sources and "neighbors" was ranked as the first in case of ranking of farm information sources based on relevancy mean score(3.75). Majority of the respondents had medium level of change agent contact (57.50%) with medium level of achievement motivation (73.33%) and majority of the respondents (95.83%) didn't not had any exposure to training programmes. In case of level of participation majority of the respondents (62.5%) had partial participation in the activities of sericulture.

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The study revealed that majority of the respondents i.e. 60.00% had medium preference towards sericulture as income generation activity. Low gestation high returns followed by high employment potential, high market demand, low investment high return, to conserve tradition, ideal for weaker section of the society, compatible for women etc were the cause for women to choose sericulture as income generating activity. Preference of farm women has strong, positive and significant relationship with age ($r = 0.3872$), experience in sericulture ($r = 0.4423$), total no of host plant ($r = 0.3880$), change agent contact ($r = 0.3851$), relevancy of information source ($r = 0.4337$) and achievement motivation ($r = 0.4807$). In case of total family size ($r = 0.3172$), extent of social participation ($r = 0.2911$), operational land holdings ($r = 0.2023$) and income from sericulture ($r = 0.2745$) were found significant and positive but weak relationship with the degree of preference. Again significant association was found in case of education and type of family with preference of farm women. Overall out of 12 variables 7 variables contributes 66.47% ($R^2 = 0.6647$) to express the variation of preference of women towards sericulture as income generating activity. Women sericulture rearer faced many problems during silkworm rearing. 'No government facility' was ranked as 1st and 86.67% respondents termed it as most serious problem in the study area followed by lack of rearing equipment, no proper rearing house, shortage of leaf, financial problem etc ranked as 2nd, 3rd, 4th and 5th, respectively. Sericulture is an occupation which is mostly done by women, but still preference is medium towards it. So effort should be given to solve the problems related to sericulture. Sericulture has a vast scope for entrepreneurship development. So respondents should be trained properly to utilize sericulture venture as a major source of family income.

Extent of Gender Participation in Paddy cultivation- A Study in West Godavari district of Andhra Pradesh

SakkuBala Jasmine Muthabathula

The study entitled “Extent of Gender Participation in Paddy cultivation- A Study in West Godavari district of Andhra Pradesh” was carried out in two revenue divisions of the district. A total of 120 respondents were selected using purposive and proportionate random sampling technique. The data were collected by means of personal interview schedule. Statistical tools employed to analyze the data included frequency distribution, percentage, mean, standard deviation, Z-test (for selected dependent variables) and Karl Pearson’s correlation coefficient (for selected dependent variable).

The findings revealed that majority (68.34%) of the men respondents and (60.33%) of the women respondents belonged to middle age groups of 37-53 and 32-48 years and was found that men had high school education (31.67%) and women had primary school education (30.00%). Majority of the farmers have primary and secondary occupation (58.33%) and 100 per cent of the farm women have agriculture as occupation. The gross annual income of the respondents ranged between Rs. 66,811-Rs. 1,68,389. Majority (76.67%) of the respondents have pucca type of house with nuclear type of family (93.33%) and small size of family of 2-4 (88.33%) with small operational landholding (40.00%). Majority (90.00%) of the respondents both farmers and farm women have high level of farming experience. It is observed that more than half of the respondents (men-58.33%) and all the farm women (100.00%) do not have any exposure to training programme. The results obtained from the study reveals that majority (70.00%) of the farmers and majority (98.33%) of the farm women have medium level of contact with extension personnel. Majority (93.33%) of the farmers do not have any orientation towards social participation and all (100.00%) the farm women have social participation in one organization. It can be seen from the results obtained from the study that majority (61.67%) of the farmers and majority (85.00%) of the farm women have medium level of exposure to mass media/information sources.

It was found that majority (78.34%; 76.67%) of the respondents have medium level of extent of involvement in activities. Majority (96.67%; 96.67%) of the respondents

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have low level of decision making in paddy cultivation activities. It was found out that majority (91.96%, 90.00%) of the men and women get access to credit from bank. The findings revealed that men in an average perform more productive work, community work and unproductive work than women where women perform household work more than men in terms of hours/day.

The Government can take certain measures for providing the farmers with better price returns. Proper training can be provided by the Government and extension workers to the women to encourage and improve the women in any of the income generating activities so that they can be involved in those activities apart from farming.

Perceived assessment of utilization pattern of remittance – A study on interstate migration from Assam to Kerala

Shinu Thomas

The present study was carried out in Ernakulam district of Kerala with the objectives to study the profile characteristics of migrants from Assam and their perceived utilization pattern of remittance along with the perceived reason for out-migration and the relation between profile characteristics and perceived reason for migration. A total of 120 migrant respondents were selected by following the snowball sampling technique. Appropriate statistical tools viz. frequency, percentage, mean, standard deviation, mean score, and chi-square analysis were employed to analyze the data.

The findings revealed that 55 per cent of the respondents were having 25-30 years of age and majority of the respondents were male. 51.66 per cent of the respondents had high school level education and 38.33 per cent were from Nagaon district of Assam. Moreover, 59.16 per cent of the respondents were unmarried. 55.83 per cent of the respondents belonged to the nuclear family and 60.83 per cent were having a family size of 4 to 6 members. 78.33 per cent of the respondents had marginal land holdings up to 1 ha and 55.83 per cent of the respondents annual family income at source was between Rs.45000 to Rs.60000. 53.33 per cent of the respondents were having one migrant in their family. 94.16 per cent of the respondents migrated for doing unskilled jobs and 60 per cent of the respondents were working in the construction sector. 68.33 per cent of the respondents stayed in the destination for a range of 1 to 5 years. 43.33 per cent of the respondents' motivational source for out-migration was family members. 51.66 per cent of the respondents were having medium level of economic motivation. 71.66 per cent of the respondents were having a monthly income between Rs.14000 to Rs.18000 at the destination. 75.83 per cent of the respondents were sending an amount between Rs.11000 to Rs.15000 as remittance to their place of origin. 80 per cent of the respondents were using banks as the means for sending remittances and majority of the respondents were sending remittances monthly. 94.16 per cent of the

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respondent households were using the remittance for household consumption. The highest impact of the remittance was seen on the increased family income. 88.33 per cent of the respondents were having a high perception on pull factors of outmigration. 77.5 per cent of the respondents perceived decreased wage rates as the main push factor for out-migration. 92.5 per cent of the respondents perceived higher wages as the major pull factor for out-migration. Chi-square analysis revealed an association between push determinants of migration and profile characters like marital status, family size, landholding size, annual income, the purpose of migration, and remittance. And also chi-square analysis revealed an association between pull determinants and the number of migrants in the family, the purpose of migration, motivation for migration, and income at source.

An appraisal of Farmer Producer Organisation operating in Assam And Karnataka

Somesh Hiremath

Farmer Producer Organisations are argued to be the institutions which can protect small farmers from exploitation of middlemen or make them participate successfully in modern competitive markets. Considering the importance of FPOs in farming community the present study entitled 'An appraisal of Farmers Producer Organization operating in Assam and Karnataka' was designed with following objectives-

1. To assess the business characteristics of Farmer Producer Organization.
2. To explore the activities performed by Farmer Producer Organization.
3. To study the performance level of Farmer Producer Organization.
4. To find out the problems faced by Farmer Producer Organization and its members in performing their roles.

The study was carried out in Nalbari and Dharwad district of Assam and Karnataka respectively where three FPOs from each district were selected randomly. Data was collected from randomly selected farmer members, office bearers and board of directors/FPO managers of the respective FPOs. To study all these aspects of the FPO i.e., business characteristics, activities performed and performance levels of the participating FPO, an appropriate schedule was prepared and data was collected from all the selected respondents. For processing the data, statistical methods like frequency, mean, percentage, standard deviation, coefficient of variance, rank, t-test, discriminate analysis were used with the help of Microsoft excel and Statistical Package for Social Sciences (SPSS) software.

The study revealed that majority of farmers were middle aged (35 to 55 yrs) and had completed high school education. Majority of farmers in Assam had land holding up to 1 ha and farmers in Karnataka had land holding between 2-4 ha with a cropping intensity between 95.4 to 137.47 %. Majority of respondents had a farming experience between 10-25 yrs. The mean credit availability of the farmers of Assam was Rs 37,701 and for the farmers of Karnataka it was Rs 1,68,409.1, the major source of credit was

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institutional banks for majority of farmers of both the states. Majority of respondents had a moderate level of economic orientation along with the moderate level of innovativeness. Majority of farmers of Assam had low mass media exposure while in Karnataka farmers had high mass media exposure. Majority of farmers had high level of 8 training exposure and majority of farmers of Assam were trained at KVK, Nalbari while in Karnataka majority farmers were trained at SAU. From the study it was observed that majority of office bearers were young aged (18-35 yrs) and majority office bearers had graduate level education level. Majority of office bearers had a low level of work experience (less than 10 yrs) and majority of office bearers had moderate level of achievement motivation.

The study also revealed majority of the FPOs had high level of profit motive, risk and uncertainty bearing ability, selling behaviour and capital utilization. Study also revealed that supply of inputs, extension services, procurement and packaging of the produce, insurance, value addition to the produce, formation of FIGs, and implementation of government sponsored schemes were some major activities of the FPOs. Study also revealed that out of six FPOs only two of them had a direct linkage with the processing units for the sale of the produce. It was observed that there was a difference in the performance levels between state of Assam and Karnataka in 13 out of 16 different dimensions of FPOs. The overall performance was better in case FPOs of Karnataka than Assam (Wilks λ -0.220 and X² value-186.261).

The findings from the study suggested that FPOs of Assam should give more emphasis in business orientation, input supply to farmer members, exploring marketing opportunities and mobilization of farmers for group activities. FPOs should establish better linkage with processing units/companies for assured market. Custom hiring centre should be established in each FPOs of Assam for speed up mechanization in agriculture.

A study on vulnerability and adaptability of farmers to climate change in North Bank Plains Zone of Assam

Trilochan Karki Chetri

The study entitled as ‘**A study on vulnerability and adaptability of farmers to climate change in North Bank Plains Zone of Assam**’ was conducted with the following objectives:

1. To assess the vulnerability of farmers to climate change
2. To assess the adaptation pattern regarding agricultural management practices followed by farmers due to climate change
3. To identify the factors influencing farmers’ vulnerability and adaptability to climate change
4. To know the perception of farmers about the effects of climate change on agriculture

The study was conducted in North Bank Plains Zone of Assam. The zone consists of 6 districts, out of which 2 districts, namely, Sonitpur and Udalguri were selected randomly for the present study. Random sampling design was followed for selection of districts, sub-divisions, ADO circles, AEA *Elekas* and villages for the study. A proportionate-cum-random sampling (probability proportionate to size) technique was followed for selection of 120 respondents which constituted the sample for the study. The head of each farm household was the respondent of the study. The primary data for the study were collected by using a pretested structured schedule with the help of personal interview method. The primary data for the study were collected during the period from February to March, 2019. The statistical techniques and tests used in the study for analysis and interpretation of the data were frequency, percentage, arithmetic mean, standard deviation, co-efficient of variation, multiple correlations, multiple regression and t-test.

Findings revealed that majority of the respondents (45.00%) were middle aged with single family type (69.17%), big family size (64.17%), small size of land holding (40.00%) and ‘farming alone’ as occupation (75.00%). Majority of them were with medium farming experience (69.17%) and medium gross annual income (69.17). Majority of them (41.67) had no membership with any organization and an equal

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proportion of them (41.67%) were member of one organization. Majority of them (49.17%) had medium credit seeking behaviour, medium degree of information exposure (65.00%), medium level of farm mechanization (64.17%), medium level of scientific orientation (65.00%), medium level of risk orientation (63.33%), medium ii level of economic motivation (77.50) and low innovativeness (45.00%). Most of them were illiterate (23.33%) followed by 19.17% with middle school level of formal education.

Findings revealed that majority of the respondents (69.17%) belonged to medium vulnerability category followed by 16.67 per cent in high vulnerability category and remaining 14.17 per cent in low vulnerability category.

Findings revealed that adaptation index was highest in use of organic manure (62.08%) followed by summer deep ploughing (58.33%) and conservation tillage (50.83%). Adaptation Index was 50.00 per cent in use of bunds followed by change in variety (45.42%), diversified farming (45.42%), changing planting dates (40.83%), use of mulching (40.42%) and contingency crop planning (37.50%). Adaptation Index was 36.25 per cent in change in crop followed by water harvesting (34.17%), use of ITK (32.50%), bird perched (23.33%), intercropping (19.17%) and protected cultivation (8.75%). Findings revealed that majority of the respondents (67.67%) belonged to medium adaptability category followed by 19.17 per cent of respondents in low adaptability category and 14.17 per cent respondents in high adaptability category.

Findings of correlation analysis indicated that out of the 16 selected independent variables, 11 independent variables were significantly correlated with the vulnerability of farmers to climate change. All the 11 variables, *viz.*, educational level, size of operational land holding, gross annual income, farm mechanization, credit seeking behaviour, degree of information exposure, scientific orientation, risk orientation, economic motivation, innovativeness and adaptability showed significant and negative relationship with the vulnerability of farmers to climate change at 0.01 level of probability.

Findings revealed that 11 independent variables were significantly correlated with the adaptability of farmers to climate change. Among the 11 independent variables, 10 variables, *viz.*, family type, family size, size of operational land holding, gross annual income, social participation, farm mechanization, credit seeking behaviour, degree of information exposure, scientific orientation and innovativeness showed significant and positive relationship with the adaptability of farmers to climate change at 0.01 level of probability. Only one variable, farmer's vulnerability to climate change showed iii significant and negative relationship with the adaptability of farmers to climate change at 0.01 level of probability.

The variables which were found to have significant correlation with the vulnerability and adaptability of farmers to climate change were further selected for multiple linear regression analysis with a view to determining the relative influence of

those variables in predicting the variation in the vulnerability and adaptability of farmers to climate change.

Findings revealed that out of 11 independent variables which were found to have significant correlation with the vulnerability, only 5 variables, *viz.* education level, degree of information exposure, scientific orientation, economic motivation and innovativeness were found to contribute significantly towards the variation in the vulnerability of farmers to climate change. The value of R² (0.778) indicated that 11 independent variables fitted in the linear regression analysis could predict 77.80 per cent of the variation in vulnerability of farmers to climate change.

Out of 11 independent variables which were found to have significant correlation with adaptability, only 4 variables, *viz.* farm mechanization, scientific orientation, innovativeness and vulnerability to climate change were found to contribute significantly towards the variation in the adaptability of farmers to climate change. The value of R² (0.813) indicated that 11 independent variables fitted in the linear regression analysis could predict 81.30 per cent of the variation in adaptability of farmers to climate change.

Findings revealed that most of the respondents (95.83%) agreed that due to climate change conditions were getting favourable to flourish different crop diseases followed by 87.50 per cent respondents who agreed that insect infestation in crops had increased in recent years, 87.67 per cent respondent agreed that cropping pattern had changed, 85.00 per cent respondents agreed that investment in agriculture had increased and 80.83 per cent respondents agreed traditional irrigation sources like field ponds had reduced. Findings implied that farmers perceived that climate change had significant effects on various aspects of agriculture.

Nutrient budgeting of NPK doses for sweet pepper (*Capsicum annuum* ssp. *grossum* var. Swarna) under protected condition

Anjela Deka

An experiment titled “Nutrient budgeting of NPK doses for sweet pepper (*Capsicum annuum* ssp. *grossum* var. Swarna) under protected condition” as carried out in the Experimental farm, Department of Horticulture, Assam Agricultural University, during 2017-18 with the objectives: to study the growth, yield and quality of sweet pepper under different levels of NPK in protected condition and to standardize the NPK requirement of sweet pepper under protected condition and nutrient budgeting. The experiment was laid out in split-split plot design with three N main plots, three P sub plots and three K sub-sub plots which was replicated three times. Three nitrogen levels were N₁ (80 kg/ha), N₂ (100 kg/ha) and N₃ (120 kg/ha); three phosphorus levels i.e. P₁(40 kg/ha), P₂(60 kg/ha) and P₃(80 kg/ha) and three potash levels i.e. K₁ (40 kg/ha), K₂(60 kg/ha) and K₃(80 kg/ha).

The mean performance of growth and yield parameters revealed that N₃ had recorded the maximum for most of the growth as well as yield attributing characters *viz.* plant height (202.44 cm), fruit volume (463.94 cc), fruits per plant (12.93), fruit yield per plant (4.28 kg), fruit yield/sq. m (17.83 kg), fruit yield/100 sq. m (17.83 q), fresh weight of the plant (5.17 kg), dry weight of plant (431.58 g) and quality character such as ash content (9.24 %). Similarly N₁ also recorded the highest fruit weight (340.09 g), seeds per fruit (289.88), seed weight (2.41 g), pericarp thickness (12.10 mm) and quality characters *viz.*, moisture content (94.69 %), ascorbic acid (28.94 mg/100 g) and shelf life (18.37 days). In respect of phosphorus levels, P₃ had recorded the maximum seeds per fruit (276.48), seed weight per fruit (2.36 g), pericarp thickness (11.11 mm), fruits per plant (10.71), fruit yield per plant (3.57 kg), fruit yield/sq. m (14.87 kg), fruit yield/100 sq. m (14.87 q), ash content (8.75 %) and moisture content (94.37 %). Similarly P₂ had recorded the highest total sugar content (104.04 mg/100 g) and shelf life (17.27 days). In respect of potassium levels, K₃ had recorded with the highest seeds per fruit (261.85),

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seed weight (2.17 g), pericarp thickness (10.4 mm), moisture content (93.95 %), ascorbic acid (27.97 mg/100 g) and shelf life (16.98 days).

In case of interaction between nitrogen and phosphorus N_3P_3 had recorded the maximum fruits per plant (15.46), fruit yield per plant (5.05 kg), fruit yield per sq. m (21.04 kg), fruit yield/100 sq. m (18.96 q), fresh weight of the plant (3.00 kg), dry weight of the plant (476.01 g) and ash content (9.94 %). While, N_3K_3 had recorded with maximum fruits per plant (13.85), fruit yield per plant (4.55 kg), fruit yield per sq. m (18.96 kg), fruit yield/100 sq. m (18.96 q), fresh weight of the plant (3.21 kg) and dry weight of the plant (466.91 g). In case of interaction between phosphorus and potassium P_3K_1 had recorded the highest seeds per fruit (287.55), moisture content (94.58 %) and ash content (9.47 %). In case of interaction among NPK, $N_3P_3K_1$ had recorded the highest fruit yield per plant (5.09 kg), fruit yield/sq. m (21.20 kg) and fruit yield/100 sq.m (21.20 q).

The cost economics indicated the superiority of $N_3P_3K_1$ i.e. $N_{120}P_{80}K_{40}$ with benefit cost ratio of 3.19 followed by $N_{120}P_{80}K_{60}$ with B:C of 3.18. Based on the results of the experiment, it was concluded that $N_{120}P_{80}K_{40}$ could be suggested as best fertilizer dose for the sweet pepper under protected condition.

From the balance sheet of nutrients, it becomes clear that capsicum is an exhaustive crop in nature and demands judicious application of the three major nutrients to derive high yield. There was a residual built up of highly mobile N content, while phosphorus and potash content declined due to reserve nature in soil.

Effect of planting depth and spacing on yield and quality of upland taro (var. Ahina kachu)

Arjun Loying

An experiment was conducted to study the “Effect of planting depth and spacing on yield and quality of upland taro (var. Ahina kachu)” in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2019-2020. Plant spacing and depth are fundamental cultural practices in taro cultivation. Therefore, this experimentation was aimed at assessing the effect of plant spacing and planting depth on yield and quality of taro. Three plant spacing (45cm x 60 cm, 60cm x 75 cm, 75cm x 90 cm) and three planting depth (10 cm, 20 cm, 30 cm) were used designed in factorial randomized block design with three replications.

During the period of investigation, plant spacing had a significant effect on plant height, girth, petiole length, leaf area, leaf area index, corm weight, cormels number, cormel weight, marketable cormel weight, number of unmarketable cormel, total marketable yield per plant and marketable yield per ha. Planting depth had significant effect only on corm and cormel length. The widest spacing (75cm x 90 cm) produced highest plant height (170.48 cm), plant girth (26.23 cm), length of petiole (146.82 cm), leaf area (800.31 cm²), plant spread (74.63 cm²), corm weight (449.77 g), numbers of cormel (18.11), cormel weight (712.00 g), marketable cormel weight (577.22g), marketable yield per plant (1027.00g). Where as closet spacing (45cm x60 cm) produced maximum leaf area index (1.689), number of unmarketable cormel (10.54) and marketable yield /ha⁻¹ (19.33 ton). Deeper planting depth (30 cm) produced maximum corm and cormel length of 22.19 cm and 25.55cm respectively. Effect of interaction of spacing x depth was found significant only on corm and cormel girth. Maximum corm length (10.22 cm) and cormel (5.77 cm) girth was found in combination of widest spacing with deep planting (S3D3). Therefore, plant spacing was positively and significantly correlated with plant height, girth, length of petiole, leaf area, plant spread, corm weight, numbers of corms, cormel weight, marketable cormel weight per plant and negatively correlated with number of unmarketable cormel and marketable yield per ha. Planting depth was significantly and positively correlated with the corm and cormel length. On the other hand, there was no any significant variation on biochemical traits due to levels of spacing and depth.

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Combination of Micronutrient and Pesticide Application for Enhancing Yield and Quality of Guava (*Psidium guajava* L.)

Arunabh Gogoi

An experiment was conducted to study “Combination of Micronutrient and Pesticide Application for Enhancing Yield and Quality of Guava (*Psidium guajava* L.), with an objective to standardize the best combination concentration of micronutrients and pesticide for increasing yield and quality of guava. The study was carried out in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat. A total of 17 treatments including a control with 3 replications were laid out in a Randomized Block Design.

In the study it was observed that the application of treatments had varied effects on the yield and quality attributing characters of the crop. The highest number of flowers per branch (17.83) and fruits per branch (13.97) were recorded in T₁₆ (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Profenophos 50 EC 0.1% after 15 days) and T₁₅ (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days) respectively in the rainy season. The highest percentage of fruit set (78.96%) was recorded in T₁₆(Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Profenophos 50 EC 0.1% after 15 days) in winter season.

The highest fruit length (8.04cm), fruit weight (161.19g), fruit volume (158.29cc), pulp weight (157.86g), pulp seed ratio (47.86) and yield per plant (18.51kg) were recorded in T₁₆ (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Profenophos 50 EC 0.1% after 15 days) in rainy season. Whereas, highest fruit girth (22.31cm) was found in T₁₅(Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days) in the rainy season. The least number of days required for maturity (125.33) was in T₁₅(Zinc sulphate 0.4% + Copper sulphate 0.4% +

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Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days) in the rainy season. Incidence of pest was observed in the control plots (T_0) in both rainy and winter seasons. The percentage of damage by pests was 23.3% during rainy season and 13.33% during winter season. The treated plots were found to be totally free of the infestation of anar butterfly.

In case of the quality parameters the highest TSS (10.63°Brix) and pectin (1.54 %) were observed in T_{16} (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Profenophos 50 EC 0.1% after 15 days) during the rainy season. The highest values for reducing sugar (2.55%), non-reducing sugar (3.28%), total sugars (5.83%) and sugar acid ratio (18.35) along with lowest titratable acidity (0.318%) were found in T_{15} (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days) during winter. Ascorbic acid (164.20mg/100g) was found to be highest in T_{14} (Zinc sulphate 0.2% + Copper sulphate 0.2% + Boric acid 0.2%; Dimethoate 30 EC 0.1% followed by Profenophos 50 EC 0.1% after 15 days) during winter season.

Evaluation of the economics of cultivation showed that the highest B:C ratio of 3.13 was obtained in T_{15} (Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days). Thus, it can be concluded that the treatment Zinc sulphate 0.4% + Copper sulphate 0.4% + Boric acid 0.4%; Dimethoate 30 EC 0.1% followed by Dimethoate 30 EC 0.1% after 15 days is most profitable for enhancing the yield and quality of guava.

Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding dahlia (*Dahlia variabilis*)

Biprajit Datta Choudhury

An experiment entitled “Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding Dahlia (*Dahlia variabilis*)” was conducted for two years during Oct, 2018 - Apr, 2019 and 2019-20 in the Horticulture Experimental Farm, Assam Agricultural University, Jorhat with the objectives to assess the seed germination, seedling vigour, plant growth, flower and seed production of annual Dahlia as influenced by different seed priming treatments and germination media. A laboratory experiment was conducted by treating the seeds with five priming agents, viz. Hydropriming (P1), CaCl₂@1% (P2), GA₃@100ppm (P3), Salicylic acid@200ppm (P4), and Untreated Control (P5) and sown in Whatman Filter paper. Pooled data of two years revealed that GA₃@100ppm (P3) treated seeds recorded significantly higher germination (87.78 %), seedling length (10.35cm), and the highest seedling vigour index (909.14), followed by CaCl₂@1%.

Three media compositions viz. M1 Cocopeat+Perlite+Vermiculite (2:1:1), M2 Cocopeat+Enriched Compost (1:1) and M3 Cocopeat+ Enriched Vermicompost (1:1) were filled up in plug trays of V-Type nursery and the seeds primed with five agents were sown for raising the seedlings. The seeds in P3M3 recorded the highest rate of germination and healthy seedling growth among all the treatments. The seedlings primed with GA₃@100ppm (P3) exhibited better field performance after transplanting while those raised in M3 (1 Cocopeat+1 Enriched Vermicompost) media showed better results as compared to the other media compositions. Combined effect of P3M3 (GA₃@100ppm and 1:1 Cocopeat+ Enriched Vermicompost) recorded significantly better vegetative growth in terms of plant height and spread (56.81cm and 44.51cm), leaf production (60.48 nos./plant), leaf length and breadth (6.11cm and 4.29cm), branch number and length (7.12 and 5.37 cm, respectively), followed by P1M3 (Hydropriming and Cocopeat + Enriched Vermicompost). Increased flower

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production (26.00nos. per plant), larger flower diameter (7.10cm) and flower weight (4.30g), seed yield per plant (7.39g) and total seed yield (4.92 q/ha) was recorded with P3M3.

Analysis of the production economics indicated that for raising annual Dahlia seedlings, sowing GA3 primed seeds in (1:1) Cocopeat+Enriched Vermicompost (M3) media composition was most remunerative (1.17), followed by P4M3 and P3M2 (B: C ratio 1.16 and 1.15 respectively). However, in the main field P3M3 (GA3@100ppm and Cocopeat+Vermicompost((1:1)+Microbial Consortia) proved to be most effective treatment combination with reference to plant growth and flower production. The maximum seed production (4.92 q/ha) was also obtained with P3M3 resulting in the highest Benefit: Cost ratio (7.77), which was followed by P3M1(6.76). The lowest B: C ratio of 2.98 was recorded in P5M2 (1:1 Cocopeat+Enriched Compost without priming).

Nutrient management in Thailand ber (*Zizyphus mauritiana*)

Bipul Das

An experiment was conducted to study the “Nutrient management in Thailand ber (*Zizyphus mauritiana*)” in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat during 2018-2019. A total of 7 (seven) treatments including a control with three replications were laid out in a Randomized Block Design. The treatments comprising of T0: Control; T1: N:P:K @ 50:75:100g/Plant after pruning and 3 months after pruning (MAP); T2: N:P:K @ 50:75:100g/plant after pruning, 3 MAP and 6 MAP; T3: N:P:K @ 75:100:125g/plant after pruning and 3 MAP; T4: N:P:K@75:100:125g/plant after pruning, 3 MAP and 6 MAP; T5: N:P:K@100:125:150g/plant after pruning and 3 MAP; T6: N:P:K@100:125:150g/plant after pruning, 3 MAP and 6 MAP with the objective to develop the nutrient requirement of Thailand ber.

During the period of investigation, the treatments showed varied response to flowering, fruiting, yield attributing characters, yield and quality of fruits. The highest flowers per cluster (14.00), flowers per branch (322.00), fruits per branch (229.67), canopy volume (8.58m³), fruiting percentage (71.47%), fruit length (4.90cm), fruit girth (4.37cm), fruit volume (39cc), fruit weight (41.33g), pulp weight (36.00g) and peel weight (3.23g) were recorded in treatment T6 while the lowest values were recorded in T0 (Control). The minimum number of days taken for flowering (121.33) and flowering to harvesting interval (71.67) were recorded in treatment T6 while the maximum was recorded in T0 (Control). The yield was found to be the highest (9.45kg/branch) and (7.20ton/ha) in T6 treatment.

Among the quality parameters, the treatment T6 recorded the highest TSS (19.00%), ascorbic acid (69.45mg/100g), total sugar (14.46%), reducing sugar (7.69%), non-reducing sugar (6.77%).

After the application of the treatments, the highest leaf N, P, K contents were recorded in the treatment T6. Soil parameters studies revealed that, organic carbon, N, P and K were found to be the highest in T6.

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Evaluation from the economics of cultivation showed that, the highest benefit-cost ratio of 3.77 was obtained in T6 followed by 3.74 in T5. The lowest B:C ratio (2.51) was recorded in T0 (Control). Thus, it can be suggested that, the treatment T6 is most profitable to improve flowering, fruiting, yield and quality of Thailand ber.

Studies on effect of different mulches on growth and yield of chilli (*Capsicum annum* L.)

Chayanika Das

The present investigation entitled “Studies on effect of different mulches on growth and yield of chilli (*Capsicum annum* L.)” was carried out during 2018 to 2020. The field experiment was conducted in the ICR Farm, Department of Horticulture, B N College of Agriculture, AAU, Biswanath Chariali to evaluate (i) The performance of different mulching materials on growth and yield of chilli and (ii) To study the effect of different mulching materials on soil moisture content and soil temperature. The experiment was laid out in RBD design with four replications incorporating six treatments *viz.*, mulching with black polyethene (T1), mulching with white polyethene (T2), mulching with transparent polyethene (T3), mulching with dry banana leaves (T4), mulching with paddy straw (T5) and control, without mulching (T6).

The morpho-physiological, phenological and yield attributing parameters were significantly influenced by mulching treatments. Among the treatments, T1 produced significantly highest plant height (18.91 cm, 37.13 cm, 68.04 cm and 76.64 cm at 30, 60, 90 and 120 DAP respectively), total number of branches per plant (8.59, 17.92, 49.26 and 64.36 at 30, 60, 90 and 120 DAP respectively), primary branches per plant (8.08, 12.00, 15.73 and 19.53 at 30, 60, 90 and 120 DAP respectively) and plant spread of 67.91 cm at the time of first harvest. The same were lowest in T3. Moreover, T1 took shortest 44.32 days to first flower appearance, 118.17 days to first harvest and longest 182.06 days to last harvest. Highest RLWC (72.75%), chlorophyll content (1.61 mg g⁻¹ fw) and CSI (0.50) were recorded in T1. The same treatment also maintained the highest fruit yield (20.18 t/ha), number of fruits per plant (93.85), length of fruit (4.76 cm), fruit girth (2.75 cm), fruit fresh weight (1.30 g), fruit dry weight (0.50 g) and fruit volume (2.21 cc) which was followed by T2 and T4.

The highest soil moisture content at 0-15 cm and 15-30 cm depth, lowest weed population (317.25 No./plot, 404.25 No./plot and 517.75 No./plot at 30, 90 & 150 DAP respectively), weight of weed per plot were found in T1. during the crop growth period. Whereas, T3 recorded the highest soil temperature. However, the B : C ratio was highest

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in T4 (4.85) followed by T5 (4.20) and T1 (3.17). Therefore, organic mulching (T4 and T5) may be recommended to the chilli growers of Assam for maximizing profit with higher production rate.

Standardization of propagation of jackfruit (*Artocarpus heterophyllus* Lam.) by grafting

Debashree Baruah

The present investigation entitled “Standardization of propagation of jackfruit (*Artocarpus heterophyllus* Lam.) by grafting” was carried out during 2018-2019 in the Instructional cum Research Farm of Biswanath College of Agriculture, AAU, Biswanath Chariali with two objectives viz. i) To determine the suitable time for propagation of jackfruit by grafting. ii) To assess the vegetative growth of grafts. The experiment was laid out in Completely randomized design (CRD) with three replications. The treatments were T1: March, T2: April, T3: May, T4: June, T5: July, T6: August, T7: September.

The growth parameters, phenological characters, physiological parameters were significantly influenced by time of grafting. The results of the investigation revealed that among the different treatments, T1 (March) showed better results in growth parameters like graft success rate (85.67%), graft survival rate (83.47%), longest scion growth (11.17 cm), longest leaf (12.67 cm), broadest leaf (7.25 cm), Bigger leaf (2.38 cm²), No. of leaves per graft (5.50). T1 also showed better results in physiological parameters like leaf area index (3.68), chlorophyll ‘a’ and chlorophyll ‘b’ was also highest (0.75 and 0.58 respectively). Phenological parameters like sprouting of buds after grafting was fastest (19.33 days) in grafts done in March (T1). The grafts produced in April (T2) recorded highest number of new shoots (1.91) per graft after 90 days of grafting. The percentage of survival of grafts gradually decreased from March to September under the study.

Days after grafting significantly influenced the percentage of success. Highest graft success was observed in 30 DAG (85.67%). Graft success declined steadily till 60 days after grafting and more reduction was observed at 90 days after grafting. Bud sprouting recorded at 3 different stages decreased gradually from month of March to September. In all the stages of observation, T7 (September) recorded the lowest bud sprouting. Grafting done in March required shortest period for bud sprouting and the period gradually longer till September (24.55 days).

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In the present study, graft success, survival percentage of grafts and growth of scions, leaf length and breadth after grafting were observed to be better in the grafts produced during March to June. Thus, it can be estimated that the time period from March to June will be the best time for the farmers of Assam (which is a sub-tropical region), to carry out the grafting method in jackfruit for propagation.

Fruit and seed production of Bhut Jolokia (*Capsicum chinense* Jacq.) as influenced by growing condition and canopy management

Deepak Ranjan Pradhan

A field experiment was conducted in Experimental Farm, Department of Horticulture, AAU, Jorhat during 2018-19 with a view to standardize the suitable growing condition & training system for Bhut Jolokia (*Capsicum chinense* Jacq.). Seeds of var. Bor Bhut were sown and the seedlings were transplanted in early November under three growing conditions viz., Polyhouse, Shade-Net house & Open Condition with three training systems (Single Stem, Double Stem and No Training).

The result revealed that the growth parameters and yield attributing characters were significantly influenced by growing conditions and training systems. Higher plant height and plant spread was observed in polyhouse plants followed by shade net plants than that in open condition. Number of days to flowering and fruit harvest was minimum in polyhouse plants (53.30 days & 78.90 days, respectively) while longer duration was taken by the plants grown in open condition (66.60 days and 98.10 days, respectively). Crop duration and harvesting latitude were found longer in polyhouse (158.3 days), followed by shade-net house (157.9 days) as compared to open condition (137.2 days). Polyhouse plants produced better fruit sizes over other growing conditions resulting in higher yield (146.21 q/ha). Untrained plants in polyhouse yielded the highest (191.65 q/ha) among all the treatments. Although the untrained plants gave more yield but the trained plants were superior in terms of fruit size. The fruits were analyzed to determine the Scoville Heat Unit (SHU) and the fruits from polyhouse registered maximum among the growing conditions while the highest SHU (4,13,772.50) was measured in the untrained plants of polyhouse among all the treatment combinations. Though, variation in incidence of disease was non-significant among the conditions, infestation was more in the open, moderate under shade net house and minimum in polyhouse plants.

Seed production was not influenced by the growing conditions while untrained plants gave higher yield and the highest production (3.81 q/ha) was recorded by the

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plants in open condition, followed by shade-net house (3.29 q/ha). Similarly growing condition and training practices did not bring about any significant change in seed viability at harvest, plants with single stem recorded the maximum (67.90%), closely followed by double stem plants (67.67 %) under shade net house.

The highest benefit: cost ratio (3.88) was obtained from untrained plants of polyhouse, followed by shade-net house plants (3.60). Single stem plants under open condition recorded the lowest (1.87).

It can be concluded that planting of autumn season Bhut Jolokia under polyhouse without any pruning practices gave early and higher fruit yield leading to maximum B: C ratio of 3.88. Growing under shade net house worked out to be the next best option for remunerative return (3.60).

Suitability Studies of *Dracaena* as Cut Foliage

Dikshita Baruah

An experiment titled “ Suitability studies of *Dracaena* as cut foliage” was conducted in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat, 2018-2019 with the objective of evaluating the performance of different species/varieties of *Dracaena* for growth and yield attributes and to study the effect of pulsing solutions on the post harvest life of cut greens of ten different species/varieties of *Dracaena* namely - three varieties of *D. Sanderiana*(Lucky Bamboo “Gold”, “Victory” and “Green”), *D.thalioides*, *D. reflexa* “Green” , *D. marginata* “Mahatma”, *D. fragrans* “Massangeana” , *D. compacta*, *D compacta* “ Purple” and *D deremensis*“Janet Craig” . The experiment was laid out in 50% agroshade net house in randomised block design with 3 replications and observations were recorded after one year of planting. Using the cut foliage of *Dracaena sanderiana* “Victory” in 15 different pulsing treatment combinations, the best five were selected, viz., BAP 25 ppm+ LHB @ 0.25%, Chlorine + Sucrose 10% , BAP 50 ppm+ LHB @ 0.25% Chlorine + Sucrose 10%, BAP 50 ppm + LHB @ 0.50 % . Chlorine + Sucrose 10%, BAP 25 ppm+ BP 0.50% + Sucrose 10%, BAP 50 ppm+ BP 0.25%+ Sucrose 10%.

D. fragrans“Massangeana” showed the best performance in terms of growth characters, namely plant height and spread (121.26 cm and 75.23 cm, respectively), leaf breadth (9.46cm), number of leaves per plant (39.66) and leaf longevity (26.7 days). This was followed by *D. deremensis* which had longest leaves (54.2cm), highest leaf area (1225.03 sq.cm) and consumer preference. *D. reflexa* “Green” reported the lowest leaf production interval (8.1 days) The chlorophyll content is highest in *D. sanderiana* “Gold”(0.85mg g⁻¹ FW). The visual plant quality rating was highest for 4 species- *D. sanderiana* Gold, *D. sanderiana* Victory, *D. sanderiana* Green and *D. compacta*.

D. compacta“Purple” showed the highest vase life (15.93 days), followed by *D.sanderiana* Green (15.27 days). *D.deremensis* recorded the highest relative leaf water content (72.31%). The physiological loss in weight was lowest for *Dracaena reflexa* Green (6.34%).

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Among the pulsing solutions, BAP 25 ppm+ BP 0.50% + Sucrose 10% recorded the highest vase life (14.40 days), followed by BAP 50 ppm+ LHB @ 0.50% Chlorine + Sucrose 10% (13.9 days). BAP 50 ppm+ BP 0.25%+ Sucrose 10% showed the highest relative leaf water content (49.41%) and the physiological loss in weight was lowest for P2-BAP 50 ppm+ LHB @ 0.25% Chlorine + Sucrose 10% (13.33%).

Response of chinese cabbage (*Brassica campestris* ssp. *Pekinensis*) to organic amendments

Dilsha Chandran

An experiment entitled “Response of Chinese cabbage (*Brassica campestris* ssp. *Pekinensis*) to organic amendments” with the objective of “to assess the growth, yield and quality of chinese cabbage under the different organic amendment” was carried out with var. G-HA01 with eleven organic amendment laid in thrice replicated blocks of randomly allotted plots. The treatments were T1: Farmyard manure (FYM) 5 tonnes per ha, T2: Farmyard manure (FYM) 10 tonnes per ha, T3: Farmyard manure (FYM) 15 tonnes per ha, T4: Farmyard manure (FYM) 20 tonnes per ha, T5: FYM 5 tonnes + Azotobacter 0.16 tonnes per ha, T6: FYM 10 tonne per ha + Azotobacter 0.16 tonnes per ha, T7: FYM 15 tonnes + Azotobacter 0.16 tonnes per ha, T8: FYM 20 tonnes + Azotobacter 0.16 tonnes per ha, T9: Enriched compost 1.33 tonnes per ha, T10: Vermicompost 3 tonnes per ha, T11: Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. The observed parameters have revealed that for all of the field parameters the performance of Chinese cabbage treated with FYM 10 tonnes + Azotobacter 0.16 tonnes per ha were the best. Petiole length was least affected by different organic amendment. Enriched compost 1.33 tonnes per ha could not produce any remarkable impact on most of the observed parameters. The nitrogen content and crude protein content were maximum (3.24%, 20.24%) in FYM 20 tonnes + Azotobacter 0.16 tonnes per ha. The TSS content was maximum (6.41degree brix) in Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. The best shelf life was imparted by FYM 20 tonnes + Azotobacter 0.16 tonnes per ha (11.93days). The final soil NPK content and organic carbon content were the highest in crop treated with FYM 20 tonnes + Azotobacter 0.16 tonnes per ha (667.13,28.86,187.63 and 0.37). The final mcrobial biomass of soil was the highest (488.45%) in Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. FYM 10 tonnes per ha gave the highest benefit cost ratio (8.58).

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Major Advisor : Dr. Luchon Saikia

Integrated Nutrient Management in Lemon var. Assam lemon (*Citrus limon* L. Burm.)

Eleza Baro

An experiment on “Integrated nutrient management in lemon var. Assam Lemon (*Citrus limon* L. Burm.)” was conducted during 2018-2020 at Instructional cum Research Farm, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali to study the effect of the integrated nutrient management (INM) on growth, yield and quality of Assam Lemon, to study the soil physical and chemical properties under INM and to standardize the suitable integrated nutrient management practices in Assam Lemon. Eight treatment combinations were laid out in Randomized Block Design with three replications in the field. The treatments were T1 (RDF *i.e.* Recommended dose of fertilizer), T2 (vermicompost @ 20 kg/plant), T3 (vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T4 (enriched compost @ 20 kg/plant), T5 (75% RDF + enriched compost @ 20 kg/plant), T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T7 (50% RDF + enriched compost @ 20 kg/plant) and T8 (50% RDF + vermicompost @ 20 kg/plant+ consortium @ 20 g/plant). The results revealed that treatments T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) showed maximum plant height (1.95 m), number of laterals per primary shoot (4.53), number of leaves (19.48) and total leaf area (522.64 cm²) with average number of hermaphrodite flower (62.49 per plant) during May 2019, fruit set (31.41% in April, 2019), total number of fruits (516.08 per plant) harvested during one year of study, fruit weight (153.92 g), fruit volume (168.43.38 cc), pulp-peel ratio (3.27) with average fruit juice (27.59%), titratable acidity (5.01%), ascorbic acid content (39.82 mg/100ml) while longest fruit (12.50 cm) was recorded in the plants treated with T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) and maximum diameter (5.59 cm) of the fruit was recorded in T5 (75% RDF + enriched compost @ 20 kg/plant). Total chlorophyll content (1.25 mg/g of fresh weight), organic carbon content (1.34%), soil moisture content (23.32% at 0-20 cm depth and 21.45% at 20-40 cm depth) were highest in T6 (75% RDF + vermicompost @ 20 kg/plant +

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consortium @ 20 g/plant). Leaf nitrogen content (2.20%) was highest in T8, highest leaf phosphorus content (0.15%) in T3 and T8, the highest leaf potassium content (1.60%) was recorded in T6 and T5. Soil pH was highest in T3 and T8. In soil, the highest available N (291.16 kg/ha) was observed in plants treated with T1, while the highest phosphorus (27.81 kg/ha) was observed in T2 (vermicompost @ 20 kg/plant) and the highest potassium (173.06 kg/ha) was found in T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant). The growth, yield and quality attributing characters of Assam lemon and improvement of soil parameters and benefit-cost ratio were higher in the plants treated with combination of 50 per cent inorganic and organic manures along with consortium. Though the highest benefit-cost ratio (5.48) was recorded in 100 per cent chemical fertilizers applied plants but considering the growth, yield and quality of Assam lemon fruits and improvement of soil parameters, the treatment T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T7 (50% RDF + enriched compost @ 20 kg/plant) and T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) might be recommended for integrated nutrient management in Assam Lemon. Continuous application of chemical fertilizers would deteriorate soil parameters and the production of plants would gradually decrease. On the other hand, integrated nutrient management would gradually improve the soil condition and increase production in long run.

Studies on physico-chemical characters of Thai Apple ber (*Zizyphus mauritiana* Lamk.) grown in Assam

Haribhakta Khanikar

The present investigation entitled “studies on physico-chemical characters of Thai Apple ber (*Zizyphus mauritiana* Lamk.) grown in Assam” was carried out during 2017-2019 in the department of Horticulture, B. N. College of Agriculture, AAU, Biswanath Chariali to evaluate the physical parameters and to estimate the biochemical composition of Thai Apple ber fruits grown in Assam. The experiment was conducted in the laboratory with Thai Apple ber fruits collected from eight different locations of Assam. BC-1: SimenChapori (Dhemaji district), BC-2: Bongalmora (Lakhimpur district), BC-3: Gela Pukhuri (Biswanath district), BC-4: Napaam (Sonitpur district), BC-5: Rowta (Udalguri district), BC-6: Kamarbandha (Golaghat district), BC-7: Naharkatia (Dibrugarh district), and BC-8: Boitamari (Bongaigaon district). The experiment was laid out in completely randomized design (CRD) with three replications.

A large variation was observed in morphological and biochemical characters among the Thai Apple ber plants of different localities in the present investigation. The leaves of Thai Apple ber collected from different locations of Assam showed elliptic shape with serrate leaf margin, obtuse apex and oblique base. The colour of the leaves was observed to be dark green. The leaf length of Thai Apple ber leaves ranged from 7.77 cm to 8.37 cm, leaf breadth ranged from 3.97 cm to 4.83 cm with petiole length ranged from 0.77 cm to 0.97 cm. The plants of SimenChapori and Gela Pukhuri recorded early flowering and harvesting among the Thai Apple ber plants of other locations in the present study.

The colour of the fruits was light green with creamy white pulp and smooth glossy skin surface. The fruits of Boitamari (BC-8) recorded longest fruit (5.10 cm) while, shortest fruit (4.03 cm) was recorded in BC-5 (Rowta). Maximum fruit weight (53.08 g) was recorded in BC-1 (SimenChapori) and lowest (42.22 g) was recorded in BC-7 (Naharkatia). Fruit width ranged from 3.97 cm to 4.23 cm.

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The shape and surface of the seeds was found to be ovate and warty. The length and weight of the seeds differed significantly and ranged from 2.04 cm to 2.68 cm and 1.07g to 1.97g, respectively. The pulp-stone ratio ranged from 18.76 to 23.28.

The biochemical analysis revealed that the quality characters like moisture content, TSS, titratable acidity, TSS-acidity ratio and ascorbic acid content differed. Total sugar (6.37 to 7.81 %) and reducing sugar (2.44 to 3.06%) contents varied significantly among the Thai Apple ber fruits of different locations. The highest vitamin A (16.08µg/ 100g) were found in Gela Pukhuri (BC-3) and highest protein (0.86g/100g) was found in BC-5 (Rowta). The calcium and phosphorus contents of the fruits ranged from 20.48 mg/ 100g to 23.50 mg/100g and 24.08 mg/100g to 25.25 mg/100 g, respectively.

Standardization of propagation method of custard apple (*Annona reticulata*) by air layering and stem cuttings

Jahnabi Hazarika

An experiment was carried out at instructional cum research farm, Department of Horticulture, BNCA, AAU, Biswanath Chariali during 2018-2019 to standardize the propagation method of custard apple (*Annona reticulata*) by air layering and stem cuttings. Experiment was carried out in two parts. Part i) propagation by air layering and Part ii) propagation by stem cuttings. There were four treatments of air layering *viz.*, Pre-conditioned with 30 days of girdling (T₁), Pre-conditioned with 30 days of etiolation (T₂), Pre-conditioned with 30 days of girdling +etiolation (T₃) and Control *i.e.* Air layering without pre-conditioning (T₄) and all these treatments were applied at monthly interval from March to August, 2018. For carrying out the propagation by cuttings, three types of cuttings *viz.*, Softwood cuttings (T₁), Semi hardwood cuttings (T₂) and Hardwood cuttings (T₃) were prepared and planted in poly bags at monthly interval from February to August, 2018 *i.e.* S₁ (February), S₂ (March), S₃ (April), S₄ (May), S₅ (June), S₆ (July) and S₇ (August). Both the parts of the study were laid out in factorial CRD with three replications.

In case of propagation by layering, there was a significant difference among the different treatments with respect to different period of layering. Among the treatments, T₂ recorded highest percentage of success of layering (62.37%), required minimum days for separation of layers from mother plant (53.02 days), maximum numbers of primary roots per layer (4.76), numbers of secondary roots per layer (12.49), longest primary root after detachment from mother plant (6.71 cm), percentage of survivability (89.05%), number of new shoots per layer at 30 days after planting (2.21), number of new shoots per layer at 60 days after planting (2.78) and number of new shoots per layer at 90 days after planting (3.09). On an average, air layering done in August (S₆) produced highest percentage of success (61.44%), minimum days for separation of layers from mother plant (51.40), numbers of primary roots per layer (5.35), numbers of new shoots per layer at 30 days (2.27), 60 days (2.75) and at 90 days (3.12) after planting

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in poly bags. Among the treatment combinations, T₂S₆ (layering done in the month of August pre-conditioned with etiolation) recorded significantly highest percentage of success of layering (71.55%), required shortest days for separation of layers from mother plant (48.10 days), number of new shoots per layer at 30 days (2.67) and 90 days (3.75) after planting in polybags.

The study on propagation of custard apple by stem cuttings, T₂ (Semi hardwood) recorded the highest percentage of survivability (44.57%) at 90 days after planting of cuttings, number of primary roots (3.72) of cuttings, longest primary roots at 90 days after planting of cuttings (8.46 cm) and number of primary shoot (5.15) per cuttings at 90 days after planting of cuttings. Cuttings planted in July (S₆) recorded the highest numbers of primary roots (3.74) per cuttings, minimum days (14.75 days) for shoot emergence, longest primary roots (7.53 cm) at 90 days after planting of cuttings. The percentage of survivability was highest (29.97%) in April (S₃) recorded at 60 days after planting of cuttings. Among all the treatment combinations, T₂S₇ (semi hardwood cuttings done in the month of August) recorded maximum length (9.20 cm) of primary roots at 90 days after planting of cuttings and number of primary shoots (6.67) per cuttings at 90 day after planting of cuttings.

Impact of sprout management on growth and yield of pointed gourd (*Trichosanthes dioica* Roxb.)

Kanchan Kumari Gupta

The present investigation entitled “Impact of sprout management on growth and yield of pointed gourd (*Trichosanthes dioica* Roxb.)” was carried out during February to October, 2018 in the Instructional cum Research Farm of Biswanath College of Agriculture, AAU, Biswanath Chariali. The experiment was laid out in Randomized Block Design with four replications incorporating five pruning treatments viz., retention of one sprout (T₁), retention of two sprouts (T₂), retention of three sprouts (T₃), retention of four sprouts (T₄) and control, without pruning (T₅).

The morpho-physiological parameters, phenological characters, yield and quality parameters were significantly influenced by pruning treatments. Among the pruning treatments, T₃ produced significantly higher vine length (195.47 cm and 384.95 cm at 90 and 120 DAP, respectively), internodal length (9.55 cm at 90 DAP and 12.21 cm at 120 DAP), number of leaves per vine with 170.33 at 90 DAP and 206.91 at 120 DAP and leaf area per vine with 5491.36 cm² and 6670.78 cm² at 90 and 120 DAP, respectively. Among the phenological parameters, duration from fruit set to harvest (10.50 days), days to first harvest (106.18 days), total duration of the crop (198.27 days) were found significantly less in T₁ treatment. Among the physiological parameters, relative leaf water content (76.99%) and leaf chlorophyll content index (29.29) recorded significantly higher values under T₃ treatment. In the same treatment of T₃, yield per plant (4.21 kg) and yield per hectare (8.77 t) were found significantly higher along with significantly more number of female flowers per plant (238.50), fruits per plant (225.58).

However, the length of fruit, fruit diameter, fruit volume, fruit fresh weight and number of seeds per fruit did not exhibit any significant difference due to pruning treatments.

Among the quality parameters, T₃ recorded significantly higher vitamin A (223.61 IU) in fruits while ascorbic acid (15.84 mg/100g) was found significantly higher in T₁.

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Pest and diseases like powdery mildew, downy mildew, gummy stem blight, fruit fly, red pumpkin beetle were observed at the initial stages of crop growth but the yield loss was minimum due to timely adoption of proper management practices.

The study therefore, advocate that pruning treatment with retention of three sprouts (T₃) produced the highest yield with higher B:C ratio of 2.14 and may be recommended for the growers of Assam for maximizing their production and profit.

Morpho-biochemical characterization of custard apple (*Annona reticulata*) grown in Brahmaputra valley of Assam

Karobi Hendique

The present investigation entitled “Morpho-biochemical characterization of custard apple (*Annona reticulata*) grown in Brahmaputra valley of Assam” was carried out during 2017-2019 in the department of Horticulture, B. N. College of Agriculture, AAU, Biswanath Chariali to characterize the morphological parameters and to estimate the biochemical composition of custard apple fruits grown in Brahmaputra valley zone of Assam. The experiment was conducted in the laboratory with custard apple fruits collected from ten different locations of Assam *i.e.* CA-1: Bokajan, CA-2: Guwahati, CA-3: Titabor, CA-4: North Lakhimpur, CA-5: Biswanath Chariali, CA-6: Narayanpur, CA-7: Sadiya, CA-8: Sivasagar, CA-9: Nagaon and CA-10: Tezpur. The experiment was laid out in completely randomized design (CRD) with three replications.

A large variation was observed in morphological and biochemical characters among the custard apple plants of different localities in the present investigation. The leaves of custard apple collected from different locations of Assam showed lanceolate leaf blade shape with entire leaf margin, acuminate apex and acute base. The colour of the leaves varied from light green to dark green. The leaf length of custard apple leaves collected from different places ranged from 16.73 cm to 24.27 cm, leaf breadth ranged from 2.83 cm to 4.63 cm with petiole length ranged from 0.90 cm to 1.53 cm. The plants of Bokajan and Guwahati recorded early flowering and harvesting among the custard apple plants of other locations in the present study.

The fruit characters of custard apple namely fruit shape, colour, length, diameter, volume, weight and pulp colour was also varied in all the fruits. The colour of the fruits was observed to be greenish yellow, yellowish, reddish and yellowish red in colour. The fruits of North Lakhimpur recorded maximum length (8.90 cm) and diameter (8.63 cm) while the fruits of Guwahati recorded minimum length and diameter of 6.10 cm and 5.80 cm, respectively. Again, the fruit weight ranged from 145.00 g to 443.33 g and volume ranged from 114.67 to 385.00 cc.

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The colour of the seeds varied from brown to dark brown and black. The length and girth of the seeds differed significantly and ranged from 0.80 cm to 1.40 cm and 0.23 cm to 0.73 cm, respectively. The total seed number per fruit ranged from 30.33 to 82.33 while the weight of ten seeds was found to be 1.14 g to 2.03 g.

The biochemical analysis revealed that the quality characters like moisture content, TSS, titratable acidity, TSS: acidity ratio and ascorbic acid content differed significantly and ranged from 52.06 per cent to 75.92 per cent, 20.33⁰Brix to 25.33⁰Brix, 0.13 per cent to 0.29 per cent, 73.94 to 191.22 and 24.82 mg/100g to 31.76 mg/100g, respectively. On the other hand, the sugars like total sugar (11.77-20.39 %), reducing sugar (11.07-16.48 %) and non-reducing sugar (0.70-6.96 %) contents of the custard apple fruits varied significantly among the fruits of different locations. The calcium and magnesium content of the fruits ranged from 21.67 mg/100 g to 30.33 mg/100g and 13.67 mg/100g to 24.67 mg/100g, respectively.

The variation in the results of the present investigation in morphological and biochemical characters among the custard apple fruits might be due to the different climatic conditions and management practices.

Response of garden pea (*Pisum sativum* L.) to foliar application of zinc

Lupita Borah

An experiment entitled “Response of garden pea (*Pisum sativum* L.) to foliar application of zinc” was conducted during the months of November-January 2018-19, at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat with the objective to assess the growth, yield and quality of garden pea as influenced by foliar application of zinc. The experiment was laid out in a Randomized Block Design with five treatments which were replicated four times. The treatments were T1: Control, T2: 0.25% zinc, T3: 0.50% zinc, T4: 0.75% zinc and T5: 1.00% zinc. The application of 0.50% zinc in the form of zinc sulphate, applied through foliar application contributed significantly towards the yield and yield attributing characters like weight of the pod, number of seeds per pod, weight of seeds per pod and shelling percentage, which ultimately contributed towards highest pod yield per plant as well as per hectare. The results revealed that the fresh and dry weights of the plant as well as root weight per plant were also significantly higher in T3. Though, the number of pods per plant was found to be the highest in case of application of 0.25% zinc. Similarly, the highest plant height and number of branches were obtained in case of T4. Days to 50% flowering, days to harvest and shoot: root ratio were found to be non significant. The quality characters of the seeds showed significant variation among the treatments. T4 gave the highest nitrogen and hence crude protein content and also the starch content of seed, while the highest total sugar and TSS content was obtained in T5. The results revealed that, the highest available nitrogen, potassium and zinc content in soil was in T5. T3 and T5 showed the highest nitrogen and zinc content in leaves respectively, whereas T1 gave the highest leaf phosphorous content. The available phosphorous in soil and potassium content in leaves were found to be non significant. The economic analysis indicated that the foliar application of 0.50% zinc, that is T3 gave maximum benefit cost ratio of 2.72. However, T2 and T4 also showed good results with ratios of 2.48 and 1.99 respectively. In many instances the trend decreases after a particular point, due to negative effect of excess micronutrient application than the optimum amount

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needed, which affects the plant in various ways. In a broader view, it can be suggested from the present study that the one with 0.50% zinc application (T3) turns out to be the optimum treatment, beneficial towards improving the growth, yield and yield attributing characters along with maximum profit which is in compliance with the percentage of zinc foliar application as suggested by National Food Security Mission of India. Moreover, the application of 0.75% zinc is also notable regarding quality characters of the seeds.

Standardization of growing media and assessment of plant species suitable for Vertical Gardening

Madhushree Ghosh

An experiment was carried out to standardize the growing media and assess plant species suitable for vertical gardening, constructed on the ground floor of the four-storey building of the Department of Horticulture of Assam Agricultural University, Jorhat during the year 2019-2020. The experiment was laid out in factorial completely randomized block design with three replications. Five ornamental plant species were selected for growing in the vertical garden which were subjected to five growing media. The five plant species selected were- S1 : Philodendron Ceylon (*Philodendron erubescens* 'Gold' K. Koch), S2: Spider Plant (*Chlorophytum comosum Variegatum* (Thunb.)), S3: Fern (*Nephrolepis exaltata* (L.) Schott), S4: Moses-in-the-cradle (*Rhoeo discolor* Sw. (syn. *Tradescantia spathacea*)) and S5: Baby Doll Cordyline (*Cordyline compacta Purple* (L.)). The media compositions were M1: soil + cocopeat + vermicompost + sand (3 : 0.25 : 1 : 1.5), M2: soil + cocopeat + vermicompost + sand (2.5 : 0.5 : 1.5 : 1.25), M3: soil + cocopeat + vermicompost + sand (2 : 0.75 : 2 : 1), M4: soil + cocopeat + vermicompost + sand (1.5 : 1 : 2.5 : 0.75) and M5: Soil.

The data analysis over the period of time revealed that growing medium M3 which was characterized by pH of 6.58, water holding capacity of 34.44% and total porosity of 47.42 % had a positive response on the growth and physiological characters of the plant species. The growth responses of the plant species grown in medium M2 followed those of the medium M3, while the least response was recorded in medium M5.

In Philodendron Ceylon (S1), the highest plant height (25.17 cm), canopy diameter (23.47 cm), number of leaves per plant (12.00), leaf length (14.24 cm), leaf breadth (4.83), leaf area (68.73 cm²), root number (11.73), longest root (16.63 cm) and root volume (12.22 cm³) was recorded in medium M3 followed by medium M2. This medium (M3) also recorded maximum net assimilation rate (0.076 mg/cm³), relative leaf water content (96.43%), total chlorophyll content (2.73 mg/g) and leaf area duration

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(75.33) in *Philodendron*. Out of the five species, *Philodendron Ceylon* recorded maximum mean root volume (11.78 cm³) and the highest mean physiological parameters- mean net assimilation rate (0.050 mg/cm³), relative leaf water content (95.86 %) and total chlorophyll content (2.10 mg/g). This species also recorded the highest ornamental value index (8.67). *Moses-in-the-cradle* (S4) performed best in medium M3 in terms of both growth and physiological parameters. It recorded highest plant height (31.33 cm), canopy diameter (24.70 cm), number of leaves (30.00), leaf area (83.52 cm²), root number (17.30), root volume (9.93 cm³) and root length (12.50 cm) in medium M3. Again it recorded the second highest net assimilation rate (0.038 mg/cm³), relative leaf water content (85.89 %) and leaf area duration (84.66) among all the species. It also achieved an ornamental value index of 8.14, which was the second of the five species.

Ferns (S3) grown in medium M3 recorded the highest plant height (21.86 cm), canopy diameter (21.60 cm), number of leaves per plant (22.67), leaf length (16.48 cm), leaf breadth (6.16 cm), leaf area (89.16 cm²), root number (32.83) and root length (19.40 cm). However, ferns had the lowest root volume (7.52 cm³) among all the species. It also recorded the lowest mean net assimilation rate of 0.015 mg/cm³ and relative leaf water content of 65.52 % among the five species. The least ornamental value index (5.85) was also observed in fern.

Thus, it can be worked out from the present investigation that growing medium M3 comprising of soil + cocopeat + vermicompost + sand in the ratio of 2: 0.75: 2: 1 by volume, followed by growing medium M2 could be considered as ideal for vertical gardening under Assam condition. Also, on the basis of their performances, it can be inferred that *Philodendron Ceylon* (S1) followed by *Moses-in-the-cradle* (S4) performed best, whereas ferns (S3) performed the least satisfactory among the five species in the vertical garden system.

Effect of Indigenous methods of ripening on shelf life and quality of banana fruits

Manuranjan Roy

The present investigation entitled “Effect of indigenous methods of ripening on shelf life and quality of Banana fruits” was carried out during 2017-2019 in the laboratories, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali. The experiment was conducted with six different ripening methods with two varieties (Amritsagar and Chenichampa). The treatments were: ripening in covered pit with smoke (T₁), ripening with ripe tomato (T₂), ripening with paddy straw (T₃), ripening in covered pit without smoke (T₄), ripening with Calcium carbide (T₅) and ripening naturally at room temperature (T₆). The study was laid out in factorial CRD with three replications.

Result of the study revealed marked variation in quality characters among the different treatments on ripening. Among the indigenous ripening methods, fruit ripened with ripe tomato (T₂) retained maximum TSS (21.75%), reducing sugar (5.12%), total sugar (6.15%), moisture content (73.85%), calcium content (17.38 mg/100g), magnesium content (58.47 mg/100g) and potassium content (427.28 mg/100g). Similarly, fruit ripened with calcium carbide (T₅) recorded highest acidity (0.347%) and phosphorous (74.81 mg/100g). The fruits ripened in covered pit without smoke exhibited maximum ash content (1.84%) and specific gravity (1.21%). The retention of ascorbic acid (5.19 mg/100g) was highest in T₃ (paddy straw) treatment.

Banana fruits ripened with calcium carbide showed rapid colour initiation within 2 days and full colour development stage in 2.5 days and followed by smoke which required 5 days for full colour development.

Significant differences in terms of biochemical characters were observed among the banana varieties. The shelf life of Chenichampa banana was found to be 11.61 days as compared to Amritsagar (8.48 days). But among the treatment combinations, fruit of Chenichampa variety ripened naturally (control) showed maximum shelf life of 14.33 days. A progressive increase in PLW of banana fruit was observed with an increase in ripening period. The overall preferential score (23.93) with

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aroma (8.01) and taste (7.88) were highest in fruits ripened with tomato (T₂) than the rest of the ripening methods. Chemically treated Banana showed highest score for colour 8.89.

In case of ripening of fruits calcium carbide, colour change in peel was faster with bright yellow colour but with short shelf life and inferior taste. The use of calcium carbide is known to be carcinogenic as reported earlier; thus an alternative method to induce ripening of fruits with ripe tomato or ripening of banana in covered pits with smoke might be used for ripening of bananas with desirable quality in terms of colour, days require for ripening, biochemical characters and shelf life. Naturally ripened fruit develop poor colour, which might reduce the market price but they had longest shelf life.

Studies on different exotic varieties of Lettuce (*Lactuca sativa*) in agro-climatic condition of North Bank Plain zone of Assam

Mrutyunjaya Behera

The present investigation entitled “Studies on different exotic varieties of Lettuce (*Lactuca sativa*) in agro-climatic condition of North bank plain zone of Assam” was carried out during 2018-2020 at the Instructional cum Research Farm, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali with two objectives viz., i) To study the growth, yield, and quality of different exotic varieties of lettuce and ii) To catalogue the pest and diseases in the different varieties of lettuce. The experiment was laid out in RBD with three replications incorporating seven treatments viz., Till (T1), Red Salad Bowl (T2), Lollo Rossa (T3), Lollo Bionda (T4), Batavia Rossa (T5), Corcarda (T6), and Pasha (T7). The morpho-physiological, phenological, yield and quality parameters were significantly varied among the seven treatments. Among the treatments, T6 produced significantly highest plant height (23.44 cm and 34.64 cm at 30 DAT and at harvest respectively), highest canopy spread (24.14 cm and 41.82 cm at 30 DAT and at harvest respectively), maximum number of leaves (21.11 and 42.00 at 30 DAT and at harvest respectively), and maximum leaf length and breadth (32.73 cm and 19.27 cm respectively) during harvest. Significant variations in leaf characters viz., shape, shape of apex, incision of margin, number of divisions, intensity of green colour, and area covered by anthocyanin coloration were observed among the varieties. Moreover, T1 took shortest duration (60 days) to first harvest, maximum harvest duration (26 days) and longest duration (86 days) to last harvest. Leaf area per plant (458.32 cm² and 1376.73 cm² at 30 DAT and at harvest respectively) and leaf area index (4.23 and 4.33 at 30 DAT and at harvest respectively) were found significantly more in T6. The maximum dry weight (28.21g) was recorded in T2, while T5 maintained the maximum fresh weight (557.64g) and the highest yield (41.31 t/ha). T3 contained significantly more amount of moisture content (96.10%) and ascorbic acid (24.57 mg/100g), whereas T6 contained significantly more amount (4.25 mg/100g) of vitamin A. There was no incidence of diseases in the vegetative stage of the crop. However Insect pest like, cutworm (*Agrotis ipsilon*) were observed at the initial stage and were controlled by incorporating malathion 5% dust near the root zone.

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Major Advisor : Dr. B.P. Gautam

Performance of radish (*Raphanus sativus* L) cv Japanese white as influenced by organic inputs and microbial consortium

Nandeesh J

An experiment was carried out on radish (*Raphanus sativus* L.) in Experimental farm, Department of Horticulture, AAU, Jorhat during 2018-2019 and 2019-2020 with the objective to assess the "Performance of radish (*Raphanus sativus* L.) cv Japanese white as influenced by organic inputs and microbial- consortium". The experiment was laid out in RBD with three replications. There were altogether 8 treatments, T1:(Rock phosphate + Consortium) ,T2:T1 +Compost (2.5 t ha-1), T3 : T1 +Compost (5t ha-1), T4 :T1+Vermicompost (2.5 t ha-1), T5: T1+Vermicompost (5 t ha-1),T6 :T1 +Enriched compost (2.5t ha-1), T7 : T1+ Enriched compost (5t ha-1)and T8 : RDF (50:50:100kg NPK ha-1) + FYM @10t ha-1 .

Pooled analysis over two years revealed that the growth and yield attributing characters were significantly influenced by application of different nutrient sources. The mean performance of growth characters revealed that the highest plant height (32.84 cm), maximum number of leaves (16.31), maximum leaf length (24.91 cm), maximum leaf width (7.6 cm) and maximum leaf area index (3.42) was exhibited by treatment T8(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1) followed by 29.25 cm, 16.0, 22.73 cm, 7.35 cm and 3.35 respectively in T7 : T1+ Enriched compost (5t ha-1).Pooled data over two years revealed that the maximum root length (25.45cm), maximum root diameter (2.715cm), maximum root weight with top (224.4g), maximum root weight without top (197.0g), highest total yield (8.44 kg/plot), maximum percentage of forked roots(2.25 %) and maximum physiological loss in weight(40.42%) was found in treatment T8[(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1]. Among organic treatments, Maximum root length (24.26 cm), highest root weight with top(190 g),highest total yield(25.41 t ha-1) were found highest in the treatment T7(T1+ Enriched compost (5t ha-1). All the growth and yield parameters were significantly poor in T1:(Rock phosphate + Consortium).

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Among the quality parameters, maximum total soluble solids (4.14) and highest ascorbic acid (15.34 mg/100g) was found in treatment T7[(T1+Enriched compost(5t ha-1)]and highest total ash content (5.28) was found under T5:[T1+Vermicompost (5 t ha-1)].

Soil physico-chemical and biological properties showed significant difference among the treatments. The T7[(T1+ Enriched compost (5t ha-1)] recorded for the best soil parameters viz., highest soil pH (5.54), highest organic carbon (0.86%), highest available K (137.24 kg ha-1) and highest available P(64.02 kg ha-1). In case of biological properties of soil, T7 was found to be statistically superior in respect of highest microbial biomass carbon (277.70), maximum dehydrogenase activity (215.40) and maximum phosphomonoesterase activity (377.10) was found in the treatment T7(T1+ Enriched compost (5t ha-1). Further, highest available nitrogen (271.66 kg ha-1) and highest B:C ratio was found in T8(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1).

The cost economics indicated superiority of T8(RDF 50:50:100kg NPK ha-1)+FYM @10t ha-1) with 2.58 benefit-cost ratio followed by 2.50 in T6 :[T1 +Enriched compost (2.5t ha-1)].

Hence, considering the positive effect on growth, yield, quality and soil health, T7 is considered the best organic treatment for adopting at a field level to reap good economic yield with better quality, shelf life, sustained soil health and high returns.

Study on the diversity of *Colocasia* germplasm of Dima Hasao District of Assam

Nehail Hojai

An experiment entitled “Study on the diversity of *Colocasia* germplasm of Dima Hasao District of Assam” was carried out during the period of 2017-19. A total of 16 germplasms were collected from the five blocks of the district namely Harangajao, Mahur, Maibang, Diyungbra and Sangbar. The Morphological study of the cultivars was done in the Experimental Farm and their taxonomic identification was carried out. The biochemical analysis of the cultivars was done in the laboratory. A total of 16 different cultivars were evaluated for their morphological traits with three replications in Randomized Block Design. The ethno botanical study was conducted in Dima Hasao district.

The mean performance of growth and yield parameters revealed that the cultivar Thaklong-1 registered the maximum plant height (138.67 cm), plant girth (23.13 cm), corm length (48.95 cm), weight of corms per plant (2250 g), weight of cormels per plant (846.67 g), yield per plant (3.36 kg). Similarly, biochemical analysis reflected highest amount of starch (77.9%), fat (1.11%), ash (7.61%) and iron (10.56 mg/100g) content in the cultivar Thaklong-1. However, the highest crude protein (5.32%) was found in cultivar Tharujung. The calcium oxalate was found highest (0.1%) in cultivar Thabasha. The highest number of suckers (13.56 numbers per plant) was observed in cultivar Thagajao-2. Maximum number of corms (2.56 numbers per plant) was found in Cultivar Thaklong-galao whereas cultivar Thagajao-2 was recorded with maximum number of cormels i.e. 23.92 numbers per plant.

The variation in leaf characters of the cultivars were also observed during study period. It was observed that out of 16 cultivars, 87.50 per cent cultivars exhibited erect apex down type of leaf orientation. Maximum colour of the petiole junction was found to be green (37.5 %) and purple colour (37.5 %). 75 per cent of the cultivars were found to have green main vein colour. Most of the cultivars (62.5 %) exhibited undulated type of leaf margin and highest leaf blade margin colour was found to be yellow (37.5 %). Among the all cultivars, majority of the cultivars i.e. 56.25 per cent exhibited purple

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colour in upper portion of petiole, while 75 per cent of the cultivars were found to have green colour in the lower portion of the petiole. The maximum (43.75 %) cultivars had red petiole junction colour in the dorsal side of the leaf. The yellow main vein colour in the dorsal side of the leaf was found to be maximum (43.75%) among the cultivars. Taxonomic study revealed that the cultivars Thagajao, Thaklong galao, Thahon and Tharujung belonged to species *Colocasia esculenta* whereas only Thaklong belonged to the species *Colocasia antiquorum*.

Ethno botanical study revealed that majority (44.17%) of the respondents was found to use taro in the district. Most of the respondents (52.5 %) cultivate taro for purpose. Majority of the respondents (50.83 %) grow taro mostly in small size land holding. 67.5 per cent of the respondents sold their produce in nearby markets. Taro was mainly grown in mixed cropping system which accounted 53.33 per cent of the respondents. The study also revealed that the respondents use petiole (53.33%), leaf (20%), and corm (15%) for medicinal purpose. Only 11.67 per cent respondents were found to have no knowledge about the medicinal uses of taro. Based on the key informants, the preferential ranking of the cultivars were: Thaklong galao > Thaklong khasiba > Thaklong 1 which ranked first, second and third respectively.

Organic amendments on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.)

Pooja Rayanna Bastawadkar

An investigation entitled “Organic amendments on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.)” was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period 2019-2020. The field experiment was laid out in Randomised Block Design (RBD) with eight treatments replicated thrice under 50% shade net condition with spacing of 50cm x 25cm. The treatments were RDF @ 100:120:80 kg/ha NPK + FYM @ 10 tonnes/ha (T1), rock phosphate + microbial consortium (T2), T2 + compost @ 2.5t/ha (T3), T2 + compost @ 5t/ha (T4), T2 + vermicompost @ 2.5t/ha (T5), T2 + vermicompost @ 5t/ha (T6), enriched compost @ 2.5t/ha + microbial consortium (T7) and enriched compost @ 5t/ha + microbial consortium (T8).

The results revealed that growth, yield and quality attributing characters were significantly influenced by different nutrient sources. T6 was found to be the best in respect to growth parameters viz. plant height, number of branches, plant spread and number of leaves measured at 30 days interval, leaf area as well as days taken to first flower. The yield attributes were the highest in T6 viz. flower number (28.40), fruit number (16.27), fruit weight (13.57g), length (4.76cm), breadth (2.95cm), fruit yield per plant (201.03g/pl) and yield per hectare (7.47t/ha). Among quality parameters, T6 recorded the maximum specific gravity of fruit (1.81), juice content (91.78%), pH (3.02), TSS (7.190B), TA (0.51%), vit C (53.95mg/100g), RS (4.01%), non-RS (3.27%) and TS (7.28%). However, T6 yielded dark red and dull fruits with minimum lightness (L*) of 41, H0 value of 20.51 (more inclined towards red zone) and chroma (C*) of 52.26.

The study on nutrient status of soil revealed that available N (292.49kg/ha), P (64.07kg/ha) and K (146.57kg/ha), pH (5.74), OC (0.88%), MBC (312.26 µg/g soil /24 hour) and activity of soil enzymes viz. Phosphomonoesterase (64.07 µg p-nitrophenol /g soil /hour) and Dehydrogenase (146.57 µg TPF /g soil /hour) were found to be the highest in treatment T6. The cost economics indicated superiority of T6 (Rock

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phosphate + microbial consortium + vermicompost @ 5t/ha) with BC ratio of 3.35 followed by T5 (3.34). On the basis of results obtained in present investigation, T6 (Rock phosphate + consortium + vermicompost @ 5t/ha) is considered the best for adopting at field level to reap a good economic yield and better quality fruits with sustained soil health and high returns.

Assessment of growth, yield and quality of different types of cluster bearing ridge gourd (*Luffa acutangula* Roxb.)

Priyanka Boruah

A field experiment entitled “**Assessment of growth, yield and quality of different types of cluster bearing ridge gourd**” was carried out in the Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali during 2018-19. Five different types of cluster bearing ridge gourd *viz.*, Type 1(T₁), Type 2(T₂), Type 3(T₃), Type 4(T₄) and Type 5(T₅) were collected from Jorhat, Golaghat and Biswanath districts of Assam for the study. The experiment was laid out in randomized block design (RBD) with five treatments replicated four times. Healthy disease and pest free seeds were sown treatment wise at a spacing of 2m×3m on 14th March, 2018.

The results of the study revealed significant difference among different types of ridge gourd with respect to morpho-physiological, phenological, yield attributes and quality parameters.

Among the types, T₄ produced the maximum vine length (440.25 cm and 687.25 cm at 90 and 120 DAS, respectively) highest number of primary branches (7.25), internodal length (13.54 cm), number of nodes per vine (50.75), number of functional leaves per vine (216.50, 415.75 and 187.00 at 90, 105 and 120 DAS respectively). On the other hand, the area of a leaf and leaf area per vine were recorded the highest in T₅ (106.54 cm² and 2.22 m² at 90 DAS respectively) and (107.05 cm² and 1.89 m² 120 DAS respectively).

The highest leaf chlorophyll content index (32.01), specific leaf weight (36.80mgcm⁻²) and relative leaf water content (75.44%) were found in T₄. While the lowest chlorophyll content index (23.00) and relative leaf water content (70.34 %) were recorded in T₂ but the lowest specific leaf weight was recorded in T₅ (21.53 mgcm⁻²).

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Only in T₃ and T₅, both male and female flowers were borne but only hermaphrodite flowers were produced in T₁, T₂ and T₄. Again T₃ required the shortest period for appearance of male flower (34.75 DAS) at node number 4.5 and female flower (40.50 DAS) at 7th node number, with lower male: female ratio of 19.50:1. Among T₁, T₂ and T₄ the T₄ required the shortest days for flowering (38.75 DAS) at node number 5.25.

Yield and yield attributing characters were found to be significant among all the types. The T₄ required the shortest duration (67.25 DAS) to first picking of fruits which produced the highest fruit circumference (14.03cm), fruit volume (174.50cc), fruit fresh weight (154.62g/fruit). However, fruits of T₅ were longest (21.23cm) among all other types. The significantly highest number of fruits (6.25) per cluster was recorded in T₁ while T₂ produced the highest number of fruit clusters per vine (43.25) and number of fruits per vine (181.50). Fruit yield per vine (7.28 kg/vine), fruit yield per hectare (12.15t/ha) and number of seeds per fruit (159.50) were recorded highest in T₄.

In case of fruit quality attributing characters, the highest TSS (4.32 °Brix), flavonoid (0.66% g) and dry matter content (9.53%) were found in T₄ followed by T₃. The highest moisture content was maintained in T₅ (94.04%). However vitamin 'C' content (4.36mg/100g) was found highest in both T₃ and T₄.

Minor incidence of downy mildew, powdery mildew, fruit fly, red pumpkin beetle, leaf miner and epilachna beetle were observed and were controlled using mild dose of chemicals during the investigation in all the types of ridge gourd.

The computation of economics of cultivation showed that T₄ recorded the highest benefit: cost ratio (2.97:1) followed by T₃ (2.90:1). The lowest benefit: cost ratio of 2.23:1 was found in T₅. The study, therefore suggests that T₄ and T₃ may be recommended to the ridge gourd growers of Assam for maximizing their production of ridge gourd which not only provide good quality ridge gourd to the consumers but also improve their socio-economic status of the growers.

Response of Bitter Gourd (*Momordica charantia* L.) to organic amendments

Raktim Kiran Das

An experiment entitled “Response of bitter gourd (*Momordica charantia* L.) to organic amendments” was carried out at the organic plot of the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat-13 during the spring-summer season of 2018-2019 with the objectives to study the impact of different organic amendments on the growth, yield and quality of bitter gourd. The experiment was laid out in Randomized Block Design with eleven treatments replicated three times and the variety selected was Bipasa F1. The treatments selected for the study were: T₁: FYM @ 5t ha⁻¹; T₂: FYM @ 10t ha⁻¹; T₃: FYM @ 15t ha⁻¹; T₄: FYM @ 20t ha⁻¹; T₅: FYM @ 5t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T₆: FYM @ 10t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T₇: FYM @ 15t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T₈: FYM @ 20t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T₉: Vermicompost @ 3 t ha⁻¹; T₁₀: Vermicompost @ 3t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T₁₁: Enriched compost @ 2t ha⁻¹.

The parameters to be studied were: growth parameters *viz.*, vine length, number of leaves/ plant, crop duration; flowering parameters *viz.*, days to appearance of first male and female flower, node position of first male and female flower, total male and female flowers, male: female flower ratio; fruit parameters *viz.*, fruit length, fruit diameter, fruit weight, fruit flesh thickness, no. of seeds/fruit, 100 seed weight; yield parameters *viz.*, total number of marketable fruits/plant, net income and B: C ratio; quality parameters *viz.*, TSS content, ascorbic acid content and carbohydrate content; soil parameters *viz.*, pH (initial), texture (initial), initial and final NPK content, initial and final organic matter content and initial and final microbial biomass carbon content.

The results revealed that all the parameters varied significantly with respect to the treatments applied, except male: female flower ratio of bitter gourd. T₁₀ (Vermicompost @ 3 t ha⁻¹ + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha) recorded maximum for all the growth, flowering, fruiting, quality and yield parameters *viz.*, highest vine length (5.54 m), highest number of leaves plant⁻¹ (310.00 nos.), longest crop duration

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(120 days), lowest days to appearance of first male (43.33 days) and female (47.33 days) flower, lowest node position/ number of first male (7.33) and female (21.00) flower, highest number of male (241.33 nos.) and female (15.33 nos.) flowers, highest fruit length (26.96 cm), highest fruit diameter (4.98 cm), maximum flesh thickness of fruit (1.16 cm), highest fruit weight (205 gram), highest number of seeds fruit⁻¹ (27.66 nos.), highest 100 seed weight (24.54 g), highest number of marketable fruits plant⁻¹ (13.33 nos.), highest TSS content (5.13°Brix), highest ascorbic acid content (42.33 mg/100g FW), highest carbohydrate content (4.53 g). T₁₁ was at par with T₁₀ in terms of fruit diameter, number of seeds/ fruit and ascorbic acid content. On the other hand, T₁ (FYM @ 5t ha⁻¹) proved to be the most inferior treatment for most of the parameters.

The soil physico-chemical and biological parameters also showed best results with application of T₁₀ viz., highest organic matter content (1.23%), highest N (296.55 kg ha⁻¹), highest P (29.29 kg ha⁻¹), highest K (172.32 kg ha⁻¹) content and highest microbial biomass carbon content (494.25 µg g⁻¹ 24 hr⁻¹). The most inferior treatment for all the soil parameters was found to be T₁.

T₁₀ provided the highest net income of Rs. 6,43,036.40 and highest B: C ratio of 3.03 followed by T₈ providing net income of Rs. 5,67,986.40 and B: C ratio of 2.96. Whereas, T₁ provided the lowest net income and B: C ratio of Rs. 1,91,265.20 and 1.07 respectively.

Thus, it could be suggested that vermicompost @ 3t ha⁻¹ in combination with biofertilizers such as AZB and PSB @ 3.6 kg ha⁻¹ each would be a good organic practice to derive more yield and profit from bitter gourd cultivation. However as an alternative, combined application of FYM @ 20 t ha⁻¹ and biofertilizers or sole application of enriched compost @ 2t ha⁻¹ can be taken into consideration.

Growth performance of some gladiolus cultivars in paired row system

Rocktim Baruah

A field experiment entitled “**Growth performance of some gladiolus cultivars in paired row system**” was undertaken with the objectives to study the performance of gladiolus cultivars in paired row system, to find out the suitable cultivars of gladiolus for cut flower production, to study the multiplication behavior of the cultivars under study and to evaluate the economics of cultivation. To achieve these objectives, seven treatments or cultivars (Friendship, Candyman, White Prosperity, Novalux, Priscilla, Summer Sunshine and Dull Queen) were considered and the trial was carried out at the Experimental Farm, Department of Horticulture, Assam Agricultural University during 2019-2020.

Different characters relating to vegetative growth, flower and corm and cormel were assessed to identify suitable cultivars under paired row system. The cultivars White Prosperity, Novalux and Candyman were better performers during the vegetative phase where White Prosperity was superior in early shoot emergence (5.566 days) and plant height (160.620 cm), Novalux was superior in shoots per corm (1.867) and Candyman in terms of number of leaves (8.33). In respect to flower characters, variety Priscilla performed better in terms of early spiking (65.33 days) and first floret opening (78.55 days), spikes per corm (1.733), self life (15.267 days) and vase life (10.733 days). While White Prosperity was superior in certain critical flower characters like florets per spike(16.400) and florets open at once(6.733), rachis(81.827 cm) and spike length(103.587 cm) and size of florets(10.673 cm). The multiplication of corms (2.400) and cormels (47.267) was highest in Dull Queen while size of corm (9.060 cm) and weight of corm (212.133 g) and cormels (20.091 g) was highest in Novalux variety. In the economic aspect, Priscilla cultivar showed good remunerative quality with highest BC ratio (1:2.4). Hence cultivars White Prosperity, Priscilla and Novalux can be concluded as suitable varieties for cultivation under paired row system.

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Effect of dehydration methods on quality parameters of drumstick (*Moringa oleifera* Lam.) leaves

Sahinur Ahmed

The present investigation entitled “Effect of dehydration methods on quality parameters of drumstick (*Moringa oleifera* Lam.) leaves” was carried out during 2018-2020 in the laboratory, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali with two objectives viz. i) Effect of dehydration on nutritive values of drumstick leaves and ii) Storage stability of dehydrated drumstick leaves. The experiment was laid out in factorial CRD with three replications. The treatments were: Three methods of drying (T1: Sun drying, T2: Shade drying and T3: abinet tray dryer) with three pre-treatments (B1: Unblanched, B2: Blanched with hot water and B3: Blanched followed by KMS dip). All the pre-treatments had significant effect on physiochemical characteristics of drumstick leaves. Among the pre-treatments, unblanched leaves (B1) retained higher nutrient contents over other two pre-treatments. The results of the investigation revealed that among the three different drying methods, shade dried sample was found to retain better nutritional properties. Significantly maximum values for moisture (11.18 %), ascorbic acid (156.27 mg/100g), vitamin-A (22.71 mg/100g), iron (16.54 mg/100g), oxalate (378.66 mg/100g), chlorophyll (5.33 mg/g) and antioxidant activity (77.11 %) was recorded in shade dried (T2) sample. The interaction effect between pretreatment and drying methods showed variation in results. However, the treatment combination T1B1 (Unblanched sun dried) was found to retained more protein (26.43 g/100g), magnesium (318.70 mg/100g) and potassium (1378.79 mg/100g) whereas T2B1 (unblanched shade dried) showed higher ascorbic acid (179.47 mg/100g), saponin (3.66 %), oxalate (541.47 mg/100g), chlorophyll (6.80 mg/100g) and antioxidant (80.33 %) than rest of the treatment combinations. During storage period, protein, ascorbic acid, vitamin-A, minerals, antioxidant and antinutritional content of drumstick leaves showed a decreasing trend. However, retention of protein (22.88 g/100g), calcium (2006.20 mg/100g), magnesium (274.85 mg/100g) and potassium (1190.16 mg/100g) were more in sun dried sample, while

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shade dried sample retained more ascorbic acid (130.57 mg/100g), vitamin-A (13.60 mg/100g), iron (11.48 mg/100g), saponin (1.70 %), oxalate (346.17 mg/100g), chlorophyll (3.91 mg/g) and antioxidant activity (68.59 %) at the end of storage period (90 days). A gradual decrease in nutritional content of leaves was observed throughout the storage period but the level of retention of protein, vitamin-A, minerals and antioxidant was much higher than the fresh leaves.

Comparative performance of marigold hybrids (*Tagetes erecta* L.) in different planting dates

Saptarisha Chetia

A field experiment entitled “Comparative performance of marigold hybrids (*Tagetes erecta* L.) in different planting dates” was undertaken with the objectives to find out the optimum planting date and hybrid variety suitable for Assam condition. To achieve these objectives, three different planting dates (November, December and January) and eight different marigold hybrid varieties (Inca Yellow, Inca Orange, Vanilla, African Double Orange, Purple, Inca Gold, Maxima and Divya) were considered and the trial was carried out at the Experimental Farm, Department of Horticulture, Assam Agricultural University during 2019-2020. Different characters relating to growth, flower and physiological characters were assessed to find out the suitable planting date and hybrid variety for Assam condition. The variety African Double Orange, Inca Yellow and Inca Orange were superior during the vegetative phase. African Double Orange recorded the maximum plant height (56.38 cm), number of branches per plant (25.66), number of leaves per plant (248.32), root number (44.23) and root length (24.52 cm). Inca Yellow was superior in leaf breadth (9.40 cm) and leaf area (150.95 cm²). With respect to the flower characters, Inca Orange followed by Inca Yellow and Inca Gold recorded the superior characters. Inca Orange recorded the maximum flower diameter (11.62 cm), fresh flower weight (19.96 g), self life of flowers (17.22 days), loose life of flowers (5.04 days), number of ray florets (228.93) and flower yield per plant (515.95 g). Maximum blooming duration was recorded in Inca Yellow (58.54 days). African Double Orange gave the highest number of flowers per plant (45.93) but it recorded less flower diameter, fresh flower weight, yield of flowers per plant and also took maximum days to full bloom. Among the physiological parameters, Inca Yellow recorded the highest chlorophyll content (24.23 mg/g), leaf area duration (97.47 days), net assimilation rate (0.047 mg/cm²) and relative leaf water content (95.88 %). Inca Orange recorded the maximum carotenoid content (0.273 mg/g). Among the three planting dates, November planted varieties showed the maximum growth and flower characters and also in the physiological parameters. In the interaction effect

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between the planting dates and the hybrids, Inca Orange showed the best performance regarding the flower characters in all the three different planting dates. While African Double Orange showed the maximum performance in growth characters followed by Inca Yellow and Inca Orange in all the planting dates. Regarding the physiological parameters, Inca Yellow followed by Inca Orange recorded the best results. Hence, Inca Orange followed by Inca Yellow can be regarded as the suitable varieties. Among the three planting dates, November is concluded as the best planting date for marigold in Assam condition.

Impact of seed priming and priming durations on early season okra [*Abelmoschus esculentus* (L.) Moench]

Sarath Krishna R

The present investigation entitled “Impact of seed priming and priming durations on early season okra [*Abelmoschus esculentus* (L.) Moench]” was undertaken to assess the impact of different priming agents and priming durations on germination and seedling growth of okra seeds in the laboratory and growth, yield parameters were studied in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Seed priming of okra seeds was done by soaking the seeds in distilled water, KCl, PEG 6000 and GA3. Germination test was carried out in the laboratory of the Department of Horticulture, Assam Agricultural University, Jorhat during 2019. The field experiment was laid out in Randomized Block Design and replicated thrice. There were nine treatments consisting of T0 (untreated dry seeds), T1 (hydropriming with distilled water for 12 hours), T2 (hydropriming with distilled water for 24 hours), T3 (halopriming with 1% KCl for 12 hours), T4 (halopriming with 1% KCl for 24 hours), T5 (osmopriming with 5% PEG 6000 for 12 hours), T6 (osmopriming with 5% PEG 6000 for 24 hours), T7 (hormonal priming with 50 ppm GA3 for 12 hours) and T8 (hormonal priming with 50 ppm GA3 for 24 hours). In germination test, T1 (hydropriming with distilled water for 12 hrs) recorded the highest root length, whereas T3 (halopriming with 1% KCl for 12 hrs) obtained the highest shoot length, seedling length and seed vigour index. The maximum shoot length, seedling fresh weight, seedling dry weight and germination index was exhibited by T6 (osmopriming with 5% PEG-6000 for 24 hours). In the field regarding germination parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) requires minimum days for appearance of first emergence and 50% emergence of seedlings in each plot respectively. However, highest plant stand per plot was observed in T3 (halopriming with 1% KCl for 24 hours). In case of flowering parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) has recorded the minimum days for appearance of first flower

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and 50% flowering in each plot respectively. The present investigation revealed that the maximum plant height at 30 days after planting (DAP), 60 DAP, 90 DAP, 120 DAP and last harvest were observed in T6. Minimum days to first fruiting, minimum days to 50% fruiting, minimum days to first picking, the maximum days to first picking and maximum harvesting latitude were recorded in T6 (osmopriming with 5% PEG-6000 for 24 hours). T6 (osmopriming with 5% PEG-6000 for 24 hours) exhibits highest number of branches per plant, maximum root biomass and root volume among all treatments. Regarding yield parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) exhibited the highest value regarding number of fruits per plant, fruit yield per plant, yield per plot and yield per hectare among all the treatments. The highest yield of 189.51 q/ha was recorded in the treatment T6 (5% PEG-6000 for 24 hrs), followed by T3 (1% KCl for 12 hrs) of yield 183.02 q/ha. In case of quality parameters such as crude protein and the total ash content, T6 (osmopriming with 5% PEG for 24 h) recorded superior results among all the treatments.

Economics of production showed that the highest benefit:cost ratio of 4.25 was obtained from treatment T6 (5% PEG-6000 for 24 hrs), followed by T3 (1% KCl for 12 hrs) with B:C ratio of 4.07. The results suggest that all the priming treatments show significantly improved germination, growth and yield than those of non-primed okra seeds. Hence, the seed priming methods can be used to improve field emergence and marketable pod yield in okra sown in early season. Seed priming improved yield was attributed principally to better stand establishment. This study showed that seed priming resulted in uniform germination, better crop establishment, higher growth and yield attributing parameters in early season okra. It can be said that these priming methods are cost effective, economic, non-toxic and eco-friendly.

Performance of Brinjal (*Solanum melongena* L.) as influenced by rootstock

Trideep Rajak

An investigation was conducted on grafting brinjal during July 2018- January 2019 in Experimental Farm, Department of Horticulture, College of Agriculture, Jorhat. The major objective was to identify suitable rootstock for better field performance and assessment of influence of rootstocks on biochemical composition of fruits.

The experiment was laid out in randomized block design with 9 treatments and three replications. Two wild *Solanum* species namely *Solanum torvum*, *Solanum khasianum* and two cultivated varieties namely Surya and Kuchia were used as rootstock and one var. Debjhuri Hazari as scion (control). The seedlings were raised on portrays and later transferred to plastic poly bags. Grafting was done when the scion seedlings attained 2-3 true leaf stage (20-25 days) and rootstock was 4-5 leaf stage (40-50 days). The grafting method followed was cleft grafting. The plant morphology, reproductive and yield parameters were significantly affected by grafting. Parameters like fruit weight, fruit yield, no. of fruits per plant, fruit volume, days to first harvest and harvesting latitude were influenced positively by grafting. Biochemical parameters like phenol, flavonoids and tannin content etc. were also influenced by grafting. Incidence of diseases such as bacterial wilt and alternaria blight were also reduced by grafting.

Based on mean performance, grafted plants of Debjhuri Hazari x *Solanum torvum* (T₁) followed by Debjhuri Hazari x Kuchia (T₄) found to be superior for plant growth and yield attributing characters without much effecting fruit quality. The highest benefit cost ratio 3.22 was recorded in grafted Debjhuri Hazari x *Solanum torvum* (T₁), followed by 2.01 Debjhuri Hazari x Kuchia (T₄). So, it can be concluded that grafting in eggplant is quite successful and alternate method of production.

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Major Advisor : Dr. Ananta Saikia

Effect of growth regulators on Assam Lemon (*Citrus limon L*)

Wahedullah Bakhtari

An experiment was conducted on Assam Lemon (*Citrus limon L.*) at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2018-2019 to study the “Effect of growth regulators on Assam Lemon (*Citrus limon L*)”. Six treatments with four replications were laid out in a Randomized Block Design. The treatments comprised of GA3 (60, 80 and 100ppm) and NAA (30, 40 and 50ppm). The growth regulators were applied as foliar spray at three growth stages: (1) at pre flowering stage in the month of November, 2018, (2) at flowering stage and (3) one month after fruit set. The plant growth regulators showed significant response on flowering. The minimum number of days (52.67days) was recorded in T2 (GA3 80ppm) from the date of plant growth regulators application and the highest number of days were required in case of T6 treatment (NAA 50ppm). The highest number of flowers per plant (476.74), highest fruit set (81.32%) and the lowest fruit drop (18.50%) was recorded from T2 (GA3 80ppm) during the experiment. Number of fruits per plant was recorded highest in GA2 80ppm (371.33) and the lowest in T6 (NAA 50ppm). The highest fruit weight (136.53g), fruit length (10.00cm), fruit girth (15.93 cm), fruit volume (162.89cc) and yield (52.72 t/ha) were recorded in T2 (GA3 80ppm) while the lowest values were recorded in T6 (NAA 50ppm). The results revealed that, pulp weight and pulp-peel ratio were significantly influenced by growth regulator applications. The highest pulp weight (108.32g) and the highest pulp-peel ratio (4.83) were recorded in T2 (GA3 80ppm). Peel thickness was lowest (0.48cm) in T2 (GA3 80ppm) and the highest of 0.73cm was recorded in T6 (NAA 50ppm). The results revealed that, T2 (GA3 80ppm) took the lowest number of days required for flowering to harvesting (102.47 days) and the highest (133.77 days) in T6 (NAA 50ppm). Regarding the total leaf chlorophyll content, the highest was recorded (1.29mg/g of fresh weight) in T2 (GA3 80ppm). However, there were no significant differences in leaf nitrogen and leaf phosphorous among the treatments. Highest leaf potassium (1.69%) was recorded in T1 (GA3 60ppm). The highest juice content (37.29cc) was recorded in T2 (GA3 80ppm).

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The highest TSS (5.18°Brix), titrable acidity (3.50%) and TSS-Acidity ratio (1.48) was recorded in T1 (GA3 60ppm), whereas, the lowest values were recorded in T6 (NAA 50ppm). From the results of the ascorbic acid content (32.15mg/100ml) the highest was recorded in T2 (GA3 80ppm). Regarding evaluation of the economics of cultivation, it can be concluded that, the highest benefit-cost ratio of 3.52 was obtained from T2 (GA3 80ppm) followed by 3.44 from T1 (GA3 60ppm). The lowest B:C ratio (2.41) was recorded in T6 (NAA 50ppm). Thus, it can be suggested that, GA3 at 80ppm is the most economical plant growth regulator to improve flowering, yield and quality of Assam Lemon.

Preparation and analysis of whey based fruit beverage

Ananya Borah

Whey is the largest by-product of dairy industry with some proteins of nutritional and therapeutical benefits. These proteins are popularly known as whey proteins. Apart from its nutritional and therapeutical benefits, the utilization of whey has been done to produce different products like beverages in combination with fruit juice, soups, lactose derivatives, etc. In the present study, the compositional analysis of cow milk, buffalo milk and goat milk was done. The highest protein content was found in buffalo milk (3.6%), followed by goat milk (3.48%) and cow milk (3.34%). The highest carbohydrate content was observed in cow milk (4.84%), followed by buffalo milk (4.37%) and goat milk (3.98%). The goat milk showed highest ash content (0.8%), followed by buffalo milk (0.75%) and cow milk (0.7%). Fat content was recorded to be highest in buffalo milk (5.2%), followed by cow milk (3.6%) and goat milk (3.3%). Comparative analysis of whey protein was done in all the three milk sources. The highest whey protein was found in goat milk (0.50%), followed by buffalo milk (0.44%) and cow milk (0.39%). SDS-PAGE was run, where protein bands of ~35 kDa and ~14 kDa were observed in all the three milk sources of whey. Finally, the investigation was extended to the preparation of whey based fruit beverage with different concentrations of whey from cow milk, buffalo milk, and goat milk, and the fruit juices from pomegranate and orange. These beverages were analyzed for some important physiochemical parameters like TSS, pH, acidity, viscosity, microbial count and acceptability. The beverages were stored up to 21 days and analysis was carried out for all the above cited parameters at 7 days interval. The results thus obtained exhibited that on storage, TSS, acidity and viscosity for all the different kinds of beverages thus prepared increased significantly. However, the pH values were found to be decreased considerably over time during storage in all the cases. Again, in all the cases, microbial growth was observed from 7 days onwards. The comparative sensory evaluation was also carried out in both the whey based fruit beverages. Cow milk based pomegranate beverage (60:40 V/V) scored the highest point, 6.50 among all the different whey based

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Major Advisor : Dr. Tankeswar Nath

pomegranate formulations. Again, the buffalo milk based orange beverage (60:40, V/V) scored the highest point, 6.25 for overall acceptance among the different whey based orange beverage formulations. Comparing the two best formulations from whey based pomegranate and whey based orange beverages, it can conclude that the cow milk based pomegranate beverage (60:40 V/V) has the highest acceptability scoring the maximum point, 6.50 in the 9 point hedonic rating scale. The prepared whey based pomegranate and orange beverages can be utilize for further exploration.

Quality of elephant apple (*Dillenia indica* L.) powder as affected by drying methods

Aradhana Boruah

Elephant apple (*Dillenia indica* L.) locally known as outenga in Assam is native to southeastern Asia. The fruits possess great medicinal properties and are rich in fiber, β -carotene, vitamins (B and C), carbohydrates and proteins. Higher moisture contents, seasonal availability and lack of proper processing techniques make it one of the most neglected wild fruits which have the potential to provide an income source if properly utilized. The present study was carried out to identify the suitable stage of fruit development and the drying method for maximum retention of quality of elephant apple fruit powder for getting its benefits during the off season. Different drying methods (oven drying at 50°C and 70°C, sun drying, solar drier drying and shade drying) were taken for the study. Flowers were tagged at first opening (days after flowering). Nutritional composition was investigated at 75, 100, 120 and 150 days after flowering under different drying methods. Significant differences in the nutritional parameters were observed in respect of growth stages of fruit and drying methods employed. Interaction between fruit development and drying methods was also found significant except for total carbohydrates. Solar drying was found better in maximum retention of crude fibre, total carbohydrate, ascorbic acid and anthocyanin. Whereas oven drying at 70°C was found better for moisture, ash & tannin and sun drying was found better for crude protein and total flavonoid. Fruit of 120 DAF was found nutritionally superior over other growth stages. Antioxidant activity of the elephant apple powder was found with fruit development drying methods employed and their interaction. Lowest activity was observed in 120 DAF dried under shade drying, whereas highest activity was found in 120 DAF dried under oven drying at 50°C, but 100 days old fruits showed better inhibition than the others.

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Major Advisor : Dr. Samindra Baishya

Ready-to-reconstitute soup mix from *Moringa* leaf and *Mentha* leaf powders

Jadhav Priyanka Yashwant

An experiment was carried out in order to develop ready-to-reconstitute soup mix from *Moringa* leaf and *Mentha* leaf powders in the Food Science and Technology Laboratory of Department of Horticulture, AAU, Jorhat during 2018-2020. *Moringa* leaves and *Mentha* leaves are of one the old ingredients used in Indian cuisine owing to their nutritive value, flavor and medicinal properties. This study was aimed to develop a reduced bulk, nutrient dense health food i.e. Ready-to-reconstitute soup mix as a nutritional and functional product. The formulations F1, F2, F3, F4 and F5 were developed by varying the proportions of *Moringa* and *Mentha* leaf powders where the ratios of *Moringa* leaf powder to *Mentha* leaf powder were (50:5), (45:10), (40:15), (35:20), and (30:25) respectively. Corn flour was added as thickening agent along with spice mix and citric acid. *Moringa* and *Mentha* leaves were dehydrated in a cabinet drier at 50°C for 3 to 4 hours and 70 °C for 5 to 6 hours respectively using the established procedures. The preliminary trials were conducted using a 9-point Hedonic rating scale in order to optimize the proportion of ingredients in the soup mixes. The developed formulations were reconstituted with the hot water in ratio 1:15 which was found to be most preferable level for reconstitution of soup mix. The developed ready-to-reconstitute soup mixes were subjected to physicochemical and sensory analysis where the formulations were found rich in protein, ash content, carbohydrates and micronutrients like iron. Formulation F4 was selected for storage study for two months based on its good nutritive profile and highest scores in sensory attributes like appearance, colour, taste, flavor, texture, consistency, mouthfeel and overall acceptability. The physicochemical analysis at the end of storage period showed that formulation F4 contained 8.48% moisture content, 4.99% ash content, 16.89% crude protein content, 62.51% carbohydrate content, 6.3% crude fat content, 5.10% crude fibre content, 1651.81mg/100g Calcium and 4.83mg/100g iron. The rehydration ratio, water absorption capacity and bulk density of formulation F4 had values 3.15, 1.95g/ml and 0.77g/ml respectively. The developed soup mix was also found to be organoleptically

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acceptable at the end of two months without deterioration in quality. The formulations were found to be comparable with other commercial soup mixes in terms of cost of raw materials processing and packaging and high in terms of nutrition and suitable for consumption by all age groups.

Development of tuber crops based composite flour

Kasturi Pusty

The present study titled “Development of tuber crops based composite flour” was carried out in the post harvest unit and food processing laboratory, under Department of Horticulture, AAU, Jorhat, during the period 2018-2019. The experiment was laid out in complete randomized design with ten treatments replicated three times. Ten types of blends were prepared to make composite flour mix. The sweet potato based blends contained sweet potato flour, sorghum flour, chickpea flour and flax seed flour in different ratios are viz. 80:10:5:5 (S1), 70:15:10:5 (S2), 60:20:15:5 (S3), 50:25:20:5 (S4), 40:30:25:5 (S5). And taro based blends contained taro flour, sorghum flour, chickpea flour and flax seed flour in different ratios viz. 80:10:5:5 (T1), 70:15:10:5 (T2), 60:20:15:5 (T3), 50:25:20:5 (T4), 40:30:25:5 (T5).

Physico-chemical properties (moisture, ash, crude protein, crude fat, crude fiber, total carbohydrate, starch, amylose, pH, total oxalate and peroxide value) of the individual as well as composite flour blends were determined and the functional properties (water absorption capacity, oil absorption capacity, foam capacity, foam stability, swelling capacity and water solubility) of the blends were determined and cookies were developed using composite flour. Cookies prepared from sweet potato and taro based composite flour mix were analyzed for physical characteristics (diameter, thickness and spread ratio) and sensorial characteristics (appearance, color, flavor, texture, taste, overall acceptability). It was observed that the physicochemical and functional properties of sweet potato and taro based composite flour varied significantly and the combinations of S3 (60% sweet potato flour, 20% sorghum flour, 15% chickpea flour and 5% flax seed flour) and T3 (60% taro flour, 20% sorghum flour, 15% chickpea flour and 5% flax seed flour) are found to be the best because it retained most of the nutritional qualities. From the sensory evaluation of sweet potato based composite flour the highest overall acceptability (7.80) was recorded in S3 (60% sweet potato flour, 20% sorghum flour, 15% chickpea flour and 5% flax seed flour) and in case of taro based composite flour mix the highest overall acceptability (7.90) was recorded in T2 (70% taro flour, 15% sorghum flour, 10% chickpea flour and 5% flax seed flour). The spread ratio of the cookies of sweet potato and taro based composite flour mix varied significantly.

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. S. Alam

Quality of Carambola RTS beverage as influenced by preservation methods

Monmayuri Phukan

The present experiment “Quality of Carambola RTS beverage as influenced by preservation methods” was conducted in the Food Processing unit and Post-Harvest Lab, under Department of Horticulture, Assam Agricultural University, Jorhat during the period 2018-2019. The experiment was laid out in Completely Randomized Design (CRD) with five treatments and six replications. The carambola juices were given different treatments and stored in different storage conditions viz. T1 (untreated samples stored in freezing conditions), T2 (untreated samples stored in refrigeration conditions), T3 (pasteurized samples stored in freezing conditions), T4 (pasteurized samples stored in refrigeration condition) and T5 (samples treated with chemical preservative and stored in ambient temperature, control).

The beverage samples were analyzed for physicochemical parameters such as viscosity, TSS, acidity, ascorbic acid, TSS-acid ratio, total sugar, total phenol and microbial and sensory attributes through storage at intervals of 15 days. The results revealed an increasing trend in the TSS, acidity and total sugar of the beverages while a decreasing trend was observed in the viscosity, ascorbic acid content, TSS-acid ratio and total phenol content. T3 (Pasteurization + Freezing) was found to be the best method with respect to retention of nutrients and organoleptic qualities like taste, flavour, colour, appearance and overall acceptability. Microbial contamination was found to be the least in this treatment till 90 days of storage which was within permissible limits and safe for consumption. Treatment T3 was followed by treatment T1 in the different aspects of physicochemical, microbial and organoleptic analysis.

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Pritom K. Borthakur

Awareness and use of food label information by consumers of Jorhat, Assam

Monosweta Gracy Shaw

The present study entitled “Awareness and use of food label information by consumers of Jorhat, Assam” was undertaken to assess the awareness and use of food label information. The objectives of the study were to determine the level of awareness of consumers on pre packaged food labelling information, assess consumers’ use of food label information, analyze consumers’ attitude towards reading food labels and determine factors associated with reading of food label. To fulfil these objectives 400 respondents from 3 supermarkets, namely Big Bazaar, Viraat Bazaar and Vishal Mega mart and 3 departmental stores namely Pariwar food mart, Doss and co., and M.D.s store were taken. The respondents were of the age 18 years and above. Data on different parameters like consumers’ socio demographic profile was recorded using a self structured questionnaire. Awareness level on food label information of the consumer was recorded using a score card adopted from Priyadarshini (2014), consumers’ attitude on food label information was assessed using an attitude scale adopted and modified from Robert and Chandran (2017), use of food label information by the consumers was documented using a modified question module by Robert and Chandran (2017) and factors affecting reading of food label by consumers was recorded using a semi structured questionnaire by Dutta and Patel (2017). Socio-demographic data revealed 57 per cent of the consumers were female, 35 per cent of the age group 39-49 years, 69 per cent were graduates, 25.5 per cent were employed, 50.5 per cent were of high income group and 49 per cent shopped once a week. Determination of awareness level on food label information revealed that 43.75 per cent of the respondents were moderately aware. Association between socio demographic characteristics of consumers and awareness level on food label information revealed gender (p value=0.01, ‘r’=+0.46), education (p value=0.00, ‘r’=+0.49) and frequency of shopping (p value=0.04, ‘r’=+0.57) had significant association and positive correlation with awareness level. Consumers’ attitude on helpfulness of food label information in buying pre-packaged food revealed 92 per cent of the respondents to have a positive attitude, 94.5 per cent had a positive

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Major Advisor : Dr. Ruma Bhattacharyya

attitude on importance of nutrition label information, 91 per cent had a positive attitude on trustworthiness on food label information. Assessment of use of food label information by consumers revealed 59.75 per cent of the respondents read food labels regularly, 51 per cent checked price of the pre packaged food, 46.75 per cent checked expiry dates on a food label, 79.75 per cent chose to buy products based on food label information, 76 per cent agreed to not buy products if there is no food label, 52.25 per cent compared food labels to make food choices. The main source of nutrition information for consumers was reported to be internet (75.25%) followed by family and friends (74.50%) and television (70.25%). The most sought nutrition information on pre packaged food was total calories (61.25%) followed by sugar (50.25%) followed by fats (50.25%) and cholesterol (49%). The motivation factor for most (79%) of the consumers to read food label information was price, the circumstance at which most 57.25 per cent of the consumers did not read food label information when they bought familiar foods and 56 per cent revealed that due to small fonts, they faced difficulty in reading food labels. It can be concluded that the awareness on food label information was moderate attributed to the socio demographic factors of consumers like gender roles, level of education and frequency of shopping pre packaged food and use of food label information by consumers was confined to reading price, expiry dates etc. and very less utilization of nutrition information. Consumer education on food label information, development of consumer guide and training of working staff at supermarkets and stores on food label information interpretation can be adopted to improve the present situation on awareness and use of food label information.

Quality of sweet potato flour as affected by pre-treatment and drying methods

Mriganka Shekhar Borah

Sweet potato (*Ipomoea batatas*, family:Convolvulaceae) is a perennial crop, grown in tropical and subtropical lowland agro-ecologies, although it is well adapted to other zones and can be grown in different environmental conditions. Sweet potato is an excellent source of energy, but due to low digestibility of the starch it is suitable for diabetic or overweighted people. Because of its highly perishable nature, there are many problems related to storage and transport of the raw sweet potatoes. However, it can be processed into flour, which is less bulky and more stable than the highly perishable fresh root. The present investigation was aimed to evaluate the effect of pre-treatment and drying methods on chemical composition and the functional properties of sweet potato flour.

Four pre-treatment methods (soaking in water, T₁; blanching, T₂; calcium chloride solution, T₃ and pre-drying at 100°C for 5 minutes, T₄ along with the control, T₅) and three drying methods (sun drying, D₁ oven drying, D₂ and microwave drying, D₃) were employed in the preparation of flour from three varieties of sweet potato (Dergaon red, Shree Bhadra and ST-14). Drying methods and pre-treatment were found to influence all the parameters studied, titratable acidity remained unaffected by the drying methods. The pre-treatments caused significant reduction in the nutritional parameters compared to control with T₄ being the worst. Sun drying was found better in maximum retention of crude protein, crude fat, starch and amylose over the other two. Microwave drying was found better for crude fibre and ash content. Functional properties of sweet potato flour were also affected by the pre-treatment and the drying methods with T₄ and D₃ affecting the most of them. The interactive effect of variety, pre-treatment and drying method was found to have a significant effect in all the attributes of sweet potato flour. Orange fleshed variety, ST-14 was found nutritionally superior over the other two and the quality and functional properties of flour was best with treatment combinations, T₅D₁. Sun drying of sweet potato slices with no pre-treatment was found better in preparing sweet potato flour over any other combinations used in the study.

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Major Advisor : Dr. Samindra Baishya

Studies on quality of dried Oyster mushroom (*Pleurotus ostreatus*) and Milky mushroom (*Calocybe indica*) as influenced by various pre-treatment and selected drying temperatures

Nastalina Borah

The present investigation was aimed to evaluate the effect of pretreatment and drying temperatures on quality of oyster (*Pleurotus ostreatus*) and milky (*Calocybe indica*) mushroom. Three chemical pretreatments: NaCl, KMS and Citric acid; each of 0.1% concentration and two hot air oven drying temperatures (45°C and 60°C) were employed in the present research work. After drying, the mushroom samples were processed into powdered form. The proximate analyses of the samples were studied followed by sensory evaluation. Among all the pre-treatments, mushroom pre-treated with Sodium Chloride (T1), was found to have higher amount of protein and crude fiber, when dried at lower temperature (D1). The highest value for calcium content was observed in KMS pre-treated (T2) oyster as well as milky mushroom irrespective of drying temperature. The mushroom samples pre-treated with KMS (T2) dried at 45°C temperature (D1) retained maximum whiteness. Sensory evaluation for texture showed greater score in Sodium Chloride (T1) pre-treated mushroom samples (*Pleurotus ostreatus* and *Calocybe indica*) followed by KMS (T2) and citric acid (T3) dried at lower temperature (D1). Aroma was found to be the highest in dried mushroom pre-treated with Sodium Chloride (T1). The drying temperature 45°C (D1) was found better for colour, texture and aroma in oyster mushroom (*Pleurotus ostreatus*) pre-treated with sodium chloride (T1). In case of milky mushroom the highest overall acceptability was observed in KMS pre-treatment (T2) combined with 45°C drying temperature (D1).

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Pritom Kr. Borthakur

Development of Vinegar from Rice Varieties of Assam with Herbal Incorporation

Pratikshya Dutta

An investigation was carried out during 2018-2020 to standardize the production process of vinegar from bora rice and black rice with the incorporation of locally available medicinal herbs and, to study the quality parameters of the developed products. *Acetobacter aceti* MTCC-3246 and 3347 were collected from Microbial Type Culture Collection & Gene Bank (MTCC), ICAR- Institute of Microbial Technology, Chandigarh. The study revealed that malted bora rice and black rice could be successfully fermented with the above-mentioned strains to develop herbal vinegar. The acetic acid content of the developed vinegars ranged from 3.89 to 4.82%, with the highest content present in vinegar C developed from bora rice using both the acetobacters strains. The lowest content was reported in the controls which were naturally fermented by wild bacteria. Alcohol residues were also observed in the vinegars (0.88-0.54% v/v). A fairly good amount of phenols was recorded in the range of 16.86-14.33 mg GAE ml⁻¹, with the highest content in vinegar C and the lowest in the controls. The range of TSS in the vinegars was 2.20-0.97 °Bx. No contamination of *Lactobacilli* and *E. coli* was observed during 15 days of storage of the vinegars. The sensory evaluation revealed that all the rice vinegar samples were rated above 5 for overall acceptance with the highest overall acceptability recorded in the case of vinegar C followed by vinegar A, which was developed from bora rice using *A. aceti* MTCC3246; while the control samples, which were fermented naturally without incorporation of any herbs, got the lowest scores for overall acceptability. Product characterization of the vinegars revealed that the vinegars developed from bora rice scored significantly higher. The investigation establishes that both bora and black rice can be effectively used to develop vinegar with acceptable flavour and quality attributes.

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Ananta Saikia

Formulation of ready-to-use curry powder for ethnic cuisines of North East India

Priyankhi Kalita

The present investigation on —Formulation of ready-to-use curry powder mix for ethnic cuisines of North East India was carried out in Assam Agricultural University, Jorhat, Assam during the year 2018-2020. The experiment was laid out in a completely randomized design with nine treatments replicated three times. The bamboo shoot (BS), mustard green (MG) and spinach (SP) were processed into powdered form and blended in different ratios for developing nine types of ready-to-use curry powder mix. The mixes were named as MIX 1 (30 SP: 60 MG: 10 BS), MIX 2 (25 SP: 55 MG: 20 BS), MIX 3 (20 SP: 50 MG: 20 BS), MIX 4 (90 MG: 10 BS), MIX 5 (80 MG: 20 BS), MIX 6 (70 MG: 30 BS), MIX 7 (90 SP: 10 BS), MIX 8 (80 SP: 20 BS) and MIX 9 (70 SP: 30 BS), respectively.

Physico-chemical properties (total carbohydrate, crude protein, crude fat, crude fiber, ash and moisture) of the raw materials as well as nine curry-powder mixes were determined followed by food value determination of the nine mixes. Results obtained were statistically analysed based on ANOVA. Significant differences were observed in respect of different mixes. A curry recipe was standardized using the ready-to-use powders for sensory evaluation. The microbial safety of the best products was studied. It was observed that MIX 3 with ratio of SP: MG: BS=20: 50: 30 powder was found to be the most acceptable. This product recorded good sensory attributes concerning colour (7.5), flavour (7.9), taste (7.85), texture (7.35) and overall acceptability (7.89). The acceptability of MIX 3 was followed by MIX 4 (90 MG: 10 BS) and MIX 9 (70 SP: 10 BS). The food value of MIX 3 was found to be 37.97 cal/100g \pm 0.03 with total carbohydrate (4.576 g/100g \pm 0.001), crude protein (3.376% \pm 0.002), crude fat (0.319% \pm 0.003), ash (2.14% \pm 0.004) and crude fiber (2.234% \pm 0.003) content, respectively. The moisture content of MIX 3 was recorded to be 7.587 % (w.b) indicating a good keeping quality and no microbial growth was observed in the products at 1, 3 and 6 months interval of storage time.

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Abhijit Borah

As no suitable mixes for the exotic non-vegetarian cuisines of North East are available in the market, the developed product can be expected to have a good market potential. Future works may be carried out by adding tastemakers like garlic powder, ginger powder, king chili powder etc. for wider acceptability.

Production of blended tea-fruit wine with efficient yeast culture

Richi Sika

Wine refers to the un-distilled alcoholic fermented fruit product. Tea is the most popular beverage in the world with known therapeutic value. Microbial fermentation of tea will lead to value addition in terms of taste, flavour and health components. Assam, a key tea producing state of India has an attractive entrepreneurial opportunity with domestic tea wine during the peak seasons with possible economic implications. Yeasts are the prominent organisms involved in wine production and determine important characteristics of the wine, including the flavour. Wines produced by selected yeasts have a better quality than those produced by spontaneous fermentation. At the moment, most of the wine production processes rely on *Saccharomyces cerevisiae* strains that allow rapid and reliable fermentations.

The present study focused on developing a tea-fruit wine using either tea leaves/infusion (tea waste, fresh tea leaves) alone or blended with pineapple/honey. Indigenous yeasts numbering 11 were isolated from rice based starter culture and fermentation efficiency was evaluated. Based on the fermentation efficiency 4 isolates were selected and along with 4 previously isolated yeast cultures obtained from the Department of Agricultural Biotechnology were evaluated for wine brewing efficiency. Among the 8 yeasts isolates tested, the isolate ABTMB-YA (KF055432) was found to produce the highest alcohol concentration (12.3%). As this isolate displayed good thermo-tolerance (40 °C), ethanol tolerance (12%) and had good growth rate, it was selected for further studies in wine preparation. Eighteen treatments with a combination of fresh tea leaves/ tea waste infusion + honey (10, 15, 20, 25%), fresh tea leaves (50% w/v) + pineapple juice (50%), fresh tea leaves (25% w/v) + pineapple juice (75 %) and waste tea (5, 10, 15 & 20 % w/v) + pineapple juice (50%) or (75%) were designed for wine preparation. Both T₁S₄ (Fresh tea leaves 50% w/v+ Honey 25%) and T₃S₄ (Tea waste infusion 10% w/v+ Honey 25%) treatments were recorded with highest alcohol content (10.20%) while least was recorded in T₁S₁ (Fresh tea leaves 50% w/v + Honey 10%) and T₅ (Fresh tea leaves (25% w/v) + Pineapple juice 75%) i.e. 4.17%. However, the sensory evaluation (9 point hedonic scale) revealed the T₈S₂ (Tea waste infusion

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Madhumita Barooah

10%w/v+ Pineapple juice 50%) treatment with alcohol content of 7.0% as the best among the tested wine samples. The study revealed that wine produced from the infused tea waste and pineapple juice as superior among the tested. Further refinement and scale up will position it for commercialization.

Development of a beverage powder using Elephant apple (*Dillenia indica*) and whey

Udangshree Borah

Dillenia indica has recently gained a lot of spotlight because of its multifarious medicinal properties; however, processed products from the same are scanty. In the present study, *Dillenia indica* juice (2% total solids) was blended with concentrated whey (30% total solids) in different proportions (v/v) (T1 (100% *Dillenia indica* juice), T2 (9:1), T3 (4:1), T4 (7:3), T5 (3:2), T6 (1:1), T7 (2:3), T8 (3:7), T9 (1:4), T10 (1:9) and T11 (100% whey)) for assessing their organoleptic acceptability. Principal Component Analysis of the sensory scores indicated good preference for four blends, namely, T6, T7, T8 and T9 over the others. Subsequent analysis of their antioxidant activity revealed the superiority of T6 amongst the four counterparts. The study was further extended to develop a ready-to-reconstitute beverage powder using T6 as the base, wherein suitable proportions of maltodextrin (MD) was added and spray dried at different inlet temperatures as per as the Rotatable Central Composite Design of Response Surface Methodology. The dependent variables selected for optimizing the process condition were yield, dispersibility, antioxidant activity and organoleptic acceptability of the beverage powder. All the powders recuperated at different experimental conditions were organoleptically favourable (scores above the limit of acceptance) with good yield (63.33-88.33%), dispersibility (33.40-56.57%), and moderate antioxidant potential (37.45-54.57%). The quadratic polynomial models for the responses were found to be significant ($p < 0.05$) and adequate for prediction, which was validated by conducting confirmatory trials at the predicted optimum condition (160°C of inlet temperature and 19.727% MD). Additional quality attributes of the beverage powders developed at different processing conditions were also evaluated; the powder developed at 120°C inlet temperature and 5% MD retained the maximum polyphenols (2.06 mg GAE/g), flavonoids (0.55 mg QE/g) and exhibited high antioxidant activity (54.57%); while that obtained at 120°C inlet temperature and 25% MD had the highest amount of sugars (293.97 mg/g) and the one obtained at 140°C inlet temperature with 29% MD concentration showed the highest soluble protein content

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Department : Food Science & Technology (Horticulture)

Major Advisor : Dr. Manashi Das Purkayastha

(105.58mg/g) and crude protein (66.50%). The effectiveness of the said optimization approach was further validated by analysing the physicochemical properties of the powder derived at the predicted optimized condition, which exhibited good solubility ($89.02\pm 0.41\%$), dispersibility (49.73 ± 0.33), intermediate hygroscopicity (23.00 ± 0.61), and fair flowability (Carr Index= 24.80 ± 3.0). With respect to the feed (T6) used for spray drying, a reduction of 49.08%, 38.41% and 54.5% were observed in the total sugar, crude protein and soluble protein of the optimized powder, respectively. Nonetheless the decrease in its antioxidant activity was only 17.42%, which was ascribed to the protective effect of high amount of MD on bioactives and formation of Maillard reaction products at high processing temperature. Organoleptic acceptability score and WI of the reconstituted optimized beverage powder were better than that of the pristine *D. indica* juice, and this improvement was credited to the masking of undesirable brown pigments of the fruit juice by amalgamation of MD and whey. Scanning electron microscope showed particles ranging from 2-30 μm in diameter. Surface morphology of the powder obtained at high inlet temperatures, revealed shrunk and wrinkled particles; while those dried at low temperatures and higher amount of MD showed fused or clumped entities. Thus, *Dillenia indica* and whey based ready-to-reconstitute beverage powder, with acceptable sensory and quality attributes, could be developed using a spray dryer under statistically optimized process condition.

Survey and management of root-knot nematode, *Meloidogyne incognita* on tuberose, *Polianthes tuberosa*

Abhijit Chetia

In the present investigation on survey and identification of plant parasitic nematodes associated with tuberose, total seven genera of plant parasitic nematodes viz., *Meloidogyne*, *Helicotylenchus*, *Hoplolaimus*, *Tylenchorhynchus*, *Pratylenchus*, *Rotylechulus reniformis* and criconematids were encountered from various tuberose growing localities of Kamrup, Jorhat and Morigaon districts. The study of perineal pattern confirmed the species of root-knot nematode as *Meloidogyne incognita*. *Meloidogyne* spp. and *Helicotylenchus* spp. population were found to be dominant in most of the surveyed localities. Studies on the pathogenicity of *M. incognita* on tuberose showed that there was a progressive decrease in the growth of tuberose plants as the inoculum level of *M. incognita* increased. An initial inoculum level of 100 J2 per kg of soil caused significant reduction in plant height, shoot and root weight and proved to be pathogenic to the tuberose plants. The reproductive rate of nematode was maximum at the initial inoculum level of 10 J2 per kg of soil and minimum at the highest inoculum level of 10,000 J2 per kg of soil. In all the five varieties of tuberose showed varied degrees of susceptibility to *M. incognita*. Out of five varieties, three varieties viz., „Prajwal“, „Phule Rajani“ and „Arka Nirantara“ were found to be susceptible and rest two varieties viz., „Local Single“ and „Shringar“ were found to be moderately resistant and resistant to *M. incognita*. Studies on efficacy of Org-Trichojoal and Org-Pochojoal for the management of *M. incognita* on tuberose showed that the treatment where bulb treated with Org-Pochojoal @ 5 ml/lit water + soil treated with Org-Pochojoal @ 40 ml/kg enriched compost was found to be most effective in increasing plant height, root length, fresh and dry weight of shoot and root of tuberose plants as well as reducing galls, eggmasses and final nematode population in soil. Maximum spike production was recorded in the treatment where bulb treated with Org-Trichojoal @ 5 ml/lit water + soil treated with Org-Trichojoal @ 40 ml/kg enriched compost.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. A. Borah

Efficacy of entomopathogenic nematodes (EPNs) against major insect pests of tea

Amuri Bharath

A total 200 soil samples were collected from tea plantation areas of district, Jorhat, Assam and were assessed for entomopathogenic nematodes using the *Galleria* baiting technique. Out of 200 soil samples, EPNs were found in 2 soil samples with 1% frequency of occurrence. One isolate of *Oscheius* sp. (0.5%), was isolated from Experimental farm for plantation crops, Section-4, 10, 19 AAU, Jorhat and another *Heterorhabditis* sp. (0.5%) was isolated from Chetiagoan, Jorhat. Morphological and morphometrical characters were used in the identification of nematode isolates. The identified species were *Heterorhabditis bacteriophora*, and *Oscheius chongmingensis*. In infectivity study, indigenous isolates of EPNs, *Heterorhabditis bacteriophora* and *Oscheius chongmingensis* tested in the laboratory bioassay, caused mortality of tea mosquito bug, *Helopeltis theivora* and bunch caterpillar, *Andraca bipunctata*. Fifty, 60 and 70 per cent mortality of *Helopeltis theivora* by *H. bacteriophora* at 150 IJs/insect was observed at 48 h, 72 h and 96h respectively. With the increase in the exposure period to 96 h, *H. bacteriophora* could induce up to 90% mortality of the tested insect at the dose of 250 IJs. Similarly, mortality of *Helopeltis theivora* increased with increase in the dosage of *O. chongmingensis* and recorded 50, 60 and 70 per cent mortality at 200 IJs/insect at 48 h, 72 h and 96h. Bioassay of *H. bacteriophora* and *O. chongmingensis* against the 3rd instar larvae of *Andraca bipunctata* indicated that at 250 IJs/larva recorded 70 and 60% mortality in 48 hours of exposure, while 100 and 90% mortality of *Andraca bipunctata* was recorded at 96h. *H. bacteriophora* was more pathogenic than *Oscheius chongmingensis* against *Helopeltis theivora* and *Andraca bipunctata* based on LD₅₀ values at 48 h, 72 h and 96 h.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. Gitanjali Devi

Bio-management of rice root knot nematode, *Meloidogyne graminicola* through native fungal bioagent

Indumoni Phukan

An *in-vitro* experiment was conducted to study the efficacy culture filtrates of native fungal bioagents viz., *Trichoderma viride*, *T. harzianum*, *Pochonia chlamydosporia* and *Purpureocillium lilacinum* on juvenile (J2) mortality of rice root knot nematode, *Meloidogyne graminicola*. The culture filtrates of these fungal bioagents were found to be effective in causing mortality of second stage juveniles at various concentrations and time of exposures. Among them *T. viride* was found to be most effective against *M. graminicola* in respect of larval mortality. There was an increase in larval mortality with increase in concentrations and time interval. Hence *T. viride* was selected for studying its efficacy against *M. graminicola* under pot conditions. For this, *T. viride* was applied as seed treatment, soil application and both. Carbofuran was applied as chemical check. The results showed that *T. viride* when applied together as seed treatment and soil application, significantly improved plant growth parameters of rice and reduced nematode multiplication as compared to when they were applied either as seed treatment or soil application. Further, the defense related enzymatic activities were worked out and it showed increase in the activities of PO, PPO, PAL and total phenol content in roots of rice. The maximum enzymatic activities like PO, PPO, PAL and total phenol content was recorded in the rice roots treated with *T. viride* when applied together as seed treatment and soil application. The results of the present investigation revealing some of the mechanisms of fungal bioagents against rice root knot nematode might be of great help in formulating rice root knot nematode management programme.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. Bhabesh Bhagawati

Mechanism of *Lantana camara* leaf extracts in the management of *Meloidogyne incognita* on tomato

Kankana Bordoloi

An experiment was carried out on the mechanism of *Lantana camara* leaf extract in the management of *Meloidogyne incognita* on tomato. For this, leaf extract of *L. camara* (25gm/75ml w/v) were evaluated at 25, 50, 75 and 100 percent concentration through egg hatch inhibition and larval mortality test. The result of the *in-vitro* efficacy test showed that maximum egg hatch inhibition of *M. incognita* was recorded in the 100 percent concentration of *L. camara* leaf extract where as minimum was recorded in the 25 percent concentration after 7 days of exposure time. The maximum mortality of *M. incognita* J₂ was recorded in the 100 per cent concentration of *L. camara* leaf extract where as minimum was recorded in the 25 per cent concentration after 24, 48, 72 and 96 hours of exposure time. No mortality was recorded in the control treatment *i.e.* sterile distilled water. It was observed that there was an increasing trend in the mortality of J₂ with increase in the concentration and time of exposure. Similarly, egg hatch inhibition was also found to be more with increase in the concentration. A pot experiment was conducted to explore the biochemical mechanism of leaf extracts of *L. camara* in the management of *M. incognita* on tomato. For this the activity of defence related enzymes *viz.*, peroxidase (PO), polyphenoloxidase (PPO) and total phenol content were observed at 25,50,75 and 100 percent concentration of *L. camara* leaf extract after 35 and 45 DAI of *M. incognita* in tomato. Among the different concentrations, highest activity of peroxidase (PO), polyphenoloxidase (PPO) and total phenol content was observed at 100 percent concentration while the minimum activity was recorded in the 25 percent concentration both after 35 and 45 DAI. However, maximum activity of the biochemical compounds was recorded at 35 DAI while the same declined at 45 DAI. The lower concentration of *L. camara* leaf extract *viz.*, 25 and 50 percent showed stimulatory effect on plant growth parameter whereas higher concentrations *viz.*, 75 and 100 percent concentration of *L. camara* leaf extract showed inhibitory effect on plant growth. The maximum plant growth parameter like shoot height, shoot weight (fresh) and root length and root weight (fresh), dry shoot weight were recorded in the 50 percent concentration

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Department : Nematology

Major Advisor : Dr. B. Bhagawati

of *L. camara* leaf extract where as the minimum was recorded in the nematode alone treatment. The minimum nematode multiplication like number of galls, number of eggmasses and final nematode population in soil were recorded in the 100 percent concentration of *L. camara* leaf extract followed by 75, 50 and 25 percent concentration.

Management of root knot nematode (*Meloidogyne incognita*) in Tomato by Bacterial Bioagent

Karter Nyodu

Investigations were carried out to evaluate the efficacy of bacterial bioagents viz., *Bacillus subtilis*, *Bacillus megaterium*, *Bacillus pumilus* and *Pseudomonas fluorescens* as seed as well as soil treatment against root knot nematode, *Meloidogyne incognita* on tomato (var. Pusa Ruby).

Seed treatment experiment was conducted with thirteen treatments viz., T₁: *B. subtilis* (1×10⁹cfu/gm of talc formulation) @ 10gm/kg of seed, T₂: *B. subtilis* (1×10⁹cfu/gm of talc formulation) @ 20gm/kg of seed; T₃: *B. subtilis* (1×10⁹ cfu/gm of vermi formulation) @ 10 gm/kg of seed; T₄: *B. subtilis* (1×10⁹ cfu/gm of vermi formulation @ 20 gm/kg of seed; T₅: *B. pumilus* (1×10⁹cfu/gm of talc formulation) @ 10gm/kg of seed; T₆: *B. pumilus* (1×10⁹cfu/gm of talc formulation) @ 20gm/kg of seed; T₇: *B. megaterium* (1×10⁹cfu/gm of talc formulation) @ 10gm/kg of seed; T₈: *B. megaterium* (1×10⁹cfu/gm of talc formulation) @ 20gm/kg of seed; T₉: *B. megaterium* (1×10⁹ cfu/gm of vermi formulation) @10gm/kg of seed; T₁₀: *B. megaterium* (1×10⁹ cfu/gm of vermi formulation) @ 20gm/kg of seed; T₁₁: *Pseudomonas fluorescens* (1×10⁹cfu/gm of talc formulation) @ 10gm/kg of seed; T₁₂: *P. fluorescense* (1×10⁹cfu/gm of talc formulation) @20/kg of seed and T₁₃: untreated control. Results revealed that there were a significant increase in plant growth parameters and significant decrease in galls, eggmass and soil nematode population in all treatments over untreated control. However, seed treated with *Pseudomonas fluorescens* @ 20g/kg seed recorded the best result in increasing the plant growth parameters of tomato and reducing the root knot nematode multiplication followed by *Bacillus subtilis* (vermi formulation) @ 20g/kg seed.

Pot experiment was conducted to evaluate the efficacy of bacterial bioagents as soil application with thirteen treatments viz., T₁: *Bacillus subtilis* (1×10⁹cfu/gm of talc formulation) @ 2%(w/w); T₂: *B. subtilis* (1×10⁹cfu/gm of talc formulation) @ 3%(w/w); T₃: *B. subtilis* (1×10⁹ cfu/gm of vermi formulation) @ 2%(w/w); T₄: *B. subtilis* (1×10⁹ cfu/gm of vermi formulation @ 3% (w/w); T₅: *B. pumilus* (1×10⁹cfu/gm of talc

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Department : Nematology

Major Advisor : Dr. Debanand Das

formulation) @ 2%(w/w); T₆: *B. pumilus* (1×10⁹cfu/gm of talc formulation) @ 2% (w/w); T₇: *B. megaterium* (1×10⁹cfu/gm of talc formulation) @ 3% (w/w); T₈: *B. megaterium* (1×10⁹cfu/gm of talc formulation) @ 2% (w/w); T₉: *B. megaterium* (1×10⁹ cfu/gm of vermi formulation) @ 3% (w/w); T₁₀: *B. megaterium* (1×10⁹ cfu/gm of vermin formulation) @ 3% (w/w); T₁₁: *Pseudomonas fluorescens* (1×10⁹cfu/gm of talc formulation) @ 2% (w/w); T₁₂: *Pseudomonas fluorescens* (1×10⁹cfu/gm of talc formulation) @3% (w/w) and T₁₃: Untreated control; The result revealed that all the treatments significantly increased plant growth parameters and significantly decreased gall per root system, eggmass per root system and final root knot nematode population in soil over untreated control. However, maximum plant growth parameters and reduction in root knot nematode multiplication were recorded in soil treated with *Pseudomonas fluorescens* @ 3% (w/w) followed by *Bacillus subtilis* (vermi formulation) @ 3% (w/w) whereas minimum was recorded in untreated control.

Evaluation of antagonistic potential of certain plants against root-knot nematode *Meloidogyne incognita*

Kasturi Goswami

In the present investigation, an effort was made to evaluate antagonistic potential of some plants against root-knot nematode *Meloidogyne incognita*. In a screening trial, nine different antagonistic plants viz. Marigold, Garlic, Mustard, Chrysanthemum, Strawberry, Periwinkle, Sesame, Broccoli and Castor were tested against *M. incognita*. All these antagonistic plants produce very low number of galls, resulting low root-knot index compared to the susceptible control. Among these plants, Marigold, Periwinkle, Garlic were found to be in the resistant category, while Broccoli was found to be moderately resistant.

In a root-knot infested field, these four plants were intercropped with root-knot susceptible tomato to see the antagonistic effect of these plants on root-knot nematode. All the treatments with these four intercrops were found to be effective in reducing number of galls, egg masses and final nematode population in soil subsequently increasing plant growth parameters. The treatment with Periwinkle was found to be most effective in increasing the growth parameters viz. shoot length, shoot weight, root length and root weight of Tomato with corresponding decrease in number of galls, egg masses, final nematode population in soil. The increase in yield of Tomato per ha was maximum when tomato was intercropped with periwinkle, followed by Marigold.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. (Mrs.) Bina B. Gogoi

Characterization and evaluation of *Heterorhabditis bacteriophora*

Madhumita Goswami

Morphological and morphometric characters of infective juveniles of entomopathogenic nematode under investigation showed close similarity with the original description of *Heterorhabditis bacteriophora* (Poinar, 1976) with respect to head shape, body length, ES, EP, NR, tail length, MBW, ratio a, ratio b, ratio c. Whereas D% was slightly variable from original description. The first generation male have higher body length than second generation. In first generation male, length of gubernaculum and tail were observed as stable characters whereas ES, NR, MBW, spicule length and testis reflexion showed slight variation. The observation of morphometric characters of second generation male revealed body length, tail length, ABW and GS% were similar with original measurement whereas ES, EP, NR, MBW, spicule length and testis reflexion were different. The amphimictic female and hermaphroditic female resembles to original description except for their body length which obtained within a range of 1,038.80-1423.58 μm and 1,881.50-2,522.80 μm , respectively.

The pathogenicity test of native *H. bacteriophora* was carried out against major pest of banana viz., banana leaf and fruit scarring beetle (*Nodostoma subcostatum*) in laboratory condition. The infective juveniles of *H. bacteriophora* were inoculated at a rate of 50,100,150 and 200 IJs/ml and mortality of the insect recorded at 24h, 48h and 72h of interval. The hundred percent mortality of banana leaf and fruit scarring beetle were observed after 72h of exposure in treatment T4 which was followed by treatment T3 and T2. While evaluating the LD50 values for *H. bacteriophora* against banana leaf and fruit scarring beetle it was found as follow 296.7 IJs/ml, 126.5 IJs/ml (95% FL 94.8-168.9) and 55.6 IJs/ml (95% FL 36.0-86.0) at 24, 48 and 72 h of exposure, respectively.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. Nibedita Borgohain

Antagonistic crop biomass as a tool for improving carrot yield in root knot nematode (*Meloidogyne incognita*) infested field

Mirlona Rongpipi

Carrot (*Daucus carota*) is a common root vegetable grown throughout the world. A number of pests like insects, fungi, bacteria and nematodes hampers carrot production in a huge way. One of the most common nematode which causes considerable damage to the carrot plant is root-knot nematode (*Meloidogyne* spp.). The present study on effectiveness of haritaki (*Terminalia chebula*) and french marigold (*Tagetes patula*) biomass in the management of *Meloidogyne incognita* in carrot, under pot condition showed that all the treatments were effective in reducing number of galls and egg masses per root system and final nematode population in soil. The treatment with french marigold @ 3% w/w was found to be the most effective. Studies on economic feasibility of carrot cultivation by using haritaki and french marigold biomass in nematode infested field showed that haritaki and french marigold were effective in all the three concentrations, in increasing carrot yield and reducing the final nematode population in soil. Among all the biomass treatments, french marigold @ 3t/ha was found to be the most effective. While determining the benefit: cost ratio in all the treatments, benefit: cost ratio was found to be more than 1. The treatment with french marigold @ 3t/ha resulted in highest gross return (Rs. 3,10,000.00/ha), net return (Rs. 2,00,952.80/ha) and benefit: cost ratio (2.84).

Keywords: Carrot; *Meloidogyne incognita*; Haritaki; French marigold; Management

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. (Mrs.) Bina B. Gogoi

Screening and pathogenicity of root-knot nematode, *Meloidogyne incognita* on bitter gourd, *Momordica charantia* (L.)

Mansi

In the present investigation on screening of bitter gourd germplasms against *Meloidogyne incognita*. Fourteen germplasms were screened along with one susceptible check, four germplasms were found to be moderately resistant and ten germplasms were found to be susceptible to *Meloidogyne incognita*.

Studies on the pathogenicity of root-knot nematode, *Meloidogyne incognita* on bitter gourd showed that there was a progressive decrease in the growth of bitter gourd plants as the inoculum level of *Meloidogyne incognita* increased. Initial inoculum levels of 100 juveniles per kg of soil caused significant reduction in plant height, shoot and root weight and were found to be pathogenic to the bitter gourd plants. The reproductive rate of nematode was maximum at the initial inoculum level of 10 juveniles per kg of soil and minimum at the highest inoculum level of 10,000 juveniles per kg of soil.

Studies on the histopathology of bitter gourd roots infected by root-knot nematode, *Meloidogyne incognita* results of the present investigation on histopathology of bitter gourd roots infected by *Meloidogyne incognita* clearly indicated that *Meloidogyne incognita* severely affected plant growth which resulted in yellowing and stunting of plants. The second stage juveniles after penetration entered into the root cortex and moved along the cortical layer of cells. Numerous giant cells were found, which acts as the feeding sites of nematodes. This feeding site acts as a sink for photosynthates and hampers the plant growth and development. Great variations in cell size were observed. *Meloidogyne incognita* induced 4-6 multinucleate giant cells around the nematode head in the vascular tissues and stellar region. The site of infection is usually vascular tissue but as a result of nematode development and giant cell formation, the entire complex of nematode and giant cells appear to be irregularly placed in the root section. The nematodes damaged complete thickness of root, this condition leads to destruction of feeder roots which ultimately effects the plant growth by reducing the absorption of water and nutrients from the soil.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. (Mrs.) A. Borah

Histopathological and biochemical changes in traditional rice cultivars due to rice root-knot nematode *Meloidogyne graminicola*

Priyanka Gogoi

An investigation was carried out to observe the histopathological and biochemical changes in traditional rice cultivars of Assam. A total of 35 rice cultivars were screened against rice root-knot nematode *Meloidogyne graminicola*. Out of these, eight cultivars *viz.*, Bongal ahu, Malbhog ahu, Naga ahu, Bahadur sub-1, Shraboni, Disang, Kolong and Jaymati were found to be resistant whereas five cultivars *viz.*, Ahu joha, Bhogali bora, Aghoni bora, Ranjit sub-1 and Kanaklata found to be moderately resistant. The two traditional cultivars *viz.*, Sambha mashuri and Kanaklata were found to be susceptible and the remaining 20 cultivars were found to be highly susceptible.

Histopathological studies of resistant cultivars revealed that there is no establishment of feeding cells with hypersensitive like reaction in pericycle areas, whereas in susceptible cultivars multinucleate giant cells with dense cytoplasm and large number of vacuole were observed. The hypertrophied and hyperplasia cell were observed surrounding the body of the nematodes and the giant cells were observed at little distance to the nematode head.

While evaluating the chlorophyll content, the highest chlorophyll was found in the cultivar Naga ahu *i.e.* 0.040 $\mu\text{g/ml}$ and lowest in Dhanshree. Similarly lowest phenolic content (0.0004 mg/ml) was recorded in the cultivar Sambha mashuri and the highest in Disang and Jaymati (0.00041 mg/ml). The enzymatic activity of PPO was maximum (0.294 mg/min) in cultivar Jaymati and minimum (0.140 mg/min) in Sambha mashuri at 3min time interval. The activity of PAL was highest in the Malbhog ahu (1.57 $\text{m}^{-1} \text{mg}^{-1}$ protein) followed by Bahadur sub-1 (1.51 $\text{m}^{-1} \text{mg}^{-1}$ protein) and minimum in Sambha mashuri (0.16 $\text{m}^{-1} \text{mg}^{-1}$ protein).

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. N. Borgohain

Effect of Silver Nanoparticles on the development of root knot nematode (*Meloidogyne incognita*) in Green gram

Rishikesh Phukan

An investigation was carried out to study the effects of silver nanoparticles (AgNPs) on plant growth parameters and multiplication rate of *Meloidogyne incognita* in green gram using two different concentrations of AgNPs viz., 0.03 ppm and 0.15 ppm. Both the concentrations of AgNPs improved plant growth parameters in green gram and reduced galls, egg masses and final nematode population in soil. Among all the treatments, the treatment with 0.15 ppm AgNPs was found to be the best treatment in increasing plant growth parameters and reducing galls, egg masses and final nematode population in soil.

Study on the effect of silver nanoparticles on genomic DNA of *Meloidogyne incognita* juveniles (J2) using two different concentrations of AgNPs viz., 0.03 ppm and 0.15 ppm along with a control (distilled water) showed that gel documentation of the PCR products of the three treatments with two universal primers (ITS-1 & ITS-4) revealed a common DNA size of 620 bp for the amplified ITS region. No difference was observed in DNA sizes among the control and treated *M. incognita* juveniles.

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. Bornali Mahanta

Morphological and morphometric variations of *Hoplolaimus* and *Helicotylenchus*

Venkadesh G

Investigations were carried out to study the morphological and morphometric variations of genera *Hoplolaimus* and *Helicotylenchus* in relation to host plants and geographical locations of Assam. Total of 163 soil samples were collected from Rice, Maize, Banana, Mango, Jackfruit, Citrus, Pea and Tea, and from different geographical locations viz., Jorhat, Kokrajhar, Sivasagar, Kamrup, Lakhimpur, Dhemaji, Nagaon and KarbiAnglong district of Assam. The populations of both genera under survey were identified as *Hoplolaimus columbus*, *Hoplolaimus indicus*, *Helicotylenchus crenacauda* and *Helicotylenchus dihystra*. In the study no morphological variations have been observed in genera *Hoplolaimus* and *Helicotylenchus* in relation to both host plants and geographical locations.

Results of morphometric characters showed that body length, a ratio, oesophagus length, b ratio, oesophageal gland overlapping length, b' ratio, ABW, MB, V, V', stylet length, SE and Pp (only in *Hoplolaimus*) were regarded as least variable characters and considered highly stable in relation to host plants for genera *Hoplolaimus* and *Helicotylenchus*. The c ratio, number of tail annules and Pa of females were least variable characters; while, tail length and c' ratio were moderately variable characters in *Hoplolaimus columbus*. The c ratio, c' ratio, number of tail annules and Pa of females were regarded as moderately variable characters; while, tail length of females was regarded as highly variable character in *Hoplolaimus indicus*. In males of *H. indicus*, tail length, c ratio, c' ratio and Pa were regarded as least variable characters; while, bursa of males was regarded as moderately variable character. The tail length, c ratio, c' ratio and O of females were regarded as moderately variable characters in relation to host plants of *Helicotylenchus dihystra*.

Influence of geographical locations on morphometric characters revealed that the body length, a ratio, oesophagus length, b ratio, oesophageal gland overlapping length, ABW, MB, V, V', stylet length and Pp (only in *Hoplolaimus*) were least variable characters and considered highly stable characters in relation to geographical locations

Abstract of M.Sc. Thesis

Department : Nematology

Major Advisor : Dr. Debanand Das

for genera *Hoplolaimus* and *Helicotylenchus*. The b' ratio, c ratio, c' ratio, SE and number of tail annules were least variable characters; while, tail length and Pa of females were moderately variable characters in *Hoplolaimus columbus*. The b' ratio, c ratio, c' ratio, SE, number of tail annules and Pa of females were moderately variable characters; while, tail length of was highly variable character in females of *Hoplolaimus indicus*. In males of *H. indicus*, b' ratio, tail length, SE, Pp, spicule length and gubernaculum length were least variable characters; while, c ratio, c' ratio, Pa and bursa of males were moderately variable characters. In case of *Helicotylenchus crenacauda* the b' ratio and SE of females were regarded as least variable characters; while, tail length, c ratio, c' ratio and O of females were moderately variable characters. The b' ratio, tail length, c ratio and SE of females were regarded as least variable characters; while, c' ratio and O of females were regarded as moderately variable characters in relation to geographical locations of *Helicotylenchus dihystra*.

Characterization of rice (*Oryza sativa* L.) cultivars for traits associated with adaptation under moisture stress

Abu Saleh Nizamuddin Ahmed

The cultivated rice, *Oryza sativa* L. is a member of the Poaceae family. It is the premier staple food widely consumed by over 50% of the world human population, of which 90% are in Asian countries. Rice crop faces a multitude of abiotic as well as biotic stresses of which drought is the major abiotic constraint. The present study was undertaken to evaluate 54 rice genotypes in PVC pipes for assessing genetic variability, correlation, path coefficients and genetic divergence under low-moisture stress condition. Analysis of variance revealed a highly significant difference for all the characters under study. High range of variation, PCV, GCV and high heritability coupled with high GAM was observed for root volume, days to 50 *per cent* flowering, root dry weight, shoot dry weight, root length density, plant height, days to maturity, filled grains per panicle and grain yield per plant. Yield component characters such as shoot dry weight, filled grains per panicle, total chlorophyll, plant height and chlorophyll stability index exhibited a highly significant association with grain yield. The phenotypic path-coefficient analysis revealed that filled grains per panicle, days to maturity, root dry weight, plant height and effective tillers per plant had the highest positive direct effect on grain yield. Using Mahalanobis' D2 statistics, genotypes were grouped into five (5) clusters in PVC pipes under low-moisture stress condition. The intra and inter-cluster distances indicated wide genetic variability. Based on cluster means, cluster V and I ranked first and fifth respectively. Among all the characters, root volume (12.83%) had the highest contribution towards genetic diversity. Highest genetic distance was observed between cluster III & V followed by cluster IV & V. Based on the mean performance of the genotypes, Haccha (cluster V) was identified for early maturity and highest root-shoot ratio. Similarly, genotypes from cluster IV viz., Saru Jahinga (effective tillers, root dry weight and root length density), Vasudev and Jaibangla (root length and root volume), Bhogali (filled grains per panicle) were found

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Major Advisor : Dr. M. K. Sarma

promising. For grain yield, Ronga Joha (cluster II) was found to yield highest among all the genotypes across all the clusters. Based on the *per se* performance of the identified genotypes and their *inter se* genetic distance an efficient hybridization programme would be possible to undertake in order to obtain desirable segregants for their further utilization in breeding varieties under moisture stress environment.

Genetic analysis of adaptive traits and assessment of seed quality in response to high temperature in a diallel cross and molecular diversity in popular varieties of rapeseed (*Brassica rapa* L.)

Aradhana Phukan

High temperature tolerance is assuming importance in breeding rapeseed-mustard. In the present investigation, an attempt was made to study genetic variation for traits related to yield, adaptation and seed quality in response to high temperature, to identify traits related to high temperature tolerance and intra and inter-population diversity in rapeseed varieties. Populations of diallel crosses involving three yellow sarson and two toria varieties were developed and screened for high temperature during flowering to pod formation stage. The diallel populations were exposed to high temperature in temperature gradient tunnel at Assam Agricultural University, Jorhat and at National Phytotron Facility, IARI, New Delhi and also grown in late sown field conditions which generally experience high temperature terminal stress. Significant variation was observed for almost all the characters in stress and non-stress conditions. Significant variation for GCA and SCA effects was observed. In stress, Jeuti showed desirable characters such as early maturity, cooler leaf temperature, high chlorophyll stability index, siliquae on main shoot, less flower drop, high siliqua density, seeds per siliqua, thousand seed weight and TS46 showed high mean performance for all these yield attributing characters in addition to heat tolerance. YSH401 showed good combining ability for heat tolerance. Crosses B9 x Jeuti, YSH401 x TS46, NRCYS05-03 x Jeuti and NRCYS05-03 x TS46 were found promising for high temperature adaptability traits. Under stress main shoot length was positively correlated with flowers on main shoot and siliquae on main shoot and seed yield per plant. Parents and the progenies of yellow sarson x yellow sarson and yellow sarson x toria crosses showed high germination percentage and seed vigour index after nine months of ambient storage of the seeds harvested from high temperature stressed plants. Under phytotron facility B9 x Jeuti, B9 x TS46, YSH401 x Jeuti and NRCYS05-03 x Jeuti were found to be

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Major Advisor : Dr. Purna K. Barua

promising for yield attributes. In field experiments, Jeuti, B9 x NRCYS05-03, B9 x YSH401, B9 x Jeuti, NRCYS05-03 x Jeuti, YSH401 x Jeuti and YSH401 x NRCYS05-03 were found promising for seed yield and its attributes. Main shoot length, siliquae on main shoot, seeds per siliqua, percent flower drop, siliqua density and biological yield per plant showed high or moderate heritability with high genetic advance. The molecular diversity of six popular toria varieties analyzed with 39 SSR markers showed high intra-population variation in all the varieties. M27 and TS36 were found more diverse than the others. TS36, TS38 and Jeuti formed distinct clusters whereas M27, TS46 and TS67 could not be clearly distinguished.

Estimation of heterosis and combining ability studies in Kharif Marigold (*Tagetes erecta* L.)

Chayanika Lahkar

The present study was conducted with three lines and ten testers in Line x Tester mating design to assess the combining ability and heterosis for different growth and flowering traits and to determine the extent of heterozygosity in the selected F₁ hybrids in African marigold. Crossing was done during *rabi*, 2017-18. The female and male parents along with their 30 hybrids were evaluated in RBD along with 3 replications during *kharif*, 2018.

Analysis of variance revealed the presence of great diversity among the parental lines used in the study. The estimates of *gca* for lines and *sca* for hybrids showed that the lines MSC1 and MSC2 and the testers Pusa Narangi Gainda (PNG), Pusa Basanti Gainda (PBG), AAUM3, AAUM4 and AAUM5 were best general combiners whereas the hybrids MSC1 x JS5, MSC1 x Pusa Basanti Gainda, MSC1 x JS3, MSC1 x AAUM5, MSC2 x AAUM3, MSC2 x JS3, MSC2 x JS4, MSC2 x JS5 were the best specific combiners for flower yield per plant and yield contributing traits. The ratio of *gca* and *sca* variance ranged from -0.02 to 2.46. The variance due to *sca* was higher than *gca* for all the characters except flower size and flower yield per plant indicating the preponderance of non additive gene action which can be utilized for development of hybrids. The hybrids MSC1 x AAUM5 (8.30%), MSC1 x AAUM3 (8.01%), MSC3 x AAUM3 (6.82%), MSC3 x PNG (6.72%), MSC1 x PBG (6.29%), MSC2 x PNG (5.32%), MSC1 x PNG (5.13%), MSC2 x PBG (5.12%), MSC3 x PBG (3.63%), MSC2 x AAUM3 (3.61%) showed heterosis for yield and yield attributing traits over standard parent.

Genomic DNA extraction protocol for African marigold (*Tagetes erecta* L.) was optimized. Fourteen SSR markers were used to test the hybridity of the selected F₁ crosses, out of which two markers (TE57, T93B) showed polymorphism among parents, indicating need to include more co-dominant markers in the study. The PIC value of TE57 was observed to be 0.345 and that of T93B was observed to be 0.543 with a mean

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Major Advisor : Dr. Reena Phookan Borkakati

value of 0.444. True hybrids were obtained between MSC1 x PNG, MSC1 x AAUM3, MSC2 x AAUM3, MSC2 x AAUM5, MSC2 x PNG, MSC2 x AAUM4, MSC3 x PNG, MSC3 x AAUM3, MSC3 x AAUM4 using TE57 and between MSC1 x PBG, MSC3 x JS2 using T93B, respectively. The extent of heterozygosity in the eleven cross combinations verified by the two polymorphic markers ranged from 25-75%, among which the percent heterozygosity was observed to be highest in MSC2 x AAUM3 with 75% heterozygosity.

Genetic Variability and Diversity in Rice (*Oryza sativa* L.) for Traits Related with Grain Yield and Thermal Indices

Daizi Durba Saharia

Rice (*Oryza sativa* L.) is the leading cereal crop of the world which is consumed by more than 55 % of global population. To feed the increased population, as per an estimate, 50 % of more rice will be required by 2050. Keeping in view the present level of productivity growth this has been a challenging task based on the existing approaches. In recent years along with conventional yield component traits, emphasis has been laid on some physiological and related meteorological indices in order to achieve further gain in selection. This investigation aimed at studying the variability, character association and genetic diversity in a set of 58 rice germplasm of Assam for some conventional yield traits as well as traits related with thermal indices. The investigation was carried out during Kharif season of 2020 at the experimental field of Biswanath College of Agriculture. Data were recorded on eleven agro-morphological characters and three agro-meteorological indices. Analysis of variance indicated that GCV was highest for filled grains per panicle followed by total grains per panicle and yield per plant. High heritability (more than 90 %) was observed for all the characters except spikelet fertility (53.18). High heritability coupled with high genetic advance *per cent* of mean was observed for traits *viz.*, days to 50 % flowering, plant height, effective tillers per plant, total grains per panicle, filled grains per panicle, 100-grain weight, grain yield per plant, biological yield and heat use efficiency. Selection thus, would be effective for these traits. At both genotypic and phenotypic level, highly significant association of all the characters with grain yield was observed. Path coefficient analysis revealed that panicle length, effective tillers per plant, spikelet fertility, 100-grain weight, biological yield, and helio-thermal unit had positive direct effect on yield at both phenotypic and genotypic level. Considerably high negative direct effect on yield was exhibited by growing degree days and heat use efficiency. Based on Mahalanobis' D² - statistics, all the genotypes were grouped into six diverse clusters following Tocher's method. The

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maximum number of genotypes were present in cluster IV followed by cluster VI. The intra-cluster distance ranged from 8.57 in cluster I to 313.79 in cluster V. The maximum inter-cluster distance was exhibited in between the clusters V and VI (1082.8), followed by cluster III and VI (752.43). Cluster I and II (53.63) exhibited the minimum inter-cluster distance. Based on the *per se* performance of the genotypes and considering their location in diverse clusters, Luit (lowest days to 50% flowering), Biriya Bhonga Bao (highest 100-grain weight, biological weight), Maizubiron (highest heat use efficiency), Konguti (highest total and filled grains per panicle) and Boga joha (highest GDD and HTU) were identified promising for undertaking hybridization programme. Efficient hybridization programme formulated among amongst these parents is expected to yield desirable segregants for their further utilization in breeding programme.

Evaluation of some rice genotypes under delayed sown condition in sali with low level of fertilizer input

Dalibha Pathak

An experiment was conducted during the late *sali* season (August) of 2018 at Instruction cum Research Farm, Assam Agricultural University, Jorhat following 3 replicated RBD. The objective of the trail was to evaluate the performance of the genotypes under late sowing situation.

Significant variation was observed for grain yield and its component characters. The mean sum of squares due to various sources of variation for 18 quantitative characters revealed the presence of significant differences for grain yield and its component characters. The estimates of phenotypic coefficient of variation (PCV) was found high for chaffs per panicle, grains per panicle, spikelet sterility %, spikelets per panicle, grain yield (kg/ha), tillers per hill, biological yield (kg/ha). The estimates of genotypic coefficient of variation (GCV) was found high for chaffs per panicle, grains per panicle, spikelet sterility %, spikelets per panicle, grain yield (kg/ha). Low estimates of GCV and PCV were recorded for the character viz., days to 50% flowering and days to maturity. In this study, a high heritability coupled with high genetic advance were observed for chaffs per panicle and grains per panicle indicating that the selection might be effective for bringing about improvement for these characters under delayed sown situation. Among the genotypes only one genotype viz., Gandhari was the top yielder (4170 kg/ha) because of its significantly lower number of days to both 50% flowering (101 days) and days to maturing (131), spikelet sterility (23.13 %) than their corresponding values of the check Manoharsali; significantly higher spikelets per panicle (238.19), grains per panicle (183.07) grain yield (17.18 g/hill), straw weight (6575.16 kg/ha), biological yield (10745.10 kg/ha) and harvest index (38.86 %) than their corresponding values of the check Manoharsali and moderate performance for the remaining characters. The high GCV was observed for chaffs per panicle, grains per panicle, spikelets per panicle, spikelet sterility (%) and grain yield (kg/ha) and high PCV

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Major Advisor : Dr. U. C. Kalita

was observed for chaffs per panicle followed by grains per panicle, spikelet sterility (%), grain yield (kg/ha), tillers per hill, spikelets per panicle and biological yield (kg/ha). Grains per panicle, days to 50 per cent flowering, plant height (cm), panicle length (cm), spikelets per panicle, chaffs per panicle, grain yield (kg/ha), grain yield (g/hill), spikelet sterility (%), 100-grain weight, days to maturity, biological yield (kg/ha), straw weight (kg/ha) and harvest index (%) had registered high heritability. A high heritability coupled with high genetic advance was observed for plant height (cm), spikelets per panicle, spikelet sterility (%), chaffs per panicle, grains per panicle, grain yield (kg/ha), grain yield (g/hill), biological yield (kg/ha), straw weight (kg/ha) and harvest index (%). Grain yield (kg/ha) exhibited significant positive correlation with plant height (cm), panicle length (cm), grains per panicle, spikelets per panicle, grain yield (g/hill) and straw weight (kg/ha). The significant negative correlation of grain yield (kg/ha) had observed with days to 50% flowering, spikelet sterility (%) and days to maturity. From the findings of this investigation, one genotype viz., Gandhari emerged as the outstanding genotype which could be directly used for cultivation in delayed sown situation. Some other promising genotypes that had average productivity more than 3500 kg/ha and yet significantly high yielder than the check Manoharsali under delayed sown condition were JR 29, JR 16, Basundhara and JR 60. These genotypes had shown their promise for recommendation under delayed sown condition provided the investigation is continued for another 2-3 years under the same condition and could be utilized as potential parental material in the hybridization programmes designed to develop suitable rice varieties for delayed sown situation.

Morphometric Characterization of Selected Mutants of Mungbean (*Vigna radiata* L. Wilczek)

Deepshikha Saikia

Mungbean (*Vigna radiata* L. Wilczek) is one of the significant *kharif* and summer pulses of India. The present investigation was conducted to evaluate genetic variation and morphometric characteristics of selected mutants at Assam Agricultural University during *kharif* season of 2018 and summer of 2019. A randomized block design of 3 replication was used. Significant differences were observed for most of the characters except for days to pod initiation and pod length in M4 generation and days to pod initiation and plant height in M5 generation. High phenotypic and genotypic coefficient of variation was observed for seed yield per plant and number of branches per plant in M4 generation. In case of M5 generation, none of the traits showed high phenotypic and genotypic coefficient of variation but number of clusters per plant, pods per cluster, seeds per cluster, seeds per pod, percentage of disease infection, 100 seed weight and seed yield showed moderate phenotypic and genotypic coefficient of variation. High heritability estimate coupled with high genetic advance as per cent of mean was observed for number of branches per plant, pods per plant, percentage of disease incidence, 100 seed weight and seed yield per plant in M4 and for number of clusters per plant, pods per cluster, seeds per pod, percentage of disease incidence and 100 seed weight in M5 generation indicate the preponderance of additive gene action. In the present study, seed yield per plant was found to be significantly and positively correlated with number of pods per cluster, seeds per pod, pod length and 100 seed weight at genotypic and phenotypic level in M4 generation and with number of clusters per pod, pod length and 100 seed weight in M5 generation. The genotypic path coefficient analysis revealed that the highest direct and positive effect on seed yield was exhibited by 100 seed weight in M4 generation and by number of pods per cluster in M5 generation. Hence, these characters could be the major components of seed yield. Both the generation showed distinct type of clustering. For M4 generation, three clusters were observed and four clusters were observed for M5 generation. The genotypes SM-1, SM-3, BARC-III and BARC-IV were observed to be consistent in both the generation.

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Department : Plant Breeding and Genetics

Major Advisor : Dr. Akashi Sarma

Assessment of genetic variability for glucosinolate in a set of Indian mustard [*Brassica juncea* (L.) Czern. & Coss.] genotypes and their relationship with economically important agronomic traits

Devidutta Lenka

Brassica juncea (L.) Czern & Coss. known as Indian mustard is one of the most important oilseed crops of the country occupying considerably larger acreage among the Brassica crops. The mustard plants are much taller than that of toria (*Brassica rapa*). It has a solid stems unlike toria and has a much higher biological yield than toria. However despite these characteristics, mustard is not a favoured crop in Assam because it takes much longer duration to mature and farmers prefer oilseed varieties which are medium to short height and duration. The present study was conducted to study the genetic variability and character interrelationship of 17 quantitative characters along with 2 biochemical parameters between 18 Indian mustard genotypes. The validation of molecular marker linked to glucosinolate QTLs for marker-assisted selection was also carried out.

The pooled analysis of variance revealed significant variation among all the genotypes along with 12 characters showed significant genotype x environment interaction. Foot length, seed yield per plant and glucosinolate content exhibited high GCV, PCV, heritability and genetic advance as % mean.

From both the years, it was observed that the character seed yield per plant showed significant positive correlation with maximum root length, biological yield per plant and harvest index. Glucosinolate content showed significant and positive correlation with days to 50% flowering, days to maturity and oil content. Days to 50% flowering was highly correlated with the trait oil content.

From the path analysis result it was observed that the overall direct effect of characters harvest index and biological yield per plant are significantly higher than positive and negative indirect effect of the other character, thereby exhibiting a high significant correlation of harvest index & biological yield per plant with yield.

Abstract of M.Sc. Thesis

Department : Plant Breeding and Genetics

Major Advisor : Dr. Rumjhum Phukan

The banding patterns of 50 SSR markers were studied, out of which 21 primers showed polymorphism. The PIC value ranged from 0.019 to 0.383 with an average of 0.171. Multiple-regression analysis of 17 characters including glucosinolate content was carried out with 18 genotypes. From this analysis, 9 primer pair showed association with 11 characters. Out of these 9 primers which showed association, 6 primers were found to be associated with more than one character. The trait glucosinolate content exhibited association with 3 marker i.e. NI03-H07a, sR7178 and OL10-A03a.

Evaluation of inbred progenies of maize (*Zea mays* L.) for yield and important morphometric traits

Dikshita Gogoi

The present investigation was conducted with evaluation of twenty-two genotypes in RBD during *rabi*, 2019-20 at the ICR farm, AAU, Jorhat with an objective to estimate genetic variability, genetic association and path coefficients among the inbred progenies for the traits. Observations were recorded for nine qualitative characters and seventeen quantitative characters. Significant to highly significant genotype mean squares were observed for the traits. The best performing S1 lines based on grain yield per plant and other important morphometric traits were IMPCH 35, IMPCH 70 and IMPCH 110. Estimates of phenotypic coefficient of variation were high for ear height and chlorophyll content and estimate of genotypic coefficient of variation was high for ear height. High heritability coupled with high genetic advance as per cent of mean was observed for the traits *viz.*, ear height, chlorophyll content at reproductive stage, 100 kernel weight, tassel length, kernels per row, ear length, kernel rows per ear and plant height indicating the preponderance of additive gene action for these traits. Association studies revealed significant and positive association of grain yield per plant with shelling percentage at both phenotypic and genotypic levels and with ear diameter, kernel rows per ear and kernels per row at genotypic level only. Negative and significant association of grain yield per plant was observed for days to 50% pollen shed and days to 50% silk at genotypic level. Genotypic path analysis revealed that days to 50% pollen-shed had the highest positive direct effect and days to 50% silk had the highest negative direct effect on grain yield per plant. The residual from path analysis was found to be 43.25% which suggested that characters taken in the path analysis contributed 56.75% of the total variability in the grain yield.

Abstract of M.Sc. Thesis

Department : Plant Breeding and Genetics

Major Advisor : Dr. N. Sarma Barua

Interspecific hybridization in the genus *Capsicum* and Molecular characterization of F1 hybrids

Gayatree Hazarika

Interspecific hybridization allows transfer of genes governing desirable traits between different species, such as those involved in disease resistance, allowing breeders to develop genetically superior genotypes. However, introgression of the desirable traits from wild-related species into cultivated species is limited by crossability barriers. Moreover, it is imperative to know about the direction of the cross, since, in some species, the interspecific cross is possible in one direction only.

The present investigation was carried out using three different species of chilli—two genotypes of *C. annuum*, five genotypes of *C. chinense* and one genotype of *C. frutescens* which exhibited significant diversity for all the traits under study. Most of the characters were found to have high heritability coupled with high genetic advance. Significant positive correlation was observed for days to first flowering, length and girth of fresh fruit, fresh and dry fruit weight, seeds per fruit, thousand seed weight and dry fruit yield per plant with fresh fruit yield per plant; while it showed negative correlation with number of primary branches per plant and number of fruits per plant.

The crosses involving *C. chinense* and *C. frutescens* were found to be compatible; whereas crosses involving *C. annuum* and *C. chinense* were found to be partially incompatible. Both the *C. annuum* (Krishna, Capsicum) species were found to be cross compatible with King chilli accession A18; while the species *C. frutescens* (Mem) was cross compatible with only accession A5 indicating genotype specificity in success of interspecific cross. Presence of pre-fertilization barriers such as drying of pollinated fruits while still on the mother plant, unilateral incompatibility and post-fertilization barriers with the formation of abnormal/empty seeds, lack of vigor and hybrid sterility etc. were observed.

The pollen viability of the parents ranged from 72.64 per cent(%) to 94.92 per cent(%) whereas pollen viability of the hybrids ranged from 23.55 to 81.02 per cent(%). Thus, hybrids exhibited lower pollen viability compared to the parents.

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Major Advisor : Dr. Rumjhum Phukan

Significant difference was observed in between parents and their hybrids for the traits under present study except for the traits- number of secondary branches, number of nodes per plant and length, breadth of leaf. On comparison of morphological characters between parents and F1 progeny it was observed that some of the characters were similar to the male or female parent and other characters were either intermediate or novel.

Estimation of Usual Euclidean distance among parents and their F1 plants revealed that Capsicum (*C. annuum* L.) had the maximum dissimilarity with rest of the genotypes including parents and their F1s.

A total of thirty SSR primers were screened for detection of parental polymorphism and then the polymorphic markers obtained were used for the confirmation of hybridity of F1s.

Study on effect of Mutation on Ranjit Sub-1 for yield and yield attributing characters

Kasturi Shivam

Rice (*Oryza sativa*) has been grown in Assam from time immemorial and it is the single most important crop in the state and its adjoining areas, because of its enormous variability, adaptability and preference in the state. *Sali* or winter rice is the dominant crop of the state covering 18.7 lakh hectares and contributing 73% of the total rice production. Out of 18.7 lakh hectares of *Sali* areas 12.7 lakh hectares come under flood free shallow lowland. Shallow lowland is as good as irrigated areas and high yielding varieties like Ranjit, Bahadur, Mahsuri, Gitesh etc. are grown. Amongst the HYVs, Ranjit was the most popular variety but farmers finding it difficult to go for *Rabi* crops after the harvesting of Ranjit due to its longer duration. One of the reasons for the low farmer's income is lower cropping intensity. Farmers of Assam prefer to grow longer duration rice variety during kharif season for which it is difficult to increase cropping intensity. Therefore, it is essential to develop the shorter duration version of popular rice variety Ranjit.

The seed of Ranjit Sub-1 was treated with three doses 170Gy, 210Gy and 240Gy of gamma ray during May, 2017. The M1 generation of each doses along with the checks (Luit, Shraboni and Ranjit Sub-1) grown during *Sali*, 2017. The experiment was conducted by Augmented Design. The data of Days to 50% flowering, Plant height, EBT, Fertile spikelet etc. was recorded. Sterility percentage increases with increases in irradiation. Highest sterility percentage was recorded in 240Gy Gamma ray. Further from the recorded data of 500 plants of each dose, it was found there is significant effect of mutation in all the three doses for all the characters except in tiller numbers. Three desirable early mutants were selected during *Sali*, 2017.

The M2 progeny was raised during *Sali*, 2018. The segregation for Days to 50% flowering and Maturity duration was studied and it was found to fit well in 9:3:3:1 ratio.

The effect of mutagens on Sub-1 QTL was also studied. We have confirmed the presence of Sub-1 QTL in treated seeds with the help of SSR marker (Sub1BC₂). Ranjit Sub-1 and Ranjit were considered as positive and negative check respectively. During gel analysis we have observed both positive and negative type among progenies and hence we concluded that there was effect of Sub-1 QTL.

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Department : Plant Breeding and Genetics

Major Advisor : Dr. Sanjay Kumar Chetia

Evaluation of rice varieties for yield and ancillary traits under organic cultivation

Lonishree Dutta

An experiment was laid under both organic and inorganic conditions with ten rice varieties grown under organic situation for more than ten years. The rice varieties collected from farmer's field were grown with an objective to observe traits suitable for varietal development under organic situation. The analysis of variance for nine quantitative characters, nine grain characters and eight biochemical characters indicated existence of variation of the characters among the varieties. The pooled analysis indicated high G x E interaction for most of the characters under investigation indicating necessity for selection of the characters separately for both organic and inorganic situations. In pooled analysis of variance, it was also found high G x E interaction for Fe (Iron) and Zn (Zinc), which indicated that for these two important micro-nutrients selection, will be effective under organic situation. The correlation coefficient for quantitative character like grain yield is positively correlated to ear bearing tiller (EBT) and Harvest Index (HI) for both organic and inorganic condition, whereas grain yield is negatively correlated to plant height for both the growing situation. It is also observed that Flag Leaf Area (FLA) is positively correlated to grain yield for inorganic condition only. Grain character like Head Rice Recovery (HRR), an important character with respect to marketability of organic produce in the international market and consumer preference, is found to be negatively correlated to Hulling Percentage (HP). In Path Analysis for both organic and inorganic cultivation, it is observed that the highest direct effect is contributed by EBT. High GCV (Genotypic coefficient of variation) and heritability were observed in most of the characters which indicated preponderance of genes in expression of characters. In most of the characters like plant height, EBT etc., GA (Genetic Advance) and Heritability were found to be high indicating additive gene action and effective action of simple selection procedure in improvement of characters under organic situation. Hence, it is concluded from the experiment that variability exist for characters in the indigenous varieties for organic situation and breeding program has to be taken separately for organic situation through selection.

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Department : Plant Breeding and Genetics

Major Advisor : Dr. K. K. Ssarma

Characterization of Hill Rice (*Oryza sativa* L.) Germplasm of Assam for Yield and Quality Traits

Manash Protim Nath

The North East India is considered as the reservoir of a large array of traditional rice germplasm. The state of Assam is also having a wide diversity in the cultivated rice. Out of different seasonal and ecological groups of rice varieties, very little attention has been paid for the genetic studies on the hill rice germplasm of Assam. Therefore, the present investigation was undertaken in order to characterize a set of 40 hill rice germplasm of Assam with respect to 24 agro-morphological and quality traits. In general, the hill rice germplasms were observed to be of medium height, medium duration, and low tillering type with good harvest index and lower grain yield. They were mostly of long grained, medium to hard textured type with little pigmentation in different plant parts. Genotypes were generally with light green colour ligules, colourless auricle, intermediate leaf angle, of yellow coloured seed coat and mostly awnless. Highest GCV was observed for filled grain per panicle followed by biological yield and total grain per panicle. High heritability coupled with high genetic advance as percent of mean was recorded for traits viz., total grain per panicle, filled grain per panicle, biological yield, harvest index and grain yield. Therefore, selection would be effective for these traits. Correlation analysis revealed that the grain yield had positive and significant association with effective tiller per plant, total grains per panicle, filled grain per panicle, spikelet fertility, 100-grain weight, biological yield, harvest index, days to flowering, days to maturity and plant height. Path coefficient analysis revealed that days to maturity, panicle length, effective tiller, total grain, spikelet fertility, 100-grain weight, biological yield and harvest index were the traits with direct positive effect on grain yield. Mahalanobis' D2 analysis grouped the genotypes into six clusters. Highest number of genotypes was observed in cluster I (14) followed by cluster III (13). The maximum inter-cluster distance was observed between cluster III and IV. Amongst the six clusters three clusters were mono-genotypic. Maximum individual contribution towards the divergence was due to days to 50 % flowering. Scoring of cluster mean indicated that Cluster VI recorded highest score followed by cluster I. Based on genetic

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diversity and their per se performances for different traits genotypes were selected for inclusion as parents in hybridization programme. The cultivars viz., Haccha for earliness, Jangaikhuwa for plant height, Manipuri Joha for effective tiller, Bra Lusai for total grain per panicle and filled grain per panicle, Kardi Sanglok for 100 - grain weight and harvest index, Inlong- a- Bara -Sanger for long grains, Mahchuri for highest grain yield and biological yield were identified as promising parents for hybridization programme in order to obtain desirable segregants and exploitation of heterosis.

Genetic enhancement in tomato for resistance to bacterial wilt and quality through intra and inter-specific hybridization

S. Yasmin Das

Tomato is the most important solanaceous vegetable crop. To estimate its production under the challenges of bacterial wilt disease, it is important to identify potential genotypes with resistance to bacterial wilt disease of tomato. To achieve this goal an investigation on ‘Genetic enhancement in tomato for resistance to bacterial wilt and quality through intra and inter-specific hybridization’ had been taken up to study the performance of few genotypes, their heterosis and combining ability and nature of gene action. The experiment was carried out at the experimental field of Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati during *rabi* seasons of 2015-16, 2016-17 and 2017-18. Evaluation of six parents, fifteen F₁, fifteen F₂, three BC₁ and three BC₂ generations of tomato revealed existence of sufficient variability and interaction effects in the genotypes. Combining ability analysis in Diallel mating design without reciprocals involving six diverse tomato cultivars/lines, viz., Singimari Local, Megha, Solan Lalima, Arka Abha, Arka Alok and Kon bilahi and their 15 cross combinations in bacterial wilt sick plots revealed importance of both additive and dominance effects. Two parents, Singimari Local and Kon Bilahi were identified as good general combiner. Ten cross combinations out of total fifteen combinations exhibited high estimates of specific combining ability for different desirable traits. Among them the crosses which merit special consideration were Singimari Local x Solan Lalima for yield per plant(g), harvest duration and bacterial wilt survival (%); Singimari Local x Kon Bilahi for number of fruits per plant(g) and bacterial wilt survival (%); Solan Lalima x Kon Bilahi for number of fruits per plant, harvest duration, pH of pulp and bacterial wilt survival (%); Arka Abha x Arka Alok for harvest duration, pH of pulp, fruit weight(g), number of primary branches per plant and yield per plant (g); Megha x Kon Bilahi for days to first picking, days to maturity, pericarp thickness(mm), TSS (° Brix) and bacterial wilt survival (%) could effectively be used to

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exploit heterosis in bringing about desired genetic improvement. Besides, the crosses showing desirable SCA for yield per plant (g) and bacterial wilt survival (%) but without significant heterosis were Arka Alok x Kon Bilahi, Megha x Arka Alok, Singimari Local x Arka Abha and Arka Abha x Kon Bilahi. These crosses could be ideal for further selection to bring them into homozygous genetically improved lines.

Generation mean analysis was carried out in three crosses *viz.* Singimari Local x Megha, Singimari Local x Kon Bilahi and Megha x Kon Bilahi involving six generations (P₁, P₂, F₁, F₂, BC₁ and BC₂). The individual scaling tests were used to test the adequacy of additive dominance model. The gene effects were estimated using three parameter model (Joint Scaling Test) suggested by Cavalli (1952) and six parameter model suggested by Haymen (1958). The analysis of variance among different generations of different crosses revealed significant variation for all the eighteen characters indicating considerable variability in the material studied. All the characters except productive flower retention (%) in cross Singimari Local x Megha recorded significance for at least one of the four individual scaling tests in all the 3 crosses. With respect to interaction effects, all the characters except productive flower retention (%) in cross Singimari Local x Megha, exhibited significant interaction effect for one or more epistatic interactions i.e. [i], [j] or [l] in all the three crosses studied. It is evident that for all the morpho-physiological and yield attributing traits, fruit quality traits and bacterial wilt survival(%) additive, dominance and interaction effects were present indicating the complex inheritance of the traits under study. Further enhancement of the genotypes identified in this study will pave the way for the development of high yielding tomato variety with resistance to bacterial wilt disease.

Genetic variability for traits related to synchronous maturity in Greengram

Nivedita Talukdar

The present study was conducted with 38 greengram genotypes with the objectives to determine the nature and extent of variation in the phenological traits related to synchronous maturity and to assess the pattern of association of yield and yield related attributes with flowering traits and to characterize them with molecular markers. Morphological data recorded on 17 quantitative traits were analysed for different variability parameters with genetic and DNA fingerprint analysis using 16 SSR primers. Analysis of variance revealed significant variation among genotypes for all the characters except for 100 seed weight. The best genotypes for yield and yield attributing characters identified were KM 2355, AKM 12-24, AKM 12-28, MH 2-15, IPM 312-20 and HUM 1. Pant M-4 was the most determinate at 90% pod maturity from first flower. RMG 1092 was the most determinate for plant height from first flower to first pod and 90% pod maturity. RMG 1087 was determinate for plant height from first pod maturity to 90% pod maturity. The GCV and PCV estimates were high for number of pods per plant followed by degree of indetermination of plant height from first pod maturity to 90% pod maturity and number of branches per plant respectively. High heritability coupled with high genetic advance as % of mean was observed for 13 traits including yield per plant. Based on D^2 values, the genotypes were grouped into eight clusters. Maximum inter cluster distance was observed between clusters III and cluster VI followed by cluster V and cluster VIII while lowest distance was noticed between cluster I and cluster VII. Days to 90% pod maturity followed by days to first flowering and days to first pod maturity had highest contribution towards genetic divergence. Yield was positively correlated with plant height at first pod maturity, branches per plant, seeds per pods and 100 seed weight but it was negatively correlated with days to first flowering, days to 50% flowering, days to first pod maturity and days to 90% pod maturity. The highest positive direct effect in path analysis was observed for days to first flowering indicating importance of this trait despite negative correlation with seed yield per plant. SSR markers used in the present study revealed low level of

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polymorphism among genotypes. Per cent polymorphism ranged from 25.67% to 82.00% with an average of 62.9%. The PIC value ranged from 0.478 (CEDG 282) to 0.983 (cp06427) with an average of 0.636. Resolving power (Rp) value ranged from 2.789 (GMES 4255) to 0.368 (cp06427) with an average value of 1.690. Jaccard's coefficient of similarity ranged from 0.92 (IPM 2-14 between Pant M-4) to 0.00 between several genotypes with an average value of 0.27. Based on dendrogram generated through UPGMA method, two major clusters (A& B) were identified with B having 7 sub-clusters. The clustering patterns indicated that geographical origin did not play role in cluster composition at molecular level and morphological level.

Genetic variability of root traits of different classes of rice (*Oryza sativa* L.) in Assam

Priyanka Bairagi

Root characters for plant selection have been major breeding objectives for development of stress tolerant varieties in rice. Therefore the present investigation was conducted for comparative study of root traits and some yield attributing traits in different classes of rice (Ahu, Sali, Bao and Hybrid) in Assam. The study revealed presence of genetic variability among the genotypes for all the root and yield attributing traits. Bao varieties showed maximum root development throughout its growth period upto maturity in comparison to the other classes of rice. Highest phenotypic coefficient of variation and genotypic coefficient of variation was observed for the root length, root volume and root: shoot ratio. Heritability in broad sense was found to be high for root length, plant height, root volume and root: shoot ratio. Genetic advance as percentage of mean was found to be maximum for the root: shoot ratio, root volume and root length. High heritability along with high genetic advance as percentage of mean indicates presence of additive gene action and simple selection procedure can be adopted for improvement of yield. Correlation coefficient revealed positive association of fresh root weight, root: shoot ratio, total tillers per plant, effective tillers per plant with grain yield per plant respectively at genotypic level. Higher genotypic correlation coefficient indicates less influence of environmental effects on traits. Genotypic path analysis revealed 1000-grain weight, fresh shoot weight showed highest positive direct effect on grain yield. D2 analysis revealed total 11 numbers of clusters and cluster I and cluster VII showed highest numbers of genotype (5 each). Contribution of traits to total divergence was observed highest for root length followed by root volume and plant height. Inter cluster average distance was found to be maximum between cluster VIII and XI; IV and VIII and intra cluster average distance was found to be maximum for cluster I followed by cluster VII and cluster II. Clustering pattern of the genotypes revealed it did not follow any particular pattern with respect to the origin of the genotypes. Parental lines selected from cluster IV, VIII and XI can be used for hybridization programme.

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Assessment of genetic variability and screening of soybean cultivars against major diseases in Assam

Priyankee Dutta

The present investigation was carried out at Instructional cum Research farm, AAU Jorhat during 2018 and 2019 to study the performance of 40 genotypes of Soybean for yield and other yield attributing traits and also to screen them against major diseases in Assam under greenhouse condition. The experiment consisted of 3 checks namely JS335, BRAGG, JS9305 and it was laid out in Randomised Block Design. Pooled analysis of variance was estimated over the two years and genotypic and phenotypic coefficient of variation using the mean squares which also helped in estimating broad sense heritability (h^2) and genetic advance expressed as % of general mean. In addition, correlation and path analyses were computed between seed yield/plant and its components being days to 50% flowering, days to maturity, plant height, number of branches/plants, number of pods/plant 100-seed weight, Pod length, number of seeds/pod and oil content. Results showed significant differences among all studied traits. RVSM2011- 35 recorded the highest value of seed yield over the two years indicating that this genotype is promising and could be recommended for Assam. Highest values of genotypic and phenotypic coefficient of variation was obtained for seed yield, number of seed/pod and oil content indicating a wide range of variation which provided a good scope for yield improvement. Also, high values of heritability and genetic advance (% of mean) were recorded for seed yield/plant, oil content, number of branches, days to 50% flowering, plant height, number of pods /plant, 100 seed weight and number of seed/pod indicating that these traits have more chances for soybean yield development among the tested genotypes. Significant genotypic correlation coefficients were detected for almost all the characters except plant height and oil content which revealed importance of these characters in determining yield. Path analysis showed that the traits number of seeds/pod and 100 seed weight were the most directly contributing traits to seed yield/plant and as such could be used as selection criteria in the present soybean breeding programme. In addition, the genotypes were

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screened for resistance against Collar rot and Rhizoctonia rot and no genotypes were found to be immune or completely resistant. HIMSO1688, PS1347, BRAGG, JS335 however showed moderate resistance against collar rot while PS1637, JS21-71, MACS1566, SL1191, HIMSO1688, PS24, RSC11-17, MAUS734, Dsb33, NRC138, PS1347, NRC139, SL1171, MAUS732, NRC148, RVSM2011-35, VLS97, NRCSL2, KDS1009, BAUS100, BRAGG and JS335 showed moderate resistance against Rhizoctonia rot under green house.

Evaluation of maize (*Zea mays* L.) hybrids at high plant density for important yield attributes

Ramesh Kanna M

The present investigation was conducted with nine genotypes in RBD during *Rabi*, 2019-20 at the ICR farm, AAU, Jorhat with the objectives to characterise maize hybrids at high plant density, estimate genetic variability and to determine genetic association and path coefficients among the hybrids for different morphological and physiological traits. All the characters studied exhibited significant genotypic mean squares in ANOVA except anthesis silking interval (ASI) as well as 100 kernel weight (100KW) at both plant density levels while kernel rows per ear (KR/E) at 60 cm x 20 cm and ears per plant (E/P) at 50 cm x 20 cm. The genotype mean square across the spacing was significant to highly significant for all the traits except ears per plant. The mean square due to genotype x spacing was significant to highly significant for the traits days to 50% silking (D50%S), ears per plant (E/P), leaf area index at 60 DAS (LAI 60DAS), leaf area index at 90 DAS (LAI 90DAS), harvest index (HI) and grain moisture content (GMC). The hybrids namely, PAC 751, CP 333 and PAC 751 ELITE at 60 cm x 20 cm, PAC 751, CP 838 and ADV 759 at 50cm x 20cm and PAC 751, CP 333 and PAC 751 ELITE at across spacing were found to be the three best hybrids to possess a high estimate of desirable traits such as days to 50% pollen shed (D50% PS), days to 50% silking (D50% S), days to 100% dry hush (D100% DH), plant height (PH), ear height (EH), ear diameter (ED), LAI (60 DAS), LAI (90 DAS), grain yield per plant (GY/P) and grain yield per hectare (GY/HA). High heritability coupled with high genetic advance was observed for the traits PH, EH, EL, K/R, CHLR, LAI 60 DAS, LAI 90 DAS, HI, GY/P and GY/HA in both the spacings and it indicated the preponderant role of additive gene action for these traits. Simple selection methods such as mass selection may improve the population with respect to these traits. Significant genetic association of GY/P and GY/HA with D50% PS, D50% S, D100% DH, K/R, LAI 60 DAS and LAI 90 DAS indicated that grain yield could be improved indirectly by selecting superior plants for easily heritable traits like D50% PS, D50% S, D100% DH

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and K/R at both the spacings. Genotypic path analysis revealed that the characters D50% PS and EH had the highest positive direct effects on grain yield per hectare while D50% PS had the highest negative direct effect on grain yield per hectare at both the spacing. The residual was found to be very low at both the spacings reflecting that the independent characters under study contributed to the variation in GY/HA to a great extent, which inherently suggested the characters taken in the investigation contributed a large extent of the variability in the population.

Study on genetic variability and character association in rapeseed (*Brassica rapa* L.) under organic farming

Sentikokla Kechu

Rapeseed (*Brassica rapa* L.) is one of the most important oilseed crops of the country occupying considerably a large acreage. Rapeseed includes brown sarson, yellow sarson and toria. Because of the advantage of short maturity duration the farmers in Assam and other North-eastern states have been cultivating predominantly the toria type and to lesser extent Indian mustard and yellow sarson type. In recent years organic farming is receiving high importance for quality of product, health benefits and sustainability of soil and environment. In the present study, a set of 15 rapeseed genotypes including four yellow sarson and eleven toria genotypes, was evaluated by laying out in randomized block design with three replications in normal sowing and delayed sowing in rice fallow following organic cultural practices during *Rabi* 2017-18 and *Rabi* 2018-19 to assess genotypic performance, genetic variability and character interrelationship. Observations were recorded for eleven yield attributing characters. Due to severe moisture stress the late sown crop failed during 2018-19. The pooled analysis of variance of the experiments on normal sowing dates in 2017-18 and 2018-19 revealed significant variation due to genotypes, environments and genotype-environment. JT14-2, PYS2012-1 and JT13-5 were the most promising genotypes in normal sowing dates, and PYS2012-1, JT13-1-1, JT14-2 and JT13-1 were good performers in delayed sowing in rice fallow condition. Medium genetic variation and high heritability was observed for days to 50% flowering, main shoot length, leaf size and plant height. Genetic advance was high for days to 50% flowering and medium for leaf size and main shoot length. Simple linear correlation coefficients between characters were computed from the mean values three replications and two years with 10 plants in each replication. Path analysis was based on these correlations. On the basis of correlation analysis, path analysis and genetic variability parameters it could be concluded that main shoot length and leaf size were important yield attributes for selection in organic plant breeding for improvement of seed yield in Indian rapeseed.

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Studies on induced mutation in gladiolus (*Gladiolus hybrida* L.) through gamma rays

Shephali Priya

Gladiolus (*Gladiolus hybrida* L.) is one of the important bulbous crop, cultivated in various parts of the country. It is an important bulbous crop which occupies important position among cut flowers in domestic as well as international market so, mutation is important for obtaining variety easily. In the present investigation to find out the genetic variability for morphological and quality traits, their association and mutation frequency, effectiveness, efficiency of gamma rays in four genotypes for 13 characters. A factorial randomized block design was conducted in four genotypes which is treated with six doses of gamma rays.

The analysis of variance for factorial randomized block design it was observed that significant variation was there for all characters except no. of leaves per plant among 4 varieties. The character spike length, no. of spike per plant exhibited highest PCV, GCV in M_1V_1 generation. The character plant height, no. of spike exhibited highest PCV, GCV in M_1V_2 generation. Heritability with genetic advance was found to be high in vase life, days to sprouting, spike length, rachis length and no. of floret per spike in M_1V_1 generation. In M_1V_2 generation, heritability high days to sprouting, spike length, vase life, days to spike initiation, breadth of leaf.

The effect of interaction between variety and doses indicated that the better plants was found at 20 Gy and as decreased as the doses were increases 'Red Majesty' is the best performed variety for breadth of leaf, no. of floret per spike, length of floret, breadth of floret, vase life, no. of spike per plant followed by Red Candiman, Pasibica Beauty.

In the correlation studies no. of spike per plant showed a highly significant and positive correlation with the characters plant height, spike length, rachis length, no. of floret per spike, length of floret and vase life. The study of path analysis revealed that the characters no. of floret per spike, breadth of leaf and days to spike initiation had direct positive effect on no. of spike whereas days to sprouting, rachis length, breadth of floret, plant height and vase life showing negative direct effect.

Highest mutation frequency observed in 40Gy, mutagenic effectiveness in 20Gy and efficiency in 50Gy of variety Red majesty.

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Department : Plant Breeding and Genetics

Major Advisor : Dr. Reena Phookan Borkakati

Evaluation and background selection of Bacterial Blight introgressed lines in Ranjit Sub-1

Sruthi R

Rice is one of the important staple cereals which is consumed as a main part of diet by more than half of world's population. Rice production in India accounts to more than 40% of country's grain production. Rice is a major crop of Assam and it plays a major role in state's economy. Ranjit is the most popular variety of Assam, which is grown in more than fifty percent of the *sali* rice growing areas of the state. Ranjit Sub-1 is a flood resistant variant of Ranjit. Rice yield is prone to a number of diseases, of which bacterial blight is a widespread one. It is a vascular disease caused by *Xanthomonas oryzae* pv. *oryzae* and leads to yellowing and drying of the leaves. Host plant resistance is considered as the effective, economical and environment friendly strategy for controlling bacterial blight. Marker assisted backcross breeding was followed to introgress the resistant genes xa5, xa13 and Xa21 to Ranjit Sub-1 background. The cross was made between ISM and Ranjit Sub-1, where ISM was taken as donor parent and Ranjit Sub-1 as recurrent parent. In the present study ten BC2F3 lines along with three checks Ranjit, Ranjit Sub-1 and ISM were evaluated for field performance, disease resistance, foreground and background selection. The experiment was conducted in randomized block design with three replications and the field performance was evaluated based eight morphological traits. Three lines showed mean yield comparable to that of the recurrent parent. Phenotypic screening for disease reaction was done by artificially inoculating the lines with Xoo strain and measuring the lesion length. Out of the 10 BC2F3 lines, 8 lines showed resistance reaction. Foreground selection was carried out for three resistant genes and Sub-1 QTL. In the foreground selection, five lines showed three resistant gene combination, three lines showed two resistant gene combination, two lines showed presence of single resistant gene and Sub-1 QTL was present in three lines. Based on field performance, disease screening and foreground selection, three lines were selected for background selection. Background recovery was done using sixty polymorphic SSR markers and the lines showed 70.16 to 82.46% background recovery of the recurrent parent genome.

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Department : Plant Breeding and Genetics

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Assessment of genetic variability and association analysis for morpho-physiological attributes in Sesame (*Sesamum indicum* L.)

Subrat Das

Sesame (*Sesamum indicum* L.) is a high value oilseed crop owing to its multifarious dietary uses, health benefits and industrial applications. The productivity of this crop is comparatively low in India. In Assam it is grown as a minor oilseed crop and it occupies only 3.8 % of the total area under oilseed crops in the state. Considering the enormous gap between the potential and realized yields, there is ample scope for enhancement of its productivity through breeding efforts. The present investigation was undertaken to evaluate 32 sesame genotypes during *Kharif* 2019 under RBD with 3 replications at the experimental field of Plant Breeding & Genetics, B. N. College of Agriculture, Biswanath Chariali. The objectives of the investigation were to study genetic variability, character association through correlation and path analysis and also to assess the genetic diversity in the accessions for twelve morpho-physiological traits. Analysis of variance revealed highly significant differences among the genotypes for all the characters studied. Moderate to higher values of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for all the characters under study except days to maturity and relative leaf water content. Moderate to high heritability estimates were shown by all the traits under study. High heritability coupled with moderate to high genetic advance as per cent of mean (GAM) was observed for all the characters except days to maturity and relative leaf water content indicating effectiveness of selection for improvement of these traits. Seed yield per plant exhibited moderate heritability coupled with high genetic advance as per cent of mean. Correlation and path analysis revealed that the characters *viz.*, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, leaf area index, relative leaf water content, chlorophyll content and harvest index had positive direct association effect along with significant positive correlation with seed yield. Based on the *per se* performance the genotypes *viz.*, SGP-26, RT-54, TKG-55 and PKG-21 exhibited better performance with respect to seed yield per plant and most of the

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other yield attributing morpho-physiological characters. Using Mahalanobis D2 statistics, the genotypes could be grouped into eight (8) clusters. The maximum intra-cluster distance was found in cluster III followed by cluster II and cluster VI. The clusters V, VII and VIII had only one genotype each. The maximum inter-cluster distance was recorded between cluster III and VIII, while minimum distance was observed between clusters V and VII. Among all the characters, seed yield per plant had highest contribution towards the genetic diversity. Based on the *per se* performance, inter-cluster distances and mean performance of clusters for different traits genotypes *viz.*, SGP-26, TKG-55 and PKG-21 belonging to cluster III and ALS-6 and ALS-7 belonging to cluster II are expected to produce desirable segregants for yield and other yield attributing traits after hybridization. Similarly, the genotypes RT-54 belonging to cluster I and JT-14 belonging to cluster IV may be selected for the crossing programme. Thus, an efficient hybridization programme may be formulated which could pave the way for obtaining basic genetic materials to undertake further selection in sesame.

Genetic variability in Rice bean (*Vigna umbellata* Thunb.) for important quantitative characteristics and their relationship with grain and forage yield

Suchitra Balmiki

Ricebean (*Vigna umbellata* Thunb.) is a minor and multipurpose grain legume crop which is mainly cultivated for food, fodder and green manure by the poor farmers in the marginal areas. It plays a major role in human, animal and soil health improvement. It is a good source of protein and essential amino acids and it also acts as a good cover crop, helps in preventing soil erosion and also has the ability to fix nitrogen. The current experiment was conducted in the Instructional-Cum-Research Farm, Assam Agricultural University, Jorhat during *Rabi* 2018 to study the genetic variability and yield performance of fourteen rice bean genotypes grown in Randomized Block Design with two replications. The analysis of variance revealed that mean squares due to genotypes was significant for all the characters. The estimates of genotypic coefficient of variation and phenotypic coefficient of variation were observed to be high for stem length, leaf-stem ratio, productive racemes per plant and seed yield per plant. High heritability coupled with high genetic advance as per cent of mean was observed for stem length, leaf area, 100 seed weight, pod length, seed breadth, leaf-stem ratio, productive racemes per plant and seed yield per plant indicating the preponderant influence of additive gene effects. The correlation studies revealed that green forage yield per plant was significant to highly significant and positively correlated with plant height, primary branches per plant, secondary branches per plant, stem length, leaf area, pod length, seed length, seeds per pod, leaf-stem ratio, productive racemes per plant, pods per raceme, days to 50% flowering, days to maturity, seed yield per plant and dry matter yield per plant. Therefore, indirect selection may be done via these traits to improve the productivity of genotypes for green forage yield. The results from the path analysis revealed that plant height, primary branches per plant, days to maturity, seeds per pod and pod length were the most important characters which could be used as selection criteria for effective improvement of dry matter yield of rice bean through

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indirect selection. In case of qualitative traits, all the rice bean genotypes under study were semi-erect type and showed indeterminate growth. All the genotypes had yellow-coloured flowers and the flowers were observed to be in cluster. The hilum shape of the seeds of all the genotypes were observed to be concave except for genotypes JCR-14-1 and Bidhan Rice bean-1, which had seeds with straight hilum. The seeds of all the genotypes were non-pigmented. Therefore, the above observations concluded that only hilum shape could differentiate the genotypes.

Performance evaluation and character relationship in a set of genotypes of Yellow Sarson (*Brassica rapa* L.)

Supriya Kaushik

Rapeseed (*Brassica rapa* L.) is one of the most important oilseed crops of the country occupying considerably a large acreage. Rapeseed includes brown sarson, yellow sarson, toria and gobi sarson (*B. napus*). Because of the advantage of short maturity duration, the farmers in Assam and other North-eastern states have been cultivating predominantly the toria and yellow sarson. In the present study, a set of fourteen yellow sarson genotypes including eleven newly developed lines and three varieties, was evaluated during year *Rabi* 2018-19 and 2019-20 to study mean performance for seed yield, duration and related traits and reaction to natural incidence of aphids and *Alternaria* blight, to estimate genetic variability parameters and to study character relationships. Observations were recorded for fourteen yield attributing characters. The pooled analysis of variance of the experiments revealed significant variation due to genotypes, environments and genotype-environment for majority of the characters. JYS15-2, JYS14-3, JYS14-2 and YSH401 were high yielders per hectare over the two years. All the genotypes were susceptible to *Alternaria* blight disease and susceptible or highly susceptible to aphid (*Lipaphis erysimi*) infestations. Medium genetic coefficient of variation was observed for most of the traits. Heritability and genetic advance were high for the character seed yield per hectare. On the basis of genetic correlation and path analysis days to 50% flowering, harvest index, number of siliquae on main shoot and siliqua density were found as important yield attributes. On the basis of D2 analysis the genotypes were grouped into four clusters, using the Tocher's method. Siliqua density, days to maturity, number of seeds per siliqua, main shoot length, seed yield per plant and plant height contributed 61 percent variation towards divergence. Hybridization between genotypes from diverse clusters is likely to yield transgressive recombinants.

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Evaluation of selected F₃-4 lines of Tomato crosses (*Solanum lycopersicum* x *Solanum pimpinellifolium*) for morpho-metric traits

Upasana Bordoloi

In the present investigation fifty selected F₄ progenies from inter-specific crosses with wild tomato *Solanum pimpinellifolium* were evaluated along with five check varieties in an augmented RBD during *Rabi*, 2018-19. Observations were recorded for nine morphometric traits. Significant genotype variation was observed for all the traits. The progenies from the cross between Arka Abha and *Solanum pimpinellifolium* were good performers in comparison to the other progenies. High to moderate estimates of genotypic as well as phenotypic coefficient of variation were observed for all the traits under study except fruit equatorial diameter and days to maturity. High heritability along with high genetic advance as percent mean was observed for average fruit weight, fruit polar diameter, number of branches per plant, plant height, fruits per cluster, fruit yield per plant, fruit equatorial diameter etc. Association studies revealed significant positive correlation of fruit yield per plant with number of branches per plant, fruit polar diameter and days to maturity. Fruit yield per plant was negatively correlated with fruits per cluster, fruit equatorial diameter and average fruit weight. Highest positive direct effect on fruit yield was shown by number of branches per plant followed by fruit equatorial diameter. The characters fruit polar diameter and average fruit weight showed negative direct effect on fruit yield per plant.

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Department : Plant Breeding and Genetics

Major Advisor : Dr. Prabalee Sarmah

Effect of Seed Enhancement on Seed Establishment, Seed Yield and Quality of Direct Seeded Rice

Himashri Baishya

An experiment was conducted during the *kharif* season of 2018 at Instruction cum Research Farm, Assam Agricultural University, Jorhat in split plot design with two seed rates in main plots and ten seed enhancement treatments in subplots replicated thrice. The seed enhancement treatments were also evaluated under laboratory conditions to study their effect on seed quality. All the characters in the laboratory evaluation, namely, speed of germination, seedling height, root length and seedling dry weight varied significantly except for the germination %. Results from the field experiment revealed significant variation among the treatments for all the characters, namely, field emergence (%), seedling height (cm), root length (cm), number of effective tillers, number of seeds/panicle, spikelet fertility (%), 100 seed weight (g), disease incidence (%) and seed yield (kg/ha) except days to 50% flowering. Interaction of the treatments with seed rates was significant for field emergence, seedling height, number of effective tillers, spikelet fertility and seed yield. The yield contributing characters, *viz.*, number of effective tillers and spikelet fertility varied significantly under the two seed rates and showed better performance under the reduced seed rate than under the normal seed rate. Lower incidence of disease was recorded in respect of the treatments combinations with consortium of biocontrol agents (*Trichoderma harzianum* + *Metarhizium anisopliae* + *Beauveria bassiana*). Under both the seed rates, field emergence, seedling height, root length and seed yield showed better performance when treated with enhancements treatments along with a consortium of bio-control agents than those seeds which were treated with the enhancement treatments alone. The seed yield didn't differ significantly between the two seed rates treatments. Hence, the results indicated that seed rate can be reduced to 56.25 kg/ha (75% of the recommended seed rate) without sacrificing performance in seed yield. Amongst all the treatments, Treatment 9 i.e. Ascorbate priming + Seed treatment with consortium of bio-control

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Major Advisor : Dr. Prakash Bora

agents showed high values for the characters namely field emergence, 100 seed weight and seed yield with respect to the control. Disease incidence was also found to be the lowest in this treatment.

Correlation studies revealed that the field emergence (%), number of effective tillers and number of seeds/panicle are significantly and positively correlated with seed yield (kg/ha), thereby indicating the importance of these characters in governing seed yield.

Effect of different storage structures on the seed quality of green gram (*Vigna radiata*)

Madhurima Bezbora

Green gram (*Vigna radiata*) is the fourth important pulse crop in India. India is the largest producer of green gram and contributes 10 to 12% national share among the total Indian pulse production (Basu, 2011). Storage is an essential part of its seed industry. The humid climatic condition of the North Eastern region, including Assam is identified for its poor storability. Lack of scientific storage facility, inappropriate storage medium makes it difficult for its storage up to the next season Green gram seeds were usually attacked in stores by different insect pests and micro-organisms. In the present investigation, the effect of different storage structures on the seed quality of green gram (*Vigna radiata*) was studied.

The seeds were stored in four different packaging materials viz., Gunny bags, Polylined gunny bags, HDPE bags and Cloth bags with and without treatments. Different seed quality parameters like moisture content, germination percentage, seedling vigour index, field emergence, biochemical parameters (alpha amylase and lipid peroxidation activities), seed health parameters like mycoflora association and insect infestation were observed at the time of storing (0 day) and at an interval of two months up to nine months (270 days) of storage.

At the end of nine months of storage, lowest moisture content was observed in seeds stored in HDPE bags+ seed treatment with fungicide (9.81 per cent), followed by polylined gunny bags + seed treatment with black pepper powder @3g/kg of seeds (9.85 per cent) and the maximum was in case of cloth bags (11.26 per cent). Germination above IMSCS level (83.67 per cent and 75.67 per cent respectively) and seed vigour index (1416.07 and 1101.47 per cent respectively) were maintained only by two treatments i.e., HDPE bags+ seed treatment with fungicide and polylined gunny bags + seed treatment with black pepper powder @3g/kg of seeds. The physiological parameters viz., speed of germination, mean daily germination, peak value and germination value were found to be reduce with increase in the storage duration. Speed of germination was significantly highest in HDPE bags + seed treatment with fungicide

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(27.66) till 270 DAT. Similar trend was also followed for mean daily germination, peak value and germination value. Mean germination time was significantly maximum in the seeds stored in cloth bags (4.94).

Among the biochemical parameters, lipid peroxidation activity was recorded to be minimum in seeds stored in HDPE bags + seed treatment with fungicide (0.38 $\mu\text{g/g}$) while the maximum was observed in seeds stored in cloth bags (0.67 $\mu\text{g/g}$) after 270 days of storage. The seeds stored in HDPE bags+ seed treatment with fungicide (0.42 mg maltose released/min) exhibited highest alpha amylase activity and the lowest was observed in cloth bags (0.10 mg maltose released/min) till 270 DAT. Six microorganisms viz., *Aspergillus flavus*, *A. niger*, *Rhizopus* spp., *Fusarium* spp., *Penicillium* spp. and *Alternaria* spp. were found to be associated with the green gram seeds under storage. The percentage of insect infestation was maximum in cloth bags (58.33 per cent) and the lowest insect infestation was maintained by HDPE bags + seed treatment with fungicide (23 per cent) upto 270 days of storage.

Identification of morpho-chemical characters for genetic purity testing of rice varieties

Madhuryya Mohan Khanikar

Characterization of cultivars, establishment of varietal identity and genetic purity of the seed lots are crucial for varietal improvement, varietal protection and seed production. A rapid and reliable technique to verify the identity and to assess the purity of seed lots is important in seed quality assurance program. So, the present study was formulated to test 50 local varieties for genetic purity and group them based on the morphological similarities and response to various chemicals. The mean performance table of varieties based on quantitative traits revealed significant variation among the varieties for the quantitative traits. Based on the grain morphology, Black Rice (B), Nekeru and Pare were found to have long slender type of grain shape while Purubenu, Kola Konamasuri, Jeera Joha, Jengoni, Samraj, Vaboli Joha, Banki Sali, Basudev Bao and Bamkokua exhibited medium slender grain shape and Black Rice (G), Malbhog and Til Bora on the other hand, depicted basmati type grain shape. These three categories are highly preferred by the consumers due to its pleasant appearance. On the basis of chemical test, Bao, Sokua Bao, Samraj & Boga Ahu exhibited unique red colouration in the NaOH test. As per the phenol & modified phenol test, unique black colour was exhibited by Purubenu, Maniki Madhuri Joha, Joha Big and Kola Amona. The cluster analysis based on grain morphology revealed 4 predominant clusters, while based on chemical data, 2 distinct groups were obtained. Cluster I of the chemical data comprised of only one variety i.e. Sokua Bao while cluster II contained all the other varieties. This cluster could be further divided into 2 sub-clusters. The sub-cluster 1 comprised of all the Joha varieties except Jeera Joha while the sub cluster 2 encompassed all the Bao and the Black rice varieties indicating the two distinct amylose ranges. The most similar varieties with regards to the amylose content were Bao (9) and Pare. 16 varieties out of the total 50 varieties were found to have unique characters based on the morphological, chemical and biochemical parameters. These varieties are - Purubenu, Maniki Madhuri Joha, Joha Big, Kola Amona, Pare, Malbhog, Nekeru, Til Bora, Sokua Bao, Bao (9), Samraj, Boga Ahu, Black rice (B) and Black rice (G).

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Department : Plant Breeding and Genetics (Seed Science & Technology)

Major Advisor : Dr. Bhaswati Sarmah

Varietal characteristics and divergence of rice varieties for genetic identity

Mannem Niveditha

The identification and characterization of crop varieties has always been the basic and pre-requisite step in maintenance breeding, pre-breeding programs. With the growing population, decreasing cultivable land, narrowing genetic diversity of the crop species, changing climatic conditions and increasing demand, it has now become essential to maintain and conserve the traditional and local crop cultivars to protect the naturally existing crop diversity among the specific crop species. In order to maintain, protect and conserve the traditional cultivars systematic identification and documentation are crucial for each crop variety, which will also be a source of information for breeding programmes. The North-eastern India, has a rich source of genetic diversity for rice crop, being one of the primary centers of origin for rice crop. The present study is a step towards characterizing few traditional rice cultivars of Assam. 20 rice genotypes collected from various regional research stations of Assam, were studied for different morphological traits supported by statistical analysis. Total of 18 quantitative and 10 qualitative traits were studied and for distinguishing the 20 rice genotypes more precisely analysis of variance, divergence analysis using D2 statistics and principal component analysis were performed. All the traits under the study showed significant differences among the 20 rice genotypes. All the genotypes under the study were identified with some unique morphological traits, supported with the divergence analysis and principal component analysis. The genotypes based on the D2 statistic of mahalanobis distance were grouped into 2 different clusters and also based on PCA the genotypes were grouped into 6 different clusters. In both the clusters the genotype Betguti was out layered as a separate cluster from all the other 19 genotypes. The genotypes Betguti, Kanaklatha, Bor Malbhog, Kekua Bao, Jul Bao, Negheri Bao, Maguri, Solpuna, Rongabordhan, Rongdoi, Basudev and Rongadhan were able to be uniquely distinguished based on yield and grain related traits in the study.

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Department : Plant Breeding and Genetics (Seed Science & Technology)

Major Advisor : Dr. Sharmila Dutta Deka

Influence of seed priming on aged seeds

Pratha Pratim Bora

Seed is the basic and most important input for sustainable agriculture which contain all the required genetic materials that can effectively influence yield potential. One of the major problems in agriculture is the loss of seed viability and vigour particularly in tropical regions with high humidity during seed storage due to seed ageing. Seed ageing is a major and inevitable problem for both cereal and pulses. During the ageing process, seeds lose their vigour and ability to germinate. The slow or poor germination problem of aged seeds can be ameliorated through seed priming. For the present investigation, seeds of rice varieties Kon Joha and Keteki Joha and, French bean variety Arun were naturally aged for a period of 9 months to evaluate the effect of seed ageing on physiological and biochemical parameters; and then hydro-primed, osmo-primed with 5% and 10% PEG, halo primed with 1% and 2% KCl and hormonal primed with 5 ppm and 10 ppm GA3 for 12 and 24 hours, to evaluate the effect of priming treatments on seed ageing. The experiment was conducted in the department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat during 2018-20. Physiological parameters like moisture percentage, germination percentage and index, mean germination time, seedling length and dry weight, seed vigour index, field emergence, seed reserve utilization rate, seed reserve use efficiency, seed reserve depletion percentage, and, biochemical parameters like electrical conductivity, lipid peroxidation and alpha amylase were observed during the study. Results revealed gradual deterioration of seed quality due to ageing during storage. Rate of deterioration was faster in seedling vigour traits than germination parameters. Also, the rate of deterioration was slower at the beginning of the storage period but faster at later period especially after 6 months. There was varietal difference in the rate of deterioration. The rate of deterioration was slower in Kon Joha, an indigenous variety which showed dormancy. The priming treatments were able to ameliorate the effect of seed ageing on seed germination, seedling growth and biochemical parameters in Kon Joha. The seed germination, seedling growth and biochemical parameters showed variation in their performance with respect to different priming agent, concentration and duration. KCl priming was found to be the best priming agent, 24 hours of priming for all agents were

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Major Advisor : Dr. Meghali Barua

found better than 12 hours. 1% KCl, 10 ppm GA3 and 5% PEG were proved better concentrations than 2%, 5 ppm and 10% concentrations respectively in enhancing almost all the germination parameters and vigour indicators. The treatments could enhance the vigour but once the seeds were dead, treatments cannot ameliorate the effect of deterioration. Since GP is positively correlated with SRUR, SRDP and alpha amylase activity but negatively correlated with EC and lipid peroxidation, hence these parameters are good indicators to estimate the quality of seed and their performance in the field.

Nutrient management for broccoli quality seed production in Assam

Pratiksha Gogoi

The broccoli (*Brassica oleracea* L. var. *italica*), a winter vegetable crop of great importance in human food belongs to the cole group having 18 chromosomes ($2n=18$, $x=9$) which is propagated through seed. The weather and climatic conditions of Assam favours production of the head as well as seeds hence broccoli becoming a popular crop of Assam. Information related to the effect of fertilizer on quality seed production is scarce for broccoli, especially for Assam condition. Hence, a study was undertaken during 2018-19 to assess the effect of nitrogen (80, 100 and 120 kg/ ha), potassium (60 and 80 kg/ ha) and method of nitrogen application (applied in 2 and 3 splits) on the seed yield and quality of broccoli variety Pusa Broccoli KTS-1. Phosphorous was applied at 60 kg/ ha in all the treatments. In two splits, 50% nitrogen was applied as basal and rest at 40 days after transplanting, and in three splits, 50% was applied as basal, 25% at 30 days after transplanting and rest at flower initiation stage. The control included application of FYM only. The treatments significantly affected various crop growth parameters *viz.*, plant height at heading and seed maturity stage; canopy spread; leaf length, width and chlorophyll content; head diameter; days to heading, flowering and seed maturity; number of siliqua/plant; number of seeds/siliqua; seed yield per plant; leaf NPK content; test weight of seed; and germination parameters *viz.*, germination percentage and index, mean germination time, seed vigour index-I and II, seedling fresh and dry weight except leaf numbers per plant. Higher dose of nitrogen (120 kg/ ha), potassium fertilizer (80 kg/ ha) and 3 splits method of nitrogen application significantly enhanced various crop growth, seed yield and germination parameters, at the same time they reduced the time taken for heading, flowering and seed maturity. Seed yield per plant was positively correlated with all the parameters except days to heading, days to flowering and days to seed maturity with which it showed negative association. Leaf chlorophyll, leaf N and K content were more at higher dose of nitrogen and potash indicating by managing N and K nutrient, the leaf chlorophyll, N and K content can be enhanced which other hand will enhance seed yield since they were positively

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associated with each other. Hence it can be concluded that N application in 3 splits, at 120 kg/ ha and K at 80 kg/ ha significantly enhanced crop growth, seed yield and quality of broccoli thus dose of 120:60:80 kg/ ha NPK with N applied in 3 splits could be recommended for quality seed production of broccoli variety Pusa Broccoli KTS-1 for agro-climatic zones of Assam.

Application of bio priming for seed invigouration and early seedling establishment

Prithviraj Pegu

Rice is the world's most important crop and is a staple food for more than half of the world's population. Worldwide, rice is grown on 161 million hectares, with an annual production of about 744.4 million tons of paddy (FAO, 2014). Organic agriculture is a rapidly developing trend all around the world and more than 150 countries have adopted this technique and now produce organic food commercially. The most compelling reason for using organic seed when growing organic crops is that seed produced organically causes a less hazardous impact on the environment. Early crop establishment, lower productivity along with non- chemical disease management is a challenging task of seed technologist in organic seed production. Seed priming an effective seed invigouration method has become a common seed treatment to increase the rate and uniformity of emergence and crop establishment in most crops. Bio-priming is a process of a biological seed treatment that refers to the combination of seed priming and inoculation of seed with beneficial organism to protect the seed and improve the quality. In the present investigation, *Beauverijal* was found to be the best bio-agent for seed treatment as the results indicate better early seedling growth followed by higher no. of seeds/panicle and seed yield and less disease infestation. Early plant development and physiological functions could be impacted by early root growth reduction of disease incidence may also result in better yield performance. Commercial bio-agents viz. *Trichojal* and *Metajal* were also found to be effective in lowering the disease incidence and increase in seedling vigour followed by better yield performance. Comparative performance of cold adaptive PGPB (*Trichoderma spp.* + *Bacillus spp.*), Microbial consortium (C4) (*Bacillus spp.* + *Pseudomonas spp.*), Microbial consortium (C7, *Bacillus spp.* + *Pseudomonas spp.*), although designated as cold adaptive strains but does not impart any significant influence in enhancing seed vigour and early seedling growth. The colonization of the microbial agents in the rhizosphere region signifies its role in nutrient absorption and imparting abiotic stress resistance. The better adaptability of local commercial bio-agents in *Trichojal*, *Metajal*, and *Beauverijal* may lead to better performance in seed vigour, early seedling growth and final seed production.

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Major Advisor : Dr. Sharmila Dutta Deka

Evaluation of a few botanicals and bioagents in seed transmission of brown spot of rice caused by *Bipolaris oryzae*

Priyanku Mazumder

Brown spot of rice caused by *Bipolaris oryzae* Subr. and Jain (syn. *Helminthosporium oryzae* Breda de Haan) is an important disease of rice which has been reported to occur in all the rice growing countries of the world. In India, it is known to occur in all the rice growing states including Assam causing loss of 5-53.33 percent annually. Considering its widespread significance, an experiment was conducted to study the effect of a few botanicals and bioagents in seed transmission of the disease. The location of *B. oryzae* in the rice seed and its transmission from seed to seedling were studied. Each part of infected seed including embryo, endosperm, lemma, palea, sterile lemma and rachilla, was found to be infected by *B. oryzae*. The highest level of infection was found in endosperm (78.50 percent) followed by rachilla (68.50 percent). Lowest infection was found in embryo (32.50 percent). Transmission studies from the infected seed to the seedling using test tube agar, blotter and sand indicated that primary symptom appeared on coleoptile and roots after 7 – 14 days. However, recovery of infection percentage was greater in test tube agar and blotter than sand method.

Efficacy of three botanicals viz., Turmeric (*Curcuma longa*), Neem (*Azadirachta indica*), Tulsi (*Ocimum sanctum*) in different concentrations (10%, 20% and 50% each in Turmeric in Neem and 20%, 30% and 50% in Tulsi) and one bioformulation, Biogreen @5%, 10% and 15% concentration was studied to reduce growth of *B. oryzae in vitro* and its transmission from treated seeds to seedlings. Turmeric @50% concentration was found to be most effective in reducing the colony growth of the pathogen (1.97 cm and 72.87 percent inhibition over control) followed by Turmeric 20% concentration (3.16 cm and 56.47 percent inhibition over control), Tulsi 50% and Biogreen 15% concentration (3.52 cm and 3.84 cm respectively). Turmeric 50% and Turmeric 20 % concentration were also the most effective in reducing the transmission of the pathogen from seed to seedling both in test tube agar method and sand method.

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These four treatments from the *in vitro* experiments were further studied for their effect on seed transmission of *B. oryzae*, Percent Disease Incidence (PDI) and seed quality parameters under pot condition. Percent Disease Incidence was found to be the lowest in the treatment Turmeric @50% during all the three observed stages (8.36, 9.58 and 18.54 percent at Tillering, Panicle Initiation and Grain filling stage respectively). At grain filling stage Turmeric @50% was followed by Tulsi @50% (19.44). However at this stage PDI observed in treatments Tulsi @50%, Turmeric @20% (22.71) and Biogreen @15% (24.59%) were at par with each other. Seed yield per plant was highest in the treatment Turmeric @50% (29.40 g) which was at par with that of Carbendazim @0.2% (28.80 g) and Turmeric 20%(28.52 g). Thousand seed weight was also highest in the treatment Turmeric @50% (22.48 g) followed by control treatment (Carbendazim @0.2%) (21.86 g). Seedling vigour and speed of germination were significantly higher in the treatment Turmeric @50% (1244.37 and 10.79 respectively) but germination percentage of the treatment Turmeric @50% (92.50%) was at par with that of treatment Turmeric @20% (89.00%) and Carbendazim @0.2% (93.50%). Mean germination time was also significantly lower in the treatment Turmeric @50% (4.74 days). Mean daily germination was found to be highest in the treatment Turmeric @50% (3.49) which is statistically at par with the treatment Turmeric @20% (3.46) and Carbendazim @0.2% (3.44).

The harvested seeds from different treatments showed varying level of association by *B. oryzae*. Seeds in Agar plate method showed infection of 25.75 percent and 37.72 percent reduction over absolute control in the treatment Turmeric @50% which was lowest among botanicals and bioagents. The treatment Carbendazim @0.2% was the best in all the observed parameters. However, seed yield per plant, germination percentage, mean daily germination and mean germination time were at par with those of the treatment Turmeric @50% concentration.

Evaluation of some indigenous rice varieties for seed morphology and cooking quality characteristics

Rajasree Rajkhowa

Assam as well as North-east India is traditionally a rice growing area. The local/indigenous varieties have been grown in the state since time immemorial and by now most of them are getting lost due to the change in biodiversity. Conservation of such varieties are highly needed as they can be grown with minimum possible input and have a considerable demand in local and international market. With the increasing awareness people tends to be more health conscious and more interested on the nutritional quality of the food. Hence if we utilize these local varieties in organic farming conditions with lowest input nature, it will benefit the farmers as well as the consumers. This local/indigenous varieties are having many such desirable properties can meet the consumer preference and market demand if utilized organically. In the present investigation, fifty (50) traditional rice genotypes were collected from different regions of North-East, characterized according to the DUS test guidelines of PPV&FR act of 2001 at Assam Agricultural University, Jorhat. Cooking quality parameters of the traditional rice genotypes were also analyzed and all the tested parameters showed significant variations among the varieties. Also a correlation was established between the seed morphological and cooking quality characters of the varieties. A rapid and reliable technique to verify the identity and to assess the purity of seed lots is important in seed quality assurance program. Based on the overall study, sixteen (16) genotypes, viz., Beji, Beto Baw, Bhogali Bora, Black Rice, Bordhan, Borsolpuna, Dhusuri Bao, Dolmora Bao, Gezep Sali, Joha Big, Jum Beji, Kutkuti Sali, Nekeru, Ronga Bordhan, Rongadhakekua Baw, Xoru Seni Lahi were found to exhibit unique features of morphology and cooking quality. The identification of such germplasms is the source of preservation and conservation in addition to being the source of genetic resources for the future crop improvement programs.

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Department : Plant Breeding and Genetics (Seed Science & Technology)

Major Advisor : Dr. Bhaswati Sarmah

Performance evaluation of pre-sowing seed treatments using bio agents in transplanted aromatic rice for organic condition

Shamima Nashrin

Rice is staple food for most of the World's population and a major source of income for farmers in developing countries. Assam being one of the centers of origin is endowed with a wide range of variability for rice. Among the specialty rice group of Assam, aromatic rice of this region occupies a major share in production and trading, specially small grained aromatic *Joha* rice, because of its wide acceptability in local and in exotic market. Organic agriculture is a rapidly developing all around the world and commercial production of agro products has become a lucrative venture. Looking at the present scenario of organic rice production, the present investigation was taken with the objectives to mitigate different challenges of field establishment at early seedling growth period, envisioned with higher productivity. Seed enhancement techniques are pre-sowing seed treatments that lead to a physiological state which enables the seed to germinate in a more efficient manner and imparts better field establishment. Seed treatment with bio-agents has emerged as an alternative to chemical inputs with many fold advantages of mitigating biotic and a-biotic stresses in field condition more precisely in organic condition. In the present study five locally prepared commercial organic bio-formulations *Organic-Metajal*, *Organic-Trichojal*, *Organic-Beauverijal*, *Azospirillum* spp. and *BIO Phos*, liquid PSB formulation were used to treat the seeds along with two root treatment in 30 days old seedlings (using *Azospirillum* spp.) and evaluated the early seedling growth and yield performance of "Keteki *Joha*" a high yielding aromatic rice variety in organic condition. In the present investigation *Org-Metajal* exhibited better germination and vigour indicators in laboratory condition whereas in field condition *Org-Trichojal* is found to be better performer. *Org-Trichojal* was found to be highest performer in regards to early vigour, seedling growth and yield parameter in field condition. However *Org-Metajal*, *Organic-Beauverijal*, *Azospirillum* spp. and *BIO Phos* are also found to be effective in improving growth and yield as

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Major Advisor : Dr. Sharmila Dutta Deka

compared to the control. The present study implies the cost effectiveness of these bio-agents which is reflected in higher productivity, hence higher net return. Simple and user friendly methodology of application of the bio agent as formulated in the study will enable easy adaptation of the bio-agents by the farming community.

Molecular screening of Citrus germplasm for simultaneous detection of *Candidatus Liberibacter* species associated with citrus greening disease

Amitha Paul

An effort was made to screen the Citrus germplasm maintained at the Citrus Research station (CRS), Tinsukia, Assam to identify the prevalence of *Ca. Liberibacter* species associated with citrus greening disease (CGD) and to understand the differential reaction of various varieties to CGD. Overall, 32 germplasm were screened comprising 16 species, 1 hybrid and 1 unidentified cultivar. The severity of CGD based on symptomatology showed that; major parts of the germplasm were infected with CGD. The conventional PCR assay with two pairs of primers of these varieties showed that, only three (3) varieties namely; Khasi Papeda, Trifoliolate Orange and Citrange are free from CGD infection. The presence of Citrus Psyllid insects in symptomatic trees, further amplification of its DNA with the specific primer confirmed the probability of vector mediated the spread of CGD in the field. Further differentiations of Asian and African strains by PCR and RFLP assays confirmed the absence of African strains. Similarly, comparative quantification of infected (10 samples) and suspected healthy (3 varieties) were done by Real time PCR to differentiate the known *Ca. Liberibacter* species in a singleplex reaction. The assay confirmed that the suspected healthy accessions were resistant and the others were infected with only *Ca. Liberibacter asiaticus*. The sequence similarity and evolutionary divergence analysis of the CGD isolates under current study showed sequence similarity with the „*Ca. L. asiaticus*“ isolates (Asian-common isolates) from Southeast Asia, rather than the other diverse atypical Indian isolates present in the rest part of the country.

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Department : Plant Pathology

Major Advisor : Dr. Palash Deb Nath

Bioassay of toxicity of green synthesized silver nanoparticles on biocontrol agents and mammalian cells

Arti Kumari

The present study was conducted to ascertain the interaction of silver nanoparticles (AgNPs) with beneficial microorganisms and mammalian cells. AgNPs were biogenically synthesized mediating *Trichoderma asperellum*. Biosynthesized AgNPs were characterized using UV-Vis spectrophotometer, Dynamic Light Scattering (DLS), Zeta Sizer, Fourier-Transform Infrared Spectrophotometer (FTIR) and Nanoparticle Tracking Analyzer (NTA). The toxicity of AgNPs were evaluated at 50, 100 and 200 ppm concentration against biological control agents viz., *Trichoderma harzianum*, *Beauveria bassiana* and *Bacillus thuringiensis* and mammalian cell line (Vero cells). Results showed that AgNPs at 200 ppm concentration caused highest inhibition in the mycelial biomass content of *T. harzianum* and *B. bassiana* i.e. up to 31.54 % and 28.40% respectively. Biochemical analysis showed that the total soluble sugar and total soluble protein content of both fungi declined with increasing concentration of AgNPs. Biological control agents like *T. harzianum* showed early sporulation when exposed to AgNP as compared to control. On the other hand, AgNPs at all the tested concentration did not show any inhibitory effect to *B. thuringiensis*. The study on uptake of NPs by Vero cells revealed rapid uptake of AgNPs in a concentration and time dependent manner. Highest uptake of NP was observed at 200 ppm concentration after 8 hrs of exposure and lowest at 50 ppm after 1 hr exposure. Similarly, cellular fluorescence microscopic study also revealed increase in AgNP uptake with highest intensity of fluorescence observed at 200 ppm. Staining the Vero cells using May-grunwald and Giemsa stain showed no alteration in cellular morphology even at 200 ppm. Morphological study done by Scanning Electron Microscope (SEM) showed distortions in cellular structure at 200 ppm AgNP. Another study on cytotoxicity of AgNPs on Vero cells showed mild toxicity in a dose dependent manner. The percent viability of Vero cells was found to be highest at 50 ppm (75.27%)

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Department : Plant Pathology

Major Advisor : Dr. Bubul Chandra Das

and lowest at 200 ppm (72.81%). The highest per cent cytotoxicity (28.22%) on Vero cells was recorded at 200 ppm and lowest (12.15%) at 50 ppm. Present study showed green synthesized AgNPs posed mild toxicity on fungal biocontrol agents and Vero cells and no toxicity against *B. thuringiensis*.

Enhancing biocontrol potential of *Trichoderma viride* with micronutrients against *Colletotrichum capsici*

Bhanusree Doley

Chilli (*Capsicum annuum* L.) is one of the most popular spices and vegetable crop which is grown worldwide belonging to the family Solanaceae and is grown for its fruits which possess characteristic color, flavor, pungency, nutritional value and is known for its health benefiting properties. Among the diseases caused by fungi, fruit rot or anthracnose incited by *Colletotrichum capsici* (Sydow.) Butler and Bisby is a serious disease prevalent throughout India by causing major damage at the ripe fruit stage of the crop. The present study was attempted to find out the role of micronutrients in enhancing biocontrol potential of *Trichoderma viride* against *Colletotrichum capsici*. In the present investigation, assessment was made *in vitro* to find out the compatibility of Zn, Mo and B at different concentrations (100, 200, 300, 400, 500, 600 ppm) on mycelial growth of fungal antagonist *T. viride* and for suppression of *C. capsici*. In the *in vitro* investigation, it was observed that Zn @100 ppm showed the maximum mycelial growth of *T. viride*, although Zn @ 100 ppm, B @100 ppm, Mo @400 ppm were at par. The incorporation of zinc and boron at higher concentration decreased the mycelial growth of the *T. viride*. The dual culture was performed from the best concentrations of the three micronutrients obtained from the compatibility test on the interaction of *T. viride* and *C. capsici*. The results of the experiment revealed that among the micronutrients tested zinc @ 100 ppm was found to be the best concentration which enhanced the biocontrol potential of *T. viride* against *C. capsici*. The best results obtained from the *in vitro* test were selected for further studies *in vivo*, both in pot and field conditions where the disease incidence was reduced to 22.12% and 33.73%, respectively over control while the yield attributing characters and residual zinc content were significantly higher in the treatment comprising of ZnSO₄ spray + Seed treatment with BCA + Soil application of BCA + Spray of BCA. Hence, *T. viride* in combination with zinc not only suppressed the incidence of fruit rot but also increased the growth parameters and zinc uptake which resulted increased in yield.

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Major Advisor : Dr. D. K. Sarmah

Study on fungal diseases of Gerbera (*Gerbera jamesonii* Bolus ex. Hook F) in Assam

Bishal Saikia

Gerbera (*Gerbera jamesonii* Bolus ex. Hooker F) belongs to Asteraceae family, is a spectacular and very popular commercial cut flower grown around the world, under a wide range of climatic condition. Random survey conducted in the gerbera growing areas of the districts viz., Jorhat, Kamrup (R) and Karbi Anglong revealed the incidence of few fungal diseases of gerbera viz., *Alternaria* leaf spot, *Botrytis* blight, *Colletotrichum* leaf spot, and *Fusarium* wilt. Based on the per cent disease incidence and per cent disease index as well as on nature of occurrence *Alternaria* leaf spot and *Botrytis* blight of gerbera were selected for further studies. Based on symptomatology, cultural, morphological and molecular characterization the isolated fungal pathogens were identified as *Alternaria alternata* (Fr.) Keissler and *Botrytis cinerea* (Pers.; Fr.) which were also confirmed by the National Centre of Fungal Taxonomy (NCFT), New Delhi. Pathogenicity test was conducted by pin-prick method and Mycelial Bit Inoculation Technique (MBIT) and confirmed the Koch's postulates. *In vitro* efficacy test of different botanicals, biocontrol agents and fungicides singly and in combination against *A. alternata* and *B. cinerea* was conducted. *Allium sativum* (10% conc.), and *T. harzianum* recorded maximum mycelial growth inhibition of 86.66% & 74.44% and 76.41% & 81.38%, respectively. Similarly, *in vitro* efficacy of fungicides evaluated alone and in combination against *A. alternata* and *B. cinerea* revealed that Hexaconazole (0.1%) and Carbendazim (0.1%) caused maximum mycelial growth inhibition of 100.00% and 88.77% respectively. In pot experiments the efficacy of botanical, biocontrol agent and chemical alone and in combination against *A. alternata* and *B. cinerea* was tested. Hexaconazole (0.1%) was found most effective against *A. alternata* which recorded lowest disease incidence (14.55%) and per cent disease index (13.26%) with highest per cent disease control of 82.05% and 84.22%, respectively. In case of *B. cinerea*, Carbendazim (0.1%) recorded lowest disease incidence (11.97%) and per cent disease index (8.57%) with highest per cent disease reduction of 84.14% and 88.95%, respectively in pot experiment. In field condition also Hexaconazole (0.1%)

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recorded lowest disease incidence (16.52%) and per cent disease index (11.76%) with highest per cent disease reduction (79.43% and 85.59%) of leaf spot caused by *A. alternata*. In case of *B. cinerea*, Carbendazim (0.1%) recorded lowest disease incidence and per cent disease index of 14.48% and 12.83% with highest per cent disease reduction of 81.41% and 84.07% respectively. The yield attributing characteristics and growth parameters of gerbera were found to be superior when treated with *T. harzianum* [Org-Trichojal (@ 5ml/l)].

Study on incidence, detection and characterization of Brinjal Little Leaf (BLL) disease in Assam

Dibya Sree Dutta

The present investigation was conducted to know the incidence, symptom development, molecular detection and characterization of Brinjal little leaf (BLL) disease in Assam, together with the leafhoppers associated with natural transmission of the disease. Roving survey was conducted during 2018 to 2020 in seven major brinjal growing districts of Assam namely, Biswanath, Darrang, Golaghat, Jorhat, Nagaon, Sibsagar and Sonitpur. The disease incidence was observed in all the surveyed locations. Highest disease incidence was recorded in Sibsagar district (23.63%) followed by Golaghat (21.68%), Biswanath (12.91%), Nagaon (12.72%), Jorhat (10.90%), Sonitpur district (5.66%) and the lowest disease incidence was observed in Darrang (3.62%) district. The BLL disease infected plants exhibited a wide range of symptoms such as reduction in the leaf size, stunted growth, yellowing of leaves, phyllody, witches' broom and mummification of fruits. Four different types of leafhoppers viz., *Amrasca biguttula biguttula* (Ishida), *Exitianus indicus* (Dist.), *Hishimonus phycitis* (Dist.), *Nephotettix nigropictus* (Stal) were collected during the survey with average population of 3.42, 3.14, 4.85 and 2.85 numbers per five net sweeps respectively.

The Brinjal little leaf disease was successfully transmitted by the leafhopper *Hishimonus phycitis* (Dist.) and dodder with transmission efficiency of 80.00 per cent and 60.00 per cent respectively. The disease severely affected both growth and yield attributing parameters of brinjal plants which was observed to be varied depending on the age of the plant at infection. The highest reduction in plant height (72.16%), leaf size (84.54%), petiole length (92.69%), internode length (72.94%), no. of fruits per plant (73.33%), fruit weight (80.48%) and fruit yield per plant (94.79%) over healthy plant (control) was observed when plants were infected at 65-70 days after transplanting (DAT). As the age of the plant at infection increased the effect on growth and yield attributing parameters also reduced significantly.

Total genomic DNA extracted from symptomatic and asymptomatic brinjal plants collected from different districts of Assam were subjected to PCR assays using

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Major Advisor : Dr. M. K. Kalita

phytoplasma specific universal primers. All the symptomatic brinjal plants yielded an expected amplicon size of ~1.5 kb from PCR confirming the presence of BLL phytoplasma. No amplification was obtained from asymptomatic brinjal plants. Plants such as datura, mustard, tomato and *Tita bhekuri* (*Solanum violaceum*) present in and around the infected brinjal fields also tested positive for phytoplasma indicating them as potential reservoir hosts of BLL phytoplasma in Assam. Sequencing and phylogenetic analysis has revealed that the Brinjal little leaf phytoplasma detected under the present investigation was associated with '*Candidatus* Phytoplasma trifolii' (16SrVI) (clover proliferation group).

Studies on the effect of tetracycline hydrochloride antibiotic in remission of BLL disease symptom elucidated that the effect was purely temporary remission of symptoms.

Enhancement of microbial load in *Bhut chilli* (*Capsicum chinense* Jacq.) rhizosphere by bioformulation application and management of bacterial wilt disease (*Ralstonia solanacearum*)

Dipankar Das

Bacterial wilt caused by *Ralstonia solanacearum* is one of the most destructive and widespread bacterial diseases of solanaceous crop plants in the tropics, subtropics, and warm and temperate region of the world. *In vitro* studies of bioagent combinations of six bioformulations were conducted against the pathogen. The antagonistic potential of the bioagents were tested *in vitro* singly and in combination against *R. solanacearum* adopting dual culture method using TTC as basal medium. The inhibition zones (mm) of bio-agents singly and in combination and per cent inhibition of target pathogen were recorded and analyzed. The highest inhibition (82.63%) against *R. solanacearum* was recorded against BIOGREEN-5 (a combination of five bioagents, viz., *T. viride*, *M. anisopliae*, *B. bassiana*, *P. fluorescens* and *B. thuringiensis*) followed by BIOTIME (a combination of three bioagents, i.e, *T. harzianum*, *M. anisopliae* and *P. fluorescens*) with 74.50% inhibition. Based on the results of the *in vitro* experiment, two talc-based bioformulations and one liquid bioformulation were selected for the management of bacterial wilt of bhut chilli. These effective bioformulations were further evaluated under field conditions for their efficacy against bacterial wilt disease when applied as seedling root treatment, soil application and spray application under field conditions. Similarly, other yield attributing characters, viz., plant height, no. of leaves, no. of primary branches, root dry weight, shoot dry weight, root fresh weight, no. of fruits per plant and fruit weight was highest in the plants treated with BIOVEER (*T. viride*). Significantly highest reduction of bacterial wilt incidence (14.06%) and highest yield (4.27 t/ha) of bhut chilli was recorded in the treatment comprising talc-based formulation of BIOVEER followed by BIOGREEN-5 and BIOTIME-L. The microbial population of the pathogen increased significantly at harvest in all the treatments as compared to before experimentation. Correlation studies recorded negative correlation (-0.96) between bacterial wilt incidence and yield of bhut chilli.

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Department : Plant Pathology

Major Advisor : Dr. P. K. Borah

Management of fruit rot of brinjal with fungal bio-formulations

Fahnaz Sultan

Fruit rot of brinjal is one of the most destructive disease causing severe damage to the fruits in the field and considerable losses during storage, transit and marketing. The causal fungus of fruit rot of brinjal was identified as *Phomopsis vexans* in the mycology laboratory, Department of Plant Pathology, AAU, Jorhat. The present investigation aimed at managing the disease by using few liquid fungal bioformulations in in vitro and pot condition. Three bio-formulations viz. Org-Trichojal (*Trichoderma harzianum*), Org- Beauverijal (*Beauveria bassiana*), Org- Metajal (*Metarhizium anisopliae*) were tested alone and in combination with each other and Carbendazim (0.1%) was used as fungicidal check against *Phomopsis vexans* by 'poisoned food technique'. Carbendazim 0.1% recorded the highest inhibition of mycelial growth (94.11%) followed by combination of Org-Trichojal + Org-Beauverijal + Org-Metajal (91.44%), Org-Trichojal + Org-Beauverijal (79.11%), Org-Trichojal + Org-Metajal (78.22%), Org-Trichojal (77.78%), Org-Beauverijal + Org-Metajal (76.22%), Org-Beauverijal (74.67%) and Org-Metajal (66.67%), respectively over the control. Amongst the fungal bio-formulation treatments, the effect of Org-Trichojal + Org-Beauverijal + Org-Metajal was found to be significantly superior over rest of the treatments. Therefore, this treatment was selected for further studies. The bioformulation was evaluated for their effect on seed germination, root length, shoot length and seedling vigour of brinjal and compared with Carbendazim (0.1%) and control. Seed treated with Carbendazim resulted highest values in all the parameters followed by seed treated with bio-formulation over control. In pot culture condition, bioformulation was also evaluated for their effect in managing the disease and was compared with Carbendazim (0.1%). Seed treatment + foliar spray with Carbendazim gives the lowest disease incidence and percent disease index (8.03% and 6.13%). This was followed by seed treatment + soil treatment + foliar spray with the bio-formulation (8.06% and 7.19%) over control which were statistically at par in their effect. Highest

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Major Advisor : Dr. Daisy Senapoty

yield (1.45 kg/plant) was recorded in seed treatment + foliar sprays with Carbendazim followed by seed treatment + soil treatment + foliar spray with the bio-formulation (1.40 kg/plant). Amongst the bio-formulation treatments lowest yield was recorded in foliar spray with the bio-formulation (0.85 kg/plant). Use of bio-formulation in different method of application were found to be most effective and have greater proposition in managing fruit rot disease of brinjal caused by *Phomopsis vexans*, but it ranked behind the chemical fungicide.

Effect of biopriming and nanoprimering on seed storage, plant vigour and wilt suppression of chickpea

Gitashree Das

Study was carried out to evaluate the *in vitro* effect of bioprimering and nanoprimering agents on storage life of chick pea and wilt suppression in pot condition. Result showed that bio-primering with *Trichoderma asperellum* for 6 hrs was found best in increasing storage life of chick pea seeds upto 9 months along with plant growth parameters. Nanoprimering agent like ZnO NP @ 100 ppm showed the highest seedling vigour index in all the storage periods (2, 4, 6 and 9 months) for all the primering time (1 hr, 2 hrs and 6 hrs) over the non primered seeds (Control). Result on POX activity showed that with increase of storage time, POX concentration was found increased. But the rate of increase is comparatively low when seeds were bio-primered with *T. asperellum* and nanoprimered with ZnO nanoparticles (NP). In case of alpha amylase activity, lowest concentration was recorded in control but seeds bio-primered with *T. asperellum* and nano-primered with ZnO NP showed highest concentration of alpha amylase activity. Highest protein content was recorded when *T. asperellum* was used as bio-primering agent. On the other hand, highest TSS was recorded in control with lowest in bio-primering with *T. asperellum* and nano-primered with ZnO NP. Out of the different primering time 6 hrs was found to be the best which results in highest physiological parameter of chick pea at 9 months of storage with positive effect on biochemical parameters. In pot experiment, seeds primered with *T. asperellum* alone and combination with *B. bassiana* results in the highest plant growth parameters as compared to the seeds treated with chemical fungicides and other biocontrol agents. Highest percent of seed germination was recorded (79.46%) with higher seed production, where seeds were primered with ZnO NP @ 100 ppm. The present study showed that bio-primering with *T. asperellum* and *B. bassiana* for 6 hrs can enhance the storage life of chickpea seeds upto 9 months with enhanced plant stand and growth parameters with positive effect of biochemical activity.

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Department : Plant Pathology

Major Advisor : Dr. Pranab Dutta

Assessment of microbial diversity of tomato plants and their relationship with bacterial wilt disease caused by *Ralstonia solanacearum*

Gurpreet Kaur Bhamra

The present study was made to assess the rhizospheric and endophytic microbial population of two different species of tomato plants, viz. *Solanum pimpinellifolium* (kon bilahi) and *Solanum lycopersicum* and development of a biocontrol strategy using these microbes for managing bacterial wilt (BW) disease caused by *Ralstonia solanacearum*. Population studies revealed the occurrence of greater rhizospheric and endophytic microbial diversity associated with *S. pimpinellifolium* compared to *S. lycopersicum*. *In-vitro* antagonistic and compatibility studies revealed that a few promising rhizospheric (RKB7) and endophytic (EKA4 and EKB6) microbes could effectively inhibit the bacterial wilt pathogen. Combination of these microbes (RKB7+EKA4+EKB6) showed highest inhibition of BW pathogen. Effective growth promoting characteristics such as production of ammonia, IAA, HCN, siderophore and zinc and phosphorus solubilisation were recorded for these microbes. Best rhizospheric and endophytic microbes and their combination along with an antibiotic check, streptomycin @ 200ppm was tested *in vivo* for their efficacy in managing BW of tomato by applying as root treatment, soil and spray application. Lowest disease incidence (31.11%) and highest yield (340.67 g/plant) was recorded in the plants treated with combination of (RKB7+EKA4+EKB6). Similarly, other yield attributing characters viz. plant height, root length, no. of leaves, no. of primary branches, shoot dry weight, root fresh weight, root dry weight, no. of fruits per plant was highest in the plants treated with the combination of (RKB7+EKA4+EKB6). The population assay studies of the antagonists and pathogen in the rhizospheric soil and living tissues of the plant revealed that the plants receiving RKB7+EKA4+EKB6 treatment had the lowest population recovery of the pathogen and correspondingly highest population recovery of the antagonists.

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Department : Plant Pathology

Major Advisor : Dr. P. K. Borah

Biological management of bacterial diseases of few ornamental crops in Assam

Hrishikesh Hazarika

Biological management of diseases and pests in ornamental crops by the use of antagonistic microorganisms can help in the reduction of the heavy use of chemical inputs involved in the ornamental industry. In the present study, 14 samples of diseased ornamental plants were collected from two districts of Assam, viz., Jorhat and Kamrup (R). Two bacterial diseases with the highest severity were selected for further study viz., leaf blight of anthurium and leaf spot of marigold. Two bacterial isolates B1 and B2 were isolated from anthurium and marigold, respectively, whereafter their pathogenicity was confirmed by following Koch's postulates. Morphological, cultural and extensive biochemical studies along with 16S rRNA sequencing exhibited the highest homology of the bacterial isolates B1 and B2 with the two pathogenic plant bacteria- *Xanthomonas axonopodis* pv. *dieffenbachiae* (*Xad*) and *Pseudomonas syringae* pv. *tagetis* (*Pst*), respectively. *In vitro* studies of bio-agent combinations of five bio-formulations were conducted against the pathogens of these two diseases. The highest inhibition (82.63 %) of *Xad* was recorded against combination of five bio-agents viz., *Trichoderma viride*, *Beauveria bassiana*, *Metarhizium anisopliae*, *Pseudomonas fluorescens* and *Bacillus thuringiensis*. However, in the case of *Pst*, a combination of three bio-agents viz., *T. harzianum*, *M. Anisopliae* and *P. fluorescens* was able to produce the highest inhibition (77.20 %). Based on the results of the *in vitro* experiment, three talc-based bioformulations and a liquid-based bio-formulation were selected for the management of bacterial leaf blight of anthurium and bacterial leaf spot of marigold. These were applied as seedling root treatment, soil application and foliar spray under pot conditions. Highest reduction (63.06 %) of bacterial leaf blight in anthurium and highest values for yield and yield attributing characters was recorded in treatment comprising of the bio-formulation BIOGREEN-5 (a combination of five bio-agents, *T. viride*, *B. bassiana*, *M. anisopliae*, *P. fluorescens* and *B. thuringiensis*). In case of marigold, highest reduction (70.13 %) of bacterial leaf spot and highest values for yield and yield attributing characters was recorded in treatment comprising of the bio-formulation BIO-TIME (a combination of three bio-agents viz., *T. harzianum*, *M. anisopliae* and *P. fluorescens*). In both cases, correlation studies revealed a negative correlation between disease incidence and yield of flowers.

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Department : Plant Pathology

Major Advisor : Dr. N. Mazumder

Exploring Actinomycetes and endophytes of rice ecosystem for management of Bacterial blight of rice

Kakumoni Saikia

The use of biocontrol agents and plant growth promoting rhizobacteria (PGPR) for the management of plant diseases are reported to be quite effective, economic and environmental friendly. Present study was made to explore endophytic microbes and rhizospheric *Streptomyces* of rice plant to develop biocontrol strategy for the management of bacterial blight (BB) of rice (*Oryza sativa* L.) caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo). *In-vitro* studies revealed that few promising endophytic microbes (EB8 and EF2) and rhizospheric *Streptomyces* (S2 and S15) could inhibit the BB pathogen effectively. Combination of microbes EB8+S2+S15 showed highest (58.71%) suppression of BB pathogen. Effective growth promoting characteristics such as production of ammonia, IAA, hydrogen cyanide, siderophore production, zinc, phosphorus and potassium solubilisation were recorded for these endophytic microbes and rhizospheric *Streptomyces*. Cell suspension of EB8, EF2, S2 and S15 were tested *in planta* for their efficacy in managing BB of rice by applying as seed treatment, root treatment, soil treatment and spray application. The BB incidence was significantly reduced when the plants were treated with all the effective microbes and their combinations. Lowest disease incidence was observed in plants treated with combination of EB8+S2+S15 (10.29 %). Similarly, the highest yield (50.06g per hill) and other yield attributing characters of rice plants was recorded with microbial treatment with EB8+S2+S15. Highest polyphenol content (2.52 %) of plant leaves was also assayed for the same treatment.

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Department : Plant Pathology

Major Advisor : Dr. L. C. Bora

Increasing the yield attributing character of different species of pleurotus through hybridization

Karishmi Riba

Interspecific hybridization studies were carried out between *Pleurotus sajor-caju*, *P. sapidus* and *P. flabellatus* for obtaining better quality strains. Out of 48 crosses, only five inter specific crosses of *P. sajor-caju* x *P. sapidus* and four inters specific crosses of *P. sajor-caju* x *P. flabellatus* were compatible. Inter specific crossing between *P. sapidus* and *P. flabellatus* failed to show any compatible reaction. The compatible crosses were tested for evaluating their growth characteristics on MEA media and the cross SC2S1 have shown significantly higher mycelial growth rate (8.89 cm) which was followed by the cross SC1S1 (8.66 cm). The obtained hybrid crosses have shown more dense and regular growth with floccose, cottony and aerial mycelial texture and also showed off-white, pure white and yellowish white in colony colour. Out of nine dikaryotic strains, the cross SC2S1 (*P. sajor-caju* x *P. sapidus*) was the best strain among all the obtained hybrid strains and its parental strains in terms of number of days required for spawn run (11.50 days), number of days required for pin head formation (15.50 days), days required for harvesting (18.50 days), total number of fruiting body (214.00), weight of the individual fruiting body (20.00 g), total yield per bag (0.95 kg) and biological efficiency (95.00%). Whereas in terms of stipe diameter, the cross SC2F2 (*P. sajor-caju* x *P. flabellatus*) has shown maximum stipe diameter (3.50 cm) as compared to other dikaryotic strain and its parental strain and among the dikaryotic strain the cross SC1S2 (*P. sajor-caju* x *P. sapidus*) have shown significantly higher stipe length (6.41 cm), which was also higher than their respected parents. Maximum cap size (6.73 cm) was recorded in the cross SC1F2 (*P. sajor-caju* x *P. flabellatus*) which was significantly higher than the other dikaryotic strain and its parental strain. During sensory evaluations, the product B (*P. sajor-caju* x *P. flabellatus*) was rated better than the global mean in overall acceptance (8.56), taste (8.90), flavour (7.90), colour (7.40) and appearance (8.13), with highest score in all the sensory parameters followed by Product A (*P. sajor-caju* x *P. sapidus*). While the lowest score was obtained by *P. sapidus* (product D) followed by *P. flabellatus* (product E) and *P. sajor-caju* (product C).

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Department : Plant Pathology

Major Advisor : Dr. D. K. Sarmah

Incidence, detection and molecular characterization of *Papaya ringspot virus* (PRSV)

Lonmow Gohain

The present investigation was conducted to know the incidence, detection and molecular characterisation of *Papaya ringspot virus* (PRSV) Assam. A roving survey was conducted between 2018-2020 growing seasons in four districts of Assam namely Jorhat, Tinsukia, Dibrugarh and Majuli. During the survey, PRSV infected plant exhibited symptoms like chlorosis, mosaic, puckering, vein clearing, filiform leaves, leaf distortion, shoestring, chlorotic ringspot on leaves, blistering and PRSV infected stem exhibited oily spots, fruits exhibited watersoaked lesions which later turns yellow-orange and develop prominent ringspot symptom, malformation of fruits. The disease incidence was observed in all the surveyed locations. Highest disease incidence was recorded in Jorhat district (78.47%) followed by Majuli (75.00%), Dibrugarh (61.66%) and Tinsukia (49.99%) district respectively. Representative samples were collected from the surveyed districts of Assam for further analysis.

PCR analysis was done to amplify the specific DNA fragments from PRSV infected and healthy samples. PCR results revealed that the PRSV specific primer pair yielded an amplicon size of 300 bp. The results revealed that a total of 44 samples out of 62, tested positive for PRSV. The highest incidence was observed in Jorhat (83.92%) followed by Majuli (80.00%), Dibrugarh (65.26%) and Tinsukia (51.40%). PCR product of PRSV infected sample of Jorhat district *viz.*, Jorhat isolate was sequenced and compared with the known PRSV isolates worldwide using nucleotide BLAST programme at National Centre for Bio Informatics (NCBI) and Mega X software. The sequence similarity of PRSV Jorhat isolate showed similarity of 89.00 per cent to 96.30 per cent. The phylogenetic analysis revealed that the PRSV Jorhat isolate is closely similar to that West Bengal isolate Accession no. LC462714.1.

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Department : Plant Pathology

Major Advisor : Dr. Phuleswar Nath

Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (*Pleurotus* spp.)

Lunisha Pegu

The present investigation, entitled “Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (*Pleurotus* spp.)” was undertaken to evaluate the incidence of contamination of the microflora on mushroom beds and amount of residue present in the Mushroom fruiting body harvested from the beds treated with formaldehyde and carbendazim. Different species of *Pleurotus* viz., *P. sajor-caju*, *P. sapidus* and a Commercial hybrid was used for the experiment. The different concentration levels of formaldehyde and carbendazim was at the rate of 500 ppm formaldehyde + 10 ppm carbendazim, 750 ppm formaldehyde + 20 ppm carbendazim, 1000 ppm formaldehyde + 30 ppm carbendazim, 1250 ppm formaldehyde + 40 ppm carbendazim, 1500 ppm formaldehyde + 50 ppm carbendazim, 1750 ppm formaldehyde + 60 ppm carbendazim, 1000 ppm formaldehyde, 40 ppm carbendazim were applied for managing the contaminants. The results revealed that the incidence of contamination was restricted on the combined application of chemicals in case of *Trichoderma* spp., but in case of *Coprinus* spp. the lowest chemical combination was ineffective against the organism. The investigation revealed that the residue of carbendazim present in mushroom fruiting body was least in the concentration at the rate of 40 ppm carbendazim in *P. sajor-caju*, 70 ppm carbendazim combined with 2000 ppm formaldehyde in *P. sapidus* and 70 ppm carbendazim combined with 2000 ppm formaldehyde and 40ppm carbendazim in Commercial hybrid. And the maximum residue was found in the concentration at the rate of 40 ppm carbendazim and highest at the rate of 30 ppm carbendazim combined with 1000 ppm formaldehyde in *P. sajorcaju* and *P. sapidus*, 40 ppm carbendazim combined with 1250 ppm formaldehyde in Commercial hybrid.

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Major Advisor : Dr. D. K. Sarmah

Comparative efficacy of different microbe based biopesticides on major pathogens

Mehjabin Rahman

The present investigation was conducted to evaluate the microbe-based biopesticides marketed in Assam. A total of twenty-eight biopesticides including those manufactured in Assam as well imported from different states were collected for the study. Quantitative and qualitative assessment revealed that of all the biopesticides only seven, viz., 'Panther TV', 'Taglife H', 'Taglife V', 'Trigen', 'Tag monas', 'Panther PF' and 'Pseudocon' showed the presence of indicated bioagents with population count of 2.0×10^5 , 1.0×10^5 , 1.0×10^5 , 3.0×10^7 , 1.3×10^9 , 6.5×10^8 , 8.0×10^8 cfu/ml or cfu/gm respectively. Three *Trichoderma viride*, one *Trichoderma harzianum* and three *Pseudomonas fluorescens* isolates from the seven biopesticides were further evaluated *in vitro* for their efficacy against eight major plant pathogens, viz., *Fusarium* spp, *Alternaria* spp, *Colletotrichum* spp, *Colletotrichum gloeosporoides*, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Xanthomonas* spp, *Ralstonia solanacearum*. *T. viride* isolated from 'Trigen' showed highest mycelial growth inhibition against three pathogens, viz., *C. gloeosporoides* (96.6%), *Colletotrichum* spp (98.2%) and *R. solani* (95.5%). *T. viride* of 'Panther TV' showed highest inhibition against *Alternaria* spp. (95.0%) and *Xanthomonas* spp. (91.5%). The highest inhibition of *Fusarium* spp was recorded by *T. viride* from 'Taglife V' with percentage inhibition of 97.5%. *T. harzianum* from 'Taglife H' and *P. fluorescens* from 'Tag monas' showed highest percentage inhibition against *S. rolfsii* (94%) and *R. solanacearum* (94%), respectively.

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Department : Plant Pathology

Major Advisor : Dr. P. K. Borah

Fungus nematode interaction and management of root rot of Patchouli

Moyurtrisna Rajkhowa

Patchouli (*Pogostemon cablin* (Blanco) Benth.), is an important aromatic plant belonging to Lamiaceae family and the crop is cultivated for its essential oil namely "Patchouli oil". The oil is extensively used in food industry as flavoring agent and perfumery industry as fixative. Besides this, it also possesses therapeutic properties, namely antidepressant, anti-inflammatory, antiseptic, aphrodisiac, astringent, carminative, diuretic, febrifuge, fungicide, insecticide, sedative and tonic. Root rot disease of patchouli is caused by *Fusarium solani* (Mart.) Sacc., a severe and wide spread disease in India. Plant parasitic nematode *Meloidogyne incognita* found to be associated with the disease and both fungus and nematode interaction causes huge damage to patchouli production in Assam as well as in India. The present study was made on interactive effect of *F. solani* and *M. incognita* in enhancing root rot of patchouli. The root rot incidence increased and the growth parameters of the crop decreased when plants were inoculated with both *F. solani* and *M. incognita*. Maximum percent disease incidence (83.33% and 88.88%) and minimum shoot length, leaf number, branch number, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight and root length were recorded when *M. incognita* (@1000 J₂/kg soil) was inoculated 15 days prior to *F. solani* (@10 g/kg soil) both in 2018 and 2019. In both the years of observation the number of galls (195.80 and 189.96), egg masses (50.58 and 47.50) per root and nematode population (477.55 and 456.22) in soil were recorded significantly higher when plants were inoculated with *M. incognita* (@1000 J₂/kg soil). In the study of efficacy of bio-formulation, MOC, fungicide and nematicide against root rot of patchouli in sterilized soil, there was no record of root rot incidence, nematode galls and egg masses per root, nematode population (J₂ stage) in soil, when plants were treated with *Biofor-pf-2* (@ 100 g/pot) + MOC (@ 50 g/pot) + furadan (@ 3g/pot) + root dip treatment with carbendazim (@ 0.1%). Similarly, these treatment also

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Major Advisor : Dr. D. K. Sarmah

significantly increased all growth parameters, viz., shoot length, leaf number, branch number, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight and root length in both the years. Combined application of *Biofor-pf-2*, MOC with carbendazim and furadan were found to be most effective in management of root rot of patchouli.

Identification and characterization of bacterial pathogens in fruits and plantation crops of Assam

Rajashree Chetia

Different pest and diseases cause significant production loss of the fruits and plantation crops leading to decline in the farm income of the potential growers. Although bacterial diseases cause severe loss to different fruits and plantation crops in different states of our country, however, not much work had been done on bacterial diseases of these crops in Assam including other North eastern states. Therefore, the present study was made to isolate, characterize and identify some of the bacterial pathogens associated with diseases of fruits and plantation crops in Assam. Suspected diseased samples from fruits and plantation crops viz., Banana (*Musa* spp.), Pomegranate (*Punica granatum*), Mango (*Mangiferae indicae*), Peach (*Prunus persica*), Plum (*Prunus domestica*), Pineapple (*Ananas comosus*), Tea (*Camellia sinensis*) and Coffee (*Coffea arabica*) were collected from Jorhat, Dibrugarh and Biswanath districts of Assam. On the basis of cultural, morphological, biochemical studies the eight bacterial isolates were identified as the genus *Ralstonia* (in Banana), *Xanthomonas* (in Pomegranate, Mango, Peach and Plum), *Erwinia* (in Pineapple), *Agrobacterium* (in Tea) and *Pseudomonas* (in Coffee). Further molecular characterization and the phylogenetic analysis was done to identify the different isolates i.e., isolate RC1 (Tea) as *Agrobacterium tumefaciens* (crown gall disease), isolate RC2 (Coffee) as *Pseudomonas syringae* (bacterial blight of coffee), isolate RC3 (Banana) as *Ralstonia solanacearum* (Moko/bacterial wilt of banana), isolate RC4 as *Xanthomonas citri* pv. *mangiferaeindicae* (bacterial canker in mango), isolate RC5 (Pomegranate) as *Xanthomonas axonopodis* pv. *punicae* (bacterial blight of pomegranate), isolates RC6 (Peach) and RC7 (Plum) as *Xanthomonas arboricola* pv. *pruni* (bacterial leaf spot of stone fruits) and the isolate RC8 as *Erwinia chrysanthemi* (bacterial collapse or heart rot in pineapple).

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Studies on occurrence and organic management of anthracnose of black pepper in nursery

Rajshree Verma

Black pepper (*Piper nigrum* L.) also called as “Black gold”, occupies a noteworthy position in spice industry. Black pepper anthracnose, caused by *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. is the widespread and emerging disease in Assam, effecting vines in the nursery as well as in field. Study on natural occurrence was done by correlating weather factors such as, rainfall, number of rainy days, relative humidity, bright sunshine hours and temperature with disease incidence in nursery. It was inferred that, rainfall, number of rainy days, relative humidity and minimum temperature have significant positive correlation, while maximum temperature and Bright sunshine hours have negative correlation with the disease incidence. The disease incidence was prevalent at high levels during the monsoon period (June 2020-August 2020). Another investigation was conducted in September 2020-December 2020 to find out the efficacy of selected bio-formulations viz. Bioveer, Biozium, Biomonas, Biogreen-5 and Copper oxychloride. Treatments were sprayed and per cent disease incidence was recorded at an interval of 15 days. None of the bio formulations was found superior than copper oxychloride, where lowest disease intensity (6.90%) was recorded. Among bio-formulations, Biogreen-5 (6.93%) found to be best, followed by Biomonas (13.13%), Biozium (14.96%) and Bioveer (15.41%) in contrast to control beds (17.73%). Bio-formulations promoted the growth of plants in terms of leaf area, shoot length, root length, root dry and fresh weight, thus showed dual roles as bio control agents and plant growth promoters. Biochemical analysis revealed the highest total chlorophyll and flavonoid content in plants treated with Biogreen-5 whereas, MDA (Malondialdehyde content) in leaf tissues was found to be highest in control and lowest in beds treated with Biogreen-5 and copper oxy chloride.

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Bioformulation of Organophosphate Degrading Bacteria and Plant Growth Promoting Microbes for pesticide degradation *vis-à-vis* management of bacterial wilt pathogen *R. solanacearum*

Shenaz Sultana Ahmed

The introduction and extensive application of xenobiotics, more precisely, the chemical pesticides have left diversified hazards on both, environment and human health via accumulation of pesticides residues. The most widely used group of pesticides belonging to the organophosphorous (OP), accounting to 38% of the global pesticide market. Continuous and excessive use of OP contaminated the agroecosystem due to accumulation of their residues. The microbial degradation of residues of OP is considered as an environmentally benign and economically preferred option. The present investigation was carried out to identify efficient OP degrading bacteria and evaluate their compatibility alongside PGPMs with emphasis on biocontrol potential against *Ralstonia solanacearum*, a soil borne pathogen responsible for wilt disease of brinjal, paving the way to development of a suitable delivery mechanism for pesticide biodegradation and biological management. A total of 10 bacterial isolates were isolated from pesticide contaminated agricultural soils having OP pesticide (chlorpyrifos) degrading potential. The most efficient ones displaying the potential growth up to 1000ppm of chlorpyrifos were studied for their growth analysis spectrophotometrically and establishing their degrading potential via High Performance Liquid Chromatography (HPLC). The selected isolates were subjected to morphological, biochemical and molecular characterization, which identified them as *Achromobacter marplatensis* (*Am*) and *Pseudomonas azotoformans* (*Pa*) having compatibility for *vice-versa*. This was accompanied with *in vitro* study further establishing the compatibility of efficient OPDBs with PGPMs such as *Pseudomonas fluorescens* (*Pf*) and *Trichoderma harzianum* (*Th*). These studies facilitated the development of bioformulation containing PGPMs and OPDBs, finally evaluated for its efficacy against bacterial wilt of brinjal and degradation of OP pesticide. The potted experiment showed that combination of *Pa*

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+ *Pf* + *Th* displaying lowest percent wilt incidence (PWI) of 5% coupled with significantly highest root biomass (5.35g/plant), shoot biomass (36.39g/plant), root length (27.88 cm/plant), shoot length (81.42 cm/plant), leaf number (83.20/plant), fruit number (5/plant), branches number (8.80/plant) and yield (1.42kg/plant) applied as seed treatment+seedling root dip+ soil application. The bioformulation consisting of *Am* + *Pa* + *Pf* + *Th* was observed most effective with 85% degradation of OP at 45 days after application followed by bioformulation of *Am* + *Pf* + *Th* with 70% degradation and *Pa* + *Pf* + *Th* with only 60% degradation. Such studies would be instrumental in providing novelty in bioremediation of pesticide contaminated soil as well as biological management of bacterial wilt disease with a single formulation.

Assay of volatile organic compounds in citrus greening disease infected Khasi mandarin (*Citrus reticulata*)

Subrata Bora

The Citrus greening disease (CGD) is a serious and widespread disease of citrus including Khasimandarin in the North-Eastern states of India. To know about the severity and incidence of CGD, a roving survey was conducted in four major citrus growing pockets of Assam viz., Tinsukia, Dibrugarh, Jorhat, Golaghat districts of UBVZ. Highest disease severity of sweet orange (100 per cent) and Khasi mandarin (41.26 per cent) was found in Golaghat district. Molecular assay confirmed the highest incidence of CGD in Golaghat and Jorhat district for sweet orange and Khasi mandarin, respectively. Quantitative analysis using Real-Time PCR revealed highest Relative Quantification (RQ) in sample from Tinsukia district, which was 403.5 fold more than control with Ct mean 20.2, while sample from Jorhat district showed lowest RQ which is 50.1 fold more than control with Ct mean 22.2. Sequence similarity and phylogenetic tree analysis showed 95-99 per cent similarity with other known isolates of *Candidatus Liberibacter asiaticus* from NCBI Genebank. Correlation and regression analysis of the vector (*Diaphorina citri*) population with the meteorological parameters was also carried out which revealed that the egg, nymph and adult stages could be predicted in relation to these parameters upto 86 per cent, 95 per cent and 88 percent, respectively. To know about the volatile organic compounds present in the samples, essential oil was extracted from both healthy and infected leaf samples. More than 100 volatiles were detected using GC-MS, out of which 28 prominent peaks of infected samples and 17 peaks of healthy samples were selected and identified. It was observed that 4 compounds (Linalool, Geranylgeraniol, 10-dodecyn-1-ol and γ -elemene) were present in both healthy and infected samples. Linalool was up-regulated, whereas, Geranylgeraniol, 10-dodecyn-1-ol and γ -elemene was down-regulated in infected samples as compared to healthy samples.

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Evaluation of antifungal activity of essential oil against grey mould of tomato caused by *Botrytis cinerea*

Sudharshan K. R.

Grey mould is one of the most destructive diseases of tomato in field and in greenhouse, causing considerable yield loss both in pre-harvest and post-harvest produce. The incitant fungus of grey mould of tomato was identified and confirmed as *Botrytis cinerea* based on cultural and morphological studies of the fungus. The present investigation was made to find an alternative to synthetic fungicides currently used in the control of devastating fungal pathogen *Botrytis cinerea*. Antifungal activities of essential oils obtained from Garlic clove, Artemisia leaves and Jatropha seeds in their seven different concentrations (25, 50, 75, 100, 250, 500 and 1000 ppm) were investigated against *B. cinerea*. Garlic essential oils at 75 ppm and above concentrations were found to be significantly superior resulting complete inhibition (100%) of the mycelial growth of the pathogen. Artemisia oil at 1000 ppm recorded the highest inhibition (62.65%) among the different concentrations tested over control. Among all three essential oils, jatropha oil was found to be least effective against *B. cinerea* resulting only 8.66 per cent inhibitory effect even at 1000 ppm. Based on the *in vitro* test, garlic essential oils at 75, 100 and 250 ppm were further tested in pot condition. Both protective and curative spray of garlic oil (250 ppm) was found highly effective in reducing the disease incidence and disease index, and in increasing the yield of tomato. However, better control was achieved when essential oil applications were made 24 hrs after pathogen inoculation (curative activity).

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Management of fruit rot of *Capsicum chinense* Jacq. with fungal bio-formulations

Sunita Dutta

Fruit rot of *Capsicum chinense* Jacq. is one of the most destructive diseases causing severe damage to the fruits in the field and considerable losses during storage, transit and marketing. The causal organism was identified as *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. The present investigation was aimed at managing the disease by using fungal bio-formulations. The efficacy of three fungal liquid bio-formulations viz., Org-Trichojal, Org-Beauverijal and Org-Metajal alone and in combination with each other and captan @ 0.2 % as fungicidal check were tested using poisoned food technique against the pathogen. Amongst the bio-formulation treatments, the effect of combination of the three bio-formulations was found to be significantly superior over rest of the treatments and was selected for further studies. Standardization of media for co-culture of three bio control agents viz., *Trichoderma harzianum*, *Beauveria bassiana* and *Metarhizium anisopliae* was carried out where the bio-control agents were allowed to grow in five different liquid media. The results showed that *Trichoderma harzianum* and *Beauveria bassiana* grew best in Malt Extract Broth media whereas the growth of *Metarhizium anisopliae* was best in Czapek Dox Broth media. Malt Extract Broth and Czapek Dox Broth media were further tested alone and in combination to standardize a co-culture media suitable for all the three bio-control agents. The results showed that the highest fresh weight, dry weight and surface coverage of the mycelial mat were recorded in Czapek Dox Broth media, when all the three bio-control agents were grown together. The effect of the bio-formulation on seed germination, root length, shoot length and vigour index of *C. chinense* were further evaluated and compared with captan 0.2% and control. Results revealed that seed treatment with fungicide captan @0.2% and seed treatment with bio-formulations resulted in higher germination, root length, shoot length and vigour index compared to untreated control. The bio-formulation was evaluated in pot condition for their effect in managing the disease and was compared with captan @ 0.2%. The seed treatment +foliar spray with captan @ 0.2% showed the lowest disease incidence (DI) and per cent

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disease index (PDI) which was followed by seed treatment + soil treatment + foliar spray with bio-formulation, the effects of which were statistically *at par*. Growth parameters, yield and yield attributing characters were also recorded where the combined application of bio-formulation as seed treatment, soil treatment and foliar spray showed the best results.

Management of seed-borne mycoflora of greengram through botanicals

Suveta T. S.

Studies were made to record the seed-borne mycoflora of greengram during storage and their management through botanicals. Greengram seeds stored after treatment with eight different botanicals and one fungicide (Carbendazim) showed the occurrence of twelve different fungal species belonging to seven genera, *Acremonium hansfordii*, *Aspergillus flavus*, *Aspergillus foetidus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus oryzae*, *Aspergillus sclerotiorum*, *Curvularia pallescens*, *Fusarium oxysporum*, *Penicillium oxalicum*, *Rhizopus oryzae* and *Syncephalastrum racemosum*. Six mycoflora viz., *A. hansfordii*, *A. foetidus*, *A. oryzae*, *A. sclerotiorum*, *P. oxalicum* and *S. racemosum* constitute new host record for Assam and India. Two methods viz., agar plate and blotter paper methods were employed for the isolation of mycoflora where nine fungal species were recorded in both the methods and the other three fungi were recorded only in blotter paper method. Among the botanicals tested, *Azadirachta indica* (44.50%), *Piper nigrum* (41.31%) and *Acorus calamus* (39.74%) were significantly effective in suppressing the storage mycoflora of greengram seeds. The greengram seeds were also infested by pulse beetle *Callosobruchus chinensis*. The seeds treated with *Acorus calamus* (77.41%), *Annona squamosa* (73.10%) and *Eucalyptus globulus* (72.69%) significantly inhibited the pulse beetle. After 9 months of storage, the germination percentage and seedling vigour of greengram were highest in the seeds treated with *Piper nigrum* (88.00% and 978.38 respectively) followed by *Azadirachta indica* (87.20% and 977.34 respectively) and *Acorus calamus* (86.80% and 953.93 respectively). The storage duration showed remarkable decrease in total soluble sugar, protein and phenol content of greengram seeds.

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Microbial consortia for management of citrus canker and regulation of defence related plant chemicals

Swagata Saikia

Citrus Canker caused by *Xanthomonas citri* pv. *citri* (Xcc) is one of the most destructive disease of citrus. The present study was aimed at managing the disease using three microbial bioformulations, viz., Biogreen (Combination of *Pseudomonas fluorescens*, *Bacillus thuringiensis*, *Beauveria bassiana*, *Metarhizium anisopliae* and *Trichoderma viride*), Bioveer (*Trichoderma viride*) and Biosona (*Beauveria bassiana*). The effective microbes present in the bioformulations were tested *in vitro* against the pathogen using dual culture assay. The results showed that *T. viride* was the most effective antagonist with 24.45% inhibition, followed by 10.01% for *P. fluorescens* and 4.45% for *M. anisopliae*. These effective bioformulations were further evaluated under field condition for their efficacy on suppression of citrus canker incidence, leaf miner infestation and increasing crop yield. Biogreen applied both in soil and as foliar spray proved to be the best treatment in suppression of canker incidence from 35.55% to 20.96%; leaf miner from 46.78% to 25.08%, and yield enhancement of fruit yield from 140 to 155 nos. Efficacy of isolated rhizospheric and phylloplane microbes were tested against *X.citri* pv. *citri*. Effective ones were identified as *Trichoderma harzianum*, *Trichoderma viride*, from rhizosphere and *Cladosporium cladosporoides*, *Geotrichum candidum* at molecular level. The induction of defence related bio chemicals in citrus plants in response to application of bioformulations was also assayed. The total phenol estimation was recorded highest in plants treated with Biogreen followed by Bioveer and Biosona. Defence related enzyme concentration was found to be highest for POX (5.250 µg/ml/min), followed by PAL (2.425µg/ml/min), PPO (1.770 µg/ml/min) and β 1,3 glucanase (1.005µg/ml/min) in plants treated with Biogreen under field condition.

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Economics of Sericulture with special reference to Jorhat district of Assam

Barsha Das

The study entitled, —Economics of Sericulture with reference to Jorhat District of Assam was conducted in order to a) see the present status of sericulture; b) assess the income and employment generation from cocoon and raw silk production and c) identify the problems encountered by the sericulture farmers in Assam. Both secondary and primary level information and data were used to accomplish the stated objective. Secondary data were collected from the published and unpublished sources of the Government and other agencies while primary data were collected directly from 100 purposively selected sample farmers with the help of a set of pre-tested schedule and questionnaire. Compound growth rates were computed on the basis of 10 years time series data and simple tabular analysis was carried out for all relevant parameters. The findings of the study clearly indicate that sericulture continues to be an important livelihood options for a sizeable number of families in different districts of Assam. The area under *eri* showed a positive growth of 12.40 per cent while *muga* and mulberry indicated a negative growth of (-) 2.30 and (-) 13.92 per cent, respectively. However, production of cocoon and silk yarns of all three types of variants registered a positive growth, though not significant, possibly due to increase in productivity. There were marked variation in area, production and productivity of *eri*, *muga* and mulberry across the districts of Assam during 2017-18 to 2019-20, as per the available statistics. In terms of cocoons, Kokrajhar was the highest *eri* and mulberry producing districts while Lakhimpur was the highest *muga* cocoon producing district in Assam. Kokrajhar was again leading in case of *eri* and *muga* silk yarn production whereas Lakhimpur emerged as the highest *muga* silk producing district. The study also reveals that all three variants of silk are grown by the sericulture farmers of Jorhat district. Per hectare per annum income generated by *eri* rearers was worked out at Rs. 1,66,838 while that of *muga* and mulberry were Rs. 96,577 and Rs. 55,946, respectively. As against this, the employment generation was found to be highest in *muga* with 1075 man days per hectare per annum followed by *eri* with 580 man days and mulberry with 336 man days per hectare per

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annum. Cost and return analysis further indicates that the benefit cost ratio of cocoon production from *eri*, *muga* and mulberry were computed at 2.25:1.00, 1.31:1.00 and 1.87:1.00, respectively, clearly indicating that sericulture continues to remain a profitable proposition over the years. Though the farmers involved in the process had long years (10 to 20 years) of working experience, they had to face a number of impediments, for which possibly the venture could not make much headway till date. The problems identified were mainly related to leaf production, cocoon production and of marketing. To be specific, occurrence of diseases, unavailability of rearing equipments and recurrent pest attack were some issues of major concern, as reported by the sericulture farmers. Besides, absence of proper market and market intelligence, exploitation by the middlemen and price fluctuation were identified as grievous problems encountered by the farmers. Redressal of the problems under reference is a must to promote sericulture in this part of the country, which can very well be taken care of by strategic planning on the part of Government and its implementation in true sense of the term. Looking at the prospects of the vocation, focused intervention may be recommended in the form of appropriate technological backstopping for disease and pest control, input support, credit provisioning on easy terms and well thought out capacity building programme. Equally important will be to develop an efficient market mechanism to channelize the products so as to ensure a fair price for the farmers. Aggressive promotional campaign and simultaneously, sensitizing and supporting the farmers by the line Departments and other agencies can bring in desirable changes in the lives and livelihoods of sericulture farmers of Assam.

A study on the ericulture based livelihood opportunities of the Kachari tribe in Jorhat district of Assam

Chowcin Borsali Buragohain

Livelihood opportunities refer to adequate and sustainable access to income and resources to meet the basic needs of life.

The present study was conducted among the eri rearers of Kachari tribe in the Jorhat district of Assam with a sample size of 120 respondents. A multistage purposive cum random sampling design was followed for the selection of the respondents. The data were collected by personal interview method with the help of a pre-tested structured research schedule measuring ten different independent variables. 'Eri-culture based livelihood opportunities of the Kachari tribe in Jorhat district of Assam' was selected as the dependent variable. Statistical techniques like frequency, percentage, mean, standard deviation, chi-square test, Spearman's correlation coefficient were used for analyzing data, drawing inferences and testing hypotheses.

The recent study revealed that 51.67 per cent respondents belonged to the age group 36-50 years having educational qualification mainly up to primary school level (38.33%). Almost 63.33 per cent had medium size of family. Majority of them had *kutchra* type houses (65.00%). The eri rearers were found to be mainly small (40.00%) category of land holdings with moderate risk bearing ability (75.00%) and decision making ability (62.50%). Most (65.84%) of the eri rearers had an annual income in the range 1,00,001 and above.

Total forty nine numbers of ericulture based livelihood options were found among the respondents. Majority (25.83%) of the eri rearers followed "ericulture + paddy + vegetable" as their livelihood option followed by 6.66 per cent involved in "ericulture + paddy + poultry + arecanut", 5.83 per cent followed "ericulture + paddy+ dairy+ poultry". Different types of respondents adopted different types of livelihood options along with eri culture to increase their income.

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The study disclosed that 48.33 per cent respondents attended training on different aspects of eri culture practices. Majority of the male eri rearers needed training on nursery preparation (66.67%), preparation of hank (66.67%) and marketing (41.67%) whereas female eri rearers needed high training on brushing of larvae (51.67%), harvesting of cocoons (51.67%), spinning of silk (48.33%) and preparation of hank (66.67%). A positive and significant relationship was found between ericulture based livelihood opportunities and type of house, family size and annual income.

The findings of the study have revealed considerable scope for the livelihood of the Kachari eri rearers which may be drawn as a relevant policy decision to facilitate to upscale and secure their livelihoods through adequate extension and training support.

Study on constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam

Dipankar Hatibaruah

Sericulture has been practiced traditionally in Jorhat district and a large portion of rural people earn their livelihood from the sericulture sector. The present study entitled “Constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam” is aimed to identify the problems faced by farmers in adoption of improved technology for enhancement of production & productivity at farmers level in the district. The study was conducted with a sample size of 120 respondents from the Jorhat and Majuli sub divisions of undivided Jorhat district of Assam. A multistage purposive cum random sampling design was followed for selection of the respondents. The data collected by personal interview from period of September, 2019 to February, 2020 with the help of a pre-tested structured research schedule on dependent, independent and descriptive variables were subjected to statistical analysis of frequency, percentage, mean, standard deviation, Karl Pearson’s co-efficient of correlation and chi-square test for interpretation and testing hypothesis.

The study revealed that majority of the sericulture farmers of the study area belonged to middle age group (60.00%), high school passed (34.17%) and belonged to Other Backward Class (OBC) caste (30.84%). Most of the respondents have small size family (60.83%) and exclusively of farming category (45.83%) as their main occupation. Majority of the respondents are marginal farmers (61.67%) having operational land holding of below 1 hectare. The annual income of most of the respondents (37.50%) were in the range of Rs.35001 to Rs.75000/-. In respect of adoption of sericulture practices, it was observed that 50% of the respondents involved in eri culture, 25% in muga culture and 25% in mulberry culture. Majority of the respondents have medium level of source of extension contact (67.50%), medium level of risk bearing ability (78.33%) and medium level of decision making ability (79.17%)

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and 42.50 % of the farmers got training exposure to sericulture practices. In respect of adoption of improved sericulture technologies, it was found that the adoption level was medium for majority of the respondents (76.67%) in eri culture, (66.67%) in muga culture and (76.67%) in mulberry culture. The correlation study between adoption behaviour of the sericulture farmers with the socio- economic profile of the rearers revealed that annual family income have positively and significantly related with the adoption behaviour of eri silkworm rearers and from the results of chi square test the variable family occupation are associated with the adoption behaviour of eri rearers.. In 6 case of muga culture the relationship between the adoption behaviour of muga rearers with socio-economic profile of the rearers was non significant. In mulberry culture, education and decision making ability have negative and significant relations with the adoption behaviour of the mulberry rearers. Lack of knowledge about training and pruning of host plants in adoption of host plant cultivation technology, improper maintenance of temperature and humidity, lack of regular technical guidance , non availability of protected storage house in villages, non availability of suitable and big market nearby villages, lack of improved reeling and spinning machine, lack of awareness on improved technology adoption, high cost of rearing and other sericulture production technologies and lack of timely guidance are the major constraints faced by the farmers of Jorhat district for adoption of improved sericulture technologies.

The study thus revealed that because of non awareness of improved sericulture technologies as well as poor living condition the adoption level of sericulture technologies of among the farmers of Jorhat district is very limited and there is still a gap in dissemination and adaptation of improved sericultural technologies in pre and post cocoon sector among the farmers for growth and development of sericulture in acreage of food plants, rearing of silkworm and production and productivity of cocoon and silk. Hence, in order to extend the adoption rate in these areas action plan may be taken by the government agencies and extension personnel by adapting the progressive rearers and trained them in the line of improved sericulture technologies to improve the adoption level of new production technologies in sericulture sector.

Effect of zinc chloride (ZnCl₂) supplementation on larval growth and economic cocoon characters of eri silkworm, *Samia ricini* Boisd. (Lepidoptera: Saturniidae)

Nanita Bora

An investigation on effect of zinc chloride (ZnCl₂) supplementation on nutritional efficacy, larval growth and economic cocoon characters of eri silkworm, *Samia ricini* Boisd. was carried out during spring and autumn season in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2019-20.

The study revealed that fortification of castor leaves with zinc chloride showed a significant impact on nutritional efficacy, larval growth and cocoon parameters of eri silkworm *Samia ricini* Boisd. Zinc chloride ingestion cause significant increase in ingesta, digesta of eri silkworm and by decreasing the excreta liberation and consumption index it accelerates the approximate digestibility (AD), efficiency conversion of ingesta (ECI) and efficiency conversion of digesta (ECD) to body biomass of the larvae. Zinc chloride supplementation at lower concentration (2µg/ml) found to have more pronounced effect followed by 5µg/ml, 10µg/ml and 15µg/ml concentrations than control. The larvae reared on 2µg/ml zinc chloride fortified castor leaves manifested better in respect of full grown and mature larval weight, pupal weight, weight of silk gland, silk gland tissue somatic index (SGT_{SI}), cocoon weight, shell weight, shell ratio, effective rate of rearing (ERR), larval and pupal duration. The larvae reared in spring season exhibited better in respect of larval growth and cocoon characters with higher rate of approximate digestibility (AD), efficiency of conversion of ingesta (ECI) and digesta (ECD) to body biomass of the larvae, while in autumn season the larval and pupal duration were shorter with lower rate of ingesta, digesta, excreta and consumption index.

Thus from the present investigation it could be inferred that fortification of castor leaves with zinc chloride solution is effective for improvement of larval growth

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and cocoon characters of eri silkworm. Lower concentration (2 μ g/ml) of zinc chloride is more effective and exert promontory role than other doses for improving larval growth and cocoon parameters of eri silkworm, *Samia ricini* Biosd. Spring was found to be more suitable season than autumn rearing for rearing of eri silkworm in terms of nutritional efficacy, larval growth and cocoon characters of the silkworm except the larval and pupal duration which were found to be shorter in autumn season.

A study on livelihood opportunities of muga silkworm rearers of Sivasagar district of Assam

Nawaab Tasmin Hussain

The study entitled “A study on livelihood opportunities of muga silkworm rearers of Sivasagar district of Assam” was carried out in Sivasagar district. The data were collected personally by the investigator through interview method. Simple frequencies, percentage, mean and standard deviation, along with regression were used for analysis.

The study revealed that majority (53.33%) of the muga rearers belonged to the Middle-aged group of 36-55 years of age with 68.33 per cent having middle school level of education with all of them belonging to the caste category of Other Backward Class (OBC). It was evident from the study that majority of the muga rearers had small sized family (52.50%) and were marginal rearers (95%). 91.66% of the muga rearers had medium income category. Only 11.66% of the muga rearers were in contact with extension personnels with more than two third (73.33%) of the them having not attended any training on muga rearing. A total of 69 respondents were involved only in sericulture alone followed by 22 of them who practiced agriculture along with sericulture. Moreover they have taken up some other options of earning livelihood as petty business, dairy, goatery, with few of them into some services as driving. It was also seen that two factors namely Operational Land Holding and Higher secondary level of education of the muga rearer determined to a greater extent his livelihood opportunities.

In the course of the study, various independent factors as age, education, caste, etc were studied and its effect on livelihood opportunities of an individual was analyzed statistically to find out the most important factors that significantly affected the livelihood options opted by the respondents of the Sivasagar district. Hence this study would be a helpful reference in the future to be used for analyzing various implications regarding the choice of livelihood for a muga farmer. It would further instigate the Govt. and concerned authorities to upscale the strategies needed for the expansion of muga culture and attract less problems.

Abstract of M.Sc. Thesis

Department : Sericulture

Major Advisor : Dr. L. C. Dutta

Topic: Sucking pests and their natural enemies in mulberry ecosystem in Jorhat district of Assam

Nilutpal Saikia

Study on sucking pests and their natural enemies in mulberry ecosystem were carried out during 2018-2019 at Regional Sericulture Research Station, Central Silk Board, Jamuguri, Jorhat, Govt. Sericulture Farm, Titabar and Assam Agricultural University, Jorhat. Five species of sucking pests were prevalent in different mulberry growing localities of Jorhat district of Assam. *Paracoccus marginatus* was dominant among the five species of sucking pests, viz., *Maconellicoccus hirsutus*, *Pseudodendothrips mori*, *Paracoccus marginatus*, *Aleurodicus dispersus*, *Clovia puncta*. Three species of coccinellid predators viz., *Coccinella septempunctata*, *Coccinella transversalis* and *Micraspis discolor*, one species of lepidopteran predator viz., *Spalgis epius* were found to associated with *Paracoccus marginatus*. Among these natural enemies, *Spalgis epius* was relatively most abundant. The appearance and peak activity of the coccinellids predator *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolor* and one lepidopteran predator *Spalgis epius* was synchronized with that of *Paracoccus marginatus*. These four predators showed a strong significant positive association with the papaya mealybug population. Rainy days, evaporative rate, wind speed and bright sunshine hour showed significant negative correlation while temperature (maximum and minimum), relative humidity (morning and evening) and rainfall showed a significant positive correlation with papaya mealybug during 2018-2019. The multiple regression analysis revealed that the combined effect of abiotic and biotic factors accounted for 98-99 per cent variation in the *Paracoccus marginatus* population during both the crop seasons.

During 2018-2019, numbers of rainy days showed a significant negative relationship with the adult and larval populations of *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolor* and *Spalgis epius*. The multiple regression analysis was computed to get the information on the interaction of weather and *Paracoccus marginatus* population on the reproduction and abundance of coccinellid and lepidopteran predators.

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Department : Sericulture

Major Advisor : Dr. Roshmi Borah Dutta

Studied on the biology of lepidopteran predator, *Spalgis epius* revealed that the larval period, pupal period and adult longevity for male and female were 10.07, 3.15 and 4.43 days, respectively.

**Effect of botanical and chemical bed disinfectants
on larval growth and economic cocoon characters
of mulberry silkworm, *Bombyx mori* L.
(Lepidoptera: Bombycidae) rearing**

Pompi Kowar

An investigation on effect of botanical and chemical bed disinfectants on larval growth and economic cocoon characters of mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) rearing was conducted in the rearing room of Department of Sericulture, College of Agriculture, AAU, Jorhat during the period of 2019-20.

The present study revealed that application of bed disinfectants had positive influence on the larval growth and economic cocoon characters of mulberry silkworm race, (CSR6 × CSR26) × (CSR2 × CSR27). Bed disinfectant Ankush manifested better result in regards of disease incidence, larval parameters, cocoon yield and cocoon parameters as compared to other two bed disinfectants Sericillin, Turmeric rhizome powder and their combinations. Performance of Sericillin was next to Ankush. However, combination of bed disinfectants like Ankush + Sericillin, Ankush + Turmeric rhizome powder and Sericillin + Turmeric rhizome powder showed better results compared to Turmeric rhizome powder alone. All the bed disinfectants showed better results compared to untreated larvae. Considering the seasons, performance was better in the late spring season.

Thus, from the present investigation it can be inferred that double hybrid mulberry silkworm race, (CSR6 × CSR26) × (CSR2 × CSR27) reared on S1635 variety treated with bed disinfectants play a major role in reducing the silkworm diseases as well as improving the larval growth and productivity of cocoon crop.

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Department : Sericulture

Major Advisor : Dr. Monimala Saikia

Effect of fortification of host leaves with silver nanoparticles (AgNPs) on larval growth and economic characters of eri silkworm (*Samia ricini* Boisd.)

Pranab Boro

An investigation on larval growth and economic characters of eri silkworm (*Samia ricini* Boisd.) fed with castor and borpat fortified with four concentrations (25%, 50%, 75%, 100%) of AgNPs was carried out in the Department of Sericulture, Assam Agricultural University, Jorhat in spring and autumn season of 2018-19.

The investigation revealed that the fortification of host leaves with 25% concentration of AgNPs resulted maximum percentage of increment in respect of larval growth and economic characters such as full grown larval weight, mature larval weight, silk gland weight, cocoon weight, pupal and shell weight and shell ratio over control batch of larvae of eri silkworm in both the season irrespective of food plants. With shorter larval duration and higher cocoon yield (effective rate of rearing) the larvae of control batch exhibited better than AgNPs treated batches. Castor leaves fed to the silkworms, exhibited better in respect of larval growth and economic characters as compared to borpat leaves irrespective of seasons. The larvae of eri silkworm reared on spring season performed better in respect of larval growth and cocoon parameters except larval duration and shell ratio which were found to be better in autumn season.

Thus from the present investigation it can be concluded that the fortification of host leaves with lower concentration (25%) of AgNPs is effective at certain level for improvement of larval growth and economic characters of eri silkworm. Whereas the higher concentrations (50%, 75%, 100%) of AgNPs did not had any positive impact on larval growth and economic characters of silkworms. Castor is better than borpat considering the larval growth and economic characters of the silkworm. The larvae performed better in spring than autumn season in respect of larval growth and cocoon characters of the silkworm.

Abstract of M.Sc. Thesis

Department : Sericulture

Major Advisor : Dr. L. C. Dutta

A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam

Pulak Rabha

The study entitled “A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam” was carried out at Assam Agricultural University, Jorhat during the year 2019-20 with a sample of 120 sericulture farmers in Kamrup district of Assam. Respondents were selected randomly from 3 (three) purposively selected blocks. Statistical techniques like frequency, percentage, mean, standard deviation, Karl Pearson's co-efficient of correlation and multiple regression analysis were used for analyzing data, drawing inferences and testing hypotheses. The study revealed that majority (43.33%) of the respondents belonged to middle age group and 36.67 per cent were illiterate. Most of the farmers (45.83%) belonged to small size family and 69.17 per cent had pucca house. In case of operational land holding, majority (34.17%) of the respondents possessed small size of land holding. Most of the farmers (33.95%) had annual income of ranging from Rs. 75,000-1,00,001. It was found that majority (75.00%) of the farmers had medium level of extension contact, moderate level of risk bearing ability (61.67%) and moderate level of decision making ability (59.17%). As regards to training exposure, only 23.33 per cent of the respondents had received training. It was observed that different types of livelihood options were adopted by the farmers along with sericulture to increase their income. Most of the sericulture farmers (35.00%) practiced “Sericulture + paddy + plantation crops” followed by “Sericulture + paddy + piggyery” (15.83%) and “Sericulture + paddy + fruits” (12.50%) as their sericulture based livelihood options. The education, family size, house type, operational land holding and decision making ability have significant relationship on livelihood options practiced by the sericulture farmers. It was observed that majority (37.20%) of the respondent's opted ‘Insurance scheme’ as a measure for potentiality and ‘Integrated farming’ (20.83%) as a measure for profitability of sericulture for sustainable livelihood generation in Kamrup district. Majority (60.83%) of the farmers’ opted ‘Cocoon + silk yarn’ as their most profitable sericulture based perceptions. The present study thus

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revealed that sericulture has immense potential in generating livelihood for every section of society in Kamrup district of Assam irrespective of gender and caste. There is a significant scope for the livelihood opportunities from sericulture in the district which may be drawn as an appropriate policy decision to facilitate, upscale and secure their livelihood. Though sericulture has been remained always as a subsidiary cottage industry it would be a good option for livelihood opportunity in the district as well as in the state.

Seasonal variation on larval, cocoon and yarn parameters of eri silkworm (*Samia ricini* Boisduval) reared on *Ailanthus* species

Raktim Ranjan Borah

An experiment was undertaken to evaluate the impact of different seasons on larval growth, cocoon and yarn parameters of eri silkworm *Samia ricini* Boisduval reared on *Ailanthus* species viz., borpat (*Ailanthus grandis*) and borkesseru (*Ailanthus excelsa*) in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2018-19.

The present investigation revealed that seasons had significant effect on all larval, cocoon and yarn parameters except twist per inch. Host plants had also significant effect in all the parameters except yarn size, elongation percentage and twist per inch. Among the different seasons, the highest full grown larval weight and matured larval weight was observed during autumn season while the shorter larval duration was found in late summer season. Between the host plants, borpat leaves registered significantly shorter larval duration with higher full grown and matured larval weight compared to borkesseru leaves. The highest cocoon yield percentage was found in the autumn season followed by spring, early summer and late summer season. Between the two *Ailanthus* species, significantly higher cocoon yield percentage was found on borpat leaves. For all the cocoon parameters viz., cocoon weight, shell weight, pupal weight and shell ratio percentage autumn season and borpat leaves exhibited better performance while early summer season and borkesseru leaves showed the lowest values. However, lowest value in regards of shell ratio percentage was recorded in spring season. Yarn size was registered highest in the autumn season whereas the lowest yarn size was registered in the early summer season. The highest breaking load and tenacity of the eri silk yarn was observed in the spring season whereas the lowest was recorded in the autumn and spring season respectively. Maximum elongation percentage of eri silk yarn was found in early summer and minimum was observed in autumn season.

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It can be concluded that late summer season and borpat leaves performed better in regards of larval duration. But, larval weight and cocoon parameters were found better in autumn season and in borpat leaves. Varied effect of season and host plant was noticed in regards of yarn characters. Thus, it can be inferred that both the plants are suitable for rearing eri silkworm in different seasons with slight variation in performance.

Study on regional variations on cocoon and yarn characteristics of muga silkworm during commercial seasons

Shilpa Saikia

An experiment was carried out in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2018-2020 to assess regional and seasonal variations on cocoon and yarn characteristics of muga silkworm.

Cocoons were procured from private rearers of Jorhat, Kamrup and Lakhimpur districts of Assam in spring and autumn season. The three muga growing regions and two commercial seasons had significant impact on cocoon and fibre parameters such as cocoon size, cocoon weight, pupal weight, shell weight, shell ratio, length, weight and size of silk filament. Cocoons of Kamrup exhibited better result in respect of cocoon and fibre characteristics as compared to Lakhimpur and Jorhat district. Cocoons of autumn season registered significantly higher values than spring season. Season and region had no significant effect on non-breakable filament length. Variation was observed in these three regions and two commercial seasons in terms of reelability percentage, raw silk recovery percentage and silk yield. Kamrup district showed better reeling performance with more reelability percentage, raw silk recovery percentage and silk yield compared to other two regions in both the seasons. The reelability performance of autumn season cocoons was better than that of spring season cocoons. Denier or size of silk filament and silk yarn, breaking load and elongation percentage of muga silk were recorded significantly higher in Kamrup followed by Lakhimpur and lowest was observed in Jorhat district. Considering the seasons, autumn season exhibited better performance in these parameters except elongation percentage which was recorded highest in spring season. However, significantly higher tenacity of silk yarn was found in Jorhat district compared to other two regions. Interaction effect due to region and season was observed to be non-significant in all aspects except single cocoon filament size.

Thus, it could be inferred that significant differences were noticed in respect of all the parameters in all the three regions in spring and autumn season. Kamrup was

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found to be better in terms of cocoon, fibre and yarn parameters except the tenacity which was higher in Jorhat district. Autumn season exhibited better performance in respect of all the parameters whereas elongation percentage was maximum in spring season.

Nutritional ability and economic characters of eri silkworm (*Samia ricini* Donovan) eco-races on different food plants

Shilpi Devi Borah

An investigation on nutrition, larval growth and cocoon characters of eri silkworm (*Samia ricini* Donovan) eco-races viz., borduar and kokrajhar on two food plants viz., castor and borpat was carried out in the Department of Sericulture, Assam Agricultural University, Jorhat during spring and autumn season of 2018-19. The investigation revealed that all the nutritional parameters except reference ratio (RR) of eri silkworm larvae increased progressively from third instar to fifth instar with the advancement of larval age irrespective of food plant, season and race. The rate of food consumption and consumption index was more in kokrajhar than borduar eco-race reared on borpat leaves. Food digestion was more in borduar than kokrajhar eco-race reared on borpat leaves. Food consumption, consumption index and digestion were better during spring season than in autumn season. Spring reared, borduar eco-race exhibited better growth rate with higher rate of efficiency of conversion of ingested and digested food than kokrajhar eco-race on castor leaves though the food consumption was lower in borduar eco-race on castor leaves. Approximate digestibility was found to be higher in spring season on borduar eco-race as the food digestion was more in spring season especially on borpat leaves. Reference ratio was also recorded higher during spring season on borduar eco-race but on castor leaves. Kokrajhar eco-race recorded lower larval duration during autumn season when fed with castor leaves. Larvae of borduar eco-race reared in spring season fed with castor leaves performed better results with higher full grown larval weight, mature larval weight and effective rate of rearing (ERR) when fed with castor leaves. Economic parameters such as cocoon weight, pupal weight were recorded higher in kokrajhar eco-race and shell weight, shell ratio (%) and rate of cocooning (%) were recorded highest in borduar eco-race during spring season when fed with castor leaves. Thus, from the present investigation, it can be concluded that castor is the most suited food plant for rearing of eri silkworm and production of

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good quality cocoons in this region. Borduar eco-race is more suitable, as the performance of nutritional indices, full grown larval weight, mature larval weight, effective rate of rearing (ERR), rate of cocooning (%), shell weight and shell ratio (%) was observed much higher than kokrajhar eco-race but the cocoon weight and pupal weight were recorded highest on kokrajhar ecorace. Between spring and autumn seasons, spring season is more preferable as leaf quality is much better than autumn, because of pre monsoon flush.

Phenology and cocoon characters of Eri silkworm (*Samia ricini*) as affected by temperature and humidity under Jorhat conditions

Sudipta Kumar Das

An investigation on “Phenology and cocoon characters of Eri silkworm (*Samia ricini*) as affected by temperature and humidity under Jorhat conditions” was carried out in the Department of Sericulture, Assam Agricultural University, Jorhat during summer, autumn, early spring and late spring seasons in the year 2018-19.

The results revealed that the occurrence of the phenophases and cocoon characters varied significantly in different rearing seasons. The phenophases *viz.* egg laying period, incubation period, egg hatching duration, larval duration (instar-wise and total), instar-wise moulting duration and cocoon spinning period were found to be longest during early spring season followed by late spring and autumn season. The shortest duration of the phenophases was observed during summer season. Cocoon characters *viz.* cocoon weight and cocoon shell weight were highest in early spring season followed by late spring and autumn season while lowest values were observed during the summer season. The egg hatching percentage and instar-wise larval weights were found to be highest during early spring season followed by late spring and autumn season while the summer season registered for the lowest values. Larval accumulated growing degree days were observed to be highest during early spring followed by summer, autumn and late spring. Most of the phenophases and cocoon characters were negatively correlated with temperature and relative humidity. The accumulated growing degree days during larval period had a positive effect on the cocoon yield parameters. Predictive models for growth and cocoon yield of eri silkworm developed which indicated the most significant weather factor (temperature and relative humidity) responsible for growth and cocoon yield.

Thus, from the present investigation, it can be inferred that the occurrence of different phenophases and cocoon characters of eri silkworm were largely regulated by the environmental temperature and relative humidity during the seasons. The best season

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for rearing was found to be early spring (March-April) considering the larval growth parameters and cocoon yield of eri silkworm. Predictive models developed on the basis of temperature, relative humidity and accumulated growing degree days can be used to estimate the growth and cocoon yield of eri silkworm in different rearing seasons. The findings of the study will help to develop agro-advisory bulletin for various seasons which will help the farmers to adapt eri culture in a proper and efficient way for quantitative and qualitative production of eri cocoon and silk.

Nutrient availability in soil and yield of tomato as influenced by manure sources and rice stubble management

Anupama Das

A field experiment was conducted in ICR farm, AAU, Jorhat from December, 2019 to April, 2020 to evaluate nutrient availability in soil and yield of tomato after winter rice (variety - Ranjit) as influenced by different organic manure sources with and without rice stubble incorporation. The experiment was conducted in a split plot design comprising individual plot size of 2.5 m x 2.1 m with four replications. Rice stubble was either removed or incorporated in the main plot, and each main plot was divided into five sub plots fertilized with different composts or recommended fertilizer dose (RDF). The nutrient management treatments comprised of unfertilized plot, RDF (farmyard manure 2 t ha⁻¹ one week before planting followed by 75:60:60 N:P₂O₅:K₂O kg ha⁻¹ applied at planting, with N in two equal splits), farmyard manure 2 t ha⁻¹ (FYM), poultry manure 2 t ha⁻¹ (PM) and vermicompost 2 t ha⁻¹ (VC). The composts were applied in two equal splits at planting and at 30 days after planting (DAP). The soil pH was significantly higher up to 56 DAP in poultry manure fertilized plots where soil exchange acidity was lowest among all the treatments. The NH₄-N and NO₃-N contents, and P and K availability in soil was highest with application of RDF, while the lowest values were observed in the unfertilized plot. The NH₄-N, NO₃-N and available P contents of soil significantly increased in VC and PM applied plots compared to FYM or unfertilized plots and were at par with RDF. However, the available K content of soil was significantly higher in RDF at 28 and 56 DAP compared to all other treatments. The exchangeable cations and soil enzyme activity at 28 DAP and 56 DAP showed significant increase in RDF, PM and VC. The highest tomato fruit yield was observed with RDF, which differed significantly over all the treatments, and was followed by PM and VC fertilized treatments. Incorporation of rice stubbles had a positive effect on nitrogen mineralization, availability of phosphorous, potassium, exchangeable cations, soil enzyme activity and yield of tomato, but the interaction with nutrient management was not significant.

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Department : Soil Science

Major Advisor : Dr. Nilay Borah

Effect of Nutrient Management on Phosphorus Transformation and its influence on yield of Bell Pepper (*Capsicum annum*) under protected cultivation

Arindam Kumar Dutta

The present investigation entitled "Effect of Nutrient Management on Phosphorus transformation and its influence on yield of Bell pepper (*Capsicum annum*) under protected cultivation was carried out in the Horticulture Farm of AAU, Jorhat- 13. The experiment was conducted maintaining Split-split design having three(3) factors(Nitrogen, Phosphorus and Potassium) and each having three (3) levels(N-80,100,120 P-40,60,80 K-40,60,80) accounting for a total treatment combination of twenty seven (27) having replicated thrice(3). Small portion of soils was collected from different treatments under protected cultivation at a depth of 0-15 cm. The soil samples were collected at two different stages of the crop viz., flowering and fruiting stages i.e 45 and 115 DAP respectively and was analyzed for different physico-chemical properties. The initial study revealed that the texture was silty loam with a bulk density of 1.176g cm⁻³ and the particle density 1.18 Mg m⁻³. Organic C (%) was found in the high range (0.94%) with a CEC of 13.7 cmol(p+) kg⁻¹ of soil. The soil was acidic with a pH value of 5.32. Soil was having initial NPK content i.e 535.66 kg ha⁻¹, 36.25 kg ha⁻¹ and 68.56 kg ha⁻¹ respectively.

The present study revealed that the single factor effect of treatment has a significant effect on soil chemical properties, plant nutrient partitioning and various forms of P, except for Residual P which was found to be non-significant. The interaction effect of NP found to be significant with the physico-chemical parameters. The NP interaction with plant nutrient partitioning found that the highest values (3.383%, 1.365%N and 0.385,0.366%P) of leaf and shoot nitrogen and phosphorus content are obtained in the higher dose of nutrients (N₁₂₀P₈₀) and highest value in leaf

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Major Advisor : Dr. Danish Tamuly

and shoot K(4.996% and 4.126%) are found in low to medium dose of fertilizer in the flowering stage but in the fruiting stage, higher values are obtained in the medium dose of NP levels . NP interaction with different forms of P is also found to be significant and the highest values are obtained in medium to high dose of fertilizer (N-100,120 and P-60,80). Available P and exchangeable Ca and Mg were found to be high in the low level of NK interaction. The leaf and shoot N and K content tends to increase with the increase level of NK fertilizers. Various forms of P were found to be high in the low to medium level of NK interaction (N-80,100 and K-40,60). For PK interaction, Available N was found to be highest (766.5 kg ha⁻¹) in the low to medium dose of PK and available P₂O₅ & K₂O were found to be high in higher level of treatments (P80K80). CEC was found to be non-significant in the flowering stage but found to be significant in the Fruiting stage. Similar results were found as in NK interaction with the plant nutrient partitioning i.e high NPK leaf and shoot content were found in the medium to high level of PK. Different forms of P were also found to be significant with the PK interaction and the highest values were observed with the higher dose of P. In the Interaction effect of NPK, all the physico-chemical properties are found to be significant. The plant nutrient partitioning and the various forms of P, except for Residual P were also found to be significant with the interaction effect of NPK. The present study suggested that the nutrient management was found to influence the physico-chemical properties of the soil as well as various forms of P, except for Residual-P. The different forms of P were found to poorly explain the yield variability and did not influence yield directly. This implies that time may be a limiting factor for conversion of applied phosphorus to different P fractions. Different soil P fractions may influence the yield indirectly through other soil factors as founded by use of appropriate statistical tools. Furthermore, only N was found to be playing a dominant role in predicting the yield of capsicum under protected cultivation. The time of application of N also plays a vital role for the increased production of capsicum. The application of N just before fruiting stage gave better result compared to other critical growth stages during the study period. The best treatment combinations for higher yield of capsicum were when medium to high dose of N (N-100, 120) and P (P-60, 80) and low to medium dose of K (K-40, 60) was applied. Further studies may be conducted at different physio-geographical locations to get a robust nutrient recommendation for capsicum under protected cultivation.

Soil Available Phosphorus Pedotransfer Function for Acidic Soils of Central Brahmaputra Valley Zone of Assam

Bishnu Jyoti Saikia

The study on “Soil available phosphorus pedotransfer function for acidic soils of Central Brahmaputra Valley Zone of Assam” was carried out with the objectives 1) to develop a soil available-P-pH pedotransfer function for acidic soils, 2) to verify the developed model with laboratory database and 3) to evaluate the relationship of available P with their various forms. In total 220 surface soil samples (0-15cm) were collected from the three districts of CBVZ of Assam viz. Nagaon (n=120), Morigaon (n=50) and Hojai (n=50). Physico-chemical properties for all the samples were determined by using standard methods. The pH, available P, OC and CEC of the collected soil samples were ranged from 3.45 to 6.50, 18.00 to 55.47 kg P₂O₅ ha⁻¹, 0.32 to 1.34 per cent and 4.38 to 8.70 c mol (p+) kg⁻¹, respectively. The average values of mechanical separates of the soils were found to be 35.82, 22.85 and 41.33 % for sand, silt and clay, respectively and the texture of these soils varied from sandy to clayey. Out of the 220 samples, 44 samples were selected on the basis of variation in soil texture for developing a pedotransfer function. The average values of mechanical separates of later consisted of 35.82 %, 22.85 % and 41.33 % sand, silt and clay, respectively. The range of pH, OC, CEC, Ald, Fed and available P ranged from 3.85 to 6.40, 0.32 to 1.34%, 4.90 to 9.40 [c mol (p+) kg⁻¹], 0.34 to 1.62%, 0.61 to 1.84% and 20.11 to 55.47 P₂O₅ kg ha⁻¹, respectively.

A pedotransfer function (PTF) for predicting soil available P from soil pH data was developed and soil available P (AP) was estimated as a function of soil pH. The developed function is : **Available P = -25.69+12.07*pH**. The predicted P (*i.e.* soil available P predicted from the available P pedotransfer function) was compared with the soil available P estimated by laboratory test using the paired samples t-test and the Bland-Altman approach. The available P predicted by the soil available P pedotransfer function was found not to be significantly different from the soil available P determined by laboratory test (P > 0.05). The mean difference between the soil available P-PTF and

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Major Advisor : Dr. Kabindra Borkakati

laboratory test was $-0.004 \text{ kg ha}^{-1}$ (95% confidence interval: -0.7699 and $0.7614 \text{ kg ha}^{-1}$; $P=1.00$). The standard deviation of the soil available P differences was $2.518 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$. More than 95% values of soil available phosphorus differences laid within the limits of agreement which in this case are -4.940 to $4.932 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$. Thus, the pedotransfer function can be accepted as it also did not show any bias between the two methods calculated by Bland-Altman approach.

Results revealed that the sequential occurrence of various inorganic P fractions followed the order: Fe-P > Al-P > organic-P > residual-P > Ca-P > saloid-P. The order of partial contribution of inorganic P fractions towards total inorganic P was Fe-P > Al-P > residual-P > Ca-P > saloid-P. Bray's-I-P showed a significant positive correlation with OC ($r= 0.742^{**}$), pH ($r= 0.524^{**}$), CEC ($r= 0.552^{**}$), clay ($r= 0.508^{**}$), Ald ($r= 0.464^{**}$), Fed ($r= 0.519^{**}$) and significantly negative correlation with sand ($r= - 0.407^{**}$).

Stepwise multiple regression analysis indicated that the highest contribution was impacted by Fe-P (38%) towards Bray's-I-P whereas inclusion of res-P increased the variability to 48 per cent. All the P fractions jointly contributed 57 per cent towards the variability of available P. Step-wise multiple regression study showed the existence of dynamic equilibrium amongst different P fractions in the soils studied.

Step wise multiple regression analysis indicated that the highest contribution was imparted by saloid-P (15%) towards predicted P while addition of Al-P contributed 22% towards predicted P. Inclusion of all the P fractions changed the variability to 37%. From the foregoing discussion, it can be concluded that the pedotransfer model can be accepted as because there was no bias between the two methods which is a pre-requisite according to Bland-Altman approach for both the methods to be in close agreement.

Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice

Dipankar Sonowal

The study on the “Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice” was conducting in the year 2019-20 which forms a part of the long term trial under AICRP on Weed Management that was established during 2016 at ICR farm of Assam Agricultural University, Jorhat-13. The experiment was laid out in randomized block design replicating three times with five treatments viz., T1 - Conventional Tillage (Transplanted) ; T2_ Conventional tillage (Transplanted + Herbicide), T3 - Conventional Tillage (Direct-Seeded + Herbicide) ; T4 - Minimum Tillage (Direct-Seeded + Herbicide), T5 - Minimum Tillage (Direct-Seeded+ Herbicide+ Residue retained on the surface) with plant residue incorporation. Ranjit and Basundhara was used as the rice variety in transplanted and direct seeded rice respectively. Results of the study showed the significant improvement in weed management through herbicides in turn significant improvement of soil microbial activity and microbial biomass carbon. The soil physico-chemical properties viz., bulk density, porosity, water holding capacity, pH, available nitrogen, phosphorus, potassium, calcium and magnesium and organic carbon were determined from surface soil (0-15 cm) samples collected after the harvest of winter rice. Minimum tillage (MT) was found to improve almost all the physico-chemical properties of soil including bulk density, porosity, WHC, CEC and pH as compared to conventional tillage (CT) system. MT with application of herbicide significantly increased soil organic carbon (SOC) content and available N, K, Ca and Mg while its effect was found to be non-significant on available P in the soil. Biological parameters were analysed from surface soils collected periodically at 0, 3, 7, 15, 23, 30, 45, 60 days after application of the herbicide and at harvest in winter rice. In the present study, herbicide application resulted in inhibition of beneficial microbes viz., Bacteria, Fungi, Azotobacter, Azospirillum and phosphate solubilising bacteria up to 7 days after which it increased towards

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harvestings. Application of pretilachlor in winter rice showed a decline in dehydrogenase and β -glucosidase activity at initial stage while it increased the activity of acid phosphatase and microbial biomass carbon. Significantly higher enzyme activities were recorded in treatments receiving MT, herbicide along with residues retained on the surface. Studying the analytical chemistry of pretilachlor, observed that degradation of pretilachlor in soil followed the first order kinetics. Hence the persistence of pretilachlor in soil, rice straw and grains was observed at below detection limit at crop harvest.

Formulation of consortia using Plant Growth Promoting Rhizobacteria

Himadri Gogoi

In the present study for formulation of consortia, three nitrogen (N) fixing bacteria [*Rhizobium sp*(PR_{Ma}), *Azospirillum brasilense*(Az_{71}), *Azotobacter chroococcum* (Az_{O52})], one each of soil nutrient solubilizers [*Bacillus subtilis* (PSB_{63}), *Serratia liquifaciens* (KSB_5) and *Burkholderia ambifaria*(ZSB) were considered. One culturable endophytic actinobacteria [*Streptomyces finlayi* (BSL_1)] isolated from rice crop was considered as biocontrol agents along with N-fixers and nutrient solubilizers.

In the initial stage two common media were standardized and modified [modified N free bromothymol blue (**MNFB**) and modified starch casein agar(**MSCA**)] for support of the growth of entire selected PGPR and actinobacteria. Compatibility tests among the PGPR without actinobacteria and compatibility among the PGPR with actinobacteria were assessed. The results of compatibility both as dual and triple culture method in solid MSCA exhibited that the entire PGPR were compatible amongst them with or without the actinobacteria.

Following compatibility tests, three different the consortia were designed based on N-fixing bacteria. As such three consortia *viz*: (i) *Rhizobium* with $PSB+KSB+ZSB$ and actinobacteria, (ii) *Azospirillum* with $PSB+KSB+ZSB$ and actinobacteria and (iii) *Azotobacter* with $PSB+KSB+ZSB$ and actinobacteria were formulated.

In the liquid consortia different growth promoting substances *viz*. indole acetic acid (IAA) and Gibberellic acid(GA) were estimated. The findings showed the consortia could release significantly differed quantities of IAA and GA. *Rhizobium* based consortia could release significantly highest quantity of $33.00 \mu\text{g mL}^{-1}$ of IAA and $43.85 \mu\text{g mL}^{-1}$ of GA in MNFB media after 10 days of incubation. However, in MSCA media, *Azospirillum* grown in specific media could release significantly highest quantity of IAA ($26.60 \mu\text{g mL}^{-1}$) followed by in rhizobium based consortia ($17.60 \mu\text{g mL}^{-1}$).

Extracellular and intracellular enzymes *viz*: Dehydrogenase, Phosphomonoesterase, Arylsulfatase, Arylesterase and Fluorescein diacetate hydrolysis primarily involve in biogeochemical activities of the soil biological system were detected in the consortia.

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The enumeration of specific PGPR and actinobacteria in three different consortia as liquid and solid formulations in both the media (MNFB and MSCA) were assessed for three months which were compared with specific growth of PGPR in specific media. Significant differences of Log cfu mL⁻¹ of each PGPR and actinobacteria were observed at monthly interval. In *Rhizobium* based consortia, significantly highest population of *Rhizobium* [>10.00 log cfu mL⁻¹ and /or g⁻¹] could be achieved in liquid and solid MNFB and MSCA media respectively during the storage period up to 90 DAI. Likewise, the other PGPR (PSB, KSB and ZSB) and actinobacteria maintained the population status >8.00 log cfu mL⁻¹ and /or g⁻¹ during the storage period. In *Azospirillum* based consortia the status *Azospirillum* population maintained at 5.94-8.20 log cfu mL⁻¹ and /or g⁻¹ irrespective of media and the form of consortia, while other PGPR (PSB, KSB and ZSB) and actinobacteria maintained >6.00 log cfu mL⁻¹ and /or g⁻¹ during the storage period. In *Azotobacter* based consortia, both the media of liquid form of product supports the highest population of actinobacteria with values >10.00 log cfu mL⁻¹ and /or g⁻¹ during the storage period. In solid form however, the *Azotobacter*, dominates the population status in between 9.70-12.70 log cfu mL⁻¹ and /or g⁻¹ during the period of storage in both the modified media. At 90 DAI, the other PGPR (PSB, KSB and ZSB) could maintain the population >6.90 log cfu mL⁻¹ and /or g⁻¹.

Significantly varied performances in germination index and vigour index of cereals and pulses were recorded for consortia and individual PGPRs.

Distribution of micronutrients under different land uses in soils of Golaghat district of Assam

Jatiprasad Barala

An investigation was carried out to study the depth-distribution of available micronutrients and their relationship with soil physico-chemical properties in soils of Golaghat district of Assam. Soil samples were collected at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm depth under five land uses *viz.* rice, vegetable, sugarcane, bamboo and tea. Results indicated that sand, silt and clay content of the soils showed a significant variation among depths. The highest content of sand (59.53%), silt (51.13%) and clay (43.17%) were found at 80-100 cm, 20-40 cm and 80-100 cm under bamboo, vegetables and sugarcane land use, respectively. The soils were very strongly to medium acidic in reaction with a pH range of 4.70 to 5.73 and significantly the highest value of pH was recorded at 80-100 cm under all land uses. Organic carbon content of the studied soils was found higher in surface layer and decreased significantly with increasing soil depths. The significantly highest (13.27 g kg⁻¹) and lowest content of organic carbon (1.47 g kg⁻¹) in soil were observed under tea and bamboo land use, respectively. The exchangeable Ca²⁺, Mg²⁺, Na⁺ and K⁺ content was higher in soils of rice as compared to other land uses. The significantly highest and lowest mean values of both cation exchange capacity and per cent base saturation were observed under rice and bamboo land use, respectively.

The content of available micronutrients showed a significant variation among different depth under different land uses. The content of available micronutrients was higher in surface layers and decreased with depths. The value of DTPA-extractable Fe, Mn, Zn and Cu content of the studied soils ranged from 10.28 to 80.28, 2.02 to 29.18, 0.08 to 0.77 and 0.12 to 1.76 mg kg⁻¹, respectively under different land uses indicating the sufficiency of Fe, Mn and Cu. Content of DTPA- Zn was sufficient at 0-20 cm depth under rice and tea whereas deficiency was observed at lower depths in all the land uses. Among the land uses, surface layer of rice land use recorded significantly the highest concentration of DTPA-Fe, Mn, Zn and Cu as compared to other land uses.

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Significantly the highest content of boron was exhibited at surface layer in all the land uses and significantly the highest content of HWS-B (0.58 mg kg⁻¹) was observed at 0-20 cm depth under tea land use. Most of the soils were found below critical limit except sugarcane and tea at 0-20 cm depth.

DTPA-extractable micronutrients and HWS-B correlated positively and significantly with soil organic carbon, cation exchange capacity and per cent clay but negatively and significantly with soil pH. Clay showed a significant and positive correlation with DTPA-Mn, DTPA-Zn and DTPA -Cu. Step-down multiple regression analysis revealed that organic carbon, pH and clay were the dominant factors accounting for maximum variability in available micronutrient contents.

Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam

Jemima Ahmed

The study on “Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam” was carried out with the objectives 1) To find out soil acidity components and available phosphorus in soils of East Karbi Anglong. 2) To assess the relationship between soil acidity components and available phosphorus. In total 99 geo-referenced surface soil samples (0-15cm) were collected from various elevations (ranging from 83m to 470 m amsl) in East Karbi Anglong district of Assam. All the soil samples were classified in to three different elevation level each containing 33 samples each, viz., Toposequence-1 (TSQ-1) <100m amsl, Toposequence-2 (TSQ-2) 100-150m amsl, Toposequence-3 (TSQ-3) >150m amsl. The pH, available P, OC, CEC and BS% of the collected soil samples varied from 4.0 to 5.6, 5.5 to 11.4 kg P ha⁻¹, 7.3 to 21.3 g kg⁻¹, 8.6 to 12.7 cmol (p+) kg⁻¹ and 15.83% to 26.34% respectively. Ca²⁺ was found to be the dominant cation followed by Mg²⁺, K⁺ and Na⁺ in all the collected soil samples. Sand, silt and clay content of the soils varied from 35.2% to 43.9%, 29.9% to 38.9% and 17.7% to 30.6%, respectively. Among the forms of soil acidity, total potential acidity [7.1 to 13.46 cmol (p+) kg⁻¹] was the most dominant form of acidity in soils of East Karbi Anglong district of Assam. It was followed by pH dependent acidity [6.45 to 11.3 cmol (p+) kg⁻¹], extractable acidity [1.2 to 4.91 cmol (p+) kg⁻¹], total acidity [1.53 to 4.51 cmol (p+) kg⁻¹], exchange acidity [0.87 to 3.97 cmol (p+) kg⁻¹], exchangeable Al³⁺ [0.57 to 2.75 cmol (p+) kg⁻¹] and non exchangeable acidity [0.15 to 1.19 cmol(p+) kg⁻¹]. All the forms of soil acidity were significantly different among all the three toposequences (P >0.05) and found to increase with elevations in the following order TSQ-3 > TSQ-2 > TSQ-1. Available phosphorus was also found to be significantly different in all the three different toposequences (P >0.05). All the forms of acidity was found to be positively and significantly correlated with each other. Available phosphorus was found to be

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significantly and negatively correlated with all the forms of acidity, *viz.*, total acidity ($r = -0.808^{**}$), exchange acidity ($r = -0.743^{**}$), exchangeable Al^{3+} ($r = -0.813^{**}$), extractable acidity ($r = 0.809^{**}$), non exchangeable acidity ($r = -0.807^{**}$), total potential acidity ($r = -0.850^{**}$), pH dependent acidity ($r = -0.817^{**}$).

Symbiotic Effectiveness of Common Bean (*Phaseolus vulgaris* L.) *Rhizobium* grown in Soils of Assam

Jyotirupa Kalita

Nodulation promiscuity and sparse nodulation in common bean (*Phaseolus vulgaris* L) are two important intrinsic characteristics besides soil chemical factors for low nitrogen (N₂) fixation compared to other grain legumes. The symbiotic effectiveness of *Rhizobia* in nodulation is significant in *Rhizobium* strain selection programme to avoid the risk of sub optimal nodulation or nodulation failure. The present study was carried out to screen the effective native *Rhizobia* isolates from field grown common bean for their symbiotic effectiveness. Root nodules and rhizosphere soil were collected from thirteen different common bean growing sites representing three districts viz: Jorhat, Golaghat and Karimganj of Assam for isolation of *Rhizobium* and to assess their symbiotic effectiveness. Prior to isolation of *Rhizobium*, the nodulation characteristics of field grown common bean were assessed in correlation with selected soil chemical parameters. The study established the significant variation of nodule number (15.33 -173.67 /plant) and nodule dry weight (8 to 77.67 mg /plant) across the sites and the variation could be attributed to soil organic carbon (r=0.75*, r=0.82*) and available P₂O₅ in the rhizosphere (r=0.56*, r=0.57*) respectively. The frequencies of purified *Rhizobia* isolated from the nodules using differential Yeast Extract Mannitol Agar containing congo red (YEMA-CR) media, similarly varied significantly (5.38 to 8.58 log cfug-1) with typical colony characteristics across the sites. Growth in YEM broth exhibited the maximum population ranges (7.29 - 8.60 log cfu mL-1) at 48h, while optical density at 550nm (0.016-0.035) remains maximum at 72h of incubation. Optimum growth was exhibited by the isolates at pH7 and temperature 30o C. Differences in response to intracellular and extracellular enzymes activities, carbon sources utilization, amino acids utilizations, intrinsic antibiotic resistance and release of polysaccharides were observed for isolated *Rhizobia*.

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The assesment of changes in shoot root ratio (-54.29 to 180.00), nitrogen content in shoot (4.76-19.01mg plant⁻¹), nodule number (11.40-70.80), nodule dry weight (0.02 to 0.20g), nodule score (3.60-7.00), symbiotic efficiency (213.00-852.00) and relative strain efficiency (3.98-41.3) in 'Leonard Jar' assembly exhibited the symbiotic effectiveness of few promising (R01, R06 and 18P) isolated *Rhizobium*. The linear correlation between shoot dry weight and shoot nitrogen content with nodule dry weight ($r=0.65^*$), further establishes the fully functional N₂ fixation system as a result of effective nodulation.

Morphometric evaluation and soil loss estimation of a transect of Subansiri watershed in Lakhimpur district of Assam

Kamal Kishor

The present investigation was carried out with the objectives to compute morphometric parameters of the drainage streams of Subansiri river basin and to evaluate soil erosion status in the basin area. The Subansiri watershed is located in the Lakhimpur district which is part of the North Bank Plains of Assam. The studied watershed encompasses 118.67 sq. km area and it lies between 94°07' E to 94°18' E Longitude and 27°021' N to 27°036' N Latitude with the elevation ranging from 86 to 124 m. Based on total variation in satellite data three distinct physiographic units of the studied watershed were delineated which includes: piedmont plain (29.75 sq. km), alluvial plain (63.05 sq. km) and flood plain (25.87 sq. km). The morphometric parameters were evaluated through measurement of linear, areal and relief aspects. The 1st, 2nd, 3rd and 4th order streams had stream numbers of 24, 5, 2 and 2, respectively. The mean bifurcation ratio for the studied area was evaluated to be 2.77. The areal aspects like circulatory ratio (0.70), elongation ratio (0.50), form factor (0.20) and shape factor (5.09) were estimated and the estimated value indicated elongated shape of the watershed. The computed relief aspects *viz.* relief ratio (0.0015), ruggedness number (0.05) and relative relief (0.082) indicated higher infiltration and lower runoff. Sixty surface soil samples (0-15 cm) along with equal no. of core samples representing all the three physiographic units were collected using handheld GPS of Garmin Etrex 20. The surface as well as core samples were analyzed for various physico-chemical properties. The texture of the studied soils varied from loamy sand to silty clay loam, sandy loam being dominant. There was a decreasing trend of total sand as well as an increasing trend of silt and clay from piedmont plain to flood plain. The bulk density, particle density and porosity of soils of the studied watershed area ranged from 1.01 to 1.61 Mg m⁻³, 2.19 to 2.88 Mg m⁻³ and 30.29 to 61.85 %, respectively. The hydraulic conductivity of the soils varied from 0.44 to 5.86 cm hr⁻¹, while the water holding

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capacity ranged between 5.65 to 49.53 %. The field capacity, permanent wilting point and the available water content varied from 8.03 to 36.46 %, 2.65 to 14.98 % and 0.54 to 24.57 %. Among the physiographic units the piedmont plain soils recorded the highest value of hydraulic conductivity and flood plain showed the highest values of water holding capacity, field capacity, permanent wilting point and available water. The value of macro aggregates, micro aggregates and mean weight diameter of the studied soils varied from 20.20 to 79.54 %, 20.46 to 79.80 % and 1.13 to 3.91 mm, respectively. The pH of the studied soils was extremely acidic (4.15) to slightly acidic (6.69). The organic matter content of the soils ranged between low (5.38 g kg⁻¹) to high (27.83 g kg⁻¹). The available nitrogen, available phosphorus and available potassium content 10 varied from low to medium (137.98 to 464.13 kg ha⁻¹), low to medium (15.96 to 55.25 kg ha⁻¹) and low to medium (35.63 to 331.45 kg ha⁻¹), respectively. Based on the estimated values of soil physico-chemical properties, various soil erodibility indices were computed. In the studied soils, the value of silt/clay ratio, clay ratio and modified clay ratio varied from 0.33 to 4.40, 1.46 to 13.25 and 1.36 to 11.73, respectively. The critical level of soil organic matter of all the studied soils was less than 5 per cent which indicated their vulnerability to soil erosion. The dispersion ratio in the studied soils varied from 0.05 to 0.42 with a mean value 0.26. The values of erosion ratio and erosion index were found to be varying between 0.01 to 0.48 and 0.02 to 0.62, respectively. It was observed that 80.59 sq. km (67.91 %) area had dispersion ratio value more than 0.15 which could be considered as erodible. Nearly 51.64 sq. km (43.52 %) area of the watershed had erosion ratio values more than 0.10 indicating their susceptibility to erosion. The erosion index values were more than 0.18 in about 44.51 sq. km (37.51 %) area. The soil loss of the studied area varied from very slight to very severe (0.87 to 67.95 t ha⁻¹ yr⁻¹) with an average value of 12.38 t ha⁻¹ yr⁻¹. The soil loss showed a significant positive correlation with very fine sand ($r = 0.402^{**}$) and elevation ($r = 0.509^{**}$). The soil loss exhibited positive correlation with various erodibility indices viz., silty/clay ratio ($r = 0.159$), clay ratio ($r = 0.251$), modified clay ratio ($r = 0.249$). However, the significant positive correlation of soil loss was noticed with dispersion ratio ($r = 0.633^{**}$), erosion ratio ($r = 0.405^{**}$) and erosion index ($r = 0.502^{**}$). The soil loss along with dispersion ratio, erosion ratio and erosion index exhibited decreasing trend from the piedmont plain to flood plain.

Profile distribution of potassium in some soils of Sarupathar block of Golaghat district, Assam

Karabi Das

The present investigation was carried out with the objectives to characterize and classify the soils and to study the profile distribution of different forms of potassium in some soils of Sarupathar Block of Golaghat District, Assam. Horizonwise soil samples from five pedons in different locations viz., P1 (rice), P2 (rice), P3 (rice), P4 (vegetable) and P5 (upland trees) were collected. The soil colour (moist) varied considerably ranging from dark yellowish brown (10YR 4/4) to very pale brown (10YR 7/4) with dominant hue of 10YR in all the pedons. The colour value ranged from 4 to 7 and chroma ranged from 1 to 8. Mottles of higher chroma (6-8) were seen in subsurface horizons of P1, P2 and P3 and dominant hue of the colour of mottles was 7.5YR. A textural variation ranging from loam to silty clay was observed in surface horizons and sandy clay loam to clay was observed in sub-surface horizons. The structure of the soils varied from very fine to medium, weak to strong and sub angular blocky except for the surface horizon of P3 pedon where structure was massive. The sand content in the soils varied from 7.6 to 46.5 per cent, silt varied from 22.3 to 52.8 per cent and clay varied from 16.1 to 49.8 per cent. The value of bulk density for different pedons ranged from 1.35 to 1.50 Mg m⁻³. Organic carbon tended to decrease with depth in all pedons except for P4. The pH values were in acidic range in all the pedons and the pH values were lower in the surface horizons as compared to the subsurface horizons. Ca²⁺ was found to be the dominant cation followed by Mg²⁺, Na⁺ and K⁺ in all the pedons except in P5, where the sequence was Mg²⁺>Ca²⁺>Na⁺>K⁺. CEC of the soils ranged from 7.5 to 14.2 cmol (p+) kg⁻¹ soil and per cent base saturation (PBS) ranged from 14.27 to 47.02. Available N and available P₂O₅ ranged from 65.80(L) to 487.60(M) and 8.21(L) to 28.78(M) kg ha⁻¹, respectively. The studied soils were classified as Aquic Dystrudepts (P1), Oxyaquic Dystrudepts (P2), Typic Endoaquepts (P3), Typic Udifluvents (P4) and Typic Dystrudepts (P5) at subgroup level. Water soluble K status of the soils was found in the range of 0.85- 8.45 mg kg⁻¹. Exchangeable K status of the soil samples was found to be in the range of 10.65 - 92.45 mg kg⁻¹. Available K status of the soil samples was

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recorded in the range of 15.55 - 100.90 mg kg⁻¹ in the studied pedons and contribution to total K was 0.15-0.76 per cent. Status of non-exchangeable K was found in the range of 172.70 - 296.60 mg kg⁻¹ which contributed 0.93-3.93 per cent of total K. No specific trend was seen in any of the profile in case of non-exchangeable K content. Lattice K status was found in the range of 4365.30 – 19966.85 mg kg⁻¹. The mineral pool of K is the main source of total K which accounts more than 90 per cent of the total K. The value of total K in the studied soils was found in the range of 4580 – 20200 mg kg⁻¹. The results indicated that the pH of the soil samples showed significant positive relationship with nonexchangeable K ($r = 610^{**}$). The organic carbon content of the studied soils showed positive and significant correlation with water soluble K ($r = 416^*$). The cation exchange capacity of the soils showed a significant positive relationship with exchangeable, available, lattice and total forms of potassium. Highly significant and negative correlations were observed between exchangeable, available, lattice and total forms of potassium with total sand content of the soils. Clay showed significant positive relationship with exchangeable, available, lattice and total forms of potassium. Available K showed a significant and positive correlation with exchangeable K ($r = 0.994^{**}$), lattice K ($r = 0.517^{**}$) and total K ($r = 0.520^{**}$). The correlation coefficient between forms of potassium indicated that exchangeable K had significant positive correlation with lattice K ($r = 0.569^{**}$) and total K ($r = 0.571^{**}$). A highly significant and positive correlation was also found between lattice K and total K ($r = 0.999^{**}$) in the studied soils of Sarupathar block of Golaghat district.

Effect of liming on soil acidity components and available nutrients in Upper Brahmaputra Valley Zone of Assam

Manoharmayum Monica Devi

A laboratory incubation study was conducted to investigate the effect of lime (CaCO₃) on the acidity components and nutrients availability in soils of Upper Brahmaputra Valley Zone (UBVZ) of Assam. Fourteen (14) geo referenced surface (0-15 cm) soil samples were collected from Sibsagar and Jorhat districts of UBVZ of Assam. Soils were treated with three different levels of lime estimated on the basis of lime requirement (LR) of the soils *viz.*, LR10, LR25 and LR50 and their initial soil properties were recorded before liming. After that samples were incubated in laboratory conditions for different periods of time *viz.*, 15, 30, 60 and 90 days after liming (DAL) maintaining the soil moisture at Field Capacity (0.33 bar). Then at four (4) DAL soils were analysed for soil acidity components *viz.*, total acidity, exchange acidity, exchangeable (Ex) Al³⁺ and exchangeable (Ex) H⁺ and available nutrients *viz.*, N, P₂O₅, K₂O, Fe, Mn, Zn, Cu, and B. The correlation between soil properties with the acidity components and available nutrients were determined statistically by simple correlations. The effect of doses of lime (LR) and days after liming (DAL) on acidity components of the soils and the available nutrients were determined statistically by analysing the data in factorial CRD design using CoStat-Statistics Software. The soils of UBVZ of Assam were highly to moderately acidic (pH range 4.27 to 5.34) with sandy loam to silty clay loam in texture and high content of organic carbon ranged from 0.72 to 2.59%. The exchangeable (Ex.) Ca and Mg value ranged from 1.40-2.64 cmol(p+)/kg and 0.7-2.0 cmol(p+)/kg, respectively with CEC from 7.8 to 14.2 cmol(p+)/kg and BS from 25.03 to 43.76%. Application of lime brought about a marked increase in soil nutrients (N, P₂O₅, K₂O and B) and decrease in soil acidity (total acidity, exchangeable acidity, Ex. Al³⁺ and Ex. H⁺ and micronutrient cations (Fe, Mn, Zn and Cu). The different forms of acidity *viz.*, total acidity, exchange acidity, exchangeable Al³⁺ and exchangeable H⁺ decreased after application of lime from 15 (DAL). Total acidity

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decreased from 1.41 cmol(p+)/kg to 0.77 cmol(p+)/kg from LR10 to LR50 at 15 DAL. The highest significant decrease in total acidity was observed with LR50 and lowest in LR10. With the highest quantity of application of lime i.e. liming @ LR50 the total acidity of the soils were found to be 0.77 cmol(p+)/kg at 15DAL and 0.63 cmol(p+)/kg at 90 DAL. Application of lime brought about significant decrease in exchange acidity of the soils with increase in DAL. The highest decreased was observed at 90 DAL. Then, from 60 to 90 DAL the magnitudes of exchange acidity of the soils became more or less equal with application of lime @ LR10, LR25 and LR50. The exchangeable Al³⁺ also significantly decreased at 30 days of DAL. The highest decrease was recorded at 90 DAL with LR50 indicating persistence of effect of liming till 90 days of incubation. Effect of levels of lime and DAL on exchangeable H⁺ of the soils were similar as exchangeable Al³⁺. The nitrogen content of the soil increased from initial value of 189.22 kg/ha to 263.24, 269.79 and 284.03 kg/ha with application of lime @ LR10, LR25 and LR50, respectively at 15 DAL. The progressive increased in available nitrogen started from 15 DAL and continued till 30 days. Initially, soil phosphorus was low (20.91 kg/ha) which increased tremendously at 15 DAL and then its availability was maximum with application of lime @ LR50 (53.23 kg/ha). The highest available K₂O content of the soils was observed with liming @ LR50 (142.77 kg/ha) at 30 DAL the soils. Micronutrients content of the soils (Fe, Mn, Zn and Cu) started declining with application of lime. After 15 DAL, the available iron content decreased from 98.49 to 50.93 mg/kg, 43.97 mg/kg and 34.54 mg/kg in LR10, LR25 and LR50 and the effect persisted till 90 days of incubation. The declining trend of available Mn was very sharp. The initial value of 42.41 mg/kg declined to 5.19, 3.95 and 2.96 mg/kg in LR10, LR25 and LR50 at 15 DAL. Available Mn content at 90 DAL was 8.91 mg/kg i.e. much lower than Mn content before liming. The initial Cu content of the soils (2.34 mg/kg) decreased to 1.05, 0.81 and 0.99 mg/kg with application of lime @ LR10, LR25 and LR50, respectively at 15 DAL. The available Zn content was lowest at 15 DAL, then it started increasing and reached its maximum at 60 DAL. After that it was also found to be decreased at 90 DAL. However, initial boron content of the soils (0.47 mg/kg) increased to 1.06, 1.09 and 1.07 mg/kg at 15 DAL in LR10, LR25 and LR50, respectively. The content of available B was maximum at 15 DAL and minimum at 90 DAL. Correlation between soil physico-chemical properties and soil acidity components revealed that OC had positive correlation with total acidity ($r=0.638^*$) and exchange acidity ($r=0.551^*$) while BS% had negative significant correlation with total acidity ($r=-0.540^*$). Exchangeable calcium was significantly correlated with total acidity ($r=-0.751^{**}$), exchange acidity ($r=-0.610^*$) and exchangeable H⁺ ($r=-0.557^*$) while Ex Mg had significant negative correlation with exchangeable H⁺ ($r=-0.596^*$). However, micronutrient cations showed positive and anions showed negative correlation with acidity components of the soils. Exchangeable Fe exhibited significant positive correlation with total acidity ($r=0.639^*$), Ex. Mn with total acidity ($r=0.534^*$) and exchangeable Al³⁺ ($r=0.611^*$) while Ex. B had significant negative correlation with

total acidity ($r=-0.537^*$). The findings of the present investigation leads to the conclusion that in soils of UBVZ of Assam had wide range of soil physical and chemical characteristics, values of soil acidity components, lime requirement values and available macro and micro nutrients. Even then the application of lime @ as low as 10 percent of LR (LR10) was found effective in enhancing the macronutrients and micronutrient B availability and reducing the soil acidity *viz.*, total and exchange acidity and Ex. Al³⁺. The residual effect of lime was found to persist till 90 days after liming. However, magnitude of the effect of liming was increasing with increase in application of lime@ from LR10 to LR25 and to LR50.

Distribution of plant nutrients in soil profiles under different land use systems

Meghna Saikia

The present study was carried out to observe the influence of different land use systems on the vertical distribution pattern of nutrients in soil profiles. Soil profiles were collected from five different locations of Jorhat and Golaghat districts for the purpose. The different land use systems chosen for the study were rice, vegetable growing area, bamboo plantation, tea plantation and natural forest. The soils were grey to reddish yellow in colour, sandy loam to clay in texture with extremely acidic to strongly acidic in nature. Organic carbon content of the soil was low to high ranging from 0.12 to 1.40 per cent. CEC of the soils varied from 7.1 to 12.3 cmol (p⁺) kg⁻¹ while base saturation ranged from 27.2 to 46.1 per cent. Based on various properties, soils under rice and tea were classified as Typic Epiaqualfs and Ultic Hapludalfs, respectively. Soils under vegetable, bamboo and forest were classified as Aeric Endoaquepts, Oxyaquic Dystrudepts and Typic Dystrudepts, respectively at subgroup level.

The available N, P and K status of the soils was rated as low to medium. Calcium was found invariably low while Mg and S status of most of the soils were found sufficient. Similarly, Fe and Mn content of all the soils were also found to be sufficient but Zn and B content was low particularly in subsurface horizons. All the nutrients exhibited a decreasing trend with the depth of the profile. The carbon stocks was highest in rice soils up to a depth of 100 cm. Nitrogen, calcium, zinc and boron stock was highest in forest soils while soils under rice was recorded for maximum magnesium, iron and manganese stock. Soil under vegetable was recorded for highest potassium and sulphur stock. Bamboo soils were observed to contain maximum amount of phosphorus stock. Considering the soil order, the stock of organic carbon, N, Ca, Mg, Fe and Mn, was found to be considerably high in Alfisols than Inceptisols up to 100 cm depth but the stock of P, K, S, Zn was high in Inceptisols.

Almost 80% of the cumulative stock of all nutrients was contributed by the subsurface horizons. The surface horizon of the soils under bamboo contributed more than 40% to the total cumulative organic carbon stock of the profile. The soil under rice

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was recorded for higher surface soils contribution for P, Mg, S, Fe, Mn and Zn while surface soil contribution for N, K, Ca, Mg and B was high in vegetable profile. The surface horizon of forest soils also contributed to highest Mn stock. The contribution of surface horizon to the total nutrient stock (0-100cm) in case of organic carbon, K, Ca and Mg was found to be maximum in case of Inceptisols and the surface contribution for the rest of the nutrient stocks was found to be maximum in Alfisols.

PCA identified four groups of components and accounted for 86.4% of the total variance. Analysis showed that organic carbon, texture, CEC and acidity are the major factors governing the nutrient distribution in these soils. It indicated that nutrient distribution pattern of these soils was not only influenced by the land use system but also partly controlled by the properties inherited from the parent material. The higher stocks of some of the nutrients in Alfisols than Inceptisols supported the influence of pedogenic factors on nutrient retention. The organic carbon content of the soils is the only one factor that was mostly controlled by land use system and played the most important role in nutrient availability in these soils.

Targeted Yield based Fertilizer Prescription Model for Scented Rice

Momin Dloey

Field experiments were conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the year 2017-18 and 2018-19 to generate Targeted Yield based Fertilizer Prescription Model for Scented Rice. In order to develop fertilizer prescription equations, fertility gradient experiment was conducted taking *khari* rice (cv. Ranjit) as exhaust crop by creating three fertility gradient strips. After harvest of gradient crop, test crop experiment was conducted in the same field with scented rice (cv. Keteki joha) by superimposing 24 treatment combinations consisting of five levels of N (0, 10, 20, 40 and 60 kg ha⁻¹), four levels of P₂O₅ (0, 5, 10 and 20 kg ha⁻¹), three levels of K₂O (0, 10 and 20 kg ha⁻¹) and three levels of vermicompost (0, 2 and 3 t ha⁻¹) in each of these fertility gradient strips.

Integrated nutrient management approach brought about a positive influence on organic carbon, soil available nutrient status, crop yield and uptake of nutrients by scented rice. Combined application of 60 kg N, 10 kg P₂O₅ and 10 kg K₂O per hectare along with 3 tonnes of vermicompost per hectare resulted the highest available NPK in soil along with the highest crop yield and uptake of nitrogen, phosphorus and potassium by rice as compared to other treatments.

Fertilizer prescription equations were formulated for scented rice by following Ramamoorthy's Inductive- cum-targeted yield approach. Based on the experiments, the nutrient requirement (NR) for producing one quintal of scented rice was found to be 2.96, 0.21 and 2.67 kg q⁻¹ with respect to N, P and K, respectively. The soil efficiency for N, P and K was found to be 36.44%, 37.13%, 50.17% in 2017-18, respectively and 35.33%, 32.88%, 49.87% in 2018-19, respectively and 35.89, 35.01, 50.02 kg q⁻¹ in pooled analysis, respectively. The N, P, K contributions to scented rice from fertilizers were 52.22%, 23.08%, 63.55%, respectively in 2017-18 and 54.43%, 23.04%, 64.13%, respectively in 2018-19 and 53.33, 23.06, 63.84 kg q⁻¹, respectively in pooled analysis and found highest in K- fertilizer. Conversely, the per cent contribution of N, P and K from

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organic component that is organic efficiency was 9.69%, 1.08%, 21.6%, respectively in 2017-18 and 10.57%, 1.15%, 22.4%, respectively in 2018-19 and 10.13, 1.12, 22 kg q⁻¹, respectively in pooled and found to be unassuming in all the nutrients. Based on nutrient requirement, contribution from soil, contribution from fertilizer and contribution from organic manure the fertilizer prescription equations were developed for scented rice (cv. Keteki joha) and an estimate of fertilizer doses were formulated in the form of ready reckoner for a range of soil test values and desired yield targets.

Phosphate adsorption in soils of Assam in relation to physico-chemical properties and plant uptake

Montrishna Rajkhowa

The study investigated the Phosphate (P) adsorption in four (4) major soil orders of Assam. It was conducted in sixteen (16) surface (0-30 cm) and sub-surface (30-60 cm) soil samples, collected from two locations each of the order Entisol, Inceptisol, Alfisol and Ultisol. There were wide variations in physico-chemical characteristics of the soils with pH, organic carbon, texture, clay content, CEC, AEC, per cent base saturation (PBS) and free oxides of Fe and Al which ranged from 4.86 to 5.60, 0.66 to 1.17 per cent, sandy loam to clay, 18 to 39.5 per cent, 6.72 to 19.73 cmol (P⁺) kg⁻¹, 1.64 to 2.80 cmol (-) kg⁻¹, 21.16 to 44.39 per cent, 1.08 to 3.21 per cent and 0.60 to 1.08 per cent, respectively. In the soils forms of phosphorus present in variable amounts but had the same sequence of abundance viz., Fe-P>Al-P>Organic P>Residual-P>Ca-P in all soils. Total acidity of the soils ranged from 1.60 to 3.36 cmol (p+) kg⁻¹. Forms of acidity revealed that total potential acidity was the most dominant forms acidity followed by pH dependent acidity, exchangeable acidity and total acidity in soils of Assam. The adsorption of P in the soils was studied by conducting batch experiment in the laboratory by equilibrating two (2) g soil in duplicate with 20 ml 0.01 M CaCl₂ solution containing 5, 10, 20, 40, 60, 80, 100 and 150 mg P L⁻¹ as KH₂PO₄. The results of adsorption studies on P were discussed in terms of per cent adsorption of added P (% AdsP), Langmuir and Freundlich adsorption parameters. The per cent of adsorbed P (% AdsP) decreased with the increased of added P. The P adsorption data was found to be the best fit in Langmuir adsorption isotherm when resolved into two parts. The Langmuir parameters viz., the adsorption maxima (b) were higher for part II (upper part) whereas the bonding energy constant (k) was higher for part I (lower part) of the isotherms. The highest b₂ of part II was found in Ultisol (5882.35 mg kg⁻¹ in S₈d₁) and the lowest was found in Entisol (1037mg/kg in S₁d₂). The highest bonding energy constant (k) value for part I was observed in Ultisol (0.795 L mg⁻¹) and the lowest in Entisol (0.055 L mg⁻¹). Phosphate adsorption maxima (b₁) of part I had a significant positive correlation with OC (r = 0.814**), clay content (r = 0.632**), Ex. Ca (r=0.701**),

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CEC ($r = 0.874^{**}$) and free Fe_2O_3 ($r = 0.840^{**}$), total P ($r = 0.541^*$), Fe-P ($r = 0.607^*$) and Al-P ($r = 0.512^*$) content of the soils. The bonding energy constant (k_1) of the part I and part II of the isotherm was found to have significant positive correlations with OC ($r = 0.731^{**}$ and 0.716^{**}), clay ($r = 0.655^{**}$ and 0.642^{**}), CEC ($r = 0.890^{**}$ and 0.640^{**}) and Fe_2O_3 ($r = 0.732^{**}$ and 0.815^{**}) of the soils, respectively. Freundlich adsorption parameter K had a significant positive correlation with OC ($r = 0.801^{**}$), CEC ($r = 0.908^{**}$), clay content ($r = 0.660^{**}$), Ex. Ca ($r = 0.537^*$), Free Fe_2O_3 ($r = 0.810^{**}$) and Al_2O_3 ($r = 0.571^*$) of the soils. The Bray 1 P significantly negatively correlated with P adsorption maxima (b_1) ($r = -0.599^*$), bonding energy constant (k_1) ($r = -0.594^*$), MPBC ($r = -0.599^*$) and Freundlich's n ($r = -0.744^*$) and K ($r = -0.616^*$). Bray 2 P also significantly negatively correlated with P adsorption maxima ($r = -0.668^{**}$), MPBC ($r = -0.533^*$) and Freundlich's n ($r = -0.736^{**}$) and K ($r = -0.571^{**}$). P uptake was highest in soil S_5d_1 ($0.042 \text{ g plant}^{-1}$) and lowest in soil S_4d_1 (0.027 and $0.026 \text{ g plant}^{-1}$) with as well as without addition of P. The P uptake by the Maize had no significant correlation with P adsorption parameters. It might be due to greater role of the intensity factor viz. P concentration and diffusion in supply of P to plant root than the P adsorption parameters. Therefore, amount of P required to obtain 0.2 mg P L^{-1} in equilibrium soil solution was different in different soil orders. It was highest in Ultisol S_8d_1 (90.89 mg PL^{-1}) and the lowest in Entisol S_2d_1 (32.78 mg PL^{-1}). The values of P supply parameter (SP) ranged from 0.38 in soil S_7d_1 to 49.38 in soil S_3d_2 . Thus the findings of present investigation on P adsorption capacity of soils of Assam will be useful in P fertilizer management and recommendation of P fertilizer for growing crops in these soils.

Enrichment of Maize Grains with Zinc through Agronomic Biofortification

NARENDRA KUMAR YADAV

Zinc malnutrition is a major global health issue associated with cereal-based diets. Agronomic biofortification with Zn aims to provide edible parts of crop plants with sufficient Zn. Biofortification with Zn fertilizers, particularly foliar applications, works well for maize and other cereals. Maize crop is regarded as a queen of cereals because it has highest potential among cereals (Jaliya *et al.*, 2008). It has emerged as third most important food crop after rice and wheat as it contribute around 24 per cent of total cereal production (Singh *et al.*, 2011). Keeping in view the importance of zinc in human health as well as the importance of maize crop in human diet, a field experiment was carried out at instructional-cum-research farm of Assam Agricultural University, Jorhat, Assam to enrich grains of a hybrid maize variety (PAC 740) with soil and soil plus foliar (0.5%) application of zinc with five levels of ZnSO₄ viz. 20,40,60,80 and 100 kg ZnSO₄ per ha.

Foliar application of Zn improved yield but statistically had no effect on yield and many of the yield components measured in this study. Highest yield (7.83 t/ha) was recorded in the treatment with 60 kg ZnSO₄/ha (S) + (F). Grain Zn concentrations and uptake were, however, more effectively increased by Zn fertilization, especially with foliar Zn applications. Significantly highest grain Zn concentration (46.94 mg/kg) and uptake of Zn (358.15 g/ha) was observed with 100 kg ZnSO₄/ha (S) + (F) application over control.

Nitrogen and potassium concentration and uptake in grains and straw increased with the increasing level of Zn but P concentration and uptake decreased. Agronomic efficiency and Apparent recovery efficiency was found highest in the treatment with 60 kg ZnSO₄/ha (S) + (F) application and 100 kg ZnSO₄/ha (S) + (F) application, respectively. Soluble protein, crude protein and starch content increased with the increase in Zn concentration.

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Zinc concentration of post harvest soil was found highest in the treatment 100 kg ZnSO₄/ha (S) + (F) (2.91 mg/kg) and lowest in control (1.22 mg/kg). The concentration of different Zn fractions in post harvest soil followed the order: Total Zn > Residual Zn > Amorphous sesquioxide bound Zn > Crystalline sesquioxide bound Zn > Organically complexed Zn > WS+Exc Zn. Positive significant correlation was observed between Zn concentration, Zn uptake and grain yield. Among the fractions, WS+Exc Zn showed significant positive correlation with organically complexed Zn, amorphous with crystalline sesquioxide bound Zn; crystalline sesquioxide bound Zn with residual Zn and residual Zn with total Zn.

Nutrient availability, soil acidity and tomato yield as influenced by FYM-lime-wood ash mixture and rice stubble management

Prantika Kakati

A field experiment was conducted in ICR farm, AAU, Jorhat from December, 2019 to April, 2020 to evaluate the forms of acidity, nutrient availability in soil and yield of tomato in winter rice-fallow as influenced by different nutrient management practices with and without rice stubble incorporation. The experiment was conducted in a split plot design with four replications. Rice stubble was either removed or incorporated in the main plot, and each main plot was divided into five sub plots with nutrient management practices. The nutrient management comprised of unfertilized plot, FYM 2 t ha⁻¹ (FYM) one week before planting followed by 75:60:60 N:P₂O₅:K₂O kg ha⁻¹ (RDF) applied at planting, with N in two equal splits (RDF+FYM), half of the lime requirement 21 days before planting ($\frac{1}{2}$ LR) followed by FYM at planting ($\frac{1}{2}$ LR+FYM), $\frac{1}{2}$ LR followed by FYM mixed with wood ash 2 kg ha⁻¹ ($\frac{1}{2}$ LR+FYM-wood ash), and FYM as mixture with lime 20 kg ha⁻¹ and wood ash 2 kg ha⁻¹ in two splits at planting and 30 days after planting (FYM-lime-wood ash). Application of lime ($\frac{1}{2}$ LR) significantly increased soil pH and decreased exchange acidity, total acidity and exchangeable Al³⁺ in soil. The NH₄-N, NO₃-N and available P and K content in soil were significantly increased by rice stubble incorporation only at 56 days after planting (DAP) of tomato. Application of RDF+FYM maintained significantly higher content of NH₄-N, NO₃-N, available P and K in soil throughout the growth stages of tomato. However, there was no significant effect on nutrient content in soil between $\frac{1}{2}$ LR+FYM with or without wood ash and FYM-lime-wood ash. The exchangeable Ca²⁺ and Mg²⁺ in soil significantly increased due to application of $\frac{1}{2}$ LR+FYM compared to unfertilized or RDF+FYM but did not differ with FYM-lime-wood ash, while the same were unaffected by rice stubble incorporation. Application of RDF+FYM or rice stubble incorporation significantly increased exchangeable K⁺ in soil. The urease, dehydrogenase, acid phosphatase activities and microbial biomass carbon in soil increased significantly with rice stubble incorporation. Except for microbial biomass

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carbon, no significant difference was observed for enzyme activities in soil between RDF+FYM and application of lime with FYM, irrespective of dose and method of application. The various growth parameters and yield of tomato were significantly enhanced due to rice stubble incorporation. Application of RDF+FYM produced highest yield, diameter, fresh and dry weight and moisture content and significantly higher nutrient uptake of tomato among the nutrient management practices, while the highest B:C ratio was observed with application of FYM-lime-wood ash. The available nutrient status of soil at harvest of tomato was significantly enhanced with rice stubble incorporation or nutrient management compared to rice stubble removal or the unfertilized plot, respectively.

Effects of conservation tillage and herbicide application on soil microbial activity in rice-mustard sequence

Rajat Kumar Parit

The study on the “Effect of Conservation Tillage and Herbicide Application on Soil Microbial Activity in Rice-Mustard sequence” in the year 2018-2019 which forms a part of the long term trial under AICRP on Weed Management that was established during 2016 at Instructional-cum-Research (ICR) farm of Assam Agricultural University. The experiment was laid out in randomized block design replicating three times with five treatments in winter rice and mustard crop separately. The treatments of winter rice was comprised of treatments *viz.*, **T1**- CT (Conventional tillage)+ Transplanting, **T2**- CT+Transplanting+ Pretilachlor, **T3**- CT+ Direct Seeded +Pretilachlor, **T4**- MT (Minimum tillage)+ Direct Seeded +Pretilachlor and **T5**- MT+ Direct Seeded+ Residue +Pretilachlor. Similarly, the treatments of mustard crop was comprised of treatments *viz.*, **T1**-CT, **T2**- MT+ Pendimethalin, **T3**- CT+ Pendimethalin, **T4**- MT+ Residues+ Pendimethalin, **T5**- MT+ Residues+ Pendimethalin. The physical and chemical properties *viz.*, bulk density, porosity, water holding capacity, pH, CEC and available nutrients *viz.*; nitrogen, phosphorus, potassium, calcium, magnesium and soil organic carbon were determined from surface soil samples collected after the harvest of both winter rice and mustard crop. Conservation tillage i.e. MT along with residue has improved soil physical properties like bulk density, porosity, water holding capacity and CEC except the pH of the soil did not vary significantly. The soil organic carbon content increased significantly due to MT, herbicide application and residues. Available nitrogen, phosphorus, potassium, calcium and magnesium content of the soil was recorded in the medium range with highest available nitrogen, phosphorus, potassium, calcium and magnesium content recorded in the treatment T₅ receiving MT+ Residues+ Herbicide Application in both winter rice and mustard crop. Biological parameters were analysed from surface soils collected periodically at 0, 3, 7, 15, 30, 45, 60 DAA of the herbicide in both winter rice and mustard crop. After the study, MT was found to improve the major enzymatic activities, soil microbial biomass carbon, physico-

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chemical properties, available nutrients and soil organic carbon content as compared to conventional tillage (CT). Application of pretilachlor in winter rice showed a decline in β -glucosidase and urease activity for first 15 DAA and then increased till harvesting. However, a stimulatory effect was observed on activity of acid phosphatase, dehydrogenase and microbial biomass carbon for short period of time which later on decreased. Application of pendimethalin in mustard caused a decrease in dehydrogenase and β -glucosidase in initial stage while it increased the activity of acid phosphatase, urease and microbial biomass carbon in initial stage. Regarding the effect of herbicide application on available nutrients and soil organic carbon content it showed a stimulatory effect on these parameters. Significantly higher enzyme activities were recorded in treatments T_5 which was comprised of MT+ Residues+ Herbicide Application.

Ecological Occurrences of Methyloprophs in Phyllosphere of crops

Sanghamitra Phukan

The phyllosphere is an ecologically important habitat that hosts a large and diverse microbial community. Bacteria are among the most abundant inhabitants of the phyllospheric leaf surface, where the conditions are very harsh, due to heat, irradiation, rainfall, etc. The present investigation envisages the isolation, biochemical characterization and screening of phyllosphericmethyloprophic bacteria associated with various crops for their plant growth promoting characteristics. Methyloprophs are a group of microorganisms that have the ability to utilize C₁ compounds such as methanol or formaldehyde along with several multi carbon compounds, the most common genera being *Methylobacterium*, comprising mostly of pink pigmented facultative methyloproph (PPFM). In the present investigation leaf samples were collected from different crops comprising of five sites of Jorhat district, Assam. Leaf being the dominant aerial part, was considered for isolation purpose. Following the leaf imprinting and serial dilution technique, isolation of phyllosphericmethyloprophic bacteria were carried out. Eighteen isolates were screened for their plant growth promoting traits like Indole acetic acid (IAA), siderophore production, antibiotic resistance, ammonia production, etc. All the isolates produced IAA within a range of 0.69- 5.53 $\mu\text{g g}^{-1}$, with the highest in spinach (M16). The total nitrogen content of the isolates ranged between 1.4- 2.6 mg g^{-1} . Siderophore production was shown by the isolates M1 (chili) and M10 (cauliflower) and resistance to common antibiotics was also shown by few isolates, isolate M4,M15, M16 and M 17 from ivy gourd, cowpea, spinach and french bean crops respectively. Isolates M1, M10 and M12, retrieved from the phyllosphere of chilli and cauliflower crop possessed the ability to solubilize phosphorus, and isolate M7 from phyllosphere of tomato could solubilize zinc. After screening for plant growth promoting traits, twelve isolates were finally selected for a series of biochemical tests. All the isolates could hydrolyze casein, but none could hydrolyze starch. Catalase test was positive for all the isolates but all isolates did not possess cytochrome c oxidase enzyme. Few isolates M1, M4, M7, M10, M15, M16, M17 from chilli, ivy gourd, tomato, cauliflower, cowpea,

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spinach and frenchbean showed nitrate reduction. The isolate M13 showed positive urease activity. Citrate utilization was seen only in case of one isolate from phyllosphere of french bean (M17). Few isolates could show positive results for indole and Voges-Proskauer's test but methyl red test was positive for one isolate from phyllosphere of chilli crop. Enumeration of methylotrophic bacterial population carried out for both phyllosphere samples and rhizospheric soil, resulted in a higher population in the phyllosphere. Soil samples of the study site were also analyzed for soil chemical (pH, available N, available P₂O₅, available K₂O, organic carbon) and biological parameters (microbial biomass carbon, fluorescein diacetate, phosphomonoesterase). Correlation studies between the population of methylotroph in leaf and that of rhizospheric soil resulted in positive correlation ($r=0.762^*$). Phyllospheric population of the methylotrophic bacteria and soil pH of the study sites also resulted in a positive correlation ($r=0.934^{**}$). From the research initiative, it could be inferred that a wide array of methylotrophic bacteria occur in the phyllosphere of different crops, and possess plant growth promoting traits. These phyllospheric methylotrophic bacteria could further be utilized for coinoculation with biofertilizers or used as bioinoculants in crop improvement.

Distribution of micronutrients in soils under Horticultural crops of Assam

Srinivasulu Kumbha

An attempt has been made for assessment of the distribution of available micronutrients in soils and their effect on physico-chemical properties of the soils under different horticultural crops of Assam. Seventy-five (75) soil samples were collected at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm depth under five horticultural crops *viz.* banana, arecanut, khasi mandarin, coconut and assam lemon. Results indicated that sand, silt and clay content of the soils showed a significant variation among depths. The significantly highest content of sand (64.63%), silt (51.73%) and clay (41.70%) were found at 0-20 cm, 80-100 cm and 80-100 cm under khasi mandarin, banana and arecanut, respectively.

The soils were very strongly to medium acidic in reaction with a pH range of 4.50 to 6.1 and the highest pH (6.1) was recorded at 80-100 cm depth in A3 under arecanut. Organic carbon content of the studied soils was found higher in surface layer and decreased significantly with increasing soil depths. The significantly highest and lowest mean value of organic carbon was recorded in profile of arecanut (7.79g kg⁻¹) and khasi mandarin (3.95 g kg⁻¹), respectively. The exchangeable Ca²⁺, Mg²⁺, Na⁺ and K⁺ content and per cent base saturation was low in surface layers and gradually increases with increasing depth. The significantly highest and lowest mean values of cation exchange capacity in soils were observed under arecanut and khasi mandarin, respectively.

The content of available micronutrients showed a significant variation among different depth under different horticultural crops. The content of available micronutrients was higher in surface layers and decreased with depths. Among the crops, soils from arecanut and khasi mandarin recorded the highest and lowest mean value of DTPA Fe, DTPA -Mn and DTPA-Cu, respectively. The mean value of DTPA-extractable Fe, Mn, and Cu content of the studied soils ranged from 4.10 to 147.25, 3.60 to 81.37 and 0.37 to 1.62 mg kg⁻¹ under different crops, respectively indicating the sufficiency of Fe, Mn and Cu in soils. Content of DTPA- Zn was sufficient under all

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crops except khasi mandarin at 0-20 cm depth and assam lemon under 60-100 cm depth. The highest content of boron was exhibited at surface layer and significantly the highest content of HWS-B (0.65 mg kg⁻¹) was observed at 0-20 cm depth under arecanut. Most of the soils were found below critical limit except at 0-20 cm depth.

DTPA-extractable micronutrients and HWS-B correlated positively and significantly with per cent clay, soil organic carbon and cation exchange capacity but negatively and significantly with sand and soil pH. Step-wise multiple regression analysis revealed that organic carbon was the dominant factors accounting for maximum variability in available micronutrient contents in soil.

Carbon and Nitrogen Mineralization in an Inceptisol with and without stubble addition

Suravi Nandi

A laboratory experiment was carried out to evaluate carbon and nitrogen mineralization in soil as influenced by rice stubble addition. Bulk surface (0-15 cm) soils (sandy clay loam with pH 4.6 and organic carbon 6.2 g/kg), collected from winter rice (*variety* - Ranjit) field after harvest of the crop, were processed and used to fill the PVC (polyvinyl chloride) pipes (diameter 9.0 cm) to a depth of 15 cm and incubated for 105 days imposing different treatments. Rice stubbles were treated in the field by spraying glyphosate (2.05 g a.i/l) and commercial yogurt (5 g/l) mixtures solution. Both treated and untreated stubbles were collected from the field, chopped into small pieces (1.5 to 2.0 cm long) and added to the columns with and without incorporation. A column was incubated without addition of the rice stubbles. The soil columns (over a layer of 10 cm sand) were kept in a tray filled with sand under constant saturation in a completely randomized design with four replications. The soil moisture content of the columns varied from 27.6 to 31.4 % (w/w) and the maximum temperature varied from 21.3 to 29.3 °C during the experiment. The CO₂ evolution from the soils increased up to 6th week of incubation and maximum value (30.6 mg/kg soil) was observed with incorporation of treated rice stubble. The lowest value during this period was observed in soil without rice stubble and differed significantly to the treatments for each sampling stage. The CO₂ evolution from the soils every third day after 6th week of incubation increased gradually reaching the peak at around 9th week after incubation in treatments receiving rice stubble. Thereafter, the CO₂ evolution from the soils decreased gradually with a little rise at 12th week after incubation. Significant differences in CO₂ evolution from the soils were not observed between incorporated and unincorporated treatments for both treated and untreated rice stubble, except a few occasions. The organic carbon content of the soils was not affected by the stubble management up to 42 days after incubation, which significantly increased due to incorporation of treated rice stubble up to 84 days, and due to addition of stubble at 84 and 105 days of incubation compared to soil without stubble. The labile organic carbon content of the soils significantly

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increased 42 days after incubation in soils with rice stubble, except untreated and unincorporated treatment compared to without stubble. However, the microbial biomass carbon was relatively non-significant, except at 63 days of incubation where incorporation of untreated and retention of treated stubbles showed higher significant contents over retaining untreated stubble or without stubble. The $\text{NO}_3\text{-N}$ significantly increased up to 84 days of incubation with stubbles, irrespective of incorporation and glyphosate-yogurt treatment compared to without stubble. The soil pH was affected only at 105 days after incubation, where it significantly decreased due to retention of treated stubble or incorporation of stubble compared to without stubble and retention of untreated stubble. However, the exchange acidity and total acidity in soils significantly increased after 63 days after incubation due to incorporation of treated or untreated stubble and retention of treated stubble. The cation exchange capacity, exchangeable cations, viz. NH_4^+ , Ca^{2+} , Mg^{2+} significantly increased with incorporation of rice stubble, while the effect for K^+ was observed only with treated stubble incorporation. The available phosphorous (P) and potassium (K) significantly increased due to stubble incorporation, but available nitrogen was unaffected by the treatments.

Soil properties in termite mounds under different land uses

Sushmita Konwar

A study was carried out to assess the physical, chemical and biological properties of termite mound soils under five land uses viz., Fallow, Horticulture, Bamboo, Tea and Forest. Three mounds from each of the land uses were selected and three soil samples were collected from the base, centre and top of each of the termite mounds. One composite soil sample was collected from the adjacent soils from each of the land uses. A total of 50 soil samples were collected for the study. The impact of the mounds of termites on their adjacent properties of soil was also investigated. The termite mound soil was found to be higher in bulk density and water holding capacity compared to surrounding soil. They were also richer in clay, organic carbon, and concentrations of N, P, K, S, Ca, and Mg and enzymatic activities than their adjacent soils. Total acidity, Potential acidity and Exchangeable Al⁺ were found to be lower in the mounds as compared to the adjacent soils under all the land uses. No definite pattern was observed for the variation of the micronutrients between the mounds and the soils adjacent to it. A two-tailed paired t-test was carried out to compare the variation in soil properties of the mounds with respect to the five land uses. Bulk Density in the termite mounds in case of Fallow soil was observed to be significantly lower as compared to that of Horticulture, Bamboo, and Tea. Bulk Density of the termite mounds under Forest soil was however significantly lower than that of Fallow. Water Holding Capacity (WHC) was significantly higher in the termite mounds under Horticulture (30.77%), Bamboo (32.06%), Tea (30.96%) and Forest (32.42%) as compared to that of Fallow (28.33 %). The organic carbon content of the termite mounds was significantly lower in Fallow land use. Although non significant, low organic carbon was observed in forest, compared to Fallow, Horticulture and Bamboo land use. The CEC in the termite mounds under Horticulture system was significantly higher than Fallow system. Available P was significantly higher in the termite mounds under Horticulture land use compared to Fallow, Tea and Forest. All the acidity components were found to be comparatively higher under fallow ecosystem. Based on the SQI calculated by combining all the

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studied physical, chemical and biological parameters, it was observed that soil under Horticulture land use (SQI 12.35) is highly enriched by the termite mounds compared to Tea (SQI 11.80), Bamboo (SQI 10.40), Forest (SQI 9.80) and Fallow (SQI 5.71). So, Horticulture land use has more aggradation followed by Tea, Bamboo and Forest. Aggradation is more in all the land uses compared to Fallow.

Morphometry and Soil Erodibility of a transect of Ranganadi Watershed in Lakhimpur district of Assam

Tilak Prasad Panika

The Ranganadi river, which originates in Arunachal Pradesh, joins the Subansiri-Brahmaputra river system at Khichikagaon of Lakhimpur district of Assam. The Ranganadi watershed area experiences frequent flood and seasonal water logging that often inundate the vicinity of the watershed. The present investigation was undertaken to compute morphometric parameters of the drainage streams of Ranganadi watershed and assessment of soil erosion status in a transect of the watershed area.

The study area covered a total of 12174 hectares and were divided into piedmont plain of 4192 hectares (34.43%), alluvial plain of 4808 hectares (39.49%) and flood plain of 3174 hectares (26.08%) physiographic units. The transect had elevation ranging from 112 m to 70 m. A total of 60 samples were drawn with 16 in piedmont, 19 in alluvial plain and another 25 in flood plain area. Morphometrically the transect is elongated in shape and has 3rd order stream distribution. The areal and relief aspects projected the area to be moderately prone to erosion.

Texturally the soils varied widely from sand to clay loam with the sand content ranging from 62.79 per cent in piedmont to 59.17 per cent in flood plain and 57.36 per cent in alluvial plain. A decreasing trend in silt from piedmont plain to flood plain was noticed. Similarly, clay content showed highest for alluvial plain, which is followed by flood plain and the lowest by piedmont plain. A decreasing trend for bulk density was observed from piedmont plain to the flood plain. Similarly, particle density was observed highest at alluvial plain (Mean value = 2.61 Mg m⁻³) and lowest at the piedmont plain (Mean value = 2.51 Mg m⁻³). Porosity was found highest at alluvial plain with mean value of 47.05 and lowest at the piedmont plain with mean value of 44.61. A decreasing trend was observed for hydraulic conductivity from piedmont plain to flood plain. It was negatively correlated with clay ($r = -0.735^{**}$), bulk density (-0.390^{**}) and organic matter ($r = -0.154$). Similarly, water retention properties showed

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wide ranging variability. The soils ranged from extremely acidic (4.15) to slightly acidic (6.14). The Organic matter content was found highest in the alluvial plain soil (Mean value of 1.53 g kg⁻¹) which was followed by flood plain (Mean value of 1.49 g kg⁻¹) and lowest was observed in the piedmont plain (Mean value 1.45 g kg⁻¹). The available N varied from low to medium (175.36 to 463.35 kg ha⁻¹) whereas, the amount of available P₂O₅ found low to high (20.77 to 69.25 kg ha⁻¹) and available potash was found low to medium (29.03 to 168.67 kg ha⁻¹). The macroaggregate content was observed highest in the alluvial plain followed by flood plain and the piedmont plain.

The silt/clay ratio of the soils of the studied watershed showed no definite trend with respect to different physiographic units. The clay ratio showed decreasing trend from piedmont plain (9.74) to alluvial plain (7.16) and flood plain (7.40). The DR showed significant positive correlation with sand ($r = 0.545^{**}$), while it had significant negative correlation with silt ($r = -0.560^{**}$) and clay ($r = -0.327^*$). The 6 erosion ratio was highest in alluvial plain and the lowest was observed in the flood plain areas. The soil erosion in the piedmont plain ranged from slight to severe. Likewise, in the alluvial plain, soil erosion ranged from slight to severe and for the flood plain soils, it ranged from slight to moderately slight erosion. A decreasing trend for soil loss from alluvial plain soil (8.52 t ha⁻¹ yr⁻¹) to piedmont plain (7.37 t ha⁻¹ yr⁻¹) soils and the lowest was observed in flood plain (3.39 t ha⁻¹ yr⁻¹). Soil loss showed negative correlation with sand, HC, macroaggregate and mean weight diameter. Similarly, it showed positive correlation with silt, clay, water retention parameters and erodibility indices.

In all the three physiographic units, the estimated soil loss was dominated by slight level showing 20, 11.67 and 33.33 per cent samples falling in the class. Overall a total of 65 per cent samples showed slight soil loss. The entire area is free from very severe (>40 t ha⁻¹) class of soil loss. It was observed that with lower elevation, the severity of soil loss decreases. About 22 hectares (0.18%) susceptible to severe soil loss and under the moderately severe class, the total area was 50 hectares (0.41%) and in moderate class, the total area was 1047 hectares (8.60%). The highest area of 5550 hectares (45.59%) showed moderately slight soil loss, while 5505 hectares (45.22%) area showed slight erosion problem. From the study it could be suggested that erosion control measures need to be undertaken in the watershed to prevent deterioration of soil health.

Scope of augmenting farmers' income in small tea plantations – a case study in golaghat sub division of Golaghat district

Anganjyoti Swarup

The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Golaghat Sub Division of Golaghat district” was undertaken with the following objectives to study the socio-economic status of the small tea growers, to examine the existing farming systems and resource utilization pattern and to identify the constraints and suggesting measures for augmenting the farm income. The present study was conducted in five Sub Divisions of Golaghat district, i.e. Golaghat East Development Block, Golaghat North Development, Golaghat Central Development Block, Kakodonga Development Block and Morangi Development Block. The sample selection was done using stratified random sampling technique, for which information was collected from primary sources and secondary sources. Primary data were collected through interview technique with structured interview schedule prepared by the researcher. The socio economic status study of the small tea growers revealed that the age group of population between 15 to 60 year was maximum which constitutes 64.54 per cent of total, where 39.98 per cent is male and 24.56 per cent is female and lowest in above 60 age group of 12.97 per cent where 7.40 per cent is male and 5.57 per cent is female. Education status of the population was highest in graduate level which constitutes of 54.09 per cent of total, where 33.10 per cent is male and 20.99 per cent is female. Occupation status of maximum respondents are engaged in tea farming constitutes 16.81 per cent as full time and 7.57 per cent as part time of total samples under the age group of 15-60 years. The study resulted in identification of six types of farming systems viz. FS I (Tea, Field and Horticultural Crops), FS II (Tea, Field and Horticultural Crops, other Plantation Crops and Allied Activities such as Fishery/dairy cattle), FS III (Tea and other Plantation Crops), FS IV (Tea and Allied Activities such as Fishery/dairy cattle), FS V (sole Tea) and FS VI (Tea, Field and Horticultural Crops and Allied Activities such as Fishery/dairy cattle) amongst which FS II was the only farming system adopting all the types of considered components of farming system with 26.81

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Major Advisor : Dr. S. C. Barua

per cent respondents. Number of growers adopting FS I was highest which is 31.80 percent of the total number of growers, whereas growers adopting FS VI & FS V has the lowest numbers of growers i.e. 5.75 and 7.66 percent of the total respectively. Operational area wise the growers of FS III has the highest area of 118.74 ha and FS VI has the lowest area of 31.09 ha. The land utilization was found highest in case of tea plantation i.e. 73.45 percent of the total and quite lowest in other plantation crops and fishery. In case of labour utilization, it was maximum in all the components of farming systems and it was observed highest in tea cultivation accounting for 528.74 mandays per hectare per year. The production rate of tea was quite lowest across all the farming systems of Golaghat district which was found to be ranging from 9199.16 to 13462.36 kg green leaf per hectare per year in FS V and FS II respectively. Intergroup analysis amongst the farming system illustrated that the FS II with all the considered components of farming systems achieved the highest benefit cost ratio of 2.36 and lowest benefit cost ratio was obtained by FS V of 1.50 with only tea as its component. From the above results, conclusion was drawn that FS II adopting all the necessary components of farming systems suitable in the study area, like tea, field and horticultural crops, other plantation crops and allied activities and utilizing all the remaining unutilized land was the most efficient mode of farming system compared to the other groups. This successful reasons behind this system was that all the components were dependent on one another, it gave continuous income round the year, recycling of by products was applicable and cost was minimized for input use.

Scope of augmenting farmers' income in small tea plantations – A case study in Bokakhat subdivision of Golaghat district

Angshuman Bezbaruah

The rise of small tea growers significant movement in the plantation history of Assam. This highly unorganized sector, over the years, has emerged as the major contributing force in changing the socio-economic sphere of the state, providing average daily employment to more than 6.86 lakh persons. An area of 82119.98 hectares is under the small tea growers with the majority of the area comes under the districts of Dibrugarh, Tinsukia, Sivasagar and Golaghat. The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Bokakhat Sub Division of Golaghat district” was undertaken with the objectives to study the socio-economic status of these small tea growers, to examine the existing farming systems and resource utilization pattern and to identify the constraints and suggesting measures for augmenting the farm income. The present study was conducted in Bokakhat Sub Division of Golaghat district, which is the home for the small tea growers’ movement in Assam. The sample selection was done using simple random sampling technique, for which information was collected from primary sources and secondary sources. Appropriate tools were used to analyse the data.

The socio economic status study of the small tea growers revealed that the maximum population of the small tea growers was in the age group 15-60 years, which constituted the main working force and across all the farming systems, the male outnumbered the female members. The overall male to female ratio was found to be 1.53 to 1. The literacy percentage was found to be very high, ranging from 92.33 to 96.02 per cent. About 30.91 per cent of the total sample population was found to be engaged in small tea farms, of which 37.61 per cent engaged full-time basis. The full time working force comprised of 76.66 per cent male members while the part-time working force comprised of 75.86 per cent male members.

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From the study identification of five types of farming systems was seen amongst the sampled growers *viz.* FS I (Tea + Field and Horticultural Crops + Other Plantation Crops), FS II (Tea + Field and Horticultural Crops + Fishery), FS III (Tea + Other Plantation Crops), FS IV (Tea + Field and Horticultural Crops) and FS V (Tea + Field and Horticultural Crops + Other Plantation Crops + Fishery). The distribution of the small tea growers was found highest in FS I (Tea + Field and Horticultural Crops + Other Plantation Crops) with 30.83 per cent of the total sample size and lowest in FS V (Tea + Field and Horticultural Crops + Other Plantation Crops + Fishery) with 13.35 per cent of the total sampled small tea growers. The land utilization was found highest in case of tea plantation i.e. 72.84 per cent of the total land holding area being utilized for tea cultivation followed by 19.62 per cent under field and horticultural crops. The utilization pattern of material inputs and labour inputs in tea was found to be higher compared to the utilization pattern in the other components of the farm. On average, the utilization of total human labour in tea was found out to be 477.60 mandays per farm, of which 71.49 per cent was hired labour and 28.51 per cent was family labour. Comparative analysis of the economics of all the existing farming systems in the study area showed that FS V was observed to be the most remunerative farming system for the farmers with a benefit-cost ratio of 2.08. The farmers in FS V gave equal importance to the performance of all its components which significantly contributed to the high overall returns from that farming system.

Lack of labour availability in the peak plucking season, difficulties in settlement of land documents in Government offices, procurement of quality planting materials like clones and biclonal seed stocks, erratic climatic conditions, low price realization of green leaves, problem of pest infestation and threat to the plantations by animals like monkey and elephants were some of the major problems identified in the study zone.

Suggestions based upon the findings of the study were also suggested to overcome the constraints of the farmers' at small tea plantations, thereby widening their scope to increase their farm income.

Impact of gas flaring on soil health and growth of tea plants adjacent to oil field in merbil Majuli OCS 6 (west) in Dibrugarh district of Assam

Anubrat Borah

An experiment was conducted to study the impact of gas flaring on soil health and growth of tea plants adjacent to oil field in Merbil Majuli OCS 6 (WEST) in Dibrugarh district of Assam during 2019-2020. The study was designed with Randomized Complete Block Design (RCBD) accommodating five levels under distance and two levels under seasons.

Soil and plant samples were collected randomly at an interval of 35-55 m, 55-75 m, 75-95 m, 95-115 m and 130-150 m (control site) starting from the gas flaring point in rainy and autumn seasons. The experimental plot was laid out at 35 metres away from the flare pit due to the presence of a road in between the flare site and the selected tea garden.

Plant physiological and soil physico-chemical properties were studied and observed that the gas flaring had adverse effect on growth and development of tea plants viz. physiological parameters such as relative turgidity, water saturation deficit, stomatal count, chlorophyll etc., growth parameters like plucking point density, number of branches and biochemical parameters such as caffeine and polyphenol content and soil physical parameters viz., bulk density, porosity, hydraulic conductivity etc. and chemical parameters such as pH, available nutrients, electrical conductivity etc. In this experiment, plant parameters viz. relative turgidity (82.22%), stomatal count (17.33 nos./microscopic field), leaf area (31.38 cm²), Chlorophyll-a content (0.52 mg/g fresh weight), Chlorophyll-b content (0.31 mg/g fresh weight), Total caffeine content (1.40 %), polyphenol content (21.65 %), Plucking point density (21.5 nos./2500 cm²), Number of branches (9 nos. /plant) were found to be decreased at distance (35-55 m) away from the gas flaring site which significantly increased with distances. Water saturation deficit of tea leaves were recorded highest (17.78%) at distance (35-55 m) and decrease with distances away from the gas flaring site. Soil physical properties viz., soil

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temperature (28.5°C) decreased with distances and soil moisture (11.83%) increased with distances away from the gas flaring site. Soil chemical properties like soil organic carbon (0.81%), available nitrogen (242.83 kg/ha), available phosphorus (13.79 kg/ha) and available potassium (254.00 kg/ha) were found to be decreased at distance (35-55 m) away from the gas flaring site which significantly increased with distances. Bulk density, Soil porosity, Hydraulic conductivity, Soil pH and Electrical conductivity of soil had no significant affect of gas flaring with respect to both distances and seasons.

Scope of Augmenting Farmers' Income in Small Tea Plantations – A case study in Dhansiri Sub Division of Golaghat district

Dipankar Handique

The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Dhansiri Sub Division of Golaghat district” was undertaken with the following objectives: 1. To study the socio-economic status of the small tea growers 2. To examine the existing farming systems and utilization of resources 3. To identify the constraints and measures for augmenting the farm income. The present study was conducted in Dhansiri Sub Division of Golaghat district, which has one development blocks *viz.* Golaghat South Development Block. The sample selection was done using Simple Random Sampling technique, for which information was collected from Primary sources and Secondary sources. Primary data were collected through interview technique with structured interview schedule prepared by the researcher. The socio economic status study of the small tea growers revealed that major section of the farmers belongs to the age group 15-60 years (69.19%) where involvement of male was found to be highest (41.65%) and 79.23 per cent of the surveyed population received minimum high school level education out of which 45.38 per cent of male and 33.87 per cent of population was female. The study on farming systems revealed that in the study area the researcher found seven types farming systems *viz.* Tea, Field & Horticulture crops, Other Plantation crops& Fishery (FS-I), Tea, Field & Horticulture crops(FS-II), Tea, Field & Horticulture crops and Other plantation crops (FS-III), Tea, Field & Horticulture crops and Fishery (FS-IV), Tea, Other plantation crops (FS-V),Tea, Other plantation crops and Fishery (FS-VI) and Tea (FS-VII). Among the farming systems the no. of respondents was found to be highest in FS-V and lowest in FS-IV and FS-VII. The variable cost involved in various farming systems was found to be highest in FS-VII (Rs.96916.45 farm⁻¹yr⁻¹) and was lowest in FS-IV (Rs.45417.80 farm⁻¹yr⁻¹). The study revealed that the best farming system was FS-I where mean value is 3.02which comprises of all the components (tea, rice, vegetables, arecanut, agarwood and fishery) and FS-VII (0.27) showed the lowest mean value of all the farming system due to

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variation in inclusion of different components in the farming systems. Present study showed that the number of physical constraints was found to be highest and social constraints was found to be the lowest. It can be stated that there is a great scope of overcoming the constraints as major constraints was found under physical category which can be rectified by using advance tool like plucking machine. Adoption of this will reduce the labour requirement and increase the efficiency in plucking. Small tea growers of the study area had a wide scope of augmenting the income from their limited farm resources by following proper cultivation practices, moving towards organic tea cultivation, forming farmer producer company through which they can collectively bargain for inputs and sell the tea in a common platform. Using high yielding varieties of other components, crop rotation, diversification of enterprise, proper utilization of fallow land and market consciousness can help in increasing the income from the components other than tea.

Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam

Eimon Bharadwaj

The study entitled “Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam” was undertaken this to study the impact of spillage in the tea plantations in nearby oil fields with probable effect on soil health and the growth of the tea crop with the following objectives to study the effluent released from the oil fields on the physiology of tea crop with respect to growth and to study the impact of effluent on soil physicochemical properties in tea plantation.

The present study was conducted in Shalmari No. 1 near Tingkhong tea estate of Dibrugarh district. The site is nearer to Oil Collecting Station (OCS) number 1 with well number 17, 25, 30, 44. Sample collection was divided into two parts i.e. plant and soil samples. Samples for plant and soil were carried out in two tea growing seasons *viz.* Rainflush, and autumn flush. Samples were collected at an interval of 0-21 m, 21-42 m and 42-63 m and beyond 63m (control site) starting from the effluent spilling point for the affected plot. For one season, a total of twelve samples were collected with respect to four distances and within each distances three replication were used in the entire investigation period. A total of twenty-four samples were collected in both the season. Plant sample was collected manually while soil sample was done by soil augur. Both for soil and plant, a total of 48 samples were collected. The laboratory works were carried out in the Department of Tea Husbandry & Technology and Department of Soil Science, Assam Agricultural University, Jorhat, Assam. Values obtained from the samples from different parameters were statistically analysed. Also, correlation analysis was done to see the significant variation and similarities amongst the parameters.

The present investigation reveals oil effluent spillage as a major factor for plant growth and soil quality deterioration in Shalmari-1, Dibrugarh field and the impact was more pronounced in the vicinity of drilling point adversely affecting plant physiological, growth and biochemical parameters also soil physical and chemical parameters. Plant

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parameters like water saturation deficit increased from 8.9 to 18.85 % in crude oil affected site while decreased the relative turgidity, stomatal count, plucking point density, number of primaries, chlorophyll, caffeine and polyphenol content in the tea plants grown in the contaminated site. Bulk density of the soils of contaminated site was increased as compared to the control site from 1.22 to 1.33 Mg m⁻³. Also, there was increase in pH, organic carbon and available nutrients in the contaminated site. However, soil porosity, hydraulic conductivity, electrical conductivity was low in the contaminated area as compared to control site.

Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1 (North), Dibrugarh district of Assam

Jayshree Konwar

Assam is one of the most popular destinations for tea (*Camellia sinensis* (L.) O. Kuntze) and it produces more than half of the country's total production. The Upper Assam region of the Brahmaputra valley is also a prime centre for crude oil drilling industry in India. During crude oil exploration a vast amount of drilling mud or oily sludge is generated which spread through rain and flood to the nearby cultivated fields including tea. The oily sludge adversely affects the soil health and also reduces the crop yield. The present investigation was aimed to study the physicochemical properties of soil and growth of tea in a tea garden of Shalmari situated near Oil Collecting Station (OCS-1) in Dibrugarh district, Assam. Different plant and soil properties were analysed using standard statistical procedure in two tea growing seasons *viz.*, Rain flush and Autumn flush. Soil samples were collected from randomly selected sites from a distance of 11m from the oil pit and at an interval of 0-21m, 21-42m, 42- 63m. For each distance three replications were selected. In each replication four soil samples were collected randomly and mixed to make a composite sample. Another three samples were collected from the unpolluted control plot *i.e.* 63-100m away from the pit site. Leaf samples were also collected in similar way. For one season, twelve samples each of soil and plants were collected. After the treatments the results revealed that the water saturation deficit was found higher near the oil pit. The relative turgidity, stomatal count, leaf area, specific leaf weight of tea leaves increased with distance from the pit site. Polyphenol, caffeine and chlorophyll content of the tea leaves was found to be low near the oil pit site. The number of branches and plucking point density of the tea plants was found to be lower near the oil pit and it gradually increased with distance. However, the soil particle analysis does not show any variation with respect to both distance and season. The bulk density, organic carbon, electrical conductivity was found to be high near the oil pit site but porosity and hydraulic conductivity was low in the vicinity of the oil pit. The soil pH was increased near the pit site making the soil medium acidic. Available N

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and K₂O was found significantly very high near the pit site and substantially decreased with distance. Conversely, available P₂O₅ significantly reduced near the pit site. The study revealed that most of the plant and soil parameters were found to be not affected beyond 63m from the pit point. Measures should be taken to reduce the adverse affects of oil effluents on tea plantations.

**IMPACT OF GAS FLARING ON SOIL HEALTH AND
GROWTH OF TEA PLANTS ADJACENT TO MERBIL
MAJULI, OCS-6 (SOUTH) IN DIBRUGARH DISTRICT OF
ASSAM**

Kalparanjan Bhuyan

Gas flaring is a major contributor to the emission of toxic gases and other gaseous pollutants into the atmosphere. The study entitled “Impact of gas flaring on soil health and growth of tea plants adjacent to Merbil Majuli, OCS-6 (South) in Dibrugarh district of Assam”. The present research work was conducted to study the impact of gas flaring released in nearby oil fields with probable effect on soil health and growth of tea plants. During the experiment, samples for the plant and soil were carried out in two tea growing seasons *viz.* rain flush and autumn flush. The experimental plots were laid out at 11 metres away from the gas flaring point due to the presence of a road in between the flare site and the selected tea garden. Plots were selected at an interval of 20 metres within the experimental design i.e. D1 (11-31m), D2 (31-51m), D3 (51-71m), D4 (71-91m) and DC (120-140m) where, DC denotes control plot. Plant samples were collected from 4 different plants for each parameter separately at each replication and for both the seasons and soil samples were collected from 4 different spots selected randomly in each replication. The present investigation revealed that the gas flaring had adverse effect on growth and development of tea plants and physico-chemical properties of tea soils in Merbil Majuli, OCS 6 (South), Dibrugarh district. The impact was more pronounced in the vicinity of flaring point. Gas flaring had adversely affected some physiological parameters of tea plants such as relative turgidity, water saturation deficit, stomatal count, chlorophyll etc., growth parameters like plucking point density, number of branches and biochemical properties of made tea such as caffeine and polyphenol content. Soil physical parameters such as bulk density, porosity, hydraulic conductivity etc. and chemical parameters such as pH, available NPK, electrical conductivity etc. were also found to be adversely affected by gas flaring. In this experiment, the results showed that during both rainy and autumn season plant physiological parameters *viz.* relative turgidity (83.33 % and 80.95 % respectively), stomatal count (17 nos./

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microscopic field and 16 nos./microscopic field respectively), leaf area (31.61 cm² and 31.15 cm² respectively), specific leaf weight (0.008 mg/cm² and 0.007 mg/cm² respectively), chlorophyll-a content (0.55 mg/g fresh weight and 0.48 mg/g fresh weight respectively), chlorophyll-b content (0.30 mg/g fresh weight and 0.31 mg/g fresh weight respectively), total caffeine content (1.44 % and 1.32 % respectively), total polyphenol content (22.24 % and 23.36 % respectively), plucking point density (21 number/2500 cm² and 21 number/2500 cm² respectively) were found to be significantly low at distance D1 (31-51 m) which was close to the flare site. Water saturation deficit of tea leaves were also significantly high (16.66 % and 19.04 % respectively) during both the season at distance D1 (31-51 m) and decreased at distances away from the gas flaring site. Soil temperature (25.23oC and 26.22oC respectively) increased significantly near the flare site (D1:31-51 m) and causing significant reduction of soil moisture (11.71 % and 11.93 % respectively) at both the season. Soil organic carbon (0.80 % and 0.79 % respectively), available nitrogen (245.66 kg/ha and 242.66 kg/ha respectively), available phosphorus (13.80 kg/ha and 13.81 kg/ha respectively) and available potassium (255.00 kg/ha and 254.33 kg/ha respectively) were also decreased significantly near the flare site (D1:31-51 m) both at rainy and autumn season. The study revealed that the gas flaring did not have any significant affect on bulk density, soil porosity, hydraulic conductivity, soil pH and electrical conductivity of soil with respect to both distances and seasons. Most of the plant parameters were found to be affected by gas flaring beyond 91 m from the gas flare point and the soil parameters were not affected beyond 71 m. This implies that tea plants are safe at or beyond 91 m from the gas flaring point and produce economic yield. Measures like growing barrier crops, improving drain status and shade status, etc. should be taken to reduce adverse impact of gas flaring on tea plantation.

Impact of oil field effluent on soil health and growth of tea in small tea farms in proximity of OCS-2 in the Digholia area of Dibrugarh district of Assam

Preetisha Dutta

Oil contamination causes serious environmental concern and adversely affects the plant as well as soil environment due to the release of toxic by-products. In the upper Assam districts of Dibrugarh and Tinsukia, a number of Oil Collecting Stations have been set up by the premier oil producing company *viz.*, Oil India Limited. In the proximity of these Oil Collecting Stations lies a large number of oil drilling pits where various drilling operations are being carried out. On the vicinity of these drilling pits, a number of people living in adjoining villages own their small tea gardens. During heavy rains these pits containing crude oil often overflow. Hence, the aim of the present study was to investigate the impact of oil field effluent on soil health and growth of tea plants during two growing seasons.

In the present investigation, a detailed study to understand and assess the adjacent soils and tea plants was attempted. The site of selection was small tea farms adjacent to the oil drill site in the Digholia area of Dibrugarh, Assam. The garden was planted with clone TV 22 and the age of plantation was 15 years. Samples for analysis were drawn at random from varying distances, *viz.* at 21 m, 42 m and 63 m from the oil drilling site. Samples were also collected from tea sections that was further away from the drill site, *viz.* beyond 80 m from the oil drilling site and unaffected by the spill of crude oil, which was homogenous and contiguous to the garden with clone TV 22 of same age. Standard analytical procedures were followed to determine various plant physiological parameters, *viz.* Relative Turgidity, Stomatal Count, Leaf Area Measurement, Water Saturation Deficit, Specific Leaf Weight, Total Chlorophyll Content, Caffeine Content and Total Polyphenol Content and Yield parameter, *viz.* Plucking Point Density and Number of Primaries/branches as well as soil physico-

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chemical parameters, viz. Bulk Density, Soil Porosity, Hydraulic Conductivity, Soil particle analysis, pH, Organic carbon, Electrical Conductivity and Available Nutrients (NPK).

The results of the study revealed that Water Saturation Deficit increased near the oil drilling site and was higher during autumn flush whereas values of other plant parameters increased with an increased in distance from the oil drilling site. Soil porosity and hydraulic conductivity was low near the oil drilling site and increased significantly with an increase in the distance. The pH of soil was found to be more acidic near the spillage point while organic carbon content increased near the oil drilling site. The available Nitrogen and available phosphorous was found to increase with an increase in distance of the area from the oil pit. Conversely, Bulk Density, Electrical Conductivity and available K₂O increased near the oil drilling site. There was no change in the texture of the soil with presence or absence of crude oil during both the seasons under investigation.

Impact of oil field effluent on some physico-chemical properties of soil and growth of tea in the plantation of small growers of Dibrugarh district of Assam

Pubali Neog

A field experiment was carried out in September, 2019 and November, 2019 as Rain Flush and Autumn Flush respectively in No. 1 Shalmari Gaon, Dibrugarh, Assam near Oil collecting station (OCS)-1, Well number 17, 25, 30 and 44. The experiment was conducted in 4x2 Factorial Randomized Block Design with 3 replications under 4 distances *viz.*, 0-21m (D1), 21-42m (D2), 42-63m (D3), Beyond 63m (Dc) and 2 seasons, Rain Flush (S1) and Autumn Flush (S2) with tea clone TV22. The results showed that the physiological parameters *viz.*, Relative turgidity, Number of stomata, Leaf area and Total chlorophyll content measurement recorded the lowest value irrespective of flushing season in the tea grown within 21m distance from the pit and recorded highest value at the distance away from the oil pit. Water saturation deficit was recorded to have the highest value near the pit irrespective of flushing season and gradually increases at the distance away from the oil pit. Discounting the Flushing season the distance have not recorded any significant variation in case of Specific leaf weight. In case of quality parameters of tea, disregarding the Flushing season the tea grown in the vicinity of the oil pit recorded the lowest value of caffeine content (1.58%) and total polyphenol content (21.47%) and found to be significantly lower than the tea grown away from the oil pit. The growth parameters *viz.*, plucking point density and number of primaries per plant recorded the lowest value in the vicinity of the effluent pit which was significantly lower than tea grown at a distance away from the pit. The number of primaries was significantly positively correlated with plucking point density. In case of soil physical parameters, both porosity and hydraulic conductivity recorded lowest value of 45.64% and 0.25 cm/min, respectively, irrespective of flushing season in the vicinity of the effluent pit which was significantly lower than the tea grown soil at

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the distance away from the oil effluent pit. The bulk density of soil near the oil effluent pit recorded the highest value (1.31 Mg/m³) and it gradually decreases along with the distance away from the oil effluent pit. Soil pH, organic carbon content and electrical conductivity recorded highest value in the vicinity of the effluent pit which was significantly higher than the soil at a distance away from the effluent pit. Regardless of the flushing season the available nitrogen of soil near the effluent pit recorded the highest value and it was significantly higher than the soil at a distance away from the effluent pit, which was significantly higher than the soil at a distance away from the effluent pit. Available phosphorous of the soil adjacent to the effluent pit recorded the lowest value and found to be significantly lower than the soil at a distance away from the effluent pit. Available potassium of tea grown soil near the effluent pit recorded the highest value (241.50 kg/ha) and found to be significantly higher than the tea grown soil at a distance away from the effluent pit. In some of the parameters the seasonal impact plays a significant variation. Among the physiological parameters *viz.*, Relative Turgidity, Stomatal count, Leaf area and total chlorophyll content measurement recorded a significantly higher value in the rain flush as compared to the autumn flush. In case of the water saturation deficit the seasonal influence seems to have recorded significantly higher in the autumn flush than the rain flush. The quality parameters including caffeine content and total polyphenol content seems to have significantly higher value in the rain flush than the autumn flush. The growth parameters *viz.* plucking point density and number of branches per plant recorded higher value in the rain flush than the autumn flush. In case of the soil physical parameters, except porosity all the parameters did not recorded any significant variation among the seasons. The porosity have recorded a significantly higher value in the autumn flush than the rain flush. Similarly the chemical parameters did not recorded any significant variation among the seasons. The Porosity and bulk density was found to have negative correlation.

Impact of Gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS North in Dibrugarh district of Assam

Rashmi Kalita

Assam is known for natural resources like oil and its tea plantations. Both of these industries co exist near each other in the districts of upper Assam. On the extraction of crude oil, low pressure natural gases are released into the environment which is burnt in open air. This continuous flaring process exposes the tea plants to uninterrupted light throughout the day and night and an increase in temperature in the tea growing areas near the gas flaring sites. Therefore the present study was undertaken, which could be an aid to determine the extent of the effect of gas flaring on plant growth and health of tea growing soils.

In the study, responses of some plant physiological and growth parameters and some soil physical and chemical parameters were studied on TV22 plants growing near gas flaring site of Kothaloni OCS North in No. 1 Naharani gaon in Dibrugarh district of Assam. The experimental plot was laid out in 5 x 2 factorial RCBD with two factors viz. different distances from the flare site and two seasons. The plant and soil samples were collected on early September and end October for rain and autumn flush respectively.

The result of the study revealed that there was a gradual decline in relative turgidity, specific leaf weight, plucking point density, stomatal count, leaf area measurement, polyphenol content, chlorophyll content, caffeine content but an increase in water saturation deficit of the green tea leaves on plants existing at a distance moving closer to the flare pit. A significant increase in rain flushing season as compared to autumn was observed in all the plant parameters except water saturation deficit. Significant increase in soil temperature and decrease in soil moisture content was observed in distance closer to the flare pit. Distance from flare did not play significance in bulk density, porosity, soil pH, hydraulic and electrical conductivity, organic matter content and soil nutrient availability in tea growing soils under the conditions of the present investigation. Change in season seems to have no significant role in the soil physical and chemical characteristics.

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Department : Tea Husbandry and Technology

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Impact of GAS flaring on soil health and growth of tea plants adjacent to Kothaloni OCS South in Dibrugarh District of Assam

Ripsita Phukan

A study entitled “Impact of gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS South in Dibrugarh district of Assam” was carried out in Kothaloni, No.1 Naharani, Dibrugarh, Assam during the year 2019-20. The study was conducted with Randomized Complete Block Design (RCBD) and analysis was done accommodating five levels of distances and with two seasons.

Soil and plant samples were collected from (40-50) metres, (50-60) metres, (60-70) metres, (70-80) metres and control site (150-160) metres away from the gas flaring site in rainy and autumn seasons. The experimental plot was laid out at 40 metres away from the flare pit due to the presence of a pond and a concrete barricade in between the flare site and the selected tea garden.

The observations were made for tea plant and soil physico-chemical parameters. As far as plant parameters are concerned, relative turgidity, stomatal count, specific leaf weight, leaf area measurement, water saturation deficit, caffeine content, quality parameters and plant growth parameters as well as soil physico-chemical parameters such as bulk density, porosity, hydraulic conductivity, soil temperature, soil moisture, pH, organic carbon content, electrical conductivity, available nutrients (NPK) were studied. From the study, mean plant parameters viz. relative turgidity (79.68%), stomatal count (19.66 no./mm²), specific leaf weight (0.007 g/cm²), tea leaf area (36.37cm²), chlorophyll-a content (0.96mg/g) and chlorophyll-b content (0.42 mg/g), caffeine content (2.35%), polyphenol content (21.37%), plucking point density (31.33 no./2500cm²) were found to be decreased at distance (40-50)metres away from the gas flaring site which significantly increased with distances. Water saturation deficit of tea leaves recorded highest (20.51%) at distance (40-50) metres which decreases with distances away from the gas flaring site. Soil physical parameters viz. soil temperature

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recorded highest (29.83°C) at distance (40-50) metres which decreases with distances and soil moisture recorded lowest (11.48%) at distance (40-50) metres which increases with distances away from the gas flaring site. Rest of the studied soil parameters *viz.*, bulk density, porosity, hydraulic conductivity, pH, organic carbon content, electrical conductivity and available nutrients (NPK) recorded non significant variations along distances and seasons.

The study suggested further research on the impact of gas flaring on effect of light intensity, biological properties of soil, tea yield, pest and disease infestation, etc.

Scope of Augmenting Farmers' Income in Small Tea Plantations - A case study in Titabor sub-division of Jorhat district

Shyamal Kishore Bordoloi

The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Titabar Sub Division of Jorhat district” was undertaken with the following objectives: 1. To study the socio-economic status of the small tea growers 2. To examine the existing farming systems and utilization of resources 3. To identify the constraints and measures for augmenting the farm income. The present study was conducted in Titabar Sub division of Jorhat district, which include two development blocks *viz.* Titabar development block and Jorhat East development block. The sample selection was done using Stratified Random Sampling technique, for which information was collected from Primary sources and Secondary sources. Primary data were collected through interview technique with structured interview schedule prepared by the researcher. The socio economic status study of the small tea growers revealed that major section of the farmers belong to the age group 15-60 years (62.85%) where involvement of male was found to be highest (59.11%) and most of the farmers had educational qualification of HS standard (37.34%) where females constitute the highest (51.91%). The study on farming systems revealed that in the study area the researcher found five types farming systems *viz.* Tea, Field & Horticulture crops, Plantation crops excluding tea (FS-I), Tea, Field & Horticulture crops, Plantation crops excluding tea, Fishery (FS-II), Tea, Field & Horticulture crops, Fishery (FS-III), Tea, Field & Horticulture crops (FS-IV) and Tea, Plantation crops excluding tea (FS-V). Among the farming systems the no. of respondents was found to be highest in FS-I and lowest in FS-IV. The variable cost involved in various farming systems was found to be highest in FS-II (Rs. 163946.96 farm-1yr-1) and was lowest in FS-IV (Rs. 52420.20 farm-1yr-1) whereas after doing ANOVA single factor analysis of the Benefit Cost ratios, it was found that FS-II has the highest mean value (2.92) and FS-IV has the lowest mean (0.89) which was due to variation in inclusion of different components in the farming systems. Studying the various constraints, it was found that the number of physical

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constraints were highest and social constraints were lowest, from where it can be analysed that there is a great scope of overcoming the constraints as major constraints was found under physical category which can be rectified by following proper farming practices. Small tea growers of the study area had a wide scope of augmenting the income from their limited farm resources by following proper cultivation practices, moving towards organic tea cultivation, forming farmer producer company through which they can collectively bargain for inputs and sell the tea in a common platform. Involving high yielding varieties of other components, crop rotation, diversification of enterprise, proper utilization of fallow land and market consciousness can help in increasing the income from the other components other than tea.

Master of Fishery Science

- **Aquaculture**
- **Aquatic Environment Management**
 - **Fish Processing Technology**
- **Fisheries Resource Management**

Extraction of fibre from *Ricinus communis* and evaluation of its physical and chemical properties

Ashim Kumar Bora

An experiment was conducted for a period of three months from July to September, 2017 at Thekerabeel, District-Morigaon, Assam to determine the optimum stocking density of Jayanti rohu (genetically improved *Labeorohita* fingerlings) reared in 12 nos. modular cages of size 48m³(6m x 4m x 2m), where in 15 fish m⁻³, 20 fish m⁻³, 25 fish m⁻³ and 30 fish m⁻³ were set as the different stocking densities designated in treatment T1, T2, T3 and T4 respectively in triplicates. The mean initial length and mean initial weight of the fingerlings used in the experiment were 6.92± 0.15 cm, 7.00±0.00 cm, 6.95±0.03 cm, 6.93±0.03 cm and 6.91±0.15 gm, 6.97±0.02 gm, 6.80±0.06 gm and 6.80±0.06 gm for treatment T1, T2, T3 and T4 respectively. Whereas, the mean harvesting length and weight in treatment T1, T2, T3 and T4 recorded were 17.43±0.11cm, 17.46 ±0.04 cm, 16.54 ±0.03 cm, 15.08 ±0.06 cm and 103.07± 1.00gm, 95.57±0.30 gm, 90.03±0.12 gm, 70.5±0.25 gm respectively. After three months rearing period, final length and weight gain was found to be the highest at lowest stocking density at treatment T1 and lowest at the highest stocking density at treatment (T4) with significance difference among the treatment (P<0.05). Further, weight gain percent (WG %), specific growth rate (SGR) and survivability % were found to be the highest at lowest stocking density (T1) and lowest at the highest stocking density (T4) with significant difference (P<0.05) among the treatments. Feed conversion ratio (FCR) values were adversely affected with the increase in stocking density. FCR value was found to be the lowest as 1.80 ±0.02 in T1 and highest in T4 as 2.20 ±0.01. The water quality parameters in the different treatments were found to be within the favorable range for fish culture. Plankton density was found to be the highest in the cage site and lowest at the outside cage area (50m away). However, plankton diversity was similar in the cage site as well as at outside cage area. The gross yield 103.45±0.2 kg and benefit cost ratio (1.66) were found to be the highest in T3 among all the treatments. Therefore, economics of operation was considered to be most important criterion in deciding the optimal stocking density for raising Jayanti rohu fingerlings in cages in a seasonally open *beel* of Assam having similar ecological characteristics like Thekerabeel.

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Department : Department of Aquaculture

Major Advisor : Dr. Dipak Kumar Sarma

Effect of Diet on Growth, Haematology and Disease Resistance of Amur Carp (*Cyprinus Carpio Haematopterus*) through Replacement of Rice Polish with Rice Beer Waste

Astrica Phukan

The objective of the research work was to determine the effect of feeding rate on growth performance such as specific growth rate, feed conversion ratio and protein efficiency ratio as well as haematological responses, such as RBC, WBC, Hb, Hct, MCV and MCHC and disease resistance of Amur carp (*Cyprinus carpio haematopterus*) against *Aeromonas hydrophila*. The experiment was conducted in cement cisterns with a water level of 80±5 cm for 120th days. Four different treatments viz. T-0, T-1, T-2 and T-3 were used in triplicates with 0%, 15%, 30% and 40% incorporation of rice beer waste respectively. Each tank (5.5m × 4m × 1m) was stocked with 100 numbers of Amur carp fingerlings and were fed twice a day with pelleted diet. A fortnight interval physico-chemical parameters of water and growth of experimental fish were recorded and evaluated. In this study, Amur carp growth was significantly ($p<0.05$) higher in treatment T-3, which had 40% inclusion level of rice beer waste. Control with 0% inclusion of rice beer waste showed lowest growth of fish. The SGR (3.30 g), FCR (1.85) and PER (4.31) value showed comparatively better in T-3 treatment. Haematological parameters in different treatments were evaluated after the end of the experiment where treatment T-1 had the highest RBC count (3.20 million/mm³) and was significantly ($p<0.05$) different from all other treatments (T-2 and T-3). The maximum WBC count (13.30 thousands/mm³) was recorded in T-3, and the lowest (11.40 thousands/mm³) was found in T-1. The highest level of haemoglobin (7.93 g/dl) and hematocrit (27.38%) was found in treatment T-1, which had 15% inclusion rate of rice beer waste and was significantly ($p<0.05$) different from the other treatments. MCV value was found to be highest (133.67 fl) in control (0%) and highest value of MCHC (28.96 g/dl) showed in T-1 (15%), while the lowest MCHC was (26.57 g/dl) in T-2

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(30%). At the end of the experiment, 120th days of experiment Amur carps were challenged with *A. hydrophila* at different dosages (10^{-2} to 10^{-9} CFU/ml) to determine the mean lethal dose (LD50), which was calculated as 10^{-7} CFU/ml. The fishes were challenged with the dose of *A. hydrophila* (2.53×10^7 CFU/ml) and RPS (Relative percentage survival) was calculated upto 10 days. The RPS value (51%) was the highest in treatment T-3. The present findings clearly indicated that incorporation with rice beer waste-supplemented diets not only influence fish growth but also interfere with hematological parameters and immunological response in Amur carp by enhancing non-specific defense mechanism in fish.

Development of Multiplex PCR Assay for Simultaneous Detection of three Major Fish Pathogenic Genera *Aeromonas*, *Pseudomonas* and *Edwardsiella*

Ganesh Borah

Two different multiplex PCR assays was developed for simultaneous detection of *Aeromonas hydrophila* and *Pseudomonas aeruginosa* and *Edwardsiella tarda* in diseased fishes. The first multiplex PCR assay was developed for simultaneous detection of *A. hydrophila* and *P. aeruginosa* from the diseased fishes targeting 130 bp fragment for haemolysin (*ahh1*) gene specific for *A. hydrophila* and 500 bp fragment for peptidoglycan associated lipoprotein (*oprL*) gene specific for *P. aeruginosa*. The optimum annealing temperature in a single tube reaction mixture of 50 µl reaction volume was found to be 59°C for 60 sec. The assay was specific and sensitive to detect a minimum of 4 and 3 cells of *A. hydrophila* and *P. aeruginosa* and up to 0.2 ng of DNA concentration. The results of validation in artificially infected fishes from the tissue correlated with the results found with the bacteriological methods and did not give any false positive results in control samples. The assay performed for 50 numbers of naturally infected fish samples showed positive for 18 nos of *A. hydrophila* and 7 nos of *P. aeruginosa*. The second assay was developed for detection of *A. hydrophila*, *E. tarda* and other *Aeromonas* spp targeting 356 bp fragment of *16S rRNA* gene specific for *Aeromonas* spp., 130 bp fragment of haemolysin (*ahh1*) gene specific for *A. hydrophila* and 450 bp fragment of *16S rRNA* gene specific for *E. tarda*. The optimum annealing temperature in a 50 µl reaction volume was found to be 63°C for 60 sec. The assay was specific and sensitive to detect up to 0.19 ng of DNA concentration and a minimum of 5 cells and 7 cells of *A. hydrophila* and *E. tarda* respectively. The results of the assay performed with DNA extracted from the tissue correlated with the bacteriological methods in artificially infected fishes and did not give any false positive results in control samples. On screening of 50 numbers of naturally infected fishes the multiplex PCR assay showed 18 samples positive for *A. hydrophila* followed by 8 samples positive for other *Aeromonas* spp. and 3 samples positive for *E. tarda*. The developed multiplex PCR assays was rapid, sensitive in simultaneous detection

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of *A. hydrophila*, *P. aeruginosa* and *E. tarda* in diseased fishes compared to the time consuming traditional bacteriological detection technique. These two multiplex PCR assays developed for simultaneous detection of the three bacteria will help the stakeholders of this region to a great extent in identification and implementation of control measures of these pathogenic bacteria.

Effect of stocking densities on growth performance and survivability of Amur Carp (*Cyprinus carpiohaematopterus*) in floating cage environment of a floodplain wetland of Morigaon District

Homen Saikia

An experiment was conducted for a period of three months from October to December, 2020 at Jaluguti beel, District-Morigaon, Assam to determine the optimum stocking density of Amur Carp (fry of genetically improved common carp) reared in 12 nos of floating cages of size 48m^3 (6m x 4m x 2m), where 15 fish m^{-3} , 20 fish m^{-3} , 25 fish m^{-3} and 30 fish m^{-3} were set as the different stocking densities designated in treatment (T₁),(T₂),(T₃) and (T₄) respectively in triplicates. The mean initial length and mean initial weight of the fry used in the experiment were $1.90\pm 0.05\text{cm}$, $1.96\pm 0.03\text{cm}$, $1.90\pm 0.05\text{cm}$, $1.90\pm 0.05\text{cm}$ and $0.17\pm 0.01\text{g}$, $0.18\pm 0.01\text{g}$, $0.17\pm 0.01\text{g}$ and $0.17\pm 0.01\text{g}$ for treatment (T₁),(T₂),(T₃) and (T₄) respectively. Whereas, the mean harvesting length and weight in treatment (T₁),(T₂),(T₃) and (T₄) recorded were $14.96\pm 0.03\text{cm}$, $14.66\pm 0.03\text{cm}$, $13.96\pm 0.03\text{cm}$, $13.36\pm 0.03\text{cm}$ and $53.03\pm 0.01\text{g}$, $42.79\pm 0.14\text{g}$, $33.20\pm 0.10\text{g}$, $29.31\pm 0.10\text{g}$ respectively. After three months of rearing, final length and weight gain was found to be highest at lowest stocking density treatment (T₁) and lowest at the highest stocking density treatment (T₄) with significance differences among the treatments ($p < 0.05$). Further, specific growth rate (SGR) and survivability % were found to be the highest at lowest stocking density (T₁) and lowest at the highest stocking density (T₄) with significant differences ($p < 0.05$) among the treatments. Feed conversion ratio (FCR) values were adversely affected with the increase in stocking density. FCR value was found to be the lowest as 1.74 ± 0.03 in (T₁) and highest in (T₄) as 2.11 ± 0.01 . The concentration of Ammonia-nitrogen recorded under present study showed that it had an adverse impact on the fish growth. Ammonia concentration was found to be increased due to increased stocking density from (T₁) to (T₄) @ of 15m^{-3} to 30m^{-3} . The other water quality parameters recorded in the different treatments did not vary significantly and

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was almost in the acceptable range conducive for fish culture. Hence it can be assumed that due to higher stocking density there was an increase in Ammonia concentration which might be the reason for the reduction in growth of fish in (T₄). The gross yield 39.41 ± 0.02 kg and benefit cost ratio (1.73) were found to be the highest in (T₂) among all the treatments. Thus, economics of operation was considered to be most important criteria in deciding the optimal stocking density for raising Amur Carp fry in cages in a seasonally open beels of Assam having similar ecological characteristics like *Jaluguti beel*.

Effect of *Streblus asper* Lour. as periphyton substrate on growth performance of jayanti rohu (*Labeo rohita* Hamilton) and amur carp (*Cyprinus carpio haematopterus* Temminck & Schlegel)

Kongkon Jyoti Bhuyan

An experiment on comparative assessment of growth performance of Jayanti rohu and Amur carp in periphyton based aquaculture system was conducted for a period of 120 days in 12 rectangular cements tanks. Three treatments in four replicate were tried: only fertilization T0 (control), only periphyton as saura gach substrate T-I and periphyton plus supplementary feed (T-II). After liming and fertilizing each of the 12 cisterns, 24 fingerlings of Jayanti rohu and Amur carp (average initial weights of Jayanti rohu and Amur carp were 20.27 ± 0.45 g and 14.61 ± 1.18 g; 11.48 ± 0.11 g and 11.72 ± 0.65 g; 14.53 ± 1.72 g and 14.08 ± 3.37 g in T0, T-I and T-II respectively). Fishes were fed with rice polish and mustard oil cake at a ratio of 1:1 on a w / w basis and fortified with vitamin and mineral mixture at 1 % of total feed. Fishes showed significantly ($p < 0.05$) higher mean weight gain in T-II, T0 and T-I (46.33 ± 9.28 g, 44.52 ± 8.75 g and 39.78 ± 6.93 respectively). The initial average weights were 17.44 ± 2.83 g, 11.6 ± 0.12 g and 14.31 ± 0.23 g in T0, T-I and T-II respectively. The specific growth rate was found to be highest in T-II (2.30 ± 0.07 %) followed by T-I (2.18 ± 0.20 %) and T0 (1.84 ± 0.09 %). The survival rate of Jayanti rohu was significantly ($p < 0.05$) higher in T-II (99.12 ± 0.56 %) followed by T-I (97.92 ± 1.20 %) and T0 (97.70 ± 0.95 %). The survival rate of Amur carp found to be higher in T-II (98.20 ± 0.86 %) followed by T-I (98.04 ± 0.87 %) and T0 (96.96 ± 0.44 %). compared to Amur carp, the survivability of Jayanti rohu was found to be higher in T-II. A total of 35 genera of periphyton were identified in the present study. Among them 24 genera of algal periphyton belonging to the Bacillariophyceae (8 genera), Chlorophyceae (10), Cyanophyceae (4) and Euglenophyceae (2) were identified as well as 11 genera of animal community belonging to Protozoa (2 genera), Rotifera (4), Copepoda (2), Cladocera (3) and macrobenthic invertebrate (1) were identified in

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treatment T-II. In T-I animal community groups were similar with T-II but in the case of Copepoda (1 genera) and Cladocera (2) were recorded in T-I from saura gach substrate. Study of water quality parameters in the different treatments trials revealed that some water quality parameters differed significantly (transparency, dissolved oxygen, ammonia- nitrogen, phosphate- phosphorous and periphyton biomass *i.e.* dry matter (DM), ash free dry matter (AFDM) and ash content) throughout the study.

Comparative growth assessment of 9th generation jayanti rohu with non-jayanti rohu cultured together with *catlacatla* and *cirrhinusmrigala*

Lucy Ingtipi

The present study was conducted to compare the growth performance of 9th generation Jayanti rohu with non-Jayanti rohu cultured together with *Catlacatla* and *Cirrhinusmrigala* in different stocking densities for 90 days period. The experiment was carried out in equal size rectangular cement cisterns (2.6m x 1.50m x 1.75m) in the wet lab. College of Fisheries, AAU, Raha. All the cisterns were drained, put with 6" soil bed then limed @500kg/ha and filled with underground water to a depth of 1.2m ±2.00 cm. After 7 days of liming, the cisterns were fertilized with a mixture of raw cow dung (RCD), Mustard oil cake (MOC) and Single Super Phosphate (SSP) @ 0.01kg/m³, 0.035 kg/m³ and 0.0025 kg/m³ respectively and thereafter fertilizer application was repeated at fortnightly intervals. Four treatments viz. T-I, T-II, T-III and TC were taken and TC was considered as reference treatment. Each treatment was conducted in triplicates. Ten numbers of fishes were stocked in each cistern. Jayanti rohu was stocked @35%, 40%, 45% and 0% in the treatments T-I, T-II, T-III and TC respectively. TC was considered as reference treatment. Non-Jayanti rohu was stocked @ 40% in TC treatment. Catla was stocked @ 55%, 50%, 45% and 50% in T-I, T-II, T-III and TC respectively. Mrigal was stocked @ 10% in all the treatments. The fishes were fed with diet of 25% crude protein twice daily @3% body weight. The percentage weight gain of 9th generation Jayanti rohu over non-Jayanti rohu showed 31.60% in T-I followed by 17.13% in T-II and lowest was recorded at 6.65% in T-III treatment. It is also clear that Jayanti rohu did not have adverse impact on catla and mrigala growth performance. The result indicated that better performance of Jayanti rohu in terms of net weight gain, average daily growth rate, FCR, SGR, survivability and production compared to non-Jayanti rohu. The study showed that T-II treatment with the stocking density of catla (50%), Jayanti rohu (40%) and mrigal (10%) is more economically profitable in a commercial aquaculture system. Benefit cost ratio was observed to be highest in T-II (3.80) followed by T-III (3.75), T-I (3.73) and TC (3.47) treatments.

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Department : Department of Aquaculture

Major Advisor : Dr. S. Borthakur

Effect of different stocking densities of mola, *amblypharyngodon mola* (Hamilton, 1822) on growth of indian major carps

Preetam Kala

An experiment on the effect of different stocking densities of mola, (*Amblypharyngodon mola*) on the growth of Indian Major Carps (*Labeorohita*, *Catlacatla* and *Cirrhinus mrigala*) was conducted in outdoor rectangular cemented tanks with soil beds for a period of 90 days from July to September, 2017. Four treatments (T₀, T₁, T₂ and T₃) in triplicates (R₁, R₂ and R₃) were tried. Catla, Rohu and Mrigal fingerlings were stocked at the rate of 8000 nos. ha⁻¹ in 2:2:1 ratio respectively in each treatment. Mola were stocked at the rate of 15,000 nos. ha⁻¹, 25,000 nos. ha⁻¹, and 35,000 nos. ha⁻¹ in treatment T₁, T₂ and T₃ respectively. T₀, where only IMC were stocked served as the control. The supplementary feed was provided at the rate of 3% body weight of IMC in each treatment. The highest net weight gain of IMC was recorded in T₀ (158.42 ± 2.42g) followed by T₁ (156.67 ± 2.80g), T₂ (153.46 ± 2.05g) and T₃ (148.39 ± 1.55g). The T₀ showed significantly (p<0.05) higher net weight gain difference of IMC from T₃. Survival rates (%) of IMC were 87.5 ± 3.6, 88.8 ± 3.2, 86.11 ± 3.8 and 81.94 ± 4.2 in T₀, T₁, T₂ and T₃ respectively where no significant (p>0.05) difference among the treatments was observed. Fish production after three months of culture period was 1202.3, 1214.8, 1148.13 and 1068.33 kg ha⁻¹ in treatments T₀, T₁, T₂ and T₃ respectively. The highest production was obtained in T₁ where mola was stocked at the lowest density. Highest production was in T₁ followed by T₀, T₂ and T₃ but not significantly (p>0.05) different. Total production of mola was 2.00, 2.83 and 3.83 kg ha⁻¹ in treatment T₁, T₂ and T₃ respectively. Production of mola was significantly (p<0.05) different in T₁, T₂ and T₃. Some water quality parameters (transparency, dissolve oxygen (evening), free carbon dioxide (morning) and pH (morning) were significantly (p<0.05) different between specific treatments. A total of 25 genera of plankton were recorded during the study period. Phytoplankton was found to be composed of 18 genera belonging to Bacillariophyceae (7), Chlorophyceae (8), Cyanophyceae (2) and Euglenophyceae (1). Zooplankton composed of 7 genera belonging to Cladocera (2), Copepoda (2) and

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Rotifera (3). The study indicated that the highest density of mola at the rate of 35000 ha⁻¹ exerts a negative impact on growth and production of rohu and mrigal. Based on the total production and profit T₁ was found to be the best.

Effect of dietary selenium on haematological parameters, antioxidant enzymes and growth in *cirrhinus mrigala* (Hamilton, 1822)

Parishmita Handique

The present experiment was conducted to evaluate the effect of dietary selenium on haematological parameters, antioxidant enzymes activity in and growth in *Cirrhinus mrigala* for period of 45 days. Experiment was conducted in glass aquariums (0.75 m X 0.45 m X 0.45m). All treatments were carried out in triplicates. Four number of experimental selenium incorporated diets were prepared for Control (0 mg organic selenium/kg of diet), Tr (2.5 mg organic selenium/kg of diet), Ta (5.0 mg organic selenium/kg of diet) and T3 (10 mg organic selenium/kg of diet). During the experiment, the water quality parameters (temperature, DO, pH, conductivity, hardness, ammonia, nitrate and nitrite) were found to be insignificant ($P > 0.05$) among all the treatments. RBC's count in T1 (4.90 million/mm³) was significantly ($P < 0.05$) higher from Control and Ta. The value of WBC's count in T1 (1.58 thousands/mm³) was significantly ($P < 0.05$) higher from T2 and T3. Haemoglobin level in T₁ (6.41 g/dl) was significantly ($P < 0.05$) higher from T₀. Superoxide dismutase (SOD) activity in T2 (6.10±0.07) was significantly ($P < 0.05$) highest from Control, Tr and T3. Catalase (CAT) activity in T₁ (13.21±0.13) was significantly ($P < 0.05$) different from Control, T2 and T3. The highest specific activity (16.94±0.08) of Glutathione Peroxidase (GPx) was observed in the T₁. This specific activity of GPx was significantly different ($P < 0.05$) from every treatment. Highest average final weight (23.88 gm), net weight gain (15.55 gm), net weight gain percentage (185.88%) and SGR (2.35) was observed in Tr (2.5 mg OS/kg diet). The final average weight, weight gain percentage and SGR value in T_y was significantly ($P < 0.05$) different from Control and T3. The result of the present study indicated that the experimental diet containing 2.5 mg organic selenium/kg of diet appears to be suitable for improved antioxidant activities, haematological parameters and growth parameters compared to the other treatments.

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Department : Department of Aquaculture

Major Advisor : Dr. Binod Kalita

Prevalent fish diseases with reference to motile aeromonas septicaemia in the Central Brahmaputra Valley Zone of Assam

Pabitra Kumar Saharia

The present study was undertaken during June 2016 to May 2017 to find out the incidence of Motile *Aeromonas Septicemia* (MAS) in the freshwater aquaculture system in three districts viz. Nagaon, Morigaon and Sonitpur of Assam. A total of 293 ponds of varying size were surveyed during the disease outbreak cases and thirteen different diseases were recorded with the highest intensity of ulcerative disease (28.01%) followed by red spot/haemorrhages(18.82%). Prevalence of argulosis was recorded (11.62%). For the first time in Assam, the study of severity of MAS in freshwater aquaculture system of Assam was undertaken and characterisation of aeromonads was done through biochemical and molecular studies. A total of 293 number pools were screened for bacteriological and mycotic studies. Out of 293 pools screened, 91 (31.05%) were found to be positive for *Aeromonas species*, 131 (44.70%) for *A. invadans* and 55 (18.77%) for *S. parasitica*. This clearly indicates that MAS has great significant in the freshwater culture system of Assam. Biochemical and molecular identification has confirmed that *A. hydrophila*, *A. veronii*, and *A. sobria* were detected from diseased fish and *A. hydrophila* was a dominant pathogen (51.64%) followed by *A. veronii*(21.97%) and *A. sobria*(18.68%). The prevalence of other *Aeromonas* species (7.69%) was also recorded during the study. Data on the seasonal prevalence of MAS reveals that the highest prevalence (62.63%) was recorded during the winter season followed by postmonsoon (20.87%) and premonsoon (12.08%). The loss in income due to MAS revealed that mean loss and SD value ($M \pm SD$) in income was Rs ha-1yr-1 (16031.32 ± 6865.25) with ($M \pm SD$) value of mortality and quantity loss (kg ha-1yr-1) due to MAS was ($5.65\% \pm 3.17\%$) and (158.92 ± 69.47) respectively during the study. The suboptimal range of water quality parameters during winter and high stocking density were found to be predisposing factors for initiation of MAS. The regression analysis of MAS on water quality parameters revealed that some of the water quality

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parameters *i.e.* temperature, pH, dissolved oxygen and alkalinity were negatively correlated whereas carbon dioxide and ammonia were found to be positively co-related. Virulence studies conducted on the three isolated aeromonads revealed that *A. hydrophila* appeared to be more virulent in nature showing a high LD50 value at low dilutions (10⁻⁷.008) compared to *A. veronii*(10⁻⁸.038) and *A. sobria*(10⁻⁸.293). Major histopathological changes in MAS infected fishes were observed in liver, kidney, gills, skin and muscles. Liver and kidney are the target organs of acute *Aeromonas* infection showing prominent histopathological changes. Antibiogram study on *A. hydrophila*, *A. veronii* and *A. sobria* revealed an almost similar pattern of sensitivity against the isolates of infected fishes. However, the resistant antibiotics *viz.* Ampicillin (AMP), Cephaloridine (CR) and Penicillin (P) as well as intermediate antibiotics *viz.* Cephatoxin (CTX), Novobiocin (NV), Amoxicillin (AMX) and Erythromycin (E) tested against aeromonads isolates is of great important to undertake monitoring studies in order to assess and check its diffusion in aquatic environments.

Effect of probiotic bacteria identified and characterized from gut of freshwater fish on growth performance of *Labeo rohita*

Rubina Yasmin

The present study was carried out to isolate, identify and characterize probiotic bacteria in the gut content of *Ctenopharyngodon idella* (Grass carp) and to study its effect on growth performance of *L. rohita* fingerlings by dietary administration for a period of 6 months. A total of 6 nos. of gram positive bacteria belonging to the genus, *Lactobacillus* spp. (3 nos.), *Bacillus* spp. (2 nos.) and *Staphylococcus* spp. (1 no.), were identified biochemically followed by molecular techniques. The identified isolates were subjected pH tolerance test, antibiotic sensitivity test, antimicrobial activity assay and enzymatic activity assay. The pH tolerance test performed showed that all the isolates were able to survive a low pH of 4.0. The pH range of the *Lactobacillus* spp. in the present study was found to be 4.0 to 9.0. The antibiotic sensitivity test showed that the isolates were sensitive towards Penicillin G, Ampicillin and Novobiocin. The *Lactobacillus* spp. was more sensitive towards all the antibiotics. The antimicrobial properties of the isolated bacteria was tested against two common bacterial fish pathogens *A. hydrophilla* and *P. putida* which showed that the strains of *Lactobacillus* spp. had inhibitory effect against both the pathogens. Two identified strains of *Lactobacillus* spp. were selected to evaluate its effect on the growth parameters of *L. rohita* fingerlings by dietary administration. The results showed that the growth of *Labeo rohita* was significantly increased by administration of *Lactobacillus* spp. fed with 5ml/kg of 10^6 cells/ml. The SGR% for *Labeo rohita* was found to be 0.796 ± 0.013 and 0.733 ± 0.006 , the average net weight gain was 25.426 ± 0.636 g and 21.629 ± 0.106 g, the average net length increment was 11.453 ± 0.243 cm and 10.089 ± 0.169 cm respectively for T1 and T2 with significant difference among the treatments (p-value <0.05) when compared with the control. The results of the present study conclude that *Lactobacillus* spp. isolated from the gut content of *Ctenopharyngodon idella* (Grass carp) could be used as a potential probiotic to improve the growth of *L. rohita*. It also open an arena to study the effect of single and conjoint *Lactobacillus* spp. in growth performance and immune response of fishes and its potential to be used in farmer's field in commercial basis.

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Department : Department of Aquaculture

Major Advisor : Dr. Pabitra Kr. Saharia

Evaluation of some non conventional animal protein sources in the practical diet formulation of fresh water cat fish *Clarias Magur* and its effect on growth and biochemical composition

Shah Mustahid Hussain

The present investigation was carried out to evaluate the growth performance of *Clarias magur* in response to different nonconventional diets, in the two locations Raha of Assam and Pasighat of Arunachal Pradesh. Juvenile magur weighing average 8.49 ± 1.98 g and 15.83 ± 4.83 g (Raha and Pasighat) were reared in tanks maintaining water level at 50 ± 5 cm with six inches of soil bed. The fish were stocked @ 4 no./m² and fed with four iso-nitrogenous (35% crude protein) experimental diets D-1 (Vermi meal), D-2 (Chicken viscera meal), D-3 (Vermi meal+ Chicken viscera meal) and D-4 (Fish meal) @ 5 to 10 % of body weight in two split doses daily in the morning and evening. The diet D-4 was considered as reference diet. The experimental diets were prepared by using ingredients such as Fish meal, Vermi meal, Chicken viscera meal, Rice polish, Wheat flour & Vitamin and mineral mixture at different combination.

The result reflected that the growth performance observed after six months of rearing the fish fed with Fish meal based diet was the best (204.93 g Raha; 194.54 g Pasighat), followed by 100% replacement of Fish Meal with Chicken viscera Meal (200.81 g Raha; 192.61 g Pasighat); Fish meal with mixture of Vermi meal and Chicken viscera meal (190.32 g Raha; 179.69 g Pasighat); and Fish meal with Vermi meal (181.30 g Raha; 174.58 g Pasighat). The present findings reflected that 100 % replacement of Fish meal can be done with Chicken viscera and mixture of Vermi meal and Chicken viscera meal without affecting the growth performance of the fish and flesh quality as differences in growth performance are almost negligible.

The feed conversion ratio ranges between 1.50 to 1.75 for the fish grown on Fish meal based diet and 1.54 to 1.77 for Chicken viscera based meal diet and 1.62 and 1.91 for mixture of Chicken viscera meal and Vermi meal diet. All the experimental diets contains almost all the essential amino acids, however glycine and glutamic acid

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Major Advisor : Dr. Sushanta Borthakur

content was higher with all the experimental diets (glycine: 1.71-2.31 g/100g feed; glutamic acid: 5.41-5.95 g/100g feed). The digestibility of protein and lipid in diets D-4 and diet D-2 (Chicken viscera meal based diet) were not significantly different ($P>0.05$). The protein digestibility was highest (78.89 ± 1.43 %) with the reference diet D-4; while among the experimental diets, the protein digestibility was better with the diet D-2 (76.21 ± 0.81 %) followed by diet D-3 (75.89 ± 2.05 %) and diet D-1 (73.72 ± 1.67 %). The protein digestibility values did not vary significantly ($P>0.05$) among the treatments.

The Moisture, Dry matter, NFE, Ash, Fibre and Protein percentage in muscles of the fishes grown with four different diets were not significantly ($P>0.05$) different, but lipid % were significantly ($P<0.05$) different for different diets for both the location. Significantly high ($P<0.05$) muscle lipid content was observed in the fish fed with diet D-2 followed by diet D-3 (mixture of Vermi Meal and Chicken Viscera meal based diet), diet D-4 and diet D-1. While assessing the consumer preference by Hedonic scale method it was found that all the fishes grown on different diet treatments was equally preferred. The present study indicated that nonconventional animal protein sources like vermi meal and chicken viscera meal are acceptable ingredients for the replacement of fish meal in practical diets of *Clarias magur*. The magur growers of North Eastern Region of India can use the formulation for preparing of feed for the fish as the ingredients used in the present study are largely available due to higher consumption of chicken in human diet as well as the approaches given for organic farming resulting in wide vermiculture practices in the region. Further, the use of chicken viscera in feed will minimize the environment pollutions converting the waste wealth round the year.

Effect of Natural and Artificial Carotenoid for Colour Enhancement in Tiger Barb, *Puntigrus tetrazona* (Bleeker, 1855)

Shilparani Hazarika

The present study was conducted to evaluate the effect of natural carotenoid (tubifex worm, bloodworm and turmeric powder) and artificial (β -carotene) carotenoid sources on colour enhancement, growth and survival of Tiger barb, *Puntigrus tetrazona*. The experiment was conducted for 90 days. All the carotenoid sources such as tubifex worm @ 100 % (T1D1) and 75 % (T1D2), bloodworm @ 100 % (T2D1) and 75 % (T2D2), turmeric powder @ 0.09 % (T4D1) and 0.2 % (T4D2) and β - carotene @ 0.015 % (T3D1) and 0.02 % (T3D2) were used in the experiment. Tubifex worm and bloodworm fed directly to the fishes, whereas other treatment diets incorporated with formulated feed containing 30 % crude protein. Diet without carotenoid supplementation served as control (T0). Each treatment diet was tried in triplicate. Ten numbers of fish were stocked in each aquarium and the fish were fed with experimental feed @ 2% of their body weight twice daily. At the end of the experiment, the total carotenoid content and the growth performance of fish were analysed. To measure the colour intensity total carotenoid was analysed by following the method of Olson (1979) and the digital analysis of fish skin was measured in Adobe Photoshop software. In the present study, the skin colour was significantly higher ($P < 0.05$) in treatment (T1D1) ($18.40 \pm 0.11 \mu\text{g/g}$) and the minimum was recorded in T0 ($6.57 \pm 0.06 \mu\text{g/g}$) in terms of total carotenoid content and digital parameters (RGB and Lab scale). Among the treatments, the highest growth was recorded in T1D1 ($1.76 \pm 0.03 \text{ g}$) but did not differ significantly ($P > 0.05$) from T1D2, T2D1 and T2D2. Similarly higher weight gain ($1.10 \pm 0.05 \text{ g}$), weight gain % (165 ± 17.16), SGR (1.01 ± 0.06) and lower FCR (2.76 ± 0.16) were observed in fish fed with diet T1D1. Among all the treatment diets, tubifex worm showed a more pronounced effect in terms of higher carotenoid content and growth performance, which was attributed to higher fat content of tubifex worm. Therefore, it is concluded that among all the tested diets, tubifex worm @100% level could be used in Tiger barb (*P. tetrazona*) diet as a pigment enhancer and growth promoter.

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Department : Department of Aquaculture

Major Advisor : Dr. Dipak Sarma

Reproductive biology of indian river shad *gudusia chapra* (Hamilton-buchanan-1822)

Abdul Malik Ahmed

The present study was undertaken to study certain aspects of reproductive biology of *Gudusiachapra* from Thekerabeel, Morigaon, Assam. The overall sex ratio (M:F) was 1:1.84 (Chi square 40.38, $P < 0.01$), indicating predominance of females over males. The length and weight of the species varied between 7.8 to 15.6 cm and 5.01 to 38.19 g respectively. The species was highly fecund and the fecundity ranged between 7095 to 48,238. The relationship between fecundity with three variables i. e. total length, body weight and ovary weight were found to be linear and highly significant ($r = 0.9794$). The Monthly Gonadosomatic index showed two peaks; one in April and another in August indicating *G. chapra* bred twice in a year. The size at first sexual maturity was found to be 9.5 to 10.2 cm in female and 8.8 to 9.2 cm in male. The cytological status of ovarian development showed asynchronous growth of ovaries. The ovaries were divided into four distinct stages of development viz. chromatin nucleolar and perinucleolar stage, corticle alveoli stage, vitellogenic stage and ripe or mature stage. The relationship between total length (TL) and Total weight (TW) of *G. chapra* were calculated and the length- weight relationship was found to be $W = 0.0104 L^{2.968}$; $W = 0.0116 L^{2.918}$ and $W = 0.0114 L^{2.9294}$ for male, female and pooled sample respectively. The correlation coefficient (r) approaching towards positive one, though the fish exhibit negative allometric correlation. It is observed that the 'b' value was significantly differing ($P < 0.01$) from the value of '3' indicating allometric growth of fish. The monthly mean relative condition factor (Kn) was maximum in the month of May (Kn = 1.34 in male and 1.37 in female) and minimum in the month of March (Kn = 1.03 in male, 1.01 in female). The Kn values also express healthy condition showing good compatibility with the nature or environment.

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. Ayub Ali

Effect of profenofos toxicity on fingerlings of *labeo goni* (Hamilton, 1822)

Abhijit Choudhury

Pesticide are biochemical compounds used for destroying pest and controlling disease vector. The pesticide entering the body of fish act as xenobiotics and causes toxicity to the animal. The present study was undertaken to evaluate the effect of profenofos, commonly used pesticide in agricultural crops in the North-East India including Assam, on freshwater fish *Labeogonius* which have a very high market demand in Assam and other North-East states of India. The acute toxicity of an economically important freshwater teleost fish *L. goni* was evaluated under static conditions. The median lethal concentration of the insecticide profenofos was found to be 0.05, 0.04, 0.03 and 0.02 ppm respectively for 24, 48, 72 and 96 hours of exposure periods indicating the high toxicity of the insecticide. Fishes were exposed to predetermined LC₅₀ value and the alterations in behavioral, histological and haematological parameters were studied at the end of definite exposure period. The fishes showed behavioural changes like hyperexcitability, imbalanced swimming, loss of reflex, lethargy and hyperventilation exposed to selected test pesticide profenofos. Histological changes were noticed in the targeted organ i.e. in gill, liver and kidney. Marked alteration like congestion of gill and cellular infiltration, fusion of secondary lamellae, desquamation of epithelium of secondary lamellae and focal mononuclear cell infiltration and necrosis of hepatocytes with distortion of hepatic cords were observed. The kidney of the profenofos treated fish *L. goni* showed alteration such as necrosis of the tubular lining epithelium, swelling of glomeruli alternating the Bowman's space and focal infiltration in the intertubular space. Haematological parameters like total erythrocyte count (TEC), haemoglobin (Hb) were decreased in the studied fish with increase in concentration of the test chemical. But total leucocyte count (TLC) were increased in the profenofos exposed fish blood with increased in concentration of test chemical. Haematological studies on the profenofos exposed fish lymphocyte and monocyte values were increased but neutrophil and eosinophil values were decreased. This shows that the selected pesticide for the present study is highly toxic to fish even at its very low concentration.

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. S.K. Bhagabati

Evaluation of length-weight relationship, age and growth parameters and reproductive biology of *mystuscavasius* (Hamilton-buchanan, 1822)

Bhargav Bhushan Nath

The present study was carried out to establish length-weight relationship, age and growth parameters and reproductive biology of *Mystuscavasius* at the downstream of river Kolong near Raha, Nagaon district from January, 2017 to December, 2017. A total of 285 specimens including 182 males and 103 females were collected for the study. The total length of males ranged between 80 mm to 195 mm and of females ranged between 82 mm to 205 mm. The regression coefficient (b) values of male, female and combined population were calculated as 2.34, 2.42 and 2.41 respectively, that indicate negative allometric growth. Correlation coefficient (r) values of male, female and combined population were 0.84, 0.91 and 0.90 respectively. Asymptotic length (L_∞), growth coefficient (K) and arbitrary origin of growth (t₀) were calculated as 217 mm, 0.8 year⁻¹ and -0.41 years for *M. cavasius*. The result indicated that *M. cavasius* attained a length of 135, 180, 201 and 210 mm at the end of 1, 2, 3 and 4 years of its life respectively. The mean values of condition factor (K) with standard deviation of male was 1.20 ± 0.28 and in case of female was 1.38 ± 0.37. The relative condition factor (Kn) for male and female were calculated as 1.28 ± 0.34 and 1.38 ± 0.37 respectively, suggesting good general condition of the fish. Gonado-somatic index revealed a prominent peak in May (3.35) for male and April (5.58) in case of female of *M. cavasius*. Based on percentage of gravid females and monthly variation of GSI, the spawning season was observed to range from April to June with peak spawning season of May in the Kolong river. The logistic curves describing the relationship between the sexes and the proportion of 50% maturity were estimated at 142-145 mm in female and 145-150 mm in male. The female reached 50% first sexual maturity at smaller length than male in this species. Considering the overall data, the sex ratio was observed to be 1 male: 1.76 female. The chi-square value also showed 21.89 which are non-significant at 5% of level.

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Major Advisor : Dr. Jiten Sarma

Fecundity (absolute fecundity) of the species varied from 5,083 to 14,753 with a mean value of 9888 ± 2554 . The results of this study would be an effective tool for fishery managers, biologists and conservationists to initiate appropriate management strategies and regulations for the sustainable management of this species in the Kolong river and surrounding ecosystem.

Hydrobiological profile of river Kolong in Nagaon, Central Brahmaputra Valley Zone

Dibya Jyoti Dev Nath

Growing population, Industrialization and Urbanization have been creating a tremendous stress on natural water bodies. Water is indispensable for Human Civilization. Kolong is one of the rivers of Central Brahmaputra Valley and it is also one of the most important Southern tributary of the mighty River Brahmaputra. This present study assessed the physio-chemical and biological profile of water of river Kolong. Water, Sediment and Plankton samples were collected for twelve consecutive months (February 2017- January 2018) from the three sampling stations of the river at regular intervals. Water parameters like pH, Temperature, Turbidity, DO, Electrical conductivity, TDS, COD, BOD₃, Nitrate, Nitrite, Ammonia, Phosphate etc. were determined by using different standard methods. The range of some important parameters were water temperature (20.5-32.5⁰ C), Turbidity (9.5-82.3 NTU), Dissolved oxygen (4.50-8.90 mg/l), pH (6.73-7.71), total dissolved solids 9201-648 mg/l, total Alkalinity (80.08-144.14 mg/l), Nitrate (1.2-3.83 mg/l) and phosphate (0.29-0.89 mg/l) etc. recorded. ANOVA analysis revealed significant variation of DO, BOD₃, COD, Nitrate, Nitrite, Ammonia, Phosphate, Sodium, Potassium and Calcium among the seasons. A total of 34 different genera of plankton groups were recorded from the study stations of river Kolong. Among these 13 belongs to chlorophyceae, 9 to Bacillariophyceae and 6 Zooplankton. Anthropogenic activities like the discharge of domestic, agricultural and municipal sewage were identified as the main cause of low to moderate pollution levels in this stretch of the river.

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

Acute Toxicity Study of Silica Nanoparticles (SiO₂-NPs) on *Cyprinus carpio* (Linnaeus, 1758)

Habiba Jahan Ahmed

Silica nanoparticles (SiO₂-NPs) are among the most widely used nanoparticles (NPs) in a variety of fields including medicines, consumer goods, biotechnological applications etc. Although studies on the toxicity of SiO₂-NPs to human and mammalian cells have been published, the effects of SiO₂-NPs on fish remain unknown. Therefore, the present study was intended to evaluate the acute toxicity, behavioural and hematological alterations in *Cyprinus carpio* (common carp) exposed to SiO₂-NPs. The median lethal concentration (LC₅₀) values were found to be 12553.05 mg l⁻¹, 9142.07 mg l⁻¹, 6637.24 mg l⁻¹ and 4479.11 mg l⁻¹ for 24 hour, 48 hour, 72 hour and 96 hour respectively, indicating SiO₂-NPs to be relatively harmless. When exposed to lethal (96 hour LC₅₀) concentration of SiO₂-NPs, the fishes showed alterations in behaviour as well as hematological parameters. Behavioural changes such as abnormal opercular movement, imbalance swimming, hyperactivity, loss of buoyancy, lethargy, excess mucus secretion and fading of skin colour. were observed during 96 hour of exposure. Hematological parameters like hemoglobin (Hb), packed cell volume (PCV) and total erythrocyte count (TEC) decreased with respect to control, while total leucocyte count (TLC) values increased initially and then decreased. The hematological indices such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) decreased while mean corpuscular hemoglobin concentration (MCHC) values increased with time in the present investigation. All the values were significantly different (p<0.05) during different exposure period except for MCHC values which did not exhibit any statistical difference (p>0.05). Overall, this report can be used in extending future research using fish as a model to assess the toxicity of SiO₂-NPs to aquatic organisms.

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. Utpal Kr. Das

In Vivo* Evaluation of Toxicity effects of a Neonicotinoid Insecticide Imidacloprid on Freshwater Cypriniform *Cyprinus carpio* var. *communis

Hemanta Pokhrel

Imidacloprid (IMI) is a systemic insecticide belonging to the class of neuro active chemicals called the neonicotinoids, used for the control of pest and insects in agricultural crops. IMI was reported to be highly toxic to bees, humans and non-targeted aquatic animals. Therefore, the aim of the present study was to evaluate the toxicity effects of commercial-grade Imidacloprid (Premise, 30.50%, SC) to standard non targeted test organism, *Cyprinus carpio* var. *communis* (Common carp) using biological endpoints like histological analysis, haematological parameters, serum biochemical analysis, antioxidant responses, neurotoxicity (Acetylcholinesterase activity), genotoxicity (Micronucleus test) and gene expression study. The current study reveals that 96hr LC₅₀ value of commercially available Imidacloprid was 208.38 mg/l (173.66 - 262.37) with 95% confidence interval. Effect of 96hr LC₅₀ concentration was determined by exposing test fish to above said concentration under laboratory static renewal test and analysis was carried out on every 24, 48, 72, and 96hr, whereas for 28 days chronic exposure semi static renewal test was deployed with 3 sub lethal concentrations LC₅₀/8 (T₁= 26.04 mg/l), LC₅₀/10 (T₂=20.83 mg/l,) and LC₅₀/12 (T₃=17.36 mg/l) which were selected based on the calculated 96hr LC₅₀ value and analysis was carried on 7th, 14th, 21st and 28th day. Behavioural alterations like jumping movement, restlessness, hyperventilation, hyperactivity, gulping, coughing and corkscrew swimming at surface and bottom of the tank were observed. Enhanced mucus secretion, loss of buoyancy and string of faeces hanging from anus or on the tank was also observed during acute exposure to 96hr LC₅₀ concentration for 24, 48, 72, and 96 hrs. Marked histological alterations in liver like exocrine pancreatic acini, hepatic degeneration and mononuclear infiltration were observed; in gills epithelial lifting,

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. S.K. Bhagabati

oedema, telangiectasis in secondary lamellae, lamellar fusion while in kidney expansion of Bowman's space, cloudy swelling of epithelial cells, necrosis of several renal tubules and multiple focal areas of inter-tubular haemorrhage were observed during both acute and chronic exposure. Results showed that immune- haematological parameters like haemoglobin (Hb), packed cell volume (PVC), red blood cells (RBC), white blood cells (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), Nitroblue tetrazolium bursts activity (NBT), lysozyme activity (LA) altered significantly ($*p < 0.05$) during both acute and chronic exposure. Serum biochemical parameters like Glucose, Cholesterol, Phospholipid, Triglyceride, HDL, VLDL, Magnesium, AST, ALT increased significantly whereas protein, albumin, globulin, A:G ratio, LDL significantly decreased during both acute and chronic exposure to IMI. Significant induction in oxidative stress enzymes (SOD, CAT, GPx, AST and ALT) and Oxidative stress biomarkers (ROS, MDA) in liver, gill and brain tissues were also observed during acute exposure, whereas in chronic exposure the same was observed in dose and time dependent manner. Significant reduction in brain AChE enzyme activity due to inhibition of acetylcholine esterase and DNA damage through significant induction of micronuclei formation in the erythrocyte of fish blood was clearly observed. Upregulation of HSP70 and CYP1A gene in both liver and gill tissues of exposed fish were observed on 7th, 14th, 21st and 28th day in dose and time dependent manner. Findings indicates that acute exposure of commercial-grade Imidacloprid (Premise, 30.50%, SC) induces immunotoxicity, neurotoxicity, oxidative stress, histological alterations and DNA damage, leading to the cause of death. Moreover, it is also observed that even at sublethal concentrations IMI can act as a potential immunosuppressor, oxidative stress enhancer and can trigger probable neurotoxic and genotoxic effects which may result in physiological imbalances leading to reduced growth. Our study also indicates that IMI is a moderately hazardous insecticide to non-target aquatic organisms and No Observed Effect Concentration (NOEC) of the product will be < 17.36 mg/l. Further study is required to determine the actual NOEC concentration of the product Premise (30.50% SC), thus warranting the product for further review of human health and environmental safety.

Evaluation of ichthyofaunal diversity and habitat ecology of the Namchik river, Changlang district of Arunachal Pradesh, North East India

Jayanta Dutta

The present study was conducted on the ichthyofaunal diversity and habitat ecology of river Namchik, Changlang district of Arunachal Pradesh for a period of one year from December, 2016 to November, 2017. Altogether 51 fish species belonging to 33 genera under 13 families from 6 orders were recorded from the river. The Cypriniformes formed the dominant group with a contribution of 4 (30.8%) families, 21 (63.6%) genera and 34 (66.67%) species. The order Siluriformes with 5 (38.5%) 5 families, 6 (18.2%) genera and 10 (19.61%) species, Synbranchiformes with (7.7%) family, 2 (6.1%) genera and 3 (5.88%) species, Perciformes with 1 (7.7%) family, 2 (6.1%) genera and 2 (3.92%) species and Mugiliformes and Belontiiformes with (7.7%) family, 1 (3.0%) genera and with 1 (1.96%) species each. The fisheries of river Namchik is mainly dominated by Garra (*Garra anandalei*, *G. naganensis*, *G. kempi*, *G. lamia*), Mahseer (*Tor putitora* and *Tor tor*), Barils (*Barilius barila*, *B. bendelisis* and *Ospariusbarna*), Minor carps (*Banganadero labeo* and *L. pangusia*), Barbs (*Pethia ticto*, *Puntius sophore* and *Systomus sarana*) and miscellaneous species (*Luoches*, Catfish, Glass fish etc.). Under IUCN conservation status, 43 (84.31%) species were recorded as least concern, near threatened 3 (5.88%), vulnerable 2 (3.92%), endangered 1 (1.96%) and 2 (3.92%) species under 'not evaluated' category. The Species diversity index (H) was found to be highest at station 4 (3.484) in post monsoon season and lowest at station 1 (1.6115) in monsoon, Simpson diversity index (1-A) recorded highest at station 1 (1.0) in monsoon and lowest at station 2 (0.9702) in monsoon season. The value of Margalef's richness index (d) was found to be highest at station 3 (8.0846) in post monsoon season and lowest in monsoon at station 2 (2.5447). Pielou's evenness index (J) was recorded maximum at station 3 (0.9858) in post monsoon and minimum at station 2 (0.9770) in pre monsoon season which showed the river is mostly diverse. The average values in respect of water quality of Namchik River were moderate water temperature (15.15-20.90°C), slightly alkaline pH

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Department : Department of Aquatic Environment Management

Major Advisor : Dr. Ayub Ali

(7.39-7.99). optimum level of dissolved oxygen (7.0-9.4 mg l⁻¹). total dissolved solids (57.75-144.20 mg l⁻¹), specific conductivity (67.80-163.60 uS cm⁻¹), alkalinity (36.02 - 44.93 mg l⁻¹), and water current (0.50-1.54 m sec⁻¹). The species composition reflects the high fishery potential of the river. Physico-chemical parameters are mostly found to be in the favourable ranges for the growth and development of aquatic organisms.

Evaluation of length-weight relationship and reproductive biology of vulnerable carp *cirrhinusreba* (Hamilton, 1822)

Jyotirmoyee Das

Cirrhinusreba is a very good candidate species for carp polyculture system and presently its seed is not commercially available. Wild population of this fish is declining due to heavy harvesting and is declared as vulnerable by International Union for Conservation of Nature and Natural Resources (IUCN, 2000) in Indian water bodies. Scant information is available on length-weight relationship data and its reproductive biology. With this background, the present study was undertaken to study its length weight relationship and reproductive biology of *Cirrhinusreba* (Hamilton, 1822) from "Kolong" river of Raha, Nagaon, Assam, India for twelve months. The fishes were separated into male and female to calculate length weight relationship and reproductive biology separately. In the present study, a total of 358 specimens of *C. reba* comprising 203 numbers of females and 155 numbers of males were analyzed for estimation of length - weight relationship. In the present study 'b' values for males ranged from 2.53 to 3.31, whereas for females it ranged from 2.54 to 3.17. The positive allometric growth in *C. reba* may be due to higher feeding proficiencies and better environmental condition whereas negative allometric growth in fishes may be attributed to the loss of energy due to gonad development during breeding season in the present study. Maximum GSI (Male: 9.6607; female: 13.9067) was recorded in June for both sexes. Fecundity in the present study, ranged from 62,391 to 1,09,991. The sex ratio of *C. reba* examined was 1:1.3 ($P > 0.0112^*$). For all the sexes, highest condition factor (K) value and lowest condition factor (K) values were found in June and December respectively. Variation in the relative condition factor (Kn) values of the fishes were also observed under the present study. For all the sexes, highest relative condition factor (Kn) values of *C. reba* were found in June and lowest in the December. On an average, the males were in a slightly better condition than females. The relative condition factor (Kn) values also express healthy condition showing good compatibility with the nature or environment.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Jiten Sarma

Assessment of Productivity and Fish Diversity of Dzii River of Kohima, Nagaland

Kedolhouse Kuotsu

Dzii river is one of the important river of Nagaland, which flows through a length of about 35 km within the district of Kohima, before joining Sidzii river below Kijiimetouma village to form the Doyang river system. The present study was conducted for a period of 1 year starting from March, 2019 to February, 2020 with three sampling stations, elevation ranging from 867 MSL to 695 MSL, to evaluate the physico-chemical and biological parameters of the river system. The range of studied important physico-chemical parameters of Dzii river are surface water temperature (17-27o C), turbidity (4.9-97 NTU), water depth (0.75-1.5m), water velocity (0.20-0.75 ms⁻¹), pH (6.4-7.8), total alkalinity (20-195 mgL⁻¹), DO (6.37-11.41 mgL⁻¹), COD (5.4-14.2 mgL⁻¹), total hardness (62.72-190.85 mgL⁻¹), TDS (43-165 mgL⁻¹), EC (11.5-559 µScm⁻¹), nitrate (0.011-0.214 mgL⁻¹), phosphate (0.046-0.102 mgL⁻¹), ammonia (0.009-0.035 mgL⁻¹). The present study also revealed that primary productivity of the river system was below the productive range with GPP value ranging from 0.090 to 0.154 g C m⁻³ d⁻¹ and NPP value from 0.041 to 0.071 g C m⁻³ d⁻¹. During the study period, a total 23 fish species belonging to 4 orders, 6 families and 13 genera were recorded. The order Cypriniformes was dominant with 17 species, followed by Siluriformes with 4 and 1 each from Anabantiformes and Synbranchyformes. Family Cyprinidae, contributes 60.86% of the total fish diversity of the river, which was found to be the most abundant family of fishes. According to IUCN conservation status (2017), of the 23 species, 1 species (*Tor putitora*) is Endangered (EN), 1 (*Schistura naganensis*) is Vulnerable (VU), 6 species are Not Evaluated (NE) and rest 15 are of Least Concern (LC).

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. S.K. Bhagabati

Acute toxicity and behavioural changes in zebra fish *danio rerio* (Hamilton,1822) exposed to a neonicotinoid pesticide “Thiamethoxam”

Lawonu Prasad Mudoi

Pesticides became one of the leading polluting agents of aquatic ecosystems. Neonicotinoid pesticide Thiamethoxam is a widely used pesticide in Assam particularly in Tea Gardens of the state. Pesticide residue in natural water bodies may affect indigenous ichthyofauna as well as human health. The present study investigated acute toxicity, behavioral and histopathological alterations in Zebrafish (*Danio rerio*) exposed to Thiamethoxam. The acute toxicity test was performed according to the standard methods EPA (1996) and the 24, 48, 72 and 96 hours LC₅₀ values of Thiamethoxam for *Danio rerio* were estimated as 35.19, 10.315 ppm, 33.83, 0.226 ppm, 32.78, 0.325 ppm and 31.69, 0.336 ppm respectively. The study also recorded the behavioural changes that observed during 24, 48, 72 and 96 hours of exposure period like Hyper Excitability, Enhanced Opercular Movement, Fin movement, Enhanced mucus secretion, Imbalanced swimming, Loss of reflex, Lethargy etc. Histopathological alterations in Gill and Liver tissues of the exposed fishes were also studied. Congestion, Hemorrhage and Enhanced Cellularity were observed in the Gill tissues whereas Focal necrosis, Fatty changes, Cell degeneration, Appearance of inflammatory cells and Congestion were recorded in Liver tissues of exposed Zebrafishes by the effect of Thiamethoxam.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

Study of Productivity and Ichthyofaunal Diversity of Kharungpat Lake, Manipur

Md. Abdul Salam

The present investigation was undertaken during the period 2019-2021 to study the productivity and ichthyofaunal diversity of Kharungpat lake located towards the southern lowlands of the central valley of Manipur (India). The lake water was characterized by moderate temperature (16.68-29.21 oC), fluctuating transparency (53.00-119.30 cm), suitable level of pH (6.26-7.74) and dissolved oxygen (5.10–9.35 mg/l), favourable total alkalinity (31.21-66.29 mg/l), total hardness with a value of 28.37-66.49 mg/l which can sustain low growth of fish, fluctuating level of free carbon dioxide (3.78-10.23 mg/l), phosphate phosphorus and nitrate nitrogen content with a value ranged from 0.001 to 0.018 mg/l and 0.01-0.30 mg/l. Sediment pH (4.00-6.20) of the lake exhibit acidic and low productive and it is not conducive for good growth of fish and microbial activity, moderate organic carbon (1.00-2.64%) and high organic matter (1.72-4.55%) was recorded. The recorded available nitrogen (7.36 to 28.42 mg/100g) and phosphorus level of sediment (0.29 to 1.15 mg/l) indicates low productive nature of the lake while the available potassium level (21.72-49.84 mg/100mg) were observed to be very poor from fishery point of view. Variation in sediment quality and physico-chemical characteristic of water was influence by temperature, rainfall and biotic communities. An average plankton population ranged between 141 to 1413 units per liter indicated low productive of the lake. Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae are the four major phytoplankton groups identified with a percentage composition of 51.79%, 31.00%, 13.12% and 4.33% respectively. Cladocera, Copepoda and Rotifera are the three major zooplankton groups identified comprising of 16 genera under 13 families and 8 orders. The gross and net primary productivity of the lake Kharungpat ranged between 55.80 to 259.35 mg C/m³/hr and 12.22 to 103.19 mg C/m³/hr respectively. The gross primary productivity indicated the low productive nature of the lake. A total of 26 aquatic macrophytes were identified comprised of 26 species belonging to 23 genera, 15 families and 11 orders.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

The luxuriant growth of aquatic macrophytes in lake indicates that the lake is eutrophic in nature. The fish diversity of Kharungpat lake comprised of 29 species belonging to 20 genera, 11 families and 6 orders in which Cypriniformes formed one of the most dominant order as compared to all other orders recorded comprising of 52% of the total fish species of the lake. Out of the total 29 fish species identified, 5 species are exotic and 24 species are recorded to be indigenous. The 5 exotic species are *Ctenopharyngodon idella* (0.38%), *Cyprinus carpio* (0.58%), *Cyprinus carpio specularis* (0.71%), *Hypophthalmichthys molitrix* (0.75%) and *Oreochromis mossambicus* (6.00%). Shannon and Margalef richness indicated less healthy environment of the lake.

The fish diversity indicted that the fish population of the lake could be enhance by supplementary stocking with *Labeo catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Labeo Calbasu*, *Labeo gonius*, *Labeo bata* with the introduction of indigenous fish like *Osteobrama belangeri* coupled with the introduction of *Ctenopharyngodon idella* is expected to augment fish yield. Clearance of aquatic macrophytes in the lake is likely to change its ecological structure to a plankton-based system, making it potentially more productive ecosystem. Monitoring of encroachment of lake catchment area, regular awareness programme on proper and judicious use of resource, protection of lake ecosystem by full participation of local community could improve the lake environment.

Effect of pH on Acute Toxicity of Synthetic Antioxidant Butylated Hydroxytoluene in Embryo of Zebrafish *Danio rerio* (Hamilton, 1822)

Nikimoni Borah

BHT (3, 5-di-tert-butyl-4-hydroxytoluene) is a synthetic antioxidant which is used in food additive, cosmetics and plastic industries to increase the reliability of food and plastic. The production, use and release of these antioxidants can create contaminant source for aquatic ecosystem. Due to the global climate change temperature is increasing now a days and this increasing temperature impacts on water physicochemical parameters like dissolved oxygen level and pH, which could affect the toxicity of contaminants to aquatic organisms. Many toxins increase or decrease in toxicity due to water quality. The present study was undertaken to evaluate the effects of pH on toxicity of BHT in zebrafish (*Danio rerio*) embryo. Zebrafish embryos were exposed to five different level of pH (5, 6, 7, 8 and 9) with 6 different concentrations of BHT for 96 hour and lethal and developmental endpoints were assessed. LC50 values for 96 hour found in this study at pH 5 to 9 were 2.067 mg l⁻¹, 2.453 mg l⁻¹, 3.356 mg l⁻¹, 1.210 mg l⁻¹ and 0.823 mg l⁻¹ respectively. Developmental deformities observed in sub-lethal concentrations at pH 5 to 9 during 24, 48, 72 and 96 hour post fertilization were pericardial edema, yolk sac edema, deformed otolith, notochord deformation, accumulation of RBC and Spine deformities. In sub-lethal concentrations, heartbeat of zebrafish embryo increased at all pH and were significantly different (p<0.05) at pH 5, 8 and 9 when compared to control. Hence, the present study could be a best for future research using fish embryo as a model to determine the effect of other environmental parameters on acute toxicity of Butylated hydroxytoluene (BHT).

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. S.K. Bhagabati

Assessment of Environmental Integrity of Northern Plain Region of the River Umtrew (Digaru) in Meghalaya and Assam with special reference to its pollution status

Nishi Sarmah

The current study presents an account of environmental integrity of northern plain region of River Umtrew (Digaru), Meghalaya and Assam. River Umtrew originates in Meghalaya traverses a distance of approximately 70 km and ultimately drains down to mighty Brahmaputra in Assam. Water and plankton samples were collected for twelve consecutive months (January 2019 to December 2019) from three stations of 30 km river stretch starting from Umtrew hydroelectric power site. During the study period, range of some of the important water quality parameters were: surface water temperature (16-32 °C), turbidity (4.4-69.5 NTU), dissolved oxygen (4.1-9.2 mgL⁻¹), pH (6.5-7.9), total dissolved solids (24-238 mgL⁻¹), total alkalinity (14-59 mgL⁻¹), total hardness (20.02-65.06 mgL⁻¹), BOD₃ (8.21-36.20 mgL⁻¹), COD (14.40-60.08 mgL⁻¹), nitrate (0.09-0.29 mgL⁻¹), phosphate (0.028-0.45 mgL⁻¹), total fecal coliform (7 to 1400 per 100 mL). A total 20 genera of plankton and some meroplanktonic forms like fish larvae and eggs were recorded from the river. Plankton density of the river was found to be poor and ranged between 8 and 48 unitsL⁻¹. The study revealed that among the three stations environmental integrity of station 1 located near Umtrew Hydroelectric Project was maintained compared station 2 and 3 located near Burnihat industrial estate and Sonapur district hospital respectively. Consequently, pollution level of station 2 and 3 were also found to be higher compared to the 1st station. Discharge from Burnihat Industrial area, agricultural runoff and domestic waste discharge were identified as the main sources of pollution in stations 2 and 3. Total fecal count index indicated that surface water of the river falls under Category C having designated best use as drinking water with conventional treatment followed by disinfections. Principal Component Analysis revealed that among all the water quality parameters of the study, six parameters namely BOD₃, COD, ammonia, alkalinity, turbidity and TDS are playing a distinctive role in determining the overall environmental condition of the river.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

Hydrobiological studies of Morakolong beel, Morigaon district, Central Brahmaputra Valley Zone

Priyanky Tamuli

A study was conducted on hydrobiological characteristics of Morakolongbeel (47 no.), Morigaon district, Central Brahmaputra Valley Zone, Assam, during February, 2017 to January, 2018 considering the importance of hydrobiological parameters of a beel on its sustainable development. The selected beel is located at 26°20'61.98"N latitude and 92°42'30.93' E longitude. The beel comes under the open category. The study region experiences sub-tropical climate with high rainfall and has four distinct seasons, viz., pre- monsoon (March to May), monsoon (June to September), post-monsoon (October to November) and winter (December to February). The beel experienced three major floods during the monsoon season. Water qualities of the beel were found within the favourable range for warm water fish. Moderate water temperature (17.4 to 33.5^o C), near- neutral p^H (6.3 to 7.3), optimum dissolved oxygen level (5.13 to 7.73 mg l⁻¹), favorable total alkalinity (32 to 62 mg l⁻¹) and total hardness (45 to 66 mg l⁻¹) shows that the studied beel is productive. Specific conductivity and total dissolved solids were directly related to organic carbon and available phosphorus in sediment indicating that both these parameters are directly influenced by sediment fertility. Nitrate- nitrogen levels (0.02 to 0.30 mg l⁻¹) and phosphate- phosphorus levels (0.002 to 0.018 mg l⁻¹) indicated productive nature of the beel. Sediment of the beel was characterized by acidic p^H (4.63 to 6.30), moderate to high organic carbon (1.16 to 3.32%), slightly higher levels of available nitrogen (9241.01 to 689.79 kg ha⁻¹), available phosphorus (10.68 to 48.78 kg ha⁻¹) and available potassium (111.29 to 294.55 kg ha⁻¹) than the other beels of Central Brahmaputra Valley Zone. The 47 no. Morakolongbeel was moderately infested (average area 41%) with aquatic macrophytes (mainly floating) and these macrophytes restricted plankton abundance (590 u l⁻¹) in the beel. The gross primary productivity (51.14 to 231.04 mgC m⁻³ hr⁻¹) of the beel indicated that the studied beel is a productive one. The different diversity indices of plankton and macrophytes showed that the beel was productive one.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. S.K. Bhagabati

Experimental breeding of *channa striatus* (Bloch, 1793) using different hormones under the agro-climatic condition of Assam

Rikki Bagra

An experiment on induced breeding of *Channa striatus* in captivity using two different GnRH based synthetic hormones viz., Gonopro-FH and Ovafish and was injected intramuscularly. The experiment was conducted following a Completely Randomized Design (CRD). This study consists of three treatments i.e., low dose (0.2 and 0.4 ml/kg), medium dose (0.4 and 0.6 ml/kg), high dose (0.6 and 0.8 ml/kg) each dose with three replications for both the hormones. Brooders (2:1) male and female were injected with doses of 0.2 and 0.4, 0.4 and 0.6, 0.6 and 0.8 ml/kg body weight male and female respectively. All the doses induced the fish to breed. The efficacy of both the hormones was evaluated for the performance parameters such as spawning fecundity, fertilisation rate, hatching rate, latency period and incubation period were the highest ($P < 0.05$) at medium dose (0.4-0.6 ml/kg). Outcomes of all the doses varied significantly with each other with the low doses of male female 0.2 and 0.4 ml/kg showed the least performance. Using Gonopro-FH more fecundity was achieved than compared to the Ovafish. Brooders injected with Ovafish has shown longer latency period of 23.73 to 27.73 hours and incubation period of 23.43 to 27.33 hours than the Gonopro-FH 21.46 to 25.46 hours and 22.5 to 25.33 hours respectively. With Gonopro-FH maximum fertilization rate was 88.68% and hatching rate was 86.06%, while for the Ovafish, fertilization rate was 87.09% and 79.43% of hatching rate was achieved. This study clearly shows that Gonopro-FH gave better results than the Ovafish in the captive breeding performance of *Channa*.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Dipak Kr. Sarma

Assessment of Acute Toxicity in Fresh Water Cypriniform *Cyprinus carpio* (Linnaeus, 1758) Exposed to a Commercial Neem based Biopesticide

Rituparna Borah

Pesticides are the leading polluting agents of aquatic ecosystems. Pesticide residue in natural water bodies may affect indigenous ichthyofauna as well as human health. Azadirachtin, a pesticide derived from the neem tree (*Azadirachta indica*), is a highly effective and widely used pesticide. The present study investigated acute toxicity, behavioural and biochemical compounds in common carp (*Cyprinus carpio*) exposed to Azadirachtin. The acute toxicity test was performed according to the standard methods EPA (1996) and the 24, 48, 72 and 96 hours LC₅₀ values of Azadirachtin for *Cyprinus carpio* were estimated as 3.924 mg/l, 2.858 mg/l, 2.075 mg/l and 1.414 mg/l respectively. The study also recorded the behavioural changes that were observed during 24, 48, 72 and 96 hours of exposure period like hyper excitability, enhanced opercular movement, fin movement, enhanced mucus secretion, imbalanced swimming, loss of reflex, lethargy etc. Serum biochemical compound such as total serum protein, serum glucose and serum albumin were analyzed with 96 hours LC₅₀ value (1.414 mg/l) of Azadirachtin. Significant reduction in values was obtained for total serum protein and albumin while significant increase was observed in glucose. However, statistical significance ($p < 0.05$) was observed during 24, 48, 72 and 96 hours for total serum protein, serum glucose and serum albumin.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Utpal Kr. Das

Acute Toxicity of Synthetic Pyrethroid Pesticide Cypermethrin in Developing Zebrafish (*Danio rerio*) (Hamilton-Buchanan, 1822) Embryo

Ruhul Amin

Cypermethrin (CP) is a type II pyrethroid that is used to protect economically important crops such as cotton, fruits, and vegetables from a wide range of insects. Pyrethroid pesticides have been applied to agriculture and aquaculture since the 1970s to replace traditional pesticides. However, pyrethroids are approximately 1000 times more toxic to fish than to mammals and birds. In the present investigation, an attempt has been made to determine median lethal concentration (LC₅₀), effective concentration (EC₅₀) and Teratogenic Index of a 10% cypermethrin commercial formulation on developing zebrafish embryo. The 96-hour LC₅₀ value was calculated as 0.129 ppm and EC₅₀ value was found to be 0.028 ppm. The abnormalities like pericardial edema, yolk sac edema, tail deformity, decrease body, eye pigmentation and axial malformation (notochord bending) were observed in zebrafish embryo exposed to different concentrations of CP. The heartbeat and heart size changed significantly (P<0.05) at higher concentrations and exposure time. The Teratogenic Index (TI) was calculated to be 4.607 which implies that the compound may be a probable teratogen. As a result, the findings of this study show that cypermethrin can have a negative impact on the early developmental stages of zebrafish. The current study opens future scope for research on its acute as well as chronic effects.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

An Assessment of Carbon Sequestration of a Floodplain Wetland (48 No. Thekera *beel*, Morigaon District) of Central Brahmaputra Valley Zone, Assam

Rupam Jyoti Nath

Floodplain wetlands are dynamic ecosystem and play a very important role in regulation of green-house gases by the mechanism of carbon sequestration. It also plays a vital role in carbon cycling, cycling of water and nutrients, food production for aquatic organism, provision of habitats, water purification, regulation of flows, and so on. The present study was carried out in a seasonally open floodplain wetland (48 No. Thekera wetland) in Morigaon district of Assam, to assess the estimated carbon sequestration rate of the wetland which was 1.57 Mg C ha⁻¹ yr⁻¹. However, the total sediment organic carbon levels up to 10 cm depth in the wetland was 17.40 Mg C ha⁻¹, which was 2.6 times higher than that deposited up to 10 cm depth in the upland reference soil (6.57 Mg C ha⁻¹). The total C content was found to be 13.43 Mg C ha⁻¹ in 10-20 cm and 10.55 Mg C ha⁻¹ in 20-30 cm. The current study also revealed that sediment organic carbon decreased progressively with depth from 0 to 30 cm. SOC content of 48 No. Thekera *beel* ranged from 0.69 to 1.05% during pre-monsoon, 0.58 to 0.93% during monsoon, 1.11 to 1.32% during post monsoon, and 0.83 to 1.14% during winter seasons, where minimum value was recorded during monsoon and maximum value was recorded during post-monsoon.

Abstract of M.Sc. Thesis

Department : Department of Aquatic Environment Management

Major Advisor : Dr. Rajdeep Dutta

Effect of garlic extract on quality of dried *Puntius sophore* during storage at ambient temperature

Ipsita Jamatia

The present study was conducted for a period of six months to evaluate the effect of garlic extract on the proximate, biochemical, microbiological and organoleptic properties of dried *Puntius sophore* during the storage period. The garlic extract was used at the rate of 5%, 7% and 10% level. During the study it was found that the yield percentage of dried *P. sophore* was 23.26%. The results showed that there was no significant ($P < 0.05$) effect in the moisture and ash content of the control and treated samples. The decrease of the protein, fat content during storage in treated sample with 10% garlic extract was significantly ($P < 0.05$) less when compared to that of control. The protein, fat, moisture and ash of the treated sample with 10% garlic extract was in the range of 42.54% - 41.40%, 23.54% - 22.58%, 13.09% - 14.01% and 16.12% - 17.10% respectively during the storage period. The effect of garlic extract on the biochemical characteristics revealed that the PV, FFA and TVB-N content in 10% garlic extract was significantly ($P < 0.05$) less when compared to that of control which ranged from 1.13 meq/100g - 1.49 meq/100g; 1.14% as oleic acid - 1.42% as oleic acid and 17.04 mg% - 22.64 mg% respectively during the storage of 180 days which were within the acceptable limits. The microbial characteristics also showed that the garlic extract (10%) have shown significantly ($P < 0.05$) lower increase in counts during the storage period which was within the acceptable limits of $< 10^6$ cfu/g. In case of organoleptic characteristics it was found to slightly decrease and was found that the odour and overall acceptability of 5% garlic extract treated samples were significantly ($P < 0.05$) higher. Overall, it can be interpreted from the findings that as the concentration of garlic extract increases its effect on the proximate, biochemical and microbiological characteristics increases, however, considering the organoleptic parameters, treatment of *P. sophore* with 5% garlic extract have significant effect on the odour and overall acceptability of the product.

Abstract of M.Sc. Thesis

Department : Department of Fish Processing Technology

Major Advisor : Dr. Pranjyoti Sarma

Effect of ginger extract on quality of dried *Amblypharyngodon mola* during storage at ambient temperature

Misan Debbarma

The quality of traditionally prepared sun-dried fish is generally poor due to oxidation, microbial activities, chemical activities, insufficient drying and also selection of low-quality raw materials, fishes may have bad smell, bitter taste, changes in colour and many more which makes it unacceptable for the consumers. Considering the above mentioned problems, an attempt was made to study the effect of ginger extract as a preservative on proximate composition, biochemical compositions, microbiological quality and organoleptic properties of sun-dried *Amblypharyngodon mola* during storage at ambient temperature.

In the present study, a 180 days experiment was conducted and *Amblypharyngodon mola* was selected as a raw material. The purpose of the study was to produce chemicals free dry fish using natural preservative. Selected raw material was treated with ginger extract of 5%, 10% and 15% with 10 % salt and compared with control sample which is treated with only 10 % salt. Significant changes were noted in protein content, fat content, TBV-N content, PV content, FFA content and microbiological quality during storage period. But in case of moisture and ash there was not that much of difference. However, as the storage period increases, moisture and ash content increases in all the samples. Slightly higher crude protein and crude fat was noted in treated samples as compared to control sample. It was observed that protein and fat content decreases with storage period in all the samples. However, lower decreasing trend of both protein and fat content was noted in treated samples. In biochemical study, the values of TVB-N, FFA and PV increases with storage period. TVB-N value was found to be 19.14 mg% (C), 18.67 mg% (T1), 18.54 mg% (T2) and 17.97 mg% (T3) at the initial days of storage. At the end of storage period values of 24.50 mg% (C), 24.27 mg% (T1), 23.34 mg% (T2) and 20.77 mg% (T3) were noted. FFA values were found to be 1.31% (C), 1.22% (T1), 1.13% (T2) and 1.16% (T3) at the initial days of storage. At the end of storage period values of 2.98% (C), 2.81% (T1), 2.17% (T2) and 1.79% (T3)

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Major Advisor : Dr. Sarifuddin Ahmed

were noted. In case of peroxide value, it was found to be 2.90% (C), 2.51% (T1), 2.47% (T2) and 1.62% (T3) at the initial days of storage. At the end of storage period values of 3.66% (C), 3.29% (T1), 2.97% (T2) and 2.27% (T3) were noted.

Low bacterial load was noted in treated samples during storage period and the highest total plate count was recorded in control sample with count of 5.64 log cfu/g at the initial days of storage. At the end of storage period 6.23 log cfu/g was noted in control sample. The lowest bacterial load was observed in 15% concentration of ginger extract treated sample (T3) with count of 5.12 log cfu/g at the initial days of storage. At the end of storage period 5.70 log cfu/g was noted in T3 sample.

Based on sensory evaluation, ginger treated fish scored higher as compared to treated with only salt. Organoleptically, sample treated with ginger extract had the best acceptance as compared to control.

The use of salt and ginger (*Zingiber officinale*) together gives the best result as compared to the use of salt alone. Treated with salt and different ginger extract concentration was found to be more effective to minimize the biochemical and microbial activity. Therefore, ginger extract can be incorporated with salt to enhance the shelf-life of dried *Amblypharyngodon mola*.

Study on Ichthyofaunal Diversity and Physicochemical Parameters Downstream of Hydroelectric Power Project Dam of Subansiri River, Assam

Imran Hussain

The present study on ichthyofaunal diversity and physico-chemical parameters downstream of Subansiri river, Lakhimpur district of Assam was conducted for a period of 1 year from April, 2020 to March, 2021. Altogether 55 fish species belonging to 42 genera, 24 families and 10 orders were recorded from the river. The largest group Cypriniformes contributed 3 families (12.50%), 15 genera (35.71%) and 20 species (36.36%). The fish diversity of river Subansiri is mainly dominated by Barils (*Barilius bendelisis*, *Opsarius barna*), Barbs (*Puntius terio*, *P. sophore*, *P. chola*), Loaches (*Acanthocobitis botia*, *Lepidocephalichthys guntea*), carps (*Labeo gonius*, *L. calbasu*, *L. bata*, *L. rohita*, *Cirrhinus mrigala*) and miscellaneous species (*Nandus nandus*, *Glossogobius giuris*, *Chaca chaca* etc.). As per IUCN conservation status, 51 (92.72%) species were recorded as Least Concern, 2 (3.64%) species under near threatened, 1 (1.82%) species under vulnerable and 1 (1.82%) species under endangered category. Margalef's richness index (d) was found to be the highest in Monsoon at station 3 (9.098) and the lowest again at station 3 (7.942) in the pre-monsoon season. Buzas and Gibson's evenness index (E) was found to be the highest at station 1 (0.8359) in post monsoon and the lowest at station 1 in monsoon season (0.763). The Shannon-Weiner index (H') was found to be the highest in pre monsoon season at station 2 (3.668) and the lowest in post monsoon season at station 2 (3.479). The Simpson index (1- λ') was found to be the highest in pre monsoon season at station 2 (0.9702) and the lowest in post monsoon season at station 2 (0.9635). It indicates a diverse fisheries potential of the river and rich distribution of fishes across the river. Altogether 40 genera belonging to 34 families, 25 orders under 12 classes recorded from 3 different stations of Subansiri river. Bacillariophyceae formed the largest group with a contribution of 7 orders (28%),

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Major Advisor : Dr. Ayub Ali

10 families (29.41%) and 11 genera (27.5%). The planktonic groups of Subansiri mainly dominated by Naviculales (*Craticula*, *Frustulia*, *Navicula* and *Pinnularia*), Desmidiaceae (*Closterium acutum*, *Closterium incurvum*, *Cosmerium* and *Penium*), Fragilariaceae (*Fragillaria*, *Synedra*, *Tabellaria flocculosa*) and Cladophorales (*Pithophora*, *Cladophora*, *Rhizoclonium*) etc. The mean value with regard to physico-chemical parameters of river Subansiri were moderate surface water temperature, (14.6 °C - 24.0 °C), slightly acidic to moderately alkaline pH (6.05-8.14), dissolved oxygen (4.10 - 6.81 mg/l), total dissolved solids (55.6- 153.2 mg/l), specific conductivity (70.8-164.1 μ S/cm), moderate total alkalinity (35.64- 82.45 mg/l), water current (1.30- 2.15 m/sec) and water transparency (30.4-54.2 cm). Thus the different water quality parameters recorded indicate a favorable condition for the growth of aquatic organism nearly round the year.

Study on Ichthyofaunal Diversity and Physico-Chemical Parameters of a Floodplain Wetland (Jaluguti *Beel*, Morigaon District, Assam) of Central Brahmaputra Valley Zone

Sheetala Chintey

The present study was conducted to evaluate the ichthyofaunal diversity and habitat ecology of Jaluguti *beel*, Morigaon district of Assam, for a period of one year from May, 2020 to April, 2021. A total of 46 fish species belonging to 33 genera, 19 families and 7 orders were recorded from the *beel*. The order Cypriniformes comprised of 3 families (15.79%), 14 genera (45.71%) and 20 species (43.48%) contributing to the total. Six families (31.58%), 7 genera (20%) and 9 species (19.57%) made up the order Perciformes. With 5 families (26.32%), 6 genera (17.14%) and 10 species (21.74%), the order Siluriformes contributed a significant portion to the total number and percentage composition of the *beel*, followed by Synbranchiformes with 2 families (10.53%), 3 genera (8.57%) and 4 species (8.70%), and the orders Clupeiformes, Osteoglossiformes and Beloniformes were represented by 1 family (5.26%), 1 genera (2.86%) and 1 species (2.17%) each. Fisheries of Jaluguti *beel* was mainly dominated by *Parambassis ranga*, *Chanda nama*, *Pachypterus atherinoides*, *Chela cachius*, *Salmostoma bacaila*, *Amblypharyngodon mola*, *Mystus bleekeri* and other miscellaneous species. Under IUCN conservation status (2021), the highest species were recorded under Least Concern (LC) category with a total number of 37 and contributed 80.43%. Under LC category, majority of the species belonged to the family Cyprinidae with 13 (28.26%) followed by Bagridae 4 (8.70%), Mastacembelidae and Channidae 3 (6.52%), Cobitidae and Ambassidae 2 (4.35%) each. Balitoridae, Notopteridae, Clupeidae, Heteropneusteidae, Schilbeidae, Synbranchidae, Nandidae, Gobiidae, Osphronemidae and Belonidae with 1 species contributed 2.17% each. Under Near Threatened (NT) category Siluridae and Cyprinidae contributed 3 (6.52%) and 1 (2.17%) species, respectively. Under Data Deficient category both Anabantidae and Cyprinidae

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Major Advisor : Dr. Jiten Sarma

contributed 1 (2.17%) each and under vulnerable, endangered and near threatened category contributed 1 (2.17%) each. Margalef's Richness Index (d), Pielou's Evenness Index (J), Shannon -Weiner Index (H') and Simpson Index (1- λ) indicated high fish diversity in the *beel*, with a more or less even distribution of fish genera indicating that the *beel* was in good condition for fish production. During the study period, a total of 20 genera of phytoplankton and 13 genera of zooplankton were recorded in the *beel*. Bacillariophyceae dominated among the phytoplankton and rotifera were dominated among the zooplankton group. The majority of physico - chemical parameters were found to be in a favorable range for aquatic species growth and reproduction. Water temperature of Jaluguti beel were ranged from 18.4 °C to 29.8 °C, water pH from 5.5 to 7.3, dissolved oxygen from 4.5 mg/l to 6.9 mg/l, total alkalinity from 42.10 mg/l to 68.10 mg/l, total hardness from 50.0 to 69.2 mg/l, specific conductivity from 83.7 μ S/cm to 110.0 μ S/cm, free carbon dioxide from 5.3 mg/l to 9.6 mg/l, turbidity from 3 NTU to 4.7 NTU, and ammonia-nitrogen were ranged from 0.14 mg/l to 0.19 mg/l

Anthropogenic activities in the beel such jute retting, household and domestic wastage, dumping of salted water used in drying fish at beel periphery may pose threats to the fish diversity of the *beel*.

Master of Veterinary Science

- **Animal Biotechnology**
- **Animal Genetics and Breedings**
 - **Animal Nutrition**
- **Animal Reproduction, Gynaecology and Obstetrics**
 - **Veterinary Anatomy and Histology**
 - **Veterinary Biochemistry**
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- **Veterinary Pharmacology & Toxicology & Jurisprudence**
 - **Veterinary Physiology**
 - **Veterinary Public Health**
- **Veterinary Surgery and Radiology**

DNA Polymorphism in Mitochondrial Genes Encoding Nd1, Co1 and Cytb in Canine Malignant Tumours

Dr. Shakeel-Ul-Rehman

Malignant tumours in dogs are frequently reported. The types of malignancies commonly reported in canines include female breast cancers, lymphomas, adenomas and carcinomas of mast cells. Specific mutations and polymorphism in mitochondrial genes have been shown to be associated with different types of human malignancies. However, similar studies in respect to malignant tumours in dogs are very limited. Hence in the present study, an attempt was made to identify frequency of occurrence of mutation and polymorphism in gene sequences encoding NADH dehydrogenase subunit 1 (ND1), cytochrome b (CYTB) fragments of mtDNA and cytochrome c oxidase subunit 1 (CO1) in dogs, and to define the association of DNA polymorphic mutations with different tumour types.

Based on histopathology, out of 10 tumours examined 5 (50%) were found to be of epithelial and the rest 5 (50%) of mesenchymal origin. Two of the five epithelial tumors were recognized as adenocarcinoma and three as squamous cell carcinoma. Of the five mesenchymal tumors, four were identified as fibrosarcoma and one as liposarcoma. Of the 10 cases, 8 (80%) were recorded in local and 2 (20%) in crossbred dogs. While 7 (70%) cases were recorded in male, 3 (30%) were observed in females. Location-wise, two each of the tumours were observed in skin and mammary gland, while one each was observed in mouth, left flank, abdominal region, testicle, right elbow and left forelimb. The dogs suffering from the neoplastic growth in different parts of the body were within the range of 5 - 13 years of age.

Analysis of three mtDNA gene fragments established a relatively low level of molecular genetic variation between the tissues (tumour tissue, normal tissue and blood) of the individuals examined. Majority of the mutational changes in the *ND1*, *COI* and *CYTB* gene fragments in the analyzed tissues in most of the dogs with tumours were insertions and deletions. Only a few polymorphisms were noted in the partial gene fragments of the analyzed tissues when compared to reference successions.

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Major Advisor : Dr. Probodh Borah

Multiple substitutions and insertions have been noted in *NDI* gene fragment; these included four substitutions (C218T, T455C, G498A and C666T) and three insertions (341InsC, 355InsC and 718InsT). However, no mutations were recorded in *NDI* gene fragment from any of the three types of tissues examined in case of a dog affected with squamous cell carcinoma. Changes in *CYTB* gene fragment included two substitutions (C322T and T799C) and one insertion (303InsG) mutation. Polymorphism C322T in the *CYTB* fragment was noted in 40% of the samples analysed. No mutation was, however, detected in this gene fragment in one case of fibrosarcoma. In the *COI* gene fragment, A735G polymorphic mutation was recorded in all (100%) the 10 cases of malignant tumours investigated in the present study. In this gene fragment, instances of mutations recorded were comparatively lesser.

Except for C218T mutation observed in *NDI* gene fragment seven cases of canine malignant tumour that induced S (Serine) to Y (Tyrosine) variation in the amino acid sequence of the coded protein at position 72, no other substitution mutation recorded in this gene fragment could cause a variation at the level of amino acid sequence. On the other hand, none of the mutations detected in *CYTB* gene fragment could induce any change in the level of amino acid sequence of the coded protein. Similarly, the only substitution mutation in the *COI* gene fragment that induced a change at the amino acid level was A813T mutation observed in a case of fibrosarcoma, which caused a G (Glycine) to A (Alanine) variation at 71 position.

Results of the present study showed the effect of two alleles (*NDI*: 218, *COI*: 813) on the amino acid sequence of the coded proteins which suggested consequently their potential role in carcinogenesis. However, the sample size in the present study was too small to infer conclusively about the association of the mutations and polymorphisms identified in the present study with specific malignant tumours in dog.

Production Performance of Daothigir Chicken under Field Condition

Dr. Banani Talukdar

A study was conducted in Chirang and Kokrajhar district of Assam to evaluate the morphological characters, production, reproductive performance, growth and mortality of Daothigir chicken. Data pertaining to records of 497 Daothigir chicken were collected from both the districts during the period from August, 2018 to June, 2019 through field survey for the purpose of present study. Predominant plumage colour of head and neck in cock was blackish white followed by whitish brown and brownish black whereas body plumage colour was mostly white with black feathers followed by black with brown feathers. In hens, the most common plumage colour observed in head and neck was blackish brown followed by white with black feathers while body colour was mostly brown with black feathers followed by black with white feathers. Tail feathers were predominantly black in colour in both the sexes, however, black with brown feathers was also seen in some birds. Skin colour was found to be mostly white followed by pinkish in both cocks and hens. Shank colour was found to be whitish and yellow. Comb was red coloured, single and erect in both cocks and hens. The average age at first egg was 198.80 ± 3.05 days and annual egg production was 68.93 ± 1.06 numbers. The hens were reported to have an indefinite pattern of clutch size and clutch interval and undergoes three to four laying cycle in a year. The overall mean of egg weight (g), albumen index, yolk index, haugh unit, shell thickness (mm), shape index and specific gravity were recorded as 42.19 ± 0.19 g, 0.08 ± 0.001 , 0.39 ± 0.005 , 69.31 ± 0.36 , 0.33 ± 0.001 mm, 75.33 ± 0.98 and 1.10 ± 0.016 respectively. The colour of the egg shell of Daothigir hens was mostly light brown. Fertility and hatchability was recorded as 91.54% and 83.89 % with a range of 87.50 to 94.11% and 80 to 86.66% in the present investigation. The hens are quite broody and about 54.31 % showed broodiness.

Average mortality rate were 13.33 %, 3.21 % and 8.12 % with a range of 9.65 to 17.01 %, 1.06 to 4.76 % and 5.43 to 11.61 % during 0 to 8th week, 9th to 20th week and 21 weeks and above ages respectively. The overall mean of body weight at day old stage, 20 weeks and 40 weeks of ages were found to be 33.56 ± 0.65 g, 975.03 ± 9.36 g

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Major Advisor : Dr. A. M. Ferdoci

and 1539.37 ± 8.41 g respectively. The mean body weight at day old stage, 20 weeks and 40 weeks in Chirang and Kokrajhar was found to be 32.46 ± 0.21 g, 32.80 ± 0.15 g; 934.15 ± 15.33 g, 989.34 ± 14.23 g and 1545.64 ± 10.23 g, 1512.21 ± 9.54 g respectively. The body weight of cocks at 20 weeks and 40 weeks of age were found to be 992.05 ± 14.44 g and 1590.74 ± 9.80 g and the corresponding values of hens were found to be 820.98 ± 7.93 g and 1416.83 ± 8.99 g respectively. Effect of district was found to be non-significant ($p \geq 0.05$) on age at first egg, annual egg production and body weight at 0 day, 20 weeks and 40 weeks of ages. However, significant effect ($p < 0.01$) of sex was found in body weight at 20 weeks and 40 weeks of age.

Growth and Reproductive Performance of Hampshire x Desi Half- Bred Pigs

Dr. Toshimongla Aier

The study was carried out in the Department of Animal Genetics and Breeding, College of Veterinary Science, AAU, Khanapara by utilizing the animal records maintained at ICAR-Mega Seed Project (MSP) on Pig located at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam. Records pertaining to 51 sows and 464 progeny of Hampshire x Desi half-bred pigs were utilized in the present study. The data obtained were classified according to the sex, season and parity of the animals. The overall least-squares means in Hampshire x Desi half-bred pigs for body weight at birth, weaning, 3 months, average daily gain during 0-42 days, 42-90 days and 0-90 days were found to be 1.149 ± 0.010 kg, 7.060 ± 0.024 kg, 13.539 ± 0.166 kg, 140.721 ± 0.443 g, 131.753 ± 3.450 g and 137.154 ± 1.823 g, respectively. Statistical analysis revealed that males were significantly ($P < 0.05$) heavier than females at birth. Significant ($P < 0.01$) effect of season on birth and weaning weight was observed indicating that piglets born during season S_2 (June to September) had significantly higher body weight. Parity had significant ($P < 0.05$) effect on body weight at 3 months of age and mean body weight during second parity was the highest followed by third and the fourth and which however, was the lowest in the first parity. The results revealed that parity had significant ($P < 0.05$) effect on average daily gain during 42-90 days and 0-90 days which was highest in the pigs born to sows during second parity. The overall least-squares mean for age at first conception, age at first farrowing, gestation period and farrowing interval were found to be 257.663 ± 4.362 , 371.006 ± 4.470 , 113.549 ± 0.115 and 182.978 ± 1.759 days, respectively in Hampshire x Desi half-bred pigs under study. Statistical analysis revealed that season had significant ($P < 0.05$) effect on farrowing interval and that sows that farrowed during season S_3 had significantly shorter farrowing interval. Parity had significant ($P < 0.05$) effect on gestation period and compared to other parities of the sow, third and fifth parity of the sow had significantly shorter gestation period. The overall average litter size at birth and weaning and litter weight at birth and weaning were 7.918 ± 0.128 numbers, $7.862 \pm$

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Major Advisor : Dr. Galib Uz Zaman

0.133 numbers, 9.231 ± 0.209 and 56.205 ± 1.386 kg respectively in Hampshire x Desi half-bred pigs. Analysis of variance revealed that second parity had comparatively higher litter size at weaning.

Characterization of Indigenous Ducks of Manipur

Dr. Y. Sovarani Devi

Data pertaining to records of 924 indigenous ducks of Manipur were utilized in the present investigation to study their morphometric characteristics, productive and reproductive performance and important egg quality traits. Predominant plumage colour of head and neck in males of indigenous ducks of Manipur was glossy green, followed by greenish black and brown colour. Body colour of grey, tan and brown were most common. In females, the most common plumage colour observed was brown, followed by white, black; other colours were also observed in little frequency. Most of the birds had speckled plumage pattern and brown speckled plumage was more common in ducks. Both sexes had an area of white bordered iridescent blue, green or purple blue feathers on their wings. About 20% of the plumage pattern was solid. Bill colour was found to be mostly yellow, followed by orange, black and mixture of black and orange in both drakes and ducks. Skin colour was found to be pale pink and yellowish white. Shank and feet colour was predominantly orange, followed by brown, yellow, black and mixture of black and orange. The least squares means for body weight at 5, 6, 7, 8, 9, 10, 11 and 12 months of age were $1.55 \pm 0.01\text{kg}$, $1.61 \pm 0.01\text{kg}$, $1.68 \pm 0.01\text{kg}$, $1.83 \pm 0.01\text{kg}$, $1.85 \pm 0.02\text{kg}$, $2.08 \pm 0.01\text{kg}$, $2.07 \pm 0.02\text{kg}$ and $2.16 \pm 0.02\text{kg}$ respectively. The least squares means of body weight and body measurements *viz.*, body length, body circumference, bill length, bill width, head length, head width, neck length, breast length and shank length at adult were found to be $1.72 \pm 0.01\text{kg}$, $61.68 \pm 0.18\text{cm}$, $38.54 \pm 0.17\text{cm}$, $5.99 \pm 0.02\text{cm}$, $3.36 \pm 0.02\text{cm}$, $6.14 \pm 0.02\text{cm}$, $3.87 \pm 0.02\text{cm}$, $14.77 \pm 0.04\text{cm}$, $17.27 \pm 0.06\text{cm}$ and $5.42 \pm 0.02\text{cm}$ respectively. The age at first egg was 170.80 ± 0.91 days and annual egg production was 175.06 ± 0.87 numbers. These ducks were reported to have an erratic pattern of clutch size and interval and had a tendency to lay eggs throughout the year. The egg quality traits including egg weight, shape index, shell weight, shell thickness, specific gravity, albumen index, Haugh unit, yolk index and yolk colour score were $61.13 \pm 1.31\text{g}$, 72.17 ± 0.47 , $6.24 \pm 0.08\text{g}$, $0.35 \pm 0.01\text{mm}$, 1.08 ± 0.01 , 0.08 ± 0.002 , 74.01 ± 0.91 , 0.37 ± 0.01 and 10.14 ± 0.45 respectively. Egg shell colour was found to be cloudy white. Broodiness was rarely observed in indigenous

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Department : Animal Genetics Breeding

Major Advisor : Dr. Arpana Das

ducks of Manipur. Fertility was recorded as 85.06% within a range of 80.72 to 87.19% and hatchability on total egg set (TES) basis was 65.38% within a range of 61.01 to 73.35% in the present investigation. Average mortality rate were 15.31, 11.08, 7.67 and 3.96% with a range of 9.08 to 21.36, 6.35 to 16.25, 5.13 to 13.26 and 1.95 to 5.49% in between 0 to 1st week, 1st to 8th week, 8th to 20th week, 6th to 12th month respectively. Significant effect ($P < 0.01$) of district as well as sex was observed on body weight and body measurements at different ages and males had higher values than females. Age at first egg also differed significantly ($P < 0.01$) due to different district. However, no significant effect of district was found on annual egg production. Adult body weight had positive correlation with all body measurements under study; the highest being with body circumference (0.72 ± 0.02) and the lowest was with shank length (0.19 ± 0.05). Age at first egg was found to have negative correlation with annual egg production (-0.11 ± 0.08). Highest correlation coefficient was observed between albumen index and Haugh unit (0.73 ± 0.08). The linear and multiple regression equations were developed for prediction of adult body weight from body length, body circumference and breast length and multiple regression equations were comparatively reliable than the linear regression equations for the purpose.

Effect of Supplementation of Certain Anti-oxidants (Vitamin E, Vitamin C and Selenium) on the Growth Performance of Broiler Chicken During Heat Stress

Dr. Chanra Deep Singh

An experiment was conducted to determine the effects of level of inclusion of the different anti-oxidant combinations on broiler chicken during heat stress. One hundred eighty (n=180) day old broilers chicks of vencobb 400 strain were distributed randomly into 5 groups (T0, T1, T2, T3 and T4) having 36 chicks in each on the basis of their body weight. Each group divided into three replicates of 12 chicks in each. The control group was fed with standard starter and finisher rations, computed by using common feed ingredients to meet the nutrient requirement as per ICAR (2013) for broiler chicken and other four groups (T1, T2, T3 and T4) were offered the the same standard ration of the control group but supplemented with the combination of vitamin E , vitamin C and Se in the drinking water as follows : T1 (vitamin E@100mg/ltr and Se@0.2mg/ltr), T2 (vitamin E@100mg/ltr and Se@0.3mg/ltr), T3(vitaminE@100mg/ltr and vitamin C@100mg/kg)and T4 (vitamin E@200 mg/ltr and vitamin C@200 mg/ltr). The result of the experiment showed significantly ($P<0.05$) higher in body weight, total weight gain, total feed intake and overall FCR in the groups T1 and T4 than the control, T2 and T3 groups. Broiler performance efficiency index was found better in T1 and T4 groups. Significant difference ($P<0.05$) was observe in the level of Hb and WBC whereas, PCV did not differ significantly ($P>0.05$) among the groups. Supplemented groups showed significant better glucose and protein content in the serum. Serum Electrolyte and liver enzymes were significantly better ($P<0.05$) in the T1 and T4 groups than other groups. Erythrocytic antioxidants viz, Catalase, SOD and Reduced glutathione, are significantly higher in the T1 and T4 groups. Heat shock protein was found highly significant ($P<0.01$) between control and supplemented groups. Whereas, no significant difference ($P>0.05$) was recorded in the carcass characteristics viz. dressing percentage, prime cuts percentage, giblet weight and lymphoid organs weight. WHC, drip loss, pH and TBARS values were noted significantly better in the T1 and T4

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Major Advisor : Dr. A. K. Gohain

groups than T0, T2 and T3 groups. The study revealed that the supplementation of vitamin E and Se @ 100mg and 0.03mg/ltr. and vitamin E and C @200mg/ltr. increased the profit for broiler production.

On the basis of above experimental findings, combination of vitamin E and Se @ 100mg and 0.03mg/ltr. & vitamin E and C @200mg/ltr was found to be better on the growth performance during heat stress.

Evaluation of Banana Stem and Urea Treated Paddy Straw Based Complete Rations for Growing Crossbred Calves

Dr. Keruulenuo Yhome

An experiment was conducted to evaluate banana stem and urea treated and untreated paddy straw based complete rations on the growth performance, feed intake, nutrient utilization, blood biochemicals and cost of feeding on growing crossbred (HF×J) male calves. A standard concentrate mixture (C) having CP-20% and TDN 75% was prepared using conventional ingredients. Two isonitrogenous and isocaloric complete rations viz. T1 using 20% banana stem and 30% paddy straw with concentrate ingredients in the ratio of 50:50 roughage and concentrate and T2 using 20% banana stem, 30% urea (3%) treated paddy straw with concentrate ingredients at the ratio of 50:50 roughage and concentrate were prepared. Banana stem and paddy straw were chopped into 2-3 cm long before mixing. Chopped banana stems were cooked for 15 minutes before mixing. Fifteen weaned crossbred (HF×J) male calves with average body weight of 87.7 kg were divided randomly into three groups viz. C, T1 and T2 consisting of five (5) animals each in randomized block design. A feeding trial for a period of 90 days duration followed by a metabolic trial of 5 days duration were conducted in the last week of the feeding trial. Calves belongs to control (C) group were fed with standard concentrate mixture (C), mixed green fodder and paddy straw. Calves of group T1 and T2 were fed with complete ration T1 and T2, respectively. Each calf became one replicate for their respective group since they were fed individually during entire feeding trial. Amount of feed were adjusted every fortnightly along with the body weight change to meet the nutrient requirements as per ICAR (2013) standard for growing calves. Daily feed consumption and fortnightly body weight of calves were recorded. Blood samples were collected from each calves at initial (0th day), mid (45th day) and end (90th day) of the experiment to estimate the blood biochemicals. Feed and biological samples were analyzed as per standard procedures (AOAC, 2007), Van Soest *et al.* (1991), Talapatra *et al.* (1940) and blood samples using method described in the kits. Data obtained were analyzed statistically as per procedure suggested by Snedecor and Cochran, (1994) and

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Major Advisor : Dr. Gunaram Saikia

significance of difference by Duncan's Multiple Range Test (Duncan, 1995) using SPSS 20.0 version.

The DMI per animal per day, per 100 kg body weight and per kg W0.75 were comparable among the groups and no significant difference ($P>0.05$) were observed between the groups. Non significant difference were observed among the groups in respect of digestibility coefficient of DM, OM and NFE but there was significant difference ($P<0.05$) in CP, EE, CF, NDF and ADF among the groups and the values were higher in T1 and T2 group as compared to control group C. Calves of different groups were in positive balance of N, Ca and P, however significant different were observed among the group in respect of balance and retention of N, Ca and P. The ADG were 242.09 ± 32.84 , 256.13 ± 17.55 and 280.89 ± 20.63 g in C, T1 and T2 group, respectively. Non significant difference was observed among the groups in respect of ADG, however values were in increase trend from group C to group T2. The FCE were 10.48 ± 0.36 , 9.63 ± 0.15 and 8.97 ± 0.16 in C, T1 and T2 group, respectively. The FCE was significantly lower in T1 and T2 groups as compared to the control group C. The complete rations (T1 and T2) were able to meet the DM, CP and TDN requirement as per ICAR (2013) standard for growing male calves. The blood biochemicals viz. serum cholesterol, total protein, serum albumin, serum globulin and albumin/globulin ratio were within the normal range and no significant difference was observed among the groups. The feed cost per kg gain in body weight were Rs. 155.86, Rs. 173.99 and Rs. 153.44, respectively for C, T1 and T2 group, respectively. The nutritive value of the complete ration T1 were CP-14.63%, DCP-11.65% and TDN- 57.53 %, DE- 2.54 MCal/kg and ME- 2.08 MCal/kg and for T2 were CP-14.63%, DCP-11.73%, TDN- 57.98%, DE-2.56 MCal/kg and ME- 2.10 MCal/kg, respectively. Based on the result of the present study, it is concluded that banana stem (*Musa balbisiana colla*) can be used upto 20% in the paddy straw based complete rations for growing calf without any adverse effect.

Effect of Supplementation of Garlic and Multi-Strain Probiotics on the Performance of Broiler Chicken

Dr. Reema Shrestha

An experiment was conducted to investigate the effect of supplementation of garlic (*Allium sativum*) and multi-strain probiotics (MSP) on the performance of broiler chicken. One hundred eighty (N=180) day old commercial Ven Cobb 50 strain broiler chicks were used having average body weight and was equally divided into four groups having three replicate (15 chicks in each replicate). The dietary treatments were control (T0- basal diet) and group supplemented with 0.25%, 0.50% and 0.75% garlic powder (GP) and multi-strain probiotics (MSP) in T1, T2 and T3, group, respectively. The basal diet was prepared according to ICAR (2013) recommendation for starter and finisher phase by using commonly available feed ingredients. Result of the study showed that average weekly body weight change, gain in body weight and total gain (g/bird) were significantly highest ($P < 0.05$) in T2 (0.50% garlic powder + MSP) group compared to other treatment groups where the total gain in weight (g/bird) were 1569.90 ± 4.16 , 1606.89 ± 0.21 , 1652.85 ± 0.16 and 1402.93 ± 0.59 g in T0, T1, T2 and T3 groups, respectively. The feed intake was not differed significantly among the groups. However better ($P < 0.05$) FCR was observed in T0, T1, T2 groups than T3 group. The Broiler Performance Efficiency Index was 68.26 ± 4.52 , 82.63 ± 5.90 , 76.75 ± 7.91 and 62.01 ± 1.48 was better ($P < 0.05$) for T0, T1, T2 and T3 groups, where T1 group had highest BPEI among the treatment groups. The digestibility of nutrients and N retention were not showing any significant affect except NFE digestibility was significantly highest in T2 group. The serum glucose, total protein, albumin and globulin did not show any significant effect ($P > 0.05$) among the treatment groups; whereas serum cholesterol and triglycerides were lowest ($P < 0.05$) in 0.50% garlic powder + MSP fed group. Erythrocytic reduced glutathione which was significantly better in T0, T2 and T3 groups as compared to T1 group. The carcass characteristics like dressing percentage, prime cuts, giblet weight and lymphoid organ weight did not differ among the groups. Caecal microbial profile in Lactic acid bacteria was increased ($P > 0.05$) and *E. coli* count

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decreased ($P>0.05$) in T2 group. Whereas, the villi height of jejunum was significantly ($P<0.05$) increased in supplementation of 0.50% garlic powder + MSP in broilers. On the basis of above findings, it can be concluded that 0.50% garlic powder + MSP can be used as synbiotic for better production and health status in commercial broilers.

Effect of Feeding Total Mixed Ration and Complete Feed Block on Productive Performance of Crossbred Cows

Dr. Sikhamoni Haloi

An experiment was planned and conducted to assess the effect of feeding of total mixed ration and complete feed block on productive performance of crossbred cows compared to conventional feeding system. Eighteen lactating crossbred cows of 1st, 2nd and 3rd lactation were randomly divided into three groups of six animals in each group following Completely Randomized Design (CRD) and were allotted to three dietary treatments (T0, T1 and T2). Feeding of animals under T0 group was done in conventional method (separate feeding of concentrate and roughage), whereas T1 and T2 groups were fed complete feed block (CFB) and total mixed ration (TMR), respectively. The feeding trial was conducted for a period of 90 days followed by digestibility trial of 5 days. The average dry matter intake was 11.09 ± 0.07 , 11.22 ± 0.07 and 11.17 ± 0.06 for T0, T1 and T2 group, respectively and did not differ significantly. The dry matter intake per 100 kg body weight was 3.65 ± 0.07 , 3.77 ± 0.10 and 3.70 ± 0.12 for the corresponding group. The dry matter intakes per kg W^{0.75} body weight were 152.01 ± 3.28 , 156.73 ± 3.78 and 153.99 ± 4.69 . The percent digestibility of DM, OM, CP, CF, NFE and NDF were significantly higher in T1 and T2 group over T0 group, however digestibility of EE and ADF did not differ significantly. The average daily milk yield was 7.79 ± 0.04 , 9.04 ± 0.03 and 8.92 ± 0.04 for the T0, T1 and T2 group, respectively which was significantly higher ($P < 0.01$) in T1 and T2 group. The feed conversion ratio per kg of milk yield was 1.52 ± 0.01 , 1.31 ± 0.01 and 1.32 ± 0.01 for the T0, T1 and T2 group, respectively. The milk constituent like total solid, solid not fat, protein and specific gravity, titratable acidity and pH of milk were not affected by system of feeding. Milk fat content was significantly higher ($P < 0.05$) in T1 and T2 group compare to T0 group. The blood glucose, total serum protein and blood urea nitrogen were comparable among the groups. The cost of milk production was lowest in TMR (Rs.20.11) followed by CFB (Rs.22.93) and conventional system (Rs. 23.40). It could be concluded that feeding of complete feed in the form of block (T1) and TMR (T2) gave better results in terms of milk yield, FCM yield, milk fat and digestibility of nutrients

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over conventional system and system of feeding had no influence on blood biochemical parameters like blood glucose, total serum protein and blood urea nitrogen.

Effect of Mannan-Oligosaccharide and Pomegranate (*Punica granatum*) Peel Powder on the Performance of Broiler Chicken

Dr. Sudhanya Nath

An experiment was conducted to study the effect of mannan-oligosaccharide (MOS) and pomegranate (*Punica granatum*) peel powder (PPP) on the performance of broiler, nutrient digestibility, blood biochemical and antioxidant profile, gut health, carcass characteristics and intestinal morphology. Two hundred forty (N=240) day old commercial Ven Cobb strain 400 broiler chicks were randomly distributed into 4 groups of 3 replicates of 20 chicks in each. The dietary treatment groups were as follows, T0 (Control; basal diet), T1 (basal diet +0.1% MOS), T2 (basal diet + 0.6% PPP) and T3 (basal diet+0.9% PPP). Chicks were fed ready-made pre-starter diet up to 6 days which was followed by starter and finisher basal (ICAR, 2013) prepared by using common feed ingredients. Results of the study showed significantly (P<0.05) higher body weight, total gain in weight and FCR in T1 and T3 groups compared to control (T0) and T2 group. Whereas, feed intake (g/bird) was not different among the groups. Supplemented groups also showed significant (P<0.05) results in respect of CP metabolizability, EE digestibility and N retention. Broiler performance efficiency index was better (P<0.05) in T1 and T3 groups. Significantly higher (P<0.05) serum glucose, A:G ratio and total cholesterol were observed in treatment groups compared to control. Erythrocytic antioxidant like catalase activity was significantly (P<0.05) higher in T1 and T3 groups. Supplementation of MOS and PPP showed significant improvement in faecal LAB and NH₃-N concentration. However, the carcass characteristics *viz.* dressing percentage, prime cuts, giblet weight and lymphoid organ weight were not showing any significant results except CP percentage in breast meat. CP percentage was significantly (P<0.05) higher in T1 and T3 groups compared to T0 and T2 groups. The intestinal villi height and crypt depth were greater (P<0.05) in 0.9% PPP supplemented group. The study indicated that supplementation of MOS @ 0.1% and PPP @ 0.9% in broiler rations increased the profit for broiler production and is inevitable for production of cost effective high quality broiler ration. On the basis of the experimental findings, the present study showed that 0.1% MOS and 0.9% PPP had better performance in respect

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of gain in weight, FCR, nutrient digestibility, blood biochemical profile and antioxidant status, gut health and intestinal morphology. Therefore, the PPP can be used as a prebiotic for broiler production.

Seroprevalence of Leptospirosis in Dairy Cows With Reproductive Disorders and Therapeutic Management of Endometritis

Dr. Alapa Baba Ikpe

The present investigation was carried out to study the seroprevalence of leptospirosis in dairy cows with reproductive disorders and therapeutic management of endometritis. A total of 130 sera collected from dairy cows with reproductive disorders maintained by private farmers in different localities in Kamrup (Metro) district and the Instructional Livestock Farm, College of Veterinary Science, A.A.U., Khanapara were screened for leptospirosis by MAT.

The seroprevalence of leptospirosis in dairy cows with reproductive disorders was found to be 14.62 per cent. Twelve *Leptospira* antigen serovars: *L. Australis*, *L. Autumnalis*, *L. Ballum*, *L. Bataviae*, *L. Canicola*, *L. Grippytyphosa*, *L. Hebdomedis*, *L. Pomona*, *L. Pyrogenes*, *L. Sejroe*, *L. Icterohaemorrhagiae*, and *L. Javanica* were used, to screen for leptospirosis. *Leptospira* antibodies were detected in four serovars: *Australis*, *Autumnalis*, *Ballum* and *Bataviae*. *Australis* was found to be the most circulating serovar with 47.37 per cent.

The reproductive disorders reported in the present study were: repeat breeding 41 (31.54%), abortion 34 (26.15%), endometritis 25 (19.23%), post-partum anoestrus 14 (10.77%), dystocia 5 (3.85%), retention of foetal membrane 4 (3.07%), anovulation 2 (1.53%), uterine prolapse 2 (1.53%), silent oestrus 2 (1.53%) and cystic ovaries 1 (0.77%). Repeat breeding was found to be the most prevalent reproductive disorder (31.54%) followed by cases of abortion (26.15%) in Kamrup (Metro) district of Assam. Out of 18 samples, 10 (55.55%) were positive for Gram negative bacteria, 2 (11.11%) for Gram positive bacteria and 6 (33.33%) for both Gram positive and Gram negative bacteria. The bacteria isolated were *E. coli*, *Proteus* spp., *Bacillus* spp. and *Staphylococcus* spp. The Gram negative bacteria were found to be the major cause of endometritis in dairy cows. Levofloxacin was found to be the most effective antibiotic against uterine microflora.

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The overall conception rate after treatment of endometritis with *E. coli* LPS, antibiotics (levofloxacin) and uraksha were 83.33, 66.66 and 33.33 per cent respectively.

Addressing Postpartum Anoestrus in Crossbred Cows

Dr. Chandra Prakash Dixit

A study was conducted on 554 crossbred cows to know the incidence of post partum anoestrus and to find out the fortification need of ovsynch and kisspeptin protocol in the treatment of postpartum anoestrous cows maintained in and around Guwahat city, Assam. Fifty postpartum anoestrous crossbred cows were selected based on history and clinico-gynaecological examination. The animals were divided into four treatment groups and treated with ovsynch, ovsynch fortified with minerals and bypass fat, kisspeptin and kisspeptin fortified with minerals and bypass fat. The study revealed that out of 554 crossbred cows surveyed, 32.13 per cent cows had one or the other reproductive disorders. The incidence of anoestrus and repeat breeding was the highest among the various reproductive disorder observed. Anoestrus and repeat breeding were common in cows ≥ 8 years of age and at 3rd parity.

Frequent urination and restlessness were observed to be typical behavioural signs of oestrus exhibited by anoestrous cows following different treatment protocols while congested and edematous vulva, good tone of uterus, open cervix and presence of large follicle with soft follicular wall were the most conspicuous physical signs of oestrus. Level of serum oestrogen increased to a significantly high ($P < 0.01$) level upto day 10 of treatment in all treatment protocol groups and the increase was more prominent in cows treated with Ovsynch and fortified Ovsynch protocol as compared to that under Kisspeptin and fortified kisspeptin protocol. Level of progesterone increased significantly ($P < 0.01$) on day 7 and declined thereafter in cows treated with Ovsynch and fortified Ovsynch protocol. Kisspeptin alone or with fortification did not show significantly changes in the level of serum progesterone upto day 10 of treatment. Higher oestrus response was observed in ovsynch + MM+ BPF, kisspeptin and kisspeptin + MM+ BPF than that of ovsynch protocol. Conception rate was recorded to be the highest in animal treated with ovsynch + MM+ BPF protocol.

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Major Advisor : Dr. Dipak Bhuyan

A Study on Centrifugation Regime and Commercial Extender on Quality of Frozen Beetal Buck Semen

Himsikha Chakravarty

Fifty two pooled ejaculates comprising eighty ejaculates from five adult Beetal bucks maintained at Goat Research Station, AAU, Burnihat collected by artificial vagina method were used to study the effect of centrifugation regime and commercial extender on quality of frozen Beetal buck semen. Thirty six pooled ejaculates were used to find out a suitable centrifugation regime for removal of seminal plasma wherein the effect of three gforces viz., 700 x g, 1100 x g and 1400 x g at three time periods viz., 5, 8 and 11 minutes were studied in Tris extender. The remaining sixteen pooled ejaculates were used for studying the effect of three extenders viz., Tris (control), Optixcell and Bioxcell extenders on quality of frozen semen by using the best centrifugation regime. Freezing of semen was done in French mini straws by rapid horizontal vapour freezing technique.

The percentage of sperm motility, live sperm, intact acrosome and HOST-reacted sperm differed significantly ($P < 0.0001$) between time periods at 700 x g, 1100 x g and 1400 x g centrifugation. On critical difference test mean post-thaw values after freezing semen centrifuged at 700 x g were significantly ($P < 0.05$) higher for 8 minutes than for 11 and 5 minutes, and significantly ($P < 0.05$) higher for 11 minutes than for 5 minutes whereas the post-thaw values at 1100 x g were significantly ($P < 0.05$) higher for 8 minutes than for 5 and 11 minutes and significantly ($P < 0.05$) higher for 5 minutes than for 11 minutes. The sperm motility, live sperm and HOST-reacted sperm at 1400 x g were significantly ($P < 0.05$) higher for 5 and 8 minutes than for 11 minutes while the incidence of intact acrosome was significantly ($P < 0.05$) higher for 5 minutes than for 8 and 11 minutes and significantly ($P < 0.05$) higher for 8 minutes than for 11 minutes. On freezing of washed Beetal buck semen centrifuged at 700 x g for 8 minutes, 1100 x g for 8 minutes and 1400 x g for 5 minutes, the sperm motility, live sperm, intact acrosome and HOST-reacted sperm differed significantly ($P = 0.0016; 0.0050; 0.0072$ and 0.0019 respectively) between centrifugation regimes. The post-thaw sperm parameters were significantly ($P < 0.05$) higher at 1400 x g for 5 minutes and 1100 x g for 8 minutes than

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in 700 x g for 8 minutes. Beetal buck semen washed at 1400 x g for 5 minutes and frozen in Tris, Optixcell and Bioxcell extenders yielded significantly ($P < 0.05$) higher post-thaw values for sperm motility, live sperm, intact acrosome and HOST-reacted sperm in Optixcell extender than in Bioxcell and Tris extenders.

Effects of Split-Weaning on the Performance and Behavioural Traits of Hampshire Piglets

Dr. Arunima Kalita

An investigation was carried out under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 during the period from September 2018 to February 2019.

Forty eight piglets of Hampshire pig of three weaning age groups from six sows, considering an average litter size of 8 were selected for the experiment and each group consisted with sixteen numbers of piglets. Two groups (Group I and II) were split weaned at 28th and 35th days of age where 50 per cent of higher body weight piglets of the litter were separated and rest 50 per cent were kept with mother up to 56 days of conventional weaning. Another litter was weaned as conventional weaning age, 56 days (Group III). After weaning, the piglets were reared up to 75 days for studying of post weaning effect. Common conventional feed was provided to all the groups as per NRC (1998).

The average split weaning body weight gain and total body weight of piglets weaned at 35 days of age (Group II) was found significantly higher followed by the piglets weaned at 56 days of age (Group III) and lower in piglets weaned at 28 days of age (Group I) while, the corresponding results also observed in the three experimental groups of piglets from birth to post weaning period till 75 days in respect to the average daily, total and final body weight gain. In regards to the average total feed consumption, feed consumption by per piglet, feed consumption by per piglet per day and total feed consumed till end of the experiment period was more or less equal; however the feed conversion efficiency was found to be comparatively higher in Group II than Group I and III.

From the study, the effect of behavioural traits *i.e.* playing, feeding, water intake, sleeping, huddling and suckling in the three split weaning groups found to be Group II was performed well in time spending on playing, water intake, sleeping and suckling except feeding and huddling, whereas Group I was showed maximum time spent for feeding and huddling and Group II showed in between the two groups.

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Overall, it might be opined from the present investigation that split weaning could be carried out at 35 days old pigs for better performances and better behaviour after weaning.

Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor

Dr. Ibasani Sawian

An investigation was conducted to see the performance of pre-weaning Hampshire piglets reared on rubber mat floor. Thirty six newborn piglets were divided into two groups of eighteen each and were randomly assigned to two floor treatments viz. concrete (Group I) and rubber mat (Group II). The final body weight at 8th week for the piglets on rubber mat and concrete floor was 9.97 ± 0.06 kg and 9.53 ± 0.20 kg respectively and the value being significantly ($P < 0.05$) higher in Group II.

The average weekly gain at 8th week in Group II was 1.56 ± 0.01 kg which was significantly ($P < 0.01$) higher than Group I piglets which showed an average weekly gain value of 1.40 ± 0.01 kg. The total body weight gains recorded for Group I and Group II piglets were 8.36 ± 0.16 kg and 8.78 ± 0.06 kg respectively. Average daily gains (ADG) were recorded as 0.149 ± 0.003 kg and 0.157 ± 0.001 kg for Group I and Group II respectively. The total and daily body weight gains appeared to be significantly ($P < 0.05$) higher in piglets housed on rubber mat floor. This puts forward that rubber mat floors had a positive influence on the body weight gains of the piglets.

The total feed intake by the piglets of Group I and Group II were recorded as 87.43 kg and 87.95 kg respectively, the weekly average feed intake for Group I and Group II was 14.57 kg and 14.66 kg respectively whereas the daily average intake was 2.08 kg and 2.09 kg respectively. Feed intake of the piglets did not exhibit any variation in respect to the floor type. The diarrhoea incidence rate was recorded as 9.79% in Group I which was higher than that of Group II piglets with a value of 5.88%.

The overall prevalence of sole bruising, sole erosion, limb abrasion, foot and limb swelling in Group I piglets was 23.61%, 28.47%, 29.17%, and 5.56% respectively. The corresponding values for Group II piglets were 21.53%, 11.81%, 8.33%, and 0.69% respectively. The piglets of Group II had lower severity and prevalence of foot and limb injuries that those of Group I piglets. The prevalence of alopecia was 67.37% and 80.55% in Group I and Group II respectively. Piglets exhibiting limb abrasion will not show alopecia in the same location and the abrasive nature of the concrete floor will rapidly replace alopecia into abrasion. Hence alopecia was observed more in piglets kept

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on rubber mat than those on concrete floor. No coronary band injuries and piglet mortality could be observed during the experimental period in both the groups.

Physicochemical and Microbiological Quality of Drinking Water for Livestock under Organized and Unorganized Sectors in the Brahmaputra Valley of Assam

Dr. Jiaur Rahman

A study was conducted to identify the sources, assess the physicochemical and microbiological quality of drinking water for livestock under organized and unorganized sectors in the Brahmaputra valley of Assam. Five different agro-climatic zones of the valley were selected and one district was selected from each zone on the basis of livestock population. The study was carried out during the period of November 2018 and February 2019. A total of 60 samples were collected both from organized and unorganized sectors (farms). The sources were identified as well, tube well, bore well, pond and river in both the sectors. The physical as well as chemical parameters were studied using JalTara water testing kits and pH and turbidity were measured with the help of digital pH meter and digital turbidity meter respectively. The most widely used drinking water source in the study area was bore well. The physical parameters viz., colour, temperature and turbidity were within the IS 10500: 2004 and WHO (2011) permissible limit. The temperature of the water samples ranged from 16.15 to 18.88 °C. The chemical parameters viz., pH, TDS, total hardness, sulfate, arsenic, fluoride, chloride and nitrate were below the permissible limit except iron which was above the permissible limit (0.3mg/l). The iron content in Kamrup (R) and Nagaon ranged from 0.85 to 0.90 mg/l and 0.95 to 0.90 mg/l respectively and were highest among all the selected districts. The lowest iron content was found in Karbi Anglong district with a value of 0.33-0.41 mg/l. Out of sixty samples, seven samples from pond, river and bore well sources were found positive for coliform organism both in organized and unorganized farms.

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Effect of Dietary Supplementation of Satomul (*Asparagus racemosus*) on Certain Production Performances of Crossbred Dairy Cows

Dr. Parteek Kumar Khera

An experiment of dietary supplementation of Satomul (*Asparagus racemosus*) powder in crossbred dairy cows was carried out to study its effect on their DM intake, feed eating time, milk yield and its composition, sensory evaluation of curd (dahi) and paneer, cost and return of milk production, body weight and body condition. There were two groups, Control (T0) and Treatment (T1) with 6 cows in each group. Cows of both the groups were fed standard diet consisted of concentrate, green fodder and paddy straw with supplementation of satomul @ 100 gm daily in the treatment group. The feeding trial was conducted for 6 weeks time. The overall daily DM intake were 9.11 ± 0.12 kg in control and 9.68 ± 0.17 kg in treatment group (Table 4.1). The result revealed that the Satomul fed treatment group, on average, consumed significantly higher ($p < 0.01$) dry matter than the non-supplemented control group. The DM intake of the cows of the Satomul supplemented increased gradually from Day-1 onward and were higher than the corresponding DM intake value in each week with significant difference ($p < 0.01$) from Day-14 to Day-42 (Table 4.2). The overall values of feed eating time (Table 4.3) were 260.26 ± 0.79 minutes in control and 257.64 ± 0.89 minutes in the treatment group daily. Analysis of variance (Table 4.4) revealed that cows of the Satomul fed treatment group consumed the feeds in significantly ($p < 0.01$) less time than the control group. The cows of the Satomul fed treatment group produced significantly ($p < 0.01$) higher average milk (Table 4.5) with 8.74 ± 0.16 litres than with 7.72 ± 0.11 litres in the control group. The average per day milk yield of cows in the Satomul fed treatment group was significantly higher ($p < 0.01$) (Table 4.6) than the control group from day-1 till end of experiment at day-42. The different compositions of milk (Table 4.7) in the control and treatment groups respectively on overall basis were as: fat $4.32 \pm 0.11\%$ and $4.99 \pm 0.09\%$, solids-not fat (SNF) $8.89 \pm 0.06\%$ and $8.93 \pm 0.07\%$, protein $3.41 \pm 0.03\%$ and $3.54 \pm 0.05\%$, lactose $4.67 \pm 0.04\%$ and $4.68 \pm 0.05\%$ and total

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solids (TS) $13.21 \pm 0.14\%$ and $13.92 \pm 0.12\%$. Results of analysis of variance (Table 4.8) revealed that treatment had significant effect ($p < 0.01$) on fat % ($p < 0.01$), protein% ($p < 0.05$) and total solids % while SNF, lactose and acidity percentages were not affected significantly. The average sensory scores of the different organoleptic evaluations of curd (dahi) and paneer samples have been presented in Table 4.9. The results revealed that the average values of curd samples were slightly higher in respect of all attributes e.g., appearance, colour, body and texture, flavor, taste and overall acceptability in treatment group as compared to control group. In the case of paneer also, similar higher values of the sensory attributes were observed in the treatment group in respect of appearance, colour, body and texture, and overall acceptability while values in respect of flavor and taste did not change in both the groups. The result of average feed cost and return from milk production (Table 4.10) revealed that the average daily feed cost in the control group was Rs. 111.03 while it was found to be Rs. 123.31 feed cost plus cost of Rs. 30 for 100 gm. Satomul supplement totaling to Rs. 153.31 in the treatment group. The feed cost per litre of milk (feed cost \div average milk yield) were Rs. 14.38 and Rs. 17.54 in control and treatment group respectively. The daily money receipt per cow from sale of milk @ Rs. 50/litre (milk yield \times sale price of milk) were Rs. 386.00 and 437.00 in control and treatment group respectively generating a gross return of Rs. 51/- over the control while corresponding income after deduction of their feed costs were found to be Rs. 274.99 and Rs. 283.70. The margin receipt in the treatment group over the control were Rs. 8.71 with 3.17% increment in margin receipt over control. The results shown in the table 4.11 revealed the body weight of the cows in control and treatment group respectively were 301.65 ± 11.71 kg and 301.72 ± 12.38 kg at day-1, 302.14 ± 11.99 kg and 303.97 ± 12.08 kg at day-14, 302.85 ± 11.94 kg and 304.45 ± 11.92 kg at day-28 and finally 303.21 ± 11.89 kg and 306.89 ± 11.42 kg at day-42. Analysis of variance test (Table 4.12) revealed that treatment with dietary supplementation of Satomul had no significant effect on average body weight of the cows. However, body weight increased linearly with the days in the treatment group. The overall body condition scores were 3.41 ± 0.05 and 3.51 ± 0.07 in the control and treatment group (Table 4.13) respectively and analysis of variance result (Table 4.14) revealed that dietary supplementation of Satomul had significant effect ($p < 0.05$) on average body condition score of the experimental cows.

Performance of Crossbred Cows under Farm Conditions

Dr. Venus Das

The present study was carried out to evaluate the performance of crossbred cows under organized farm condition. Total 260 numbers of complete lactation record, 115 records of age at first calving and 577 cases incidence of disease was collected from Instructional Livestock Farm (cattle) of College of Veterinary Science, Khanapara, Guwahati-781022 during the period from 2007-2017. The data were classified according to genetic group *viz.* Jersey crossbred (G1) and Holstein-Friesian (G2) crossbred cows; seasons *viz.* Pre monsoon (S1), Monsoon (S2), Post monsoon (S3) and Winter (S4) and periods *viz.* period one (P1) (2007-2012) and period two (P2) (2012-2017). Overall mean lactation length, drying period, calving interval, service period, age at first calving of Jersey cross was found to be 299.99±2.13, 99.15±1.72, 399.14±2.22, 120.81±2.39 and 1079.53±23.33 days, respectively and lactation milk yield was 2589.57±51.73 liters. The effect of genetic group was highly significant on all the traits except dry period. The mean lactation length, dry period, calving interval, service period and age at first calving was found to be 294.95, 98.38, 394.75, 115.4 and 1017.50 days, respectively and lactation milk yield was 2316.36 liters in Jersey crossbred cows. The corresponding mean for Holstein-Friesian crossbred cows was 305.88, 99.80, 404.26, 127.03 and 1127.24 days and 2908.31 liters, respectively. The effect of season of calving was highly significant on lactation length, lactation milk yield, calving interval and service period and non- significant on dry period. Mean lactation milk yield was 2798.24±98.96, 2474.04±115.78, 2451.96±117.76 and 2505.86±82.32 liters; lactation length was 281.82 ± 4.25, 299.23 ± 3.52, 314.51 ± 3.68 and 291.51 ± 4.95; dry period was 90.95±3.82, 101.12±2.98, 101.95±3.17 and 98.38±4.02; calving interval was 372.77±4.05, 400.36±3.89, 416.46±3.54 and 389.89±4.67; service period was 88.93±4.17, 122.32±4.43, 140.94±3.47 and 111.08±4.80 and age at first calving was 912.12±26.24, 1200.53±39.20, 1270.85±43.71 and 917.30±32.65 days, during S1, S2, S3 and S4, respectively in crossbred cows. The effect of season of birth was highly significant on age at first calving. The effect of period was observed to be significant for

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Department : Livestock Reproduction and Management

Major Advisor : Dr. Ranjit Roychoudhury

lactation length and calving interval while it was non- significant for lactation milk yield, dry period, service period and age at first calving. Out of total 577 incidence of diseases there was 10.22, 11.26, 11.95, 12.99, 4.5, 17.5, 13.69,7.62 and 10.22 per cent of respiratory diseases, reproductive diseases, GIT infection, non specific fever & diseases, abscess, lameness & wounds, parasitic infestation, metabolic disease and mastitis, respectively in crossbred cows during the study period. Incidence of disease was found to be apparently less in Jersey crossbred compared to Holstein-Friesian crossbred cows. Chi-square test revealed that there was significantly highest incidence of diseases during monsoon season than other seasons. In regards to period higher incidence of diseases was observed during the first period.

The performance of Jersey crossbred cows was better in respect of reproductive traits with less incidence of diseases, where as the performance of Holstein-Friesian crossbred cows was better in respect of production traits. The overall performance of crossbred cows was better during pre-monsoon (S1) season in the present study.

Carcass and Meat Quality Characteristics of *Kamrupa* Chicken

Dr. Jameel Ahmad

Kamrupa is a new variety of chicken developed after crossing three different types of local strains i.e. Assam local, coloured broiler (PB-2) and Dahlem red in the All India Co-ordinated Research Project on Poultry breeding, C.V.Sc, AAU, Khanapara . The new variety of chicken is becoming popular among the rural people of Assam. Many farmers have adopted this chicken as backyard poultry for their regular livelihood generation. Since 'Kamrupa' is a dual purpose variety, certain information like carcass and meat quality of the chicken are important for the farmers and the consumers as well as the information on these is very scanty. It is imperative to gather data on carcass and meat qualities of the new chicken if commercial venture on production, processing and marketing of meat is chosen.

Keeping in view the above facts, the proposed study was undertaken to generate data on various parameters related to carcass and meat qualities of Kamrupa chicken. It was also envisaged in the study to gather information on generation of different by-products after slaughter of the birds and shelf life of the meat at chilling temperature.

Under carcass traits, pre-slaughter body weight, carcass weight, dressing percentage, meat bone ratio, wholesale cuts and yield of by-products were taken into consideration while under meat quality traits physico-chemical qualities, muscle fibre diameter, shear force value, textural qualities, colour analysis, microbial quality, sensory properties and shelf life of meat of two age groups (12 and 54 weeks) and both the sexes (total 20 no of birds) were covered in this study. The carcass of 54 weeks of Kamrupa chicken had shown comparatively better results for most of the carcass traits when comparison was made with the carcasses of 12 weeks of age. With respect to yield of wholesale cuts the breast cut was found to be heaviest and the neck cut was the lightest. Body weight and carcass weight influenced the yield of both the edible (giblet) and inedible by-products and thus, birds of 54 weeks age group gave higher yields.

Physico-chemical qualities of meat samples indicated inconsistent and conflicting results. Meat from 54 weeks of age had shown a higher shear force value and larger

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Major Advisor : Dr. M. Hazarika

muscle fibre diameter but not much variation between the two age groups and sexes were observed in other traits like pH, WHC and ERV. Lipolysis was seen to be very quick as TBARS values exceeded the acceptable limit on 5th day of storage. Muscles of higher age group revealed higher crude protein, fat and ash content, while moisture content, drip losses and cooking losses were found to be lower in this group. All textural characteristics exhibited higher values in 54 weeks of birds in both the sexes. Colour analysis of muscle revealed a lighter colour in male birds of 12 weeks age group while redness and yellowness were seen to be brighter in 54 weeks of birds. Sensory qualities of the meat of both the age groups and sexes were found to be similar as no significant differences were observed.

High initial microbial loads were recorded for mesophilic, psychrophilic, yeast and mould counts and Coliform counts. Speedy growth was observed for all the microorganisms during the storage period. Shelf life of the stored meat samples at $4\pm 1^{\circ}\text{C}$ was less than 5 days. Considering overall quality performances, chicken of 54 weeks age group may be considered better than 12 weeks of age group.

Effects of Starter Culture and Types of Bamboo on Quality Attributes of *Banhor Chunga Doi*

Dr. Sumi Roy

A study was undertaken to elucidate the effects of starter culture and bamboo types on quality attributes of *Banhor Chunga Doi*. The study was carried out in the Department of Livestock Products Technology and the All India Coordinated Research Project on Post Harvest Engineering and Technology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati -781022 during the period from August, 2018 to February, 2019.

Yoghurt culture NCDC 144 obtained from the National Dairy Research Institute, Karnal was used @ 1.5% (v/v) in the study.

pH and lactic acid content, proximate composition, microbiological and sensory qualities and shelf-life of the product at room temperature were analysed to ascertain the effects of starter culture and bamboo types on the quality attributes of *Banhor Chunga Doi*.

Amongst the 4 treatment groups, the samples of B (JB) i.e., *Banhor Chunga Doi* prepared from boiled and cooled buffalo milk and stored in tubes of *Jati* bamboo at room temperature for 5d showed the highest pH value of 4.01 ± 0.011 with a corresponding least lactic acid content of $1.21 \pm 0.005\%$.

The *Banhor Chunga Doi* of the treatment group B (JB) was found to contain highest fat of $4.50\% \pm 0.883$. The samples of C (JMB) contained the highest quantity of protein at $5.914\% \pm 0.52$ while the sample of the *Banhor Chunga Doi* of the starter culture added treatment group SC (JB) was found to contain highest moisture and the least total solids and total ash contents.

Amongst the 2 control and 4 treatment groups, the highest mean TVC of $8.69 \log_{10} \text{cfu/g} \pm 0.001$ was enumerated in the samples of SC (JB) which might be due to the addition of the starter culture at the dose level of approximately $6.86 \log_{10} \text{cfu/g}$ in the beginning of the production process. The starter culture added samples [SC (JB) and SC (JMB)] showed an increasing TVC up to 3rd day of storage. Thereafter, the TVC of

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Department : Livestock Reproduction and Management

Major Advisor : Dr. T. Borpujari

these samples decreased on 5th day. The lowest mean TVC of $4.38 \pm 0.003 \log_{10} \text{cfu/g}$ was noted in the samples of B (JMB) which is due to the thermal destruction of the contaminating microbes during boiling of the milk sample. The samples of the buffalo milk *Banhor Chunga Doi* that were not inoculated with the starter culture exhibited an increasing TVC from 1st to the 5th d of storage at room temperature. Over the storage period, none of the *Banhor Chunga Doi* samples either from the control or the treatment groups were found to possess coliform organisms, *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus aureus*, yeast and moulds and anaerobic spores.

Yield of the *Banhor Chunga Doi*, calculated as the weight of the curd after draining out the whey over the total volume of buffalo milk poured into the bamboo tubes, was found to be highest in samples of the treatment group SC (JB) at 96.94% while the lowest yield of 94.64% was recorded in samples of B (JB).

Amongst the treatment groups, *Banhor Chunga Doi* of the treatment group SC (JB) enjoyed the highest panel ratings for appearance, colour, body and texture, flavour, taste and overall acceptability.

The results of the present study lead us to draw the following conclusions:

1. Good quality buffalo milk curd can be prepared by using tubes of *Jati* and *Jatie makal* bamboos.
2. The ITK on use of both *Jati* and *Jatie makal* bamboo tubes in preparation of *Banhor Chunga Doi* is validated. Boiling and cooling of the buffalo milk and addition of starter culture @1.5% (v/v) prior to filling in bamboo tubes add value to the finished product in terms of superior physico-chemical, microbiological and sensory properties.
3. Buffalo milk *Banhor Chunga Doi* had a shelf-life of 5d at room temperature.
4. *Jati* bamboo tubes are found to be better than the *Jatie makal* bamboo tubes in terms of sensory properties and per cent yield of buffalo milk *Banhor Chunga Doi*.
5. *Jati* bamboo tubes are found to be better than the *Jatie makal* bamboo tubes in terms of sensory properties and per cent yield of buffalo milk *Banhor Chunga Doi*. Cost of production of buffalo milk *Banhor Chunga Doi* using *Jati* bamboo tube is less by Rs. 7.00 as compared to *Jatie makal* Bamboo tubes.

Suggestion:

Since non-availability of suitable commercial yoghurt culture in the region is a hindrance in transfer of the technology to the traditional producers of *Banhor Chunga Doi*, development of a repository of dairy starter cultures and commercial production of suitable yoghurt cultures in the region may be a boon to the traditional producers in production of uniform quality *Banhor Chunga Doi* with superior sensory, microbiological and safety indices.

Influence of Zinc Oxide Nanoparticle on the Growth of Intestinal Epithelium and Microflora in Broiler Chicken (*Gallus gallus domesticus*)

Dr. Alline Josph Pathil

Zinc is an essential micronutrient. It is a trace mineral found in feed. Zinc plays a major role in both growing and adult animals. Zinc has a wide range of activities like maintaining the intestinal mucosal integrity, helps in wound healing, as an anti-diarrhoeal agent especially in infants, development of gut micro flora, epithelial integrity and as co-factor to very many enzymes. Broilers are the most preferred meat of the people in India. Hence, in the present study zinc oxide nanoparticle was used because of better absorbing and adsorption capacity due to its increased surface area and higher bioavailability. As the application of nanotechnology is on the rise, it is essential to find an optimum dose rate to meet the needs of broiler for increasing their growth performance without hampering their normal health.

A total of 96 broiler chickens were utilized in the present study. The birds were divided into 4 groups; one control (E_0) and 3 experimental groups [E_1 (40mg/kg ZONP), E_2 (80mg/kg ZONP) and E_3 (120mg/kg ZONP)]. The birds were slaughtered at 4 different ages viz. 7 days, 14 days, 28 days and 42 days and were utilized for studying the gross characteristics, histomorphology, micrometry and the intestinal microbial load. Six (6) birds from each of the experimental groups of respective ages were sacrificed. Haemato-biochemical parameters of all the birds were studied to check the effects of zinc nanoparticle. Antioxidant profiles of the birds were studied to estimate the zinc antioxidant levels at the various levels in the different experimental groups.

Epithelial height recorded for the various levels of ZONP administered birds were $27.13 \pm 1.21 \mu$, $22.27 \pm 1.25 \mu$, $25.38 \pm 1.91 \mu$ and $25.18 \pm 2.07 \mu$ for the experimental groups E_0 , E_1 , E_2 and E_3 respectively for the duodenum. The duodenal villi height were recorded as $1047.71 \pm 83.85 \mu$, $987.67 \pm 80.81 \mu$, $1326.93 \pm 83.70 \mu$ and $873.20 \pm 104.40 \mu$ for E_0 , E_1 , E_2 and E_3 respectively. Duodenal crypt depth for the groups E_0 , E_1 , E_2 and E_3 are $171.98 \pm 17.17 \mu$, $111.10 \pm 5.05 \mu$, $158.14 \pm 14.98 \mu$ and $147.36 \pm 7.88 \mu$ respectively.

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Department : Veterinary Anatomy and Histology

Major Advisor : Dr. Munmun Sarma

The jejunal villi length were recorded as $737.40 \pm 83.31 \mu$, $1156.10 \pm 63.01 \mu$, $1144.46 \pm 118.77 \mu$ and $593.02 \pm 30.50 \mu$; epithelial height were recorded as $29.08 \pm 2.19 \mu$, $26.79 \pm 1.35 \mu$, $39.03 \pm 0.74 \mu$ and $31.84 \pm 2.11 \mu$; crypt depth were recorded as $146.00 \pm 10.86 \mu$, $143.64 \pm 12.98 \mu$, $137.02 \pm 7.67 \mu$ and $86.54 \pm 2.97 \mu$ for the groups E₀, E₁, E₂ and E₃ respectively.

The Ileal villi length were recorded as $527.83 \pm 61.79 \mu$, $465.14 \pm 35.74 \mu$, $623.75 \pm 80.54 \mu$ and $410.10 \pm 22.92 \mu$, and ileal crypt depth were recorded as $105.65 \pm 5.31 \mu$, $146.85 \pm 13.25 \mu$, $94.76 \pm 3.92 \mu$ and $96.63 \pm 4.62 \mu$; and ileal epithelial height were recorded as $21.44 \pm 1.25 \mu$, $18.36 \pm 0.67 \mu$, $25.55 \pm 1.72 \mu$ and $24.93 \pm 1.74 \mu$ for the experimental groups E₀, E₁, E₂ and E₃ respectively.

Histochemical studies revealed that the activity of zinc oxide nanoparticle on the brush border enzymes of the intestinal epithelium increased with the dose of zinc supplemented. Alkaline phosphatase activity and Adenosine triphosphatase activity showed a very strong activity with increase in the age and increase in the administration of zinc oxide nanoparticle. Maximum activity was shown at 80mg/kg ZONP. Acid phosphatase showed a very weak activity, no change with ZONP was observed. Non specific esterase showed a faint to moderate activity, 80mg/kg ZONP administered group showed a moderate activity.

Biochemical activity showed an increase in the liver and kidney markers but they were recorded within the normal range. Antioxidant markers used showed maximum activity for the experimental group where 80mg/kg ZONP was administered. All the biochemical parameters showed a highly significant difference ($P < 0.01$) between the groups and the age groups.

The intestinal microbial count showed a constant growth in all the experimental groups at all the age groups, zinc maintained the microbial load of the intestine. No significant difference was observed between the groups.

The growth performance of the birds increased with the increase in administration of zinc oxide in comparison to the control group. The E₂ group (80mg/kg ZONP) showed the best feed conversion ratio of 1.34 followed by E₃ (120mg/kg ZONP). The highest body weight was recorded in the groups E₃ followed by E₂. E₂ showed the best dressing percentage of 77.72%. Carcass characteristics did not vary considerably between the groups. Liver weight alone showed an increase in the E₂ and E₃ group.

From the present study therefore, it was evident that there was a highly significant ($P < 0.01$) increase in the anatomical, biochemical and performance traits of the birds in the E₂ group. This could be due to the higher bioavailability of zinc in the system and zinc acts as a natural anti stress factor, hence giving the birds an ambient growth condition. Zinc has a direct effect on the epithelium of the intestine, thereby increasing the enzyme activity of epithelial cells, which increase the functional state of the intestine and thereby increasing the growth performance of the birds.

Prevalence of Eye Diseases in Dog with Special Reference to Bacterial Infection

Dr. Dibyajyoti Das

Ocular disease is a common problem in dogs, occurs mostly due to bacterial infection, trauma, injury, viral infection, allergic condition, vitamin deficiency, old age and hereditary. In the study period 9138 numbers of dogs were screened and ocular disease was recorded in 71 numbers of dog. The prevalence of ocular diseases in dog was recorded 0.78%.

On the basis of clinical categorization, the highest prevalence of ocular disease was recorded as conjunctivitis (49.29%) and lowest in corneal opacity (7.05%). In the present study, the highest affection of eye was recorded in both eye (45.07%) and highest clinical findings recorded in congested mucous membrane (84.50%). The season wise prevalence of ocular disease in dogs was highest in winter (45.07%) and lowest in pre-monsoon (8.45%) season. In present study sex wise prevalence of ocular diseases were more in male (64.78%) than female (35.22%). Age - wise prevalence was highest in the >3 years – 6 years (29.58%) age group and lowest in below 1 year (4.22%) age group and breed wise prevalence the highest was recorded in German Shepherd (19.72%) and lowest in Boxer (2.82%).

The most common species of bacteria isolated were Staphylococcus (22.39%), Streptococcus (19.40%) and Pseudomonas (8.95%) species. More number of coagulase positive Staphylococcus species were recorded. Staphylococcus and Streptococcus species were mostly isolated from conjunctivitis condition and Pseudomonas species were highest isolated from keratitis condition. The sensitivity pattern of the isolates showed highest sensitivity to ciprofloxacin whereas less sensitive to ofloxacin. For therapeutic management of bacterial infection (conjunctivitis and keratitis) of eye, 36 dogs were randomly divided into 2 groups, Group I and Group II. In group I, ciprofloxacin was found effective on 14th day post-treatment in subgroup A and C dogs and in group II, gentamicin was found effective on 14th day post-treatment in subgroup D and F dogs.

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Department : Veterinary Clinical Medicine, Ethics and Jurisprudence

Major Advisor : Dr. A. Phukan

Management of Hypovitaminosis-D for the Prevention of Periparturient Hypocalcaemia in Dairy Cows

Dr. Patel Nisha Manish

The present study entitled “Management of hypovitaminosis-D for the prevention of peri-parturient hypocalcaemia in dairy cows” was undertaken w.e.f. 1st September, 2018 to 31st March, 2019. The objectives of the study were to know the status of vitamin-D and calcium in crossbred dairy cows reared under intensive system, along with alterations of serum levels of related minerals and biochemical parameters associated with peri-partum hypocalcaemia and to assess the efficacy of parentally administered synthetic analogue of vitamin-D for the prevention of peri-parturient hypocalcaemia. From the study, the prevalence of pre-partum hypocalcaemia in crossbred dairy cows was recorded as 33.33%, with a higher occurrence (34.48%) in Jersey crossbred cows compared to HF crossbred cows (32.55%) and a predominance in cows of 6-8 years age (40.90%). However, there were statistically no significant differences in prevalence between the two breeds and among the different age groups. The only observed clinical signs associated with the recorded hypocalcaemia were lowered appetite and a rough body coat. Biochemical studies revealed a significant increase ($P<0.01$) in the levels of serum total vitamin-D (cholecalciferol), blood urea nitrogen and creatinine, which reduced significantly ($P<0.01$) after treatment to the levels of the control group towards at the end of the study. A significant increase ($P<0.01$) was recorded in the levels of serum calcium and phosphorus after treatment however, no abnormal variation was recorded in the levels of serum magnesium throughout the study. Use of synthetic (α) analogue of vitamin-D (cholecalciferol) was found to be effective in increasing the serum calcium level and thereby preventing the occurrence of peri-parturient hypocalcaemia in crossbred dairy cows.

Abstract of M.Sc. Thesis

Department : Veterinary Clinical Medicine, Ethics and Jurisprudence

Major Advisor : Dr. B. C. Baishya

Canine Pyoderma : Diagnosis and Therapeutic Management

Dr. Sabetini S. Marak

The present study entitled “Canine pyoderma: Diagnosis and therapeutic management” was undertaken w.e.f. 1st August 2018 to 31st May 2019 with the objective to study the prevalence, identification of causative organism, hemato-biochemical alteration and to assess therapeutic efficacy in canine pyoderma. The overall prevalence of pyoderma in dogs was 14.59% with higher occurrence in Labrador breed (40%) with males (63.75%) being predominantly affected and in age group below 1 year (33.75%). Clinical signs associated with canine pyoderma were pruritis, pustules, alopecia, papule, scale and crust, patches, erythema, moth eaten appearance, dry coat, epidermal collaret, hyperpigmentation, abscess, lichnification, edema, erosion and fissure. The causative organisms isolated from canine pyoderma were *Staphylococcus* species (100%) of which highest was *Staphylococcus intermedius* (43.75%) followed by *Staphylococcus aureus* (13.75%), coagulase negative *Staphylococcus* species (12.5%), *Staphylococcus intermedius* and *Staphylococcus aureus* (5%), *Staphylococcus intermedius* with *Pseudomonas* species (6.25%) and *Staphylococcus intermedius* with *Klebsiella* species (11.25%), *Staphylococcus aureus* with *Pseudomonas* species (5%) and Coagulase negative *Staphylococcus* species and *Pseudomonas* species (2.5%). The antibiotic sensitivity test for *Staphylococcus intermedius* isolates revealed highest sensitivity to linezolid (100%); *Staphylococcus aureus* to cephalixin and linezolid (94.73%); Coagulase negative *Staphylococcus* species to cephalixin and linezolid (100%); however gram negative organisms like *Pseudomonas species* and *Klebsiella species* revealed highest sensitivity to enrofloxacin (100%) but complete resistant to cephalixin and linezolid. Hematobiochemistry revealed anaemia (Low Hb and TEC), leukocytosis, neutrophilia, reduction in serum albumin, A:G ratio and zinc when compared with apparently healthy dogs. Dogs treated with cefpodoxime, ceftriaxone and tazobactam and linezolid showed faster recovery in clinical symptoms weekly than that of cephalixin and enrofloxacin but complete remission of clinical signs in all the animals was observed only in cephalixin treated group.

Abstract of M.Sc. Thesis

Department : Veterinary Clinical Medicine, Ethics and Jurisprudence

Major Advisor : Dr. (Mrs.) Bendangla Changkija

Empowerment of Women Through Milk Cooperative Societies on Selected Districts of Assam

Dr. (Ms) Banani Das

Taking into consideration the issues of success and failure of milk cooperatives in the state of Assam and the ever debatable topic of women empowerment the present study on “Empowerment of Women through Milk Cooperative Societies in Selected Districts of Assam” was undertaken. Two districts of Assam i.e., Darrang and Barpeta were purposively selected for the study with the objectives to explore a) The socio-economic status of women involved in dairy cooperatives of two selected districts of Assam, b) To find out the extent of involvement of women in different activities of dairy cooperatives, c) To assess the areas of empowerment through milk cooperatives, d) To find out the constraints related to dairy cooperatives as perceived by the respondents. From the two selected districts two blocks, Pathorighat and Bajali, were selected and from these blocks two milk cooperative societies were considered for the current research work. From both the cooperatives 60 women dairy farmers were selected by random sampling making the total sample size 120. A pretested, reliable and valid interview schedule was used for data collection. The data collected were analysed using standard statistical methods. Majority of the women dairy farmers i.e. 57.50 per cent were in middle age category and the average age was found to be 36.8 years. 95.83 per cent of respondents were married while only 4.16 per cent were widow. Further, in Darrang district 83.33 per cent respondents and 51.66 per cent respondents in Barpeta district belonged to general caste. It was observed that 80.33 per cent women dairy farmers resided as nuclear family while 19.16 per cent as joint family. Majority of respondents in Darrang district i.e. 83.33 per cent had medium family size with 3-6 numbers of family members while in Barpeta 75.00 per cent had medium family size 3-6 numbers. It was found that in Darrang district 56.66 per cent respondents had medium level of educational qualification and in Barpeta district educational qualification of respondents was found to be 61.66 per cent which is of medium level. Majority of the respondents in both the districts Darrang and Barpeta had medium herd size i.e. 80.00

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Department : Veterinary Extension Education

Major Advisor : Dr. (Mrs) Leema Bora

per cent and 71.66 per cent, respectively. It was observed from the study that 51.66 per cent of respondents in Darrang district and 63.33 per cent in Barpeta district had medium social participation. Maximum number of respondent i.e., 56.66 per cent in Darrang district and in Barpeta district 45.00 per cent had medium extension contact. A fairly large number of respondents i.e., 68.33 per cent of both Darrang and Barpeta district had medium level of mass media exposure. In case of Darrang district 86.66 per cent of respondent had medium level of daily milk contribution to the cooperative with 15-64 litres while in Barpeta the corresponding figure was 58.33 litres. It was observed that in Darrang district majority i.e., 78.33 per cent had medium land holding and in Barpeta district 70.00 per cent of respondent had medium land holding. 100.00 per cent respondents in Darrang district had medium annual income from dairying and in Barpeta district 55.00 per cent had medium income. It was found that in Darrang district 68.33 per cent of respondent had medium annual income from other sources while 51.66 per cent of respondents had medium income. The study depicted that in Darrang district 100 per cent respondents had medium total annual income of while in Barpeta district 56.66 per cent of respondent had medium level of total annual income. In Darrang district maximum number of respondents i.e., 71.66 per cent were in the medium category while 28.33 per cent were in high category of extent of involvement of women in different activities of dairy cooperatives. In case of Barpeta district majority of respondents i.e., 66.66 per cent were in medium level and 33.33 per cent in low level of involvement in dairying activity. The mean difference of the two districts was found to be highly significant ($t=13.505^{**}$, $p<0.01$). Majority of respondents in Darrang district i.e., 58.33 per cent had medium level of empowerment while 41.66 per cent had high level of empowerment. The mean value was 239.20 with standard deviation 10.79 and range 213-256. Among the respondents in Barpeta district majority of respondents i.e., 63.33 per cent had medium level of empowerment while 36.66 per cent had high level of empowerment. The mean difference of the two districts was found to be highly significant ($t=10.658^{**}$, $p<0.01$). In correlational analysis 3 independent variables viz. educational qualification land holding and annual income from other sources had positive and highly significant correlation with extent of involvement of women in different activities of dairy cooperatives and milk yield had negative and significant correlation in Darrang district. In Barpeta district educational qualification and land holding had negative and significant correlation with the dependent variable. Independent variables like age, land holding and annual income from other sources had positive and highly significant correlation with areas of empowerment through milk cooperatives while mass media exposure had negative and significant correlation and herd size had negative and highly significant correlation with areas of empowerment through milk cooperatives in Darrang district while none of the independent variable had significant correlation with the dependent variable in Barpeta district. In multiple regression analysis the co-efficient of multiple determination (R^2) with 12 independent variables under study could explain 61.20 and 25.1 per cent variation in extent of

involvement of women in different activities of dairy cooperatives in districts of Darrang and Barpeta. The co-efficient of multiple determination (R^2) revealed that the 12 independent variables under study could elucidate 47.70 per cent variation in areas of empowerment through milk cooperatives in Darrang district. It was found that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) "Lack of land for fodder cultivation" was ranked first among all the constraints faced by the women dairy farmers of Pathorighat Dugdha Utpadak Samiti followed by "High feed cost", "Lack of emergency health services". The rank correlation coefficient in Darrang district was found to be 0.731 which was highly significant at 0.01% level of significance. It was observed that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) "Lack of land for fodder cultivation" was ranked the most important constraint followed by "Lack of technical knowledge for management", "Lack of training in dairy". The rank correlation coefficient of respondents in Barpeta district was found to be 0.864 which was highly significant.

Empowerment of Women of Selected Tribes in Tripura Through Livestock Enterprises

Dr. Keshab Jamatia

An investigation was undertaken to study the empowerment of women of selected tribes in Tripura through livestock enterprises. Two major tribes namely Deb Barma and Jamatia were selected from among the nineteen tribes that inhabit in Tripura and from each of the two tribes 100 respondents were selected by snow ball sampling technique from the purposively selected two districts namely Sepahijala and Gomati to make the sample size 200. The sole criterion of the respondent was that she should have atleast two pigs or two goats or ten poultry or one cattle. The data were collected by the researcher personally by using a pre-tested valid and reliable interview schedule which consisted of five parts:- first part dealt with socio-personal, economic and psychological traits of the respondents, second part assessed the gender participation of tribal people in livestock enterprises, third part was meant for measuring the empowerment level, fourth part was used to find out the constraints perceived by respondents in livestock enterprises and the last part was made in identifying and documenting the indigenous technical knowledge practised by the tribal people of Tripura in livestock enterprises. The data thus collected were subjected to statistical analysis like percentage, frequency, mean, SD, t-test, correlation and regression. The research study revealed that in pooled data majority (64.00 per cent) of the respondents from both the tribes belonged to middle (29-47 yrs.) age category and had nuclear families (68.50 per cent) with family size ranging from 3-6 members. Majority of the respondents had read upto high school level (33.00 per cent) with medium level in the traits like social participation (48.00 per cent), land holding (0.98-2.81 acre), herd size (0.195-2.864 nos.), experience in livestock farming (4-22 yrs.), mass media exposure (84.50 per cent), extension contact (79.00 per cent), entrepreneurship behaviour (75.00 per cent) and liking of information source (83.50 per cent). On the other hand, most of the respondents had neutral attitude towards improved livestock farming (77.50 per cent) with medium level of participation in livestock enterprises (74.50 per cent) and spent an average time of 1.94 hours daily in livestock enterprises. In respect of their occupation majority of the respondents were

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Department : Veterinary Extension Education

Major Advisor : Dr. Manindra Nath Ray

involved in agriculture along with animal husbandry and self-employment (28.00 per cent) with an average annual earning of Rs. 31,993.50 from livestock and poultry, Rs.1, 56,507.00 from sources other than livestock and poultry and average of Rs.1, 88,684.50 from all the sources. Most of the respondents performed alone in livestock related activities like collection of eggs, preparation of feed for animals, feeding and watering of birds, feeding and watering of animals, cleaning of animal shed, maintenance of bird shed, care of sick animals, care of new born animals, care of health condition of animals, bathing of animals and milking of animals. They also performed jointly the activities like selling of animal at market age, maintenance of animal shed, collection of fodder and grazing of animals and had medium level of participation in livestock enterprises (74.50 per cent). Majority of the respondents had medium level of perceived overall empowerment and in this regard their appeared no significant difference between the two tribes. Out of sixteen independent variables only five showed highly significant positive relationship with overall empowerment level. Similarly, out of seventeen variables only five variables had significant contributing effect on variation of empowerment level and the coefficient of determination was 4.66 which indicated that only 46.60 per cent variation could be explained by these variables. The significant F value (9.968) indicated that these five variables were good predictors of empowerment level. While assessing the constraints as many as 12 constraints were identified through R.B.Q. technique, where the perceived constraints “non-availability of grazing land due to rubber plantation” was ranked 1st by Deb Barma respondents and “feed and feed related problems like less availability of feed and improper growth even after proper feeding” was ranked 1st by Jamatia respondents. In respect of indigenous technical knowledge practised by the tribal people in Tripura a total of 24 medicinal plants (14 herbs, 5 shrubs and 5 trees) used in treating and feeding animals and 3 mixtures were identified and documented properly with the help of local healers and some respondents.

Prevalence of Newcastle Disease Virus in Backyard and Commercial Poultry in Assam

Dr. Pubaleem Deka

Newcastle disease (ND) is a highly contagious and economically important viral disease of poultry. This study was undertaken to have a detailed study of the prevalence of ND and to characterize the circulating Newcastle disease virus (NDV) along with some epidemiological studies. A seroprevalence study was conducted in 18 districts of Assam, where a total of 925 sera samples from 231 unvaccinated backyard poultry flocks were collected and subjected to haemagglutination test (HI) test to determine the level of antibodies against NDV. An overall seroprevalence was recorded to be 23.89%. Age-wise seroprevalence revealed that the adult birds >12 months of age had higher antibody titre. A total of 274 tissue samples and 158 cloacal swabs were collected and subjected to HI and RT-PCR targeting *F* gene. NDV could be detected in 61.68% tissue samples. Subsequently, NDV was also detected from 22.15% cloacal swabs from clinically affected vaccinated birds providing evidence of shedding of the virus despite of vaccination. Representative samples were sequenced and subjected to phylogenetic analysis. A phylogenetic tree was constructed which revealed that the sequences clustered with Genotype XIII in Class II. Molecular pathotyping which comprised of F protein cleavage site analysis revealed that all the seven isolates had amino acid sequences of 112RRKQRF117 revealing them to be of virulent type. Restriction mapping revealed the presence of cleavage site for *HhaI* restriction enzyme in the sequence confirming the sequences to be of mesogenic pathotype. Further, mean death time (MDT) of the present NDV isolates were between 76.0±2.69 to 87.6±1.00 hours confirming them to be of mesogenic strain. A questionnaire survey was conducted to evaluate the risk factors for ND occurrence. The analysis showed that the factors like close proximity of nearby poultry farms (OR=30, 95% CI: 10.38-86.68, p<0.0001), frequent contact with wild birds (OR=16.92, 95% CI: 6.57-43.59, p<0.0001), floor space of the poultry house (OR=4.33, 95% CI: 1.96-9.59, p=0.003), usage of non-chlorinated drinking water (OR=10.68, 95% CI: 4.43- 25.70, p=<0.0001), separation of diseased birds (OR= 2.64,

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Department : Veterinary Epidemiology and Preventive Medicine

Major Advisor : Dr. Mrinal Kumar Nath

CI: 1.13-6.17, $p= 0.024$), awareness of biosecurity procedures (OR= 14.80, CI: 5.40-40.55, $p= <0.0001$) and frequent entry of visitors (OR= 28.88, CI: 6.41- 130.11, $p= <0.0001$) etc had significant association and higher risk of ND outbreak. The present study reveals that the ND is endemic in Assam state and the presently circulating genotype of NDV falls under genotype XIII. Further, risk factors related to biosecurity and farm practices appear to have a significant role in the occurrence of ND outbreaks.

Immune Response of Pigs Vaccinated with Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine

Dr. Nouluongunuo Suokhrie

Classical swine fever is a highly contagious, haemorrhagic, and multisystemic viral disease affecting domestic pigs, wild hogs and pygmy hogs. It is an economically devastating disease and therefore control of the disease is of utmost importance. In endemic country like India including north Eastern States, vaccination is the best way to prevent and control the disease. Although live attenuated vaccines are available, protective immunity is obtained only after booster vaccination. Therefore, immune response can be enhanced with use of oil adjuvanted vaccines. A great disadvantage of live attenuated vaccine is its inability to differentiate infected with that of vaccinated populations. Therefore, CSF-DIVA based vaccine with a reliable companion diagnostic assay is highly desirable for successful implementation of control programme against CSF. In the present study, two groups of CSFV free pigs were immunized with Baculovirus expressed Erns-deleted CSF virus like particle (VLP) as vaccine as well as PK-15 cell culture adapted whole CSFV vaccine, both adjuvanted with montanide oil adjuvant. Potency of Erns deleted classical swine fever VLP-DIVA vaccine was first carried out with aluminium hydroxide as the adjuvant. Immune response was assayed by indirect ELISA and neutralizing assay. Vaccinated pigs elicited early antibody by 7th dpv (2.86 ± 0.09 ; 2.10 ± 0.15) with peak antibody titre on 30th dpv (3.86 ± 0.07 ; 3.51 ± 0.10) and maintained high antibody titre upto 180th dpv (2.91 ± 0.06 ; 2.45 ± 0.20). Single montanide oil adjuvanted whole CSFV vaccine effectively stimulated neutralizing antibody with 90-95% inhibition titre. However, montanide oil adjuvanted CSF-VLP vaccinated group failed to elicit neutralizing antibody.

To develop DIVA based companion ELISA, CSFV Erns protein was expressed in PK-15 cell line. Cell lysate used as the coating antigen was optimized with the concentration of 5 µg/well and blocking buffer standardized with 5%LAH and 2% goat serum. The Erns ELISA could distinctly differentiate CSF-VLP-DIVA vaccinated

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Department : Veterinary Microbiology

Major Advisor : Dr. N. N. Barman

animals from naturally infected CSFV as well as whole CSFV vaccinated animals. The present study highlights that oil adjuvanted whole CSFV vaccines was safe and elicited high neutralizing antibody titre with single vaccination till marketable age of pigs. Although oil adjuvanted CSF-VLP-DIVA vaccine elicited high ELISA titre, it failed to develop neutralizing antibody. Therefore, factors related to the development of neutralizing antibody in oil adjuvanted CSF-VLP-DIVA vaccine in pigs need to be explored further in details. As companion DIVA based ELISA, Erns coated protein could distinctly differentiate CSF-VLP-DIVA vaccinated animals from naturally infected CSFV as well as whole CSFV vaccinated pigs.

Isolation of Foot-and-Mouth Disease Virus Type ‘O’ of Bovine and Porcine Origin in Different Cell Lines and Molecular Characterization of the Adapted Virus

Dr. Ray Kayaga

The aim of this study was to isolate Foot-and-mouth-disease virus type O from bovine and porcine origin in different cell lines and molecular characterization of the adapted virus after passaging. The study showed that, the virus clustered in a different group with a confident bootstrap value of 99%. The strains appeared to branch out as a topologically distinct group among the different topotypes, along with two other isolates from India and neighbouring countries. The strains when aligned with other Indian isolates showed distinct point mutations. Furthermore, the FMD strains showed 68 bootstrap confidences among themselves emphasizing on difference among isolates from different host. Following isolation and adaptation in different cell lines, the study reveals that BHK-21 cells are the most suitable cells for supporting maximum infectivity titer of FMD virus serotype ‘O’ followed by MDBK and PK-15 cell lines. Findings in the second objective of molecular characterization of the adapted virus showed that the sequence of VP1 gene remains the same in as many as five adapted virus in different cell lines. However, in this study there were single nucleotide point mutations observed among the adapted strains when compared with the parental strain. Furthermore, these point mutations did not cause any change in the amino acid pattern except for one change from tryptophan to isoleucine at amino acid residue number 74 in the bovine origin strain adapted in BHK21 cells after at 10th passages level. Such change from nonpolar to hydrophobic amino acids might result in conformational changes in the protein structure affecting its functionality. The study confirmed that the VP1 gene of FMD isolates were quite stable on cell adaptation.

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Department : Veterinary Microbiology

Major Advisor : Dr. Krishna Sharma

Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate From Assam

Dr. Shyama Prasad Panda

Goatpox and Sheeppox are highly contagious, trans-boundary viral diseases of sheep and goats, clinically characterized by pyrexia, lacrimation, secondary bronchopneumonia with nasal discharges and generalized pox lesions with lymphadenopathy causing high mortality and morbidity. Diseases caused by CaPVs are economically important as they cause significant production losses due to high morbidity, reduced milk yield, decrease in weight gain, increase abortion and damage to wool and hides. Control of the disease can only be effective by mass vaccination of all susceptible sheep and goats by single vaccine through intradermal or subcutaneous route with OIE recommended safe dose of GTPV vaccine (102.5 TCID₅₀). A variety of live and inactivated goatpox vaccines are being produced commercially. However, inactivated vaccines produce only short-term immunity. Live attenuated vaccine is the better choice for long term immunity against CaPVs. Therefore, in the present study one indigenous strain of goatpox virus was adapted and attenuated in Vero cell line and characterized molecularly. In the present study total nine local GTPV isolates, maintained in the Department of Microbiology, C.V.Sc, AAU, were revived in Vero cell line. Identity of the isolates were confirmed by virus specific cytopathic effects and molecularly by realtime PCR and PCR-RFLP. Among all the isolate GTPV/AsKa/14 was selected for attenuation, based on the degree of characteristic CPE and TCID₅₀ evaluated virus titer at passage 15 (i.e. 105.75TCID₅₀) in Vero cells. Selected isolate was propagated up to passage 50 with confirmation of presence of virus at different passage level by partial length amplification of P32 gene of goatpox virus. Gradual increase in the infectivity titer of the virus isolate was observed and found to be 106TCID₅₀ at passage 50. Required titer of virus was calculated and adjusted to single recommended vaccine dose 103TCID₅₀ and 50 vaccine dose 104.7TCID₅₀ for preparation of inoculum. Sterility test of the prepared virus inoculum was performed to

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Major Advisor : Dr. D. P. Bora

confirm the absence of any contamination. After 14 days of incubation prepared inoculum was found to be sterile. Total 18 no. of goats under 3 groups were used for safety test of the attenuated virus isolate. Group 1 animals were immunized with 1 single recommended vaccine dose of the isolate where group 2 animals were immunized with 50 recommended vaccine doses subcutaneously and group 3 animals, injected with 1ml of normal saline were kept as control. Animals were found apparently healthy without any adverse reaction or any thermal reaction even after 28 days post immunization showing the safety of the attenuated virus isolate. Antibody response was also calculated by indirect ELISA and SNT. Initially on 7th day ELISA titer (Log10) was 30 ± 4.9 while on 28th day it was 426.67 ± 78.3 . Similarly, in SNT 50% neutralization titer (Log10) was 24 ± 1.66 and on 28th day it was found to be highest 150 ± 15.4 . Molecular characterization and sequence analysis of P32 gene of goatpox virus isolate under the present study revealed that the attenuated GTPV isolate shared identity to some extent with other GTPV isolate from different parts of world and with the commercial vaccine strain. At nucleotide and amino acid level the attenuated virus isolate shared 99.6% sequence identity and 0.4% deviation from the original virus isolate. Though, there was no significant difference in amino acid sequence level.

Characterization of Methicillin Resistant *Staphylococcus aureus* Isolated From Raw Meat

Dr. Leons Mathew Abraham

Staphylococcus aureus is an opportunistic pathogen capable of causing multiple diseases of varying severity. Among *S. aureus*, Methicillin-resistant (MRSA) strains have gained particular attention during recent years due to its multi drug resistance property and ability to affect the various systems of the body. The frequent use of antimicrobials at farm is discussed as a risk factor for the wide dissemination of MRSA in livestock production chains including meat and meat products. The present study was taken up primarily with an intention to isolate and characterise methicillin-resistant *S. aureus* from meat sold at the retail outlets in Guwahati city of Assam. The study also included analysis of antimicrobial susceptibility pattern of the isolates and detection of important virulence-associated genes by PCR .

For the study, a total of 309 meat samples were collected. *Staphylococcus* species could be isolated from 166 (53.72%) samples while only 65 (21.03%) were found to be coagulase-positive comprising of 35, 14, 11 and 5 isolates respectively from chicken, pork, chevon and beef samples. On the basis of biochemical tests and PCR detection of *aro A* gene, 61 (93.84%) out of the 65 coagulase positive isolates were confirmed as *Staphylococcus aureus*, of which 33 (94.28%) were from chicken, 12 (85.71%) from pork, 11 (100%) from chevon and 5 (100%) from beef samples. The antibiogram of the 61 *S. aureus* isolates was determined by the Disk diffusion method employing 12 antimicrobial agents. The highest resistance was observed against Penicillin (85.24%) followed by Oxytetracycline(63.93%), Enrofloxacin (62.29%), Amoxycillin/ Clavulanic acid (44.26%), Oxacillin (36.06%), Neomycin (36.06%), Cefuroxime (34.42%), Gentamicin (31.14%), Cefoxitin (29.50%), Streptomycin (26.22%), Piperacillin/Tazobactam (26.22%) and Teicoplanin (6.55%). Out of the 61 isolates, 50 (81.96 %) showed resistance against 3 or more antibiotics while six (9.83%) isolates were resistant to ten out of the twelve drugs tested. All the isolates were

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Major Advisor : Dr. Sophia M. Gogoi

resistant to atleast one antibiotic but none showed resistance against all the 12 antibiotics.

Cefoxitin and Oxacillin based disc diffusion test was employed for phenotypical detection of Methicillin resistance. A total of 18 (29.50%) *S. aureus* isolates were resistant to Cefoxitin while 22 (36.06 %) isolates were resistant to Oxacillin. Growth characteristics on MeReSa agar and Epsilometric test using Cefoxitin yielded similar results to that of the disk diffusion test using Cefoxitin. For confirmation, the 18 phenotypically positive MRSA isolates were subjected to PCR for the detection of the *mecA* gene, and all the 18 (100%) were found to be positive. Considering the total number of samples collected (n=309), MRSA could be isolated from only 18 (5.82%) samples. It was observed that 11 (7.63%) out of the total 144 chicken samples, 3 (4.16%) out of 72 pork, 3 (5.17%) out of 58 chevon and 1 (2.85%) out of 35 beef samples were MRSA. Furthermore, the PCR amplification of the isolates targeting the thermonuclease, *nuc* gene showed that all the 61 *S. aureus* isolates were positive. This study also evaluated the presence of the enterotoxin A, *sea* gene in meat as *S. aureus* is a major pathogen when it comes to food-borne illnesses. Interestingly, only 2 (3.27%) out of the 61 isolates were found carrying the *sea* gene.

Trematode Parasites of Asian Elephant (*Elephas maximus*) with Special Reference of Liver Fluke

Dr. Bandanpreet Kour Raisim

A prevalence study of intestinal trematode parasites in Asian elephant (*Elephas maximus*) was conducted on faecal samples received from 5 different protected areas of Assam including the Assam State Zoo-cum-Botanical Garden from the month of March 2019 to June 2019. Out of total 85 samples examined, 50.00 (58.82%) sample was found positive for trematode parasitic infection. Samples received from Pobitora Wildlife Sanctuary had highest rate of infection (81.81%) followed by samples from Manas National Park, Laokhowa Wildlife Sanctuary and Assam State Zoo-cum-Botanical Garden which had lowest (33.33%) rate of infection. Amongst positive samples the rate of infection for *Fasciola jacksoni*, amphistomes and mixed infection of *F. jacksoni* and amphistomes was found in 21 (42.00%), 43(86.00%) 35 (70.00) samples, respectively. Four different trematode parasites could be recovered from the samples. Morphologically the parasites could be identified as *Pseudodiscus collinsi* (Cobbold, 1875), *Gastrodiscus secundus* (Looss, 1907), *Pfenderius birmanicus* (Bhalerao, 1935) and *Pfenderius pappilatus* (Cobbold, 1882). Surface morphology of *G. secundus* was studied using SEM. Molecular characterization of *P. collinsi* and *G. secundus* was done amplifying ITS2 rDNA gene with conventional PCR method. The query sequence showed 99.16% similarity with *G. hominis* and 98.88% similarity with *Homalogaster paloniae*. The distance matrix of *P. collinsi* showed a maximum similarity of 93.36% with *Watsonius watsoni*. Comparative morphological studies between liver fluke of Asian elephant and *Fasciola* species of cattle, buffalo and goat showed that the elephant liver fluke was *Fasciola jacksoni* (Cobbold, 1869) and the *Fasciola* species of cattle, buffalo and goat was *Fasciola gigantica* (Cobbold, 1885). Morphologically the *F. jacksoni* differed substantially from the latter species. Ultrastructural studies conducted with SEM on *F. jacksoni* revealed significant surface features. A phylogenetic analysis conducted for *F.jacksoni* of Asian elephant and *F. gigantica* of cattle, buffalo and goat targeting ITS1, ITS2 and *nadI* gene by conventional

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Department : Veterinary Parasitology

Major Advisor : Dr. S. Islam

PCR showed that *F. jacksoni* was a distant outlier to *F. gigantica* of cattle, buffalo and goat. Phylogenetically *F. jacksoni* (Assam isolate) was similar to Sri-Lankan isolate of *F. jacksoni* and *Fascioloides magna*. A comparative gross and histopathological study was conducted on the liver of Asian elephant affected with *F. jacksoni* and *F. gigantica* in cattle, buffalo and goat. There were both gross and histopathological differences between the affections caused by *F. jacksoni* in elephant and *F. gigantica* in the three ruminant hosts. Moreover, the lesions in elephant liver produced by *F. jacksoni* when compared with that of lesions produced by *Fascioloides magna* from published literature revealed similarities.

Clinico Pathological Studies of Canine Parvoviral Infection

Dr. Ginah Maria Binny

Present study was investigated for a period of one year from March 2018 to February 2019. A total of 138 diarrheic dogs were suspected for Canine Parvovirus (CPV) infection and were examined. CPV was confirmed on the basis of rapid diagnostic kit. 62 dogs showed positive in the rapid diagnostic kit. 62 fecal samples from each dog showing positive in the rapid kit test were subjected for polymerase chain reaction (PCR) and haemagglutination (HA). In the current study 54 (87.10%) fecal samples were found positive by PCR and 41 (66.13%) were positive by HA. Dogs of the age group above 3 to 6 months were found to be most susceptible (37.09 %). Season wise highest occurrence of CPV was found in the monsoon (40.03 %). The unvaccinated dogs showed higher occurrence of CPV (45.16 %) in comparison to the partially vaccinated dogs (30.64 %) and the vaccinated dogs (24.19 %). It was observed that occurrence of CPV had no significant effect on either of the sex. Haematological studies revealed significant decrease in Hb, PCV, TEC, MCV, MCH and MCHC in CPV affected dogs along with significant increase in eosinophils. There was significant thrombocytopenia and lymphocytopenia. A non-significant increase in WBC, neutrophils and monocytes were also recorded. Biochemical estimation revealed significant increase in ALT, AST and BUN levels with significant decrease in Na and K level of CPV affected dogs. A non-significant decrease in glucose, creatinine and chloride level was also recorded.

Cytological studies were done in 12 live dogs affected by CPV and 19 dogs that died due to clinically confirmed CPV. Among the total 31 dogs, tongue smears from 22 dogs showed the presence of intracytoplasmic basophilic inclusion bodies both in the Diff quick and Giemsa stain.

The prominent clinical signs observed in the affected dogs were anorexia, dehydration, depression, lethargy, emaciation and fever. Foul smelling diarrhea was the most common finding. The conjunctival mucous membrane and the gums were pale due to anemic condition of the dog. Severely affected dog when presented showed prolonged capillary refill time, poor pulse rate, tachycardia and hypothermia. Gross

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Department : Veterinary Pathology

Major Advisor : Dr. (Mrs.) Shameem Ara Begum

examination revealed congested gastric mucosa, hemorrhagic enteritis and hepatomegaly. Hemorrhage was observed in the medulla of kidney in some of the CPV affected dogs. Cerebrum congestion of the capillaries. Erosive hemorrhagic ulcers were frequently seen in the tongue.

The histopathological examination revealed the presence of intracytoplasmic and intranuclear inclusion bodies in the brain, tongue, lungs and intestine. Endothelial cell proliferation was observed in most of the organs. Brain showed congestion, neuronophagia and satellitosis. Tongue revealed sloughing of the villi and congestion of blood vessel in the sub epithelial layer. Hyperplasia of the basal cell layer was also observed in the tongue of some cases. Heart showed degeneration of the myocardial fibers, congestion and focal infiltration of mononuclear cells. Interstitial and serous pneumonia associated with hyperplasia of bronchial epithelium were recorded in the lungs of the affected dogs. Liver sections revealed congestion and hemorrhage in the sinusoidal space and proliferation of biliary epithelial cells. Intestine revealed necrosis and sloughing of the epithelium, flattening of the villi associated with congestion and hemorrhage in the mucosal and muscular layer. Necrosis of the Peyer's patches with depletion of the lymphocytes were also recorded. Shrinkage of the glomerular tuft with associated cystic glomeruli was observed in the renal parenchyma. Interstitial nephritis, congestion and hemorrhage were the common findings. Changes in the lymphoid organs such as spleen, thymus and lymph node consisted of hemorrhage, congestion and depletion of lymphocytes from lymphoid follicle.

PCR was found to be more sensitive in the diagnosis of CPV in comparison to the HA test. HA test showed that although CPV can agglutinate both swine and chicken RBCs, the characteristic agglutination was observed when the swine RBCs were used. PCR confirmed CPV isolates by molecular detection of CPV-VP2 gene at 160 bp. The phylogenetic analysis revealed that the isolates recorded in the present study were CPVtype 2b and was in the same cluster as other CPV-VP2 isolates from Hissar (EU2743041.1), India, Anand (JN625224.1) and India, Tamilnadu (MH536199.1).

***In Vitro* Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent**

Dr. Monoshree Sarma

Parthenin, a sesquiterpene lactone was evaluated for its anti-cancer potential. Looking at the prevalence of head and neck cancer and triple negative breast cancer in North-Eastern India, parthenin was screened against FaDu (Human pharyngeal cancer) cells and MDA-MB-231 (triple negative breast cancer) cells. For studying the cytotoxicity of parthenin against FaDu cells and MDA-MB- 231 cells, MTT assay was used. Cytotoxicity was observed against FaDu and MDA-MB- 231 cells. The IC₅₀ of parthenin against FaDu and MDA-MB-231 are 5.11 μ M and 5.65 μ M respectively. The cytotoxicity of parthenin against FaDu cells is at par with that of the standard drug hydroxychlorquine. However, the standard drug hydroxychlorquine is more potent against MDA-MB-231 cells as compared to that of parthenin. The nuclear and cellular morphologies of parthenin treated FaDu were studied using Hoechst 33258 dye that revealed that parthenin induces nuclear fragmentation and damage in two doses PAR-1 (1.23 μ M) and PAR-2 (5.11 μ M). The nucleus of parthenin treated FaDu cells assumed the shape of horse-shoe indicating the potential of parthenin to bring about apoptosis.

Mitochondrial membrane potential (MMP) of parthenin treated FaDu cells were studied using JC-1 dye. For this study, two doses were considered: PAR-1 (1.23 μ M) and PAR-2 (5.11 μ M). The study revealed that parthenin causes disruption of mitochondrial membrane potential and integrity which was higher in PAR-2 dose. This illustrates that parthenin might activates the intrinsic pathway of apoptosis. Parthenin treated FaDu cell exhibited up regulation of pro-apoptotic factor BAX and down regulation of anti-apoptotic factor BCL-2. This result confirms the activation of intrinsic pathway by parthenin in FaDu cells. Other factors like Caspase-9 and Caspase-3 which are involved in intrinsic pathway of apoptosis were also up regulated by parthenin in FaDu cells. Also, there was up regulation of p53, a gene which is involved in tumour suppression and generally found inactivated in malignant tumours. Parthenin also causes down regulation of PARP 1 and NF κ B in FaDu cells, two factors involved in cell

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Department : Veterinary Pharmacology and Toxicology

Major Advisor : Dr. Chandana Choudhury Barua

signalling, cell proliferation and repairment of DNA damage. Parthenin brings about cell death of FaDu cells by activating and inhibiting pro-apoptotic and anti-apoptotic pathways respectively. Parthenin enhances the expression of BAX and decreases the expression of BCL-2 of MDA-MB-231 cells. Not only this, in MDA-MB-231 cells, parthenin also up regulates the expressions of various pro-apoptotic factors involved in intrinsic way of apoptosis like Caspase-9 and Caspase-3. The expression of p53, a tumour suppressor gene, which is inactivated in most of the malignant tumours is up regulated in parthenin treated MDA-MB-231 cells. In MDA-MB-231 cells, parthenin also causes down regulation of PARP 1 and NFκB, two factors involved in cell signalling, cell proliferation and repairment of DNA damage. Parthenin causes death of MDA-MB-231 cells by activating and inhibiting pro-apoptotic and anti-apoptotic pathways respectively.

Evaluation of *In-Vitro* Antiviral Effect of Nanocurcumin and Nano Eugenol against Goat Pox

Dr. Namitha. A

Five treatment combinations namely Curcumin, Eugenol, Nanocurcumin, nano eugenol and their combinations were considered, which are known for their medicinal values especially their anti-viral effects against various viruses are screened for their anti-viral effect against Goatpox virus replication in-vitro. Nanocurcumin and Nano eugenol prepared by Evaporative precipitation of nanosuspension (EPN) and ultrasonication method had Z-average particle size of 64.22nm and 7.270nm, respectively which was found to be physically stable without any phase separation. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol were found to be safe for oral administration up to 2000mg/kg body weight. In-vitro cytotoxicity studies of curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations showed their Maximum Non-Toxic Doses to be 39.06µg/ml, 78.12µg/ml, 140.62µg/ml, 156.25µg/ml and 296.875µg/ml, respectively and Cytotoxic Concentration₅₀ values to be 290.4±1.419µg/ml, 319.7±1.301µg/ml, 1462±1.0620µg/ml, 432.7±1.1656µg/ml, and 1309±1.2887µg/ml, respectively. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations were found to have their viral percentage inhibition of 74.88, 79.43, 97.48, 99.55 and 99.85, respectively which are found to be significant at P<0.05 at their MNTDs. Out of which Nanocurcumin, Nano eugenol and their combinations showed >80% inhibition and their EC₅₀ values found to be 92.47±1.586µg/ml, 54.93±1.1220µg/ml and 52.48±1.1481µg/ml with their therapeutic indices to be 15.81, 7.877 and 24.94, respectively. One step growth inhibition of goatpox virus by Nanocurcumin showed inhibition up to 0 hour post infection, but Nano eugenol and combination of nanocurcumin and nano eugenol showed inhibition upto 72 hour post infection. The nano-ointment was prepared by the combination of nanocurcumin and nano eugenol and applied on skin lesions of positive goatpox cases which resulted in better and faster healing. Results indicated that combination of nanocurcumin and nano eugenol had the highest antiviral effect with

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Department : Veterinary Pharmacology and Toxicology

Major Advisor : Dr. Jadav Sarma

greater therapeutic index followed by Nanocurcumin and Nano Eugenol and there was dose dependent increase in percentage of inhibition of goatpox virus with their action being virucidal and also inhibited viral entry and some steps of viral replication in-vitro. Combination of nanocurcumin and nano Eugenol Nano-ointment showed better healing in clinical cases of goatpox.

Physio-Biochemical Studies of Adult Pati Ducks Reared under Semi-Intensive System

Dr. Tenzing Lopsang Lachenpa

The Pati duck is the only recognized duck breed of India and is indigenous to Assam. It has remained a largely popular duck variety among the locals due to its ability to grow with low inputs and easy management, greater resistance to diseases and hot and humid weather conditions which is prevalent across most parts of the state. The present experiment was carried out to study some hematological and biochemical parameters of adult Pati ducks reared under semi-intensive system for summer (July-August) and winter (December-January) seasons. A total of 24 ducks comprising 12 males and 12 females aged 10 weeks and above were considered for the experiment. The ducks were maintained in the duck farm adjacent to a pond and were housed during the night on concrete floor with deep litter and let loose during day time. The experimental ducks were subjected to blood collection at 7-day intervals during both the seasons and analyzed for total erythrocyte count, hemoglobin content, hematocrit, differential leukocyte count, and total leukocyte count for hematological study and superoxide dismutase (SOD), lactate dehydrogenase (LDH), total protein, alkaline phosphatase (ALP), HSP90 and cortisol for blood biochemical study. The hematological parameters were almost similar between male and female Pati ducks within the same season. However, the monocyte count was significantly higher ($P<.01$) in male Pati ducks and the lymphocyte and eosinophil counts were significantly higher ($P<.01$) in female Pati ducks during winter season. The hemoglobin content (Hb), and the total leukocyte count (TLC) were significantly higher ($P<.01$) for both male and female Pati ducks during summer season whereas the total erythrocyte count (TEC), and hematocrit (PCV) were significantly higher ($P<.01$) during winter season for both the sexes. Similarly, the biochemical parameters were also almost similar between male and female Pati ducks within the same season. However, alkaline phosphatase (ALP) and HSP90 levels were significantly higher ($P<.01$) during summer season in both male and female Pati ducks while lactate dehydrogenase (LDH) activity, total protein

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Department : Veterinary Physiology

Major Advisor : Dr. Arup Dutta

concentration, superoxide dismutase (SOD), and cortisol levels were significantly higher ($P<.01$) during winter season. Thus, from the experimental findings we can conclude that LDH, SOD, and cortisol could be considered good indicators of cold stress whereas HSP90 could be considered a good indicator for heat stress.

Sero-Prevalence and Risk Factor Analysis of Leptospirosis among Cattle Population in West District of Tripura State

Dr. Banitya Mohan Tripura

Leptospirosis is a re-emerging zoonotic, occupational and water-borne bacterial disease. The disease is endemic in our country since 20th century. The current study was investigated to know the seroprevalence of this particular zoonosis among cattle population in West District of Tripura. The research was carried out from March 2018 to February 2019. A total of 255 blood samples were collected from 3 (three) subdivisions of West Tripura both from clinically ill and apparently healthy cattle randomly irrespective of their age, breed and sex. The presence of anti-Leptospiral antibody is screened by Enzyme Linked Immunosorbent Assay (ELISA) and detection of serovars by Microscopic Agglutination Test (MAT).

Out of the 255 serum samples screened, the overall seroprevalence was recorded to be 24/255 (9.41%) and 17/255 (6.66%) by ELISA and MAT respectively. Also the following serovars were encountered *viz.* Autumnalis (29.41%) followed by Bataviae (23.52%), Ballum, Australis, Grippotyphosa, Hebdomadis and Javanica. A comparative study was made out for the sensitivity and specificity of ELISA and MAT with 100% and 70.83% respectively and concordance (97.25%). From the study it was observed that ELISA is superior than MAT based on its sensitivity, easy and rapid to detect circulating antibody.

Out of the three subdivisions studied, the seroprevalence was recorded highest in Mohanpur (15.29%) followed by Sadar (9.41%) and lowest in Jirania (3.52%). Statistical analysis by Chi-Square test showed that there was significant association of *Leptospira* seropositivity with the risk factors *viz.* health status, farm hygiene, rodent infestation, feeding quality, water source, herd size and season (P-value<0.05). Average temperature and rainfall were also recorded highest in monsoon. Seropositivity among cattle was recorded more with clinically ill cattle (21.43%) than apparently healthy cattle. Farm with poor hygiene was recorded highest (18.05%) with *Leptospira*

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Department : Veterinary Public Health

Major Advisor : Dr. P. Hussain

infection. Farm with history of rodent infestation was recorded higher with leptospirosis (32.3%). In consideration to feeding quality more cases of leptospirosis was recorded in cattle fed with cultivating grasses (13.63%). The recorded leptospirosis associated with stored water as risk factor was 15.18%. Farm with herd size >5 of animals was recorded with *Leptospira* infection (15.45%). Based on season highest *Leptospira* infection was recorded in monsoon (20.75%) and lowest in winter (3.38%). Whereas, there was no significant association with the risk factors viz. breed, sex, age, farm location, grazing pattern and contact with other animals.

Therefore, the current study will give a baseline seroprevalence of leptospirosis among cattle population in West District of Tripura.

Prevalence of Cysticercosis in Jorhat District of Assam

Dr. Mrinmoyee Sarma

A study on prevalence and seroprevalence of porcine cysticercosis and its associated risk factors and a retrospective study of NCC in man were conducted for a period of one year from July'18 to June '19 in Jorhat district of Assam. A total of 104 numbers of carcasses were examined in different market places from 5 different locations, out of which 1 carcass was found positive for *Cysticercus cellulosae* infection with the prevalence rate of 0.96%. A single positive carcass (1.85%) was reported between the age group of 7-12 months. Number of positive cases in male and female was 1(1.53%) and 0 (0%) respectively. The prevalence rate in non descript and crossbred pigs was 0 (0%) and 1(1.26%) respectively. To validate the results of meat inspection, DNA sample of the cyst were examined by PCR with TBR primer and Cox-1 primer. The PCR product with molecular size of 286 bp and 984 bp were amplified targeting large subunit rRNA Gene and cytochrome oxidase sub unit 1 gene respectively. On characterization of cystic fluid protein profile of porcine larval cestode by SDS-PAGE, two highly antigenic bands and one moderately antigenic band was observed.

A total of 140 number of serum samples were collected from 20 farms from 5 locations of Jorhat district. All the serum samples were analyzed by using RIDASCREEN *Taenia solium* IgG kit (R- Biopharm AG, Germany) to detect the presence of circulating antibody against *C. cellulosae*. Out of 140 samples examined, 13 were found to be positive for antibody against porcine cysticercosis with the prevalence rate of 9.2%. The highest numbers of cases were recorded from Madhupur (17.85%). The highest seroprevalence (12.06%) was recorded in the age group of 7 to 12 months and lowest (5.4%) in the 1-6 months. Sex- wise seroprevalence in female and male was 9 (10.22%) and 4 (7.69%) respectively. The proportional distribution of infection in female and male was 57% and 43% respectively. The seroprevalence rate in non descript and crossbred pigs was 3 (7.69%) and 10 (9.9%) respectively. The proportional distribution between non descript and crossbred pigs was 44% and 56% respectively.

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Department : Veterinary Public Health

Major Advisor : Dr. A. G. Barua

A total of 20 household associated with pig husbandry practices from 5 different locations and 50 consumers from different markets of Jorhat district were interviewed with the help of two suitable questionnaires to collect the baseline information to assess the risk factors associated with cysticercosis. Risk factors associated with cysticercosis were absence of latrines, defecation in open, poor personal hygiene, awareness to the disease, food habit, system of pig rearing, lack of meat inspection, lack of vaccination in pigs against cysticercosis, lack of periodic deworming of pigs as well as of human beings.

A total of 20 patients from Jorhat district were registered in Jorhat Medical College and Hospital for treatment of Neurocysticercosis (NCC) from July'17 to June'19. A backward study of patients (using retrospective and current data) was carried out with the help of a suitable questionnaire to determine the factors influencing the prevalence of NCC in the study area. Risk factors associated with the prevalence of NCC among the patients were gender of the patient, source of water supply, poor personal hygiene, consumption of raw salad and lack of periodic deworming.

Intraoperative Assessment of Intestinal Viability In Rabbits

Dr. Evakordor Hynniewta

Intraoperative assessment of bowel of questionable viability remained a challenge to surgeons. In this study, a rabbit experimental model was used to compare the accuracy of standard clinical criteria (SCC), pulse oximetry technique (POX) and fluorescein dye technique (FDT) in the determination of intestinal viability. Viability end point of each segment was established by histopathological studies and results were compared with results obtained from SCC, POX and FDT. Twelve ischemic intestinal segments were created experimentally by ligation of a branch of superior mesenteric artery along with the clamping of the loop supplied by the ligated artery. Viability assessment was then carried out after 4 hours in Group I and 8 hours in Group II of ischemic intervals. Standard clinical criteria included judging the bowel based on the color, pulsations and peristalsis. Pulse oximetry readings were made by placing the probe of the pulse oximeter on the anti-mesenteric border of the intestine. Fluorescein dye technique was carried out by injection of fluorescein sodium intravenously @75mg/kg body weight and fluorescence pattern was judged following 2 to 3 minutes of administration under ultraviolet illumination using Wood's lamp in a dark room. The overall accuracy of FDT was found to be 100%, while SCC and POX had 83.33% each. Fluorescein dye technique was found to be 100% accurate in making correct predictions of bowel of questionable viability. Standard clinical criteria and pulse oximetry were equally effective in predicting the non-viable loops with 100% sensitivity. However, this was at the cost of 83.33% positive predictive value. Fluorescein dye technique was found to have 100% sensitivity and specificity. Therefore, fluorescein dye technique in combination with standard clinical criteria can be recommended for intraoperative viability assessment of ischemic intestine. Blood and peritoneal fluid were collected at zero hour and after 4 hours in Group I and 8 hours in Group II. Estimation of serum alkaline phosphatase (U/L), alanine aminotransferase (U/L), cholesterol (mg/dl), creatinine (mg/dl) and phosphorus (mg/dl) was carried out in both the groups. Peritoneal fluid evaluation of alkaline phosphatase (U/L) and lactate dehydrogenase (U/L) was also done. A significant increase in the biochemical parameters of blood was seen following

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Department : Veterinary Surgery and Radiology

Major Advisor : Dr. D. Kalita

8 hours of ischemia. However, creatinine, did not reveal any significant changes after 8 hours of ischemia. A significant increase could be seen following 8 hours of ischemia in peritoneal fluid alkaline phosphatase and lactate dehydrogenase. Creatinine was not a good indicator of ischemia as it did not reveal any significant change at both the ischemic intervals. The significant increase seen in these biochemical markers of blood and peritoneal fluid marked the severity of the ischemia following 8 hours of ischemic insult. Thus, it can be concluded that these biochemical markers cannot reveal the fate of an ischemic bowel but can help in the diagnosis of ischemia.

Tiletamine-Zolazepam Anaesthesia in Cat

Dr. Monalisa Ahmed

In this study, ten clinically healthy cases of domestic cat (*Felis catus*), requiring surgical intervention for various conditions were considered. The cats were of either sex, weighing 3 to 4 kg, and of 2 to 4 years of age. They were randomly divided into 2 (two) equal groups with five animals in each group. The cats of group I received tiletamine - zolazepam (Zoletil 100 vet.) @ 5 mg/kg body weight and the cats of group II were administered the same anaesthetic combination @ 10 mg/kg body weight intramuscularly. The mean induction time of 2.40 ± 0.24 minutes and 1.60 ± 0.24 minutes, duration of anaesthesia of 24.40 ± 1.69 minutes and 43.60 ± 5.87 minutes, and the recovery time of 34.20 ± 3.00 minutes and 57.00 ± 4.84 minutes were recorded in the cats of group I and group II, respectively. Group I and II showed significant difference ($p < 0.05$) in induction time and duration of anaesthesia; and high significant difference ($p < 0.01$) in recovery time between the groups. Animals of both the groups showed initial pawing, unconsciousness, eyes remained open throughout the duration of anaesthesia, mydriasis, presence of corneal and pupillary reflexes, smaking of lips, and protrusion of tongue without salivation. Animals of group I exhibited moderate analgesia and muscle relaxation; but in case of animals of group II, good analgesia as well as muscle relaxation were ascertained. No unwanted effects like salivation, catalepsy, vomiting, urination, or defaecation were observed in any of the groups.

In both the groups, heart rate increased significantly ($p < 0.01$), whereas, nonsignificant ($p > 0.05$) decrease of respiration rate was seen. The rectal temperature and SpO₂ for both the groups showed significant ($p < 0.01$) decrease with time. Moreover, the MAP increased significantly ($p < 0.01$) in both the groups. Haematological parameters like Hb, PCV and TEC revealed significant ($p < 0.01$) decrease in both the groups. In case of biochemical parameters, there was non-significant ($p > 0.05$) increase of GGT, blood glucose and cortisol but non-significant ($p > 0.05$) decrease of total protein and creatinine levels in both the groups. All the changes were transient in nature.

From the above studies, it can be concluded that tiletamine – zolazepam @ 5 mg/kg body weight produced moderate anaesthesia of shorter duration allowing minor

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Department : Veterinary Surgery and Radiology

Major Advisor : Dr. Bhupen Sharma

surgical interventions like castration, removal of external growths, aural haematoma operations, etc., and tiletamine – zolazepam @ 10 mg/kg body weight intramuscularly produced balanced anaesthesia permitting major surgical procedures like spaying, gastrotomy, cystotomy, etc. in domestic cats.

Sevoflurane Anaesthesia in Butorphanol-Midazolam Premedicated Dogs Induced with Propofol and Ketamine

Dr. Sarahna Taufiq

Twelve clinical cases of female Mongrel dogs of 1-5 years, weighing 10-15 kg were considered for the study. The animals were randomly divided into two groups with the following anaesthetic regime: premedication with butorphanol @ 0.3 mg/kg, IM and midazolam @ 0.3 mg/kg, IM followed by induction of anaesthesia with ketamine @ 7.5 mg/kg, IV (Gr A) and propofol @ 4.0 mg/kg, IV (Gr B) and maintenance of anaesthesia with sevoflurane in oxygen in both the groups.

Time of sedation was recorded 5.00 ± 0.29 mins in Gr A and 5.17 ± 0.31 mins in Gr B. Four (66.67%) animals showed excellent quality of sedation and two animals (33.33%) showed light sedation in both the groups. Time of induction was recorded 2.43 ± 0.13 mins in Gr A and 2.32 ± 0.08 mins in Gr B. Quality of induction was smooth without any adverse signs, although apneustic respiration in two (Gr A) and apnoea in four animals (Gr B) was observed after induction. Intubation score was graded as excellent in four (66.67%) and good in two (33.33%) animals in Gr A whereas excellent in all the animals (100%) in Gr B. Quality of analgesia was found to be excellent in Gr A and good in Gr B. Muscle relaxation was graded as excellent in four (66.67%) and moderate in two (33.33%) animals in Gr A, while all the animals (100%) showed excellent muscle relaxation in Gr B. Time for return of swallowing reflex was shorter in Gr B (13.83 ± 0.60 mins) than Gr A (14.83 ± 0.48 mins). The time required for head raise was significantly ($p < 0.05$) shorter in Gr B (23.42 ± 0.52 mins) than Gr A (25.67 ± 0.84 mins). The time required for standing was 33.00 ± 0.93 mins in Gr A and 33.17 ± 0.70 mins in Gr B. The time for complete recovery was shorter in Gr B (51.50 ± 1.52 mins) than Gr A (53.50 ± 1.57 mins). Quality of recovery was excellent in both the groups however, two animals in Gr A showed signs of shivering, salivation and urination. Also, two animals in Gr B showed slight whimpering, salivation and urination during recovery. Heart rate increased significantly, respiration rate and rectal

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Major Advisor : Dr.(Mrs.) Bitupana Deuri

temperature were reduced significantly ($p < 0.05$) in both the groups. Oxygen saturation was well maintained and not less than 88% at various time intervals in both the groups. CRT at various time intervals was less than 2 seconds in all the animals. Hb, PCV, TEC and TLC decreased significantly ($p < 0.05$) and total platelet count decreased non-significantly for both the groups throughout the period of study. Total protein decreased significantly ($p < 0.05$) while total albumin and total globulin decreased non-significantly in both groups. ALP, GGT increased non-significantly in both groups. Creatinine increased in both Gr A ($p > 0.05$) and Gr B ($p < 0.05$). The value of BUN was found to increase in both Gr A ($p < 0.05$) and Gr B ($p > 0.05$). In conclusion, both the anaesthetic combinations were found to produce balanced anaesthesia in dogs and could be recommended for clinical use. However, Gr B was observed to be better among the two groups in terms of smooth induction, ease of intubation, good degree of analgesia, excellent muscle relaxation and an overall smooth recovery.

Master of Science (Home Science)

- **Extension and Communication Management**
 - **Family Resource Management**
 - **Food Science and Nutrition**
- **Human Development and Family Studies**
 - **Textile and Apparel Designing**

Entrepreneurial behaviour of members of Self Help Groups of Jorhat district of Assam

Dhruba Jyoti Mudoi

Self Help Groups are considered as one of the most significant tools to adopt participatory approach for social and economic empowerment of women. Now it has been realized that sustainability of Self Help Group is possible through inoculation of the entrepreneurial behaviour and qualities among the members of SHG. Keeping this in view, the present study is entitled as “Entrepreneurial behaviour of member of Self Help Groups of Jorhat district of Assam” was taken with objectives (i) To study the background profile of the members of Self Help Groups of Jorhat district of Assam. (ii) To find out the extent of participation of the members of Self Help Groups in selected entrepreneurial activities. (iii) To explore the entrepreneurial behaviour of the members of selected Self Help Groups of Jorhat district of Assam.

The study was carried out in the state of Assam which is situated in the north east part of India. A purposive cum random sampling design was followed for the present study .Jorhat district was purposively selected for the present study. Blocks were selected from National Rural Livelihood Mission (NRLM) initiative blocks. NRLM has clustered all blocks of Jorhat district into 6 blocks. Out of the 6 blocks , 4 blocks were selected purposively. A list of SHG from each selected blocks who had continuously functioning for the last 10 years and engaged in some entrepreneurial activities were prepared. From the list four SHG favourable were selected by using simple random sampling method. Thus all total 16 Self Help Groups were selected for the present study. After selection of the SHG, 10 members from each SHG were selected using simple random sampling for the study. Thus a total of 160 respondents were taken as a sample for the study

The findings revealed that a majority of the respondents belonged to the young aged category who were mostly married and had education up to high school level. Most of them belonged to nuclear family with small family size and having marginal land holdings with cultivation as the main occupation of the family. Most of the respondents had medium income level and were member of one organization. A high percentage

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Department : Extension and Communication Management

Major Advisor : Dr. Sayanika Borah

(62.50 %) of the members depended on Gramin Vikash Bank for their financial support in the entrepreneurial activities of the SHG's. From the study, it was observed that majority (48.00 %) of the respondents had medium level of participation in terms of selected entrepreneurial activities in managerial and marketing activities. In terms of entrepreneurial behaviour, a majority (71.00 %) of the respondents had medium level of entrepreneurial behaviour and out of all the behaviour, management orientation seen as the common behaviour and therefore was given Rank I (48.8) .

Food habit of tribal community of Assam with special reference to Shyam tribe

Manash Pratim Konwar

The present study on —Food habit of tribal community of Assam with special reference to Shyam tribe was carried out with the following objectives 1. Complete understanding of the Shyam tribe. 2. Food consumption and dietary habit of people of Shyam tribe. 3. Indigenous food practices in treatment of common health problems. The study was carried out in the Jorhat district of State of Assam. From Jorhat district Titabar development block was purposively selected. A list of the villages which are predominantly inhabited by Shyam tribe was prepared from which two villages were selected randomly. From each of the village 30 Shyam people were selected through judgmental method. Thus total numbers of respondent were 60. Data was collected using structured interview schedule and analysed using appropriate statistical techniques viz., frequency, percentage, mean and standard deviation. The data revealed that more than half of the respondents were of middle adulthood group of 40-60 years, had nuclear family (51.67%) medium family size (5-7 members) (56.67%). The status of education was up to middle school level (26.67%), majority of the respondents were married. Main occupation of the family was farming (63.34%), had small land (31.67%) to marginal land holding (18.33%) and ownership was in the name of respondent mostly male members. More than half of the respondents did not have membership in any organization and sometimes contacted bank personnel rather than other extension personnel. Cent per cent had mobiles phones and half of them had low mass media exposure. Almost all of them possessed birds (90.00%), followed by cow (26.67%) and goats (20.00%). Traditional housing pattern is still prevailing among the respondents, as regard to rituals related to marriage and funeral high majority (86.00%-88.00%) still followed completely and all the festivals are observed by all respondents such as *Sangken*, *Poi-leng*, *Mai-ko-sum-phai*, *Poi-kathing*. Traditional costume is used mostly by the older generation which is less worn by young generation. Basically respondents are non vegetarian, boiling and steaming are common cooking method, some of the traditional food items are sticky steamed rice, jolokia-pitika, laitenga, khautak, boiled

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Major Advisor : Dr. Manoshi B. Deka

pork with vegetable. They have a good treasure of indigenous knowledge which is still followed by majority of the respondents in treatment of common health problems. The finding of the study suggest that documentation and preservation of their traditional culinary practices and plethora indigenous knowledge is the need of the hour before it is lost with the passage of time which will be an addition to the knowledge basket of wisdom and also this can serve for the taking up startups for the new generation. It is evident from the study that the indigenous knowledge holders of Shyam tribe collect the different medicinal, edible plant species from the surrounding plant resources located in the periphery of the village and some species that are grown in their traditional homestead gardens. Thus it can be concluded that like many other tribal communities of the world, Shyam people also have their system, rituals, customs, festivals and preparation of food. The ethnic foods are important and have cultural values.

Management practices of fast food street vendors of Jorhat district of Assam

Parsha jyoti Bharadwaj

The present investigation was carried out to study the management practices of fast food street vendors of Jorhat district of Assam. The study was undertaken to obtain the preliminary information of Fast Food Street Vendors, to find out the existing management practices of Fast Food Street Vendors and to identify the problems faced by the Fast Food Street Vendors. The registered fast food street vendors of Jorhat city were purposively selected as the locale of the present study. A total of 111 respondents were randomly selected for the present study which was 50 percent of the total population. An interview schedule was constructed for collection of data. Appropriate statistical methods were used such as frequency, percentage, mean, factor analysis and intensity index. Under financial management buying of raw materials, buying of utensil for cooking and kitchen equipment for serving were found significant through factor analysis. Under social problem, it was found that 96 percent of the respondents could fulfil the demands of the customers. Under family management, food for the family, education for the family and the entertainment for the family were found significant through factor analysis. Under administrative management factor analysis showed there was no significant factor responsible in this area of management. Under management of hygiene, majority of the respondents did not use apron, headcover and gloves .It was also found 50 percent of the respondents managed other hygienic practices in their business. The investigator concluded from the finding of present study that the fast food vendors of Jorhat city had different management practices pertaining to financial, social, family, maintenance of hygiene and administration. The respondents also faced a number of problems in different areas and of different intensity. Among financial problem, the problems related to repayment of loans from financier and realising the credit from customers were ranked first and second and were of moderate intensity. Among the familial problem, the problems relating to construction of the sanitary system for the family and medical check up of the family members were ranked first and second and were of severity intensity. Problems pertaining to hygiene, it was found that use of

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Major Advisor : Dr. Daisy Hazarika

apron and use of head covers were ranked first and second. Both these problems were of severe intensity. Among the social problem, it was found that the problem regarding sudden strike in the locality was ranked first and of severe intensity, followed by problem regarding competition with other vendors was ranked as second and were of moderate intensity. Among administrative problem it was found that the problems pertaining to local administrative tax, location tax were ranked first and second and of mild intensity. Some suggestive measures directly influencing the health status of the people in large through street food vendors need to be planned meticulously .A training programme to inform the fast food vendors regarding health and hygiene is the need of the hour. Local administration may be approached to sponsor such a training programme to prepare a training kit containing apron, head cover and gloves. Moreover, the local administration may be requested to make it mandatory to use this hygienic kit by all fast food vendors and become a proud pioneer to show case a step towards popularising the healthy fast food centres in Jorhat city thereby attracting the unemployed educated youth to start fast food centres as a good start up. Government can also provide minimum facilities in appropriate places for the street food vendors, since major economic return from this sectors are more in a developing country like India.

Problems faced by undergraduate students of Assam Agricultural University in obtaining scholarships

Santosh

Various academic scholarship schemes were introduced by the Government of India with the aim to empowering and inspiring students to do excel in academic and to provide financial support to low income group students. But students are not much aware about scholarship schemes and encounter many problems in getting scholarship. With this background the present study entitled “Problems faced by undergraduate students of Assam Agriculture University in obtaining scholarships” was conducted with the specific objective: 1.To study the background characteristics of the respondents. 2. To assess the level of awareness of the respondents regarding different scholarship. 3. To explore the types of scholarships availed by the respondents. 4. To find out the problems faced by respondents in obtaining scholarships. Two colleges were selected purposively for the present study. Equal number of respondents selected from each of the selected colleges through stratified random sampling. Thus the total number of respondents was 240. Data were collected through the self-prepared questionnaire and analysed using appropriate statistical test and techniques i.e. frequency, percentage, mean, standard deviation and chi- square. The data revealed that highest percentage of respondents (59.20%) were in the age group of above 20 years, majority of the respondents (70.40 per cent) were female, 42.50 per cent of respondents belonged to general caste, 90.00 per cent of respondents were Hindu, 49.60 of the respondents belonged to urban area, 75.80 per cent of the respondents’ mother tongue was Assamese, 28.40 per cent of respondent had family income above rupees five lakhs, 52.90 per cent of the respondent got admission in 1stcounseling, 75.40 per cent of the respondents got orientation after getting admission. Finding further showed that majority (88.75%) of respondent was aware about State Merit Scholarship followed by 83.75 per cent of respondents about IshanUdya scholarship, 53.33 per cent respondents were aware about National Talent Scholarship whereas 2.91 per cent about Financial

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Department : Extension and Communication Management

Major Advisor : Dr. Mayuri Bora

Support to the Economically Backward Students of AAU. Majority of the respondents i.e. 90.00 per cent had senior as source of awareness. Around 50.00 per cent respondents were availing IshanUday scholarship from College of Agriculture whereas the corresponding percentage for College of Community Science was 42.59. The data on problems faced by students in availing scholarship indicated that 52.92 per cent had faced moderate level of problem. Among the problems related to submission 'Detail information of the scholarship was not known' ranked I with mean score 0.42 whereas out of the problems related to amount and regularity of receiving the scholarship 'Delay in receiving the scholarship' ranked I with mean score 0.51. Association between college and awareness regarding State Merit Scholarship of the respondents was significant ($p < 0.05$) and IshanUday scholarship with class of respondents was highly significant ($p < 0.01$).

Knowledge of Anganwadi workers (AWWs) for rendering Nutrition and Health Education service under ICDS scheme in Karbi-anglong district of Assam

Semson Engeng

The present investigation was undertaken to study the nutrition and health knowledge of the Anganwadi workers (AWWs) and problems faced by the AWWs for rendering Nutrition and Health Education component of ICDS in Karbianglong District of Assam with the following objectives: (i) To study the profile of the Anganwadi workers. (ii) To assess the Nutrition and Health knowledge of Anganwadi workers for rendering Nutrition and Health Education service of ICDS. (iii) To identify the problems faced by the Anganwadi workers for rendering Nutrition and Health Education service of ICDS

The study was conducted in two sub-divisions of Karbianglong district namely, Bokajan and Hawraghat. From each sub-division, ten circles were selected. From each of the circles, five AWWs with a minimum of five years work experience as Anganwadi worker were selected randomly to make a total of 100 Anganwadi workers as respondents for the study.

The study revealed that majority of the respondents (65%) belonged to the age group of 33 – 40 years, 72 per cent were married and educational qualification of 35 per cent respondents was up to matriculation level. Majority of the respondents were from Schedule caste (82%) and from nuclear family (56%). Farming was the main family occupation of 68 per cent of the respondents and family income was Rs.10000-15000 per month of 54 per cent of respondents. The study indicates that majority of the respondents (88%) visited the urban area frequently, had a medium level of exposure to mass media (56%) and a medium level of contact with extension agent (81%).

The study showed that 53 per cent of respondents had a medium level of nutrition knowledge and 63 percent had a medium level of health knowledge. The respondents has no knowledge regarding function of food and source of nutrients and

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Department : Extension and Communication Management

Major Advisor : Dr. Juliana Sarma

also had less knowledge on importance of milk consumption during pregnancy and also had less knowledge on children's diet after one year old. The findings further revealed that there was a significant relationship between nutritional knowledge of the respondents and their educational qualification, mass media exposure, contact with extension agent and years of experience. The findings also revealed that there was a significant relationship between the educational qualification, mass media exposure and contact with the extension agent of the respondents with their health knowledge.

The study also revealed that the major problems faced in rendering NHE service 'Lack of time for Nutrition' and 'Low wage compared to workload' as these statements were ranked I by the respondents. Statements like 'Irregular in sanction of monthly official funds' and 'Difficulty in maintaining records' were also problems for the respondents for rendering NHE program under ICDS scheme and the statements were ranked II.

Status of Women Tea Plantation Workers in Jorhat District of Assam

Toko Jumi

The present study entitled as “Status of Women Tea Plantation Workers in Jorhat District of Assam” was conducted in Jorhat district of Assam. Four (4) tea gardens under public corporation from Jorhat sub-division were selected using purposive sampling method. A total of 100 women tea plantation workers were selected randomly using a simple random sampling method. The personal interview method was applied for the collection of primary data. Data were analysed using percentage, mean, standard deviation and ranking. It has been observed that the majority of respondents (45.00%) were under the age group young category i.e. 18-30 years. Majority of respondents (77.00%) were married. More than half of the respondents (52.00%) were illiterate. Cent per cent of the respondents was under Minority and Other Backward Class (MOBC). The data also revealed that the majority of respondents were from the nuclear family (77.00%) and 55 per cent of respondents belonged from a small family (till 4 members). Majority of the respondents lived in Katcha house (88.00%). The pipeline was the source of water for 66 per cent of respondents. 46 per cent of respondents had a low-cost latrine. Daily wage labourer was the occupation of respondent's head of the family for 81 per cent of the respondents. 50 per cent of the respondents earned between (Rs. 4492- Rs. 5012) monthly. A large percentage of the respondents had no subsidiary source of income (96.00%). 51 per cent of the respondents had no membership in any organisation. In material possession, a very high percentage of the respondents possessed traditional Chulha (99.00%), 36 per cent of respondents possessed two-wheeler and in livestock, 52 per cent the respondents possessed hen. It was highlighted that 71 per cent of the respondents had a medium level of mass media exposure. More than half of the respondents had a medium level of conservatism- liberalism (63.00%). It is revealed from the findings that the majority of the respondents made a joint decision with their husbands in taking the final decision in various activities. Independent decision was also seen among the respondents which were highest in areas of maintenance of the house (84.00%), selection and preparation

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Major Advisor : Dr. Sayanika Borah

of food (73.00%), voting in the election (66.00%), taking part in social events (44.00%), and recreational activities (40.00%). The data revealed that the majority (51.00%) of the respondents were most interested in poultry farming followed by goat rearing (14.00%). The data also highlighted that in an average respondents spent 7.94 hours in working at tea garden in a day followed by 7.88 hours in sleep, 2.08 hours in kitchen, 0.95 hours in watching TV, listening radio etc, 0.91 hours in personal care, 0.815 hours in care for children and family, 0.69 hours in cleaning, 0.29 in fetching water and cleaning, 0.28 hours in religious activities, 0.25 hours in collection of firewood, 0.10 hours in care for animals and 0.77 hours in social activities. The findings revealed that insufficient wage was ranked I with mean score (2.99), lack of toilet facilities at work was ranked II with mean score (2.95), no provisions for protective gears at work was ranked III with mean score (2.82), back pain due to carrying of tea baskets for a long time was ranked IV with mean score (2.45), cuts and rashes on fingers and palm due to plucking of tea leaves was ranked V with mean score (2.43).

School backpack weight and prevalence of musculoskeletal discomfort among adolescent students

Bristi Ankita Saikia

Every morning children with their backpack on and heading towards school might not seem harmless enough, but this very concern has drawn in many researchers to explore beneath the veil. This is because the practice of lifting heavy load is often found to be accompanied by health issues. And the school backpack is nowadays considered as a daily occupational load. The present study ‘School backpack weight and prevalence of musculoskeletal discomfort among adolescent students.’ was carried out with the objectives (1) to determine the backpack weight of adolescent students and its association with selected variables, (2) to ascertain the prevalence of musculoskeletal discomfort and its association with selected variables, and (3) to suggest measures to reduce the risk involved in carrying the backpack load.

For this study a total of 120 samples (30 samples from each school) were selected from four different schools of Jorhat district, Assam by simple random sampling, comprising of both the gender. Survey method was used and collection of data was done through a questionnaire and still photographs. Information on demographic profile, anthropometric factors, and information on backpack and its use and characteristics of musculoskeletal discomfort, such as frequency and severity were collected. Further Chi Square analysis was done to determine the association between variables. The samples selected were of the age group 11 years to 14 years and the study revealed that only 3 per cent students carried backpack less than 4kg, 38 percent were carrying between 4-6kg and 59 per cent were carrying more than 6kg. In terms of percentage of body weight carrying; only 16 per cent were found to be carrying less than 10% of their body weight, which is the recommended bag weight by many scientific associations. Data further revealed that the highest musculoskeletal discomfort reported was in shoulders (94.2%), followed by upper back (78.3%), neck (73.3%) and others. It was observed that there is a significant association between backpack weight and

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Department : Family Resource Management

Major Advisor : Dr. Ruplekha Borah

musculoskeletal discomfort ($p=0.001^*$), class of the respondent ($p=0.009^*$) and age of the respondents ($p=0.018^*$). And musculoskeletal discomfort was found to be associated with class of the respondent ($p=0.009^*$).

Further, an effort was made to determine the comfortable backpack carrying position. The body joint angles formed in the sagittal plane while hanging the backpack in three different positions on the back was compared. Ten percent of the total sample students were selected for this experimental study of average body weight of 44.39 kg and carrying backpack of average weight 5.8 kg. Data analyzed in the software Ergo Master revealed that carrying the backpack high on the back i.e. upper back (Position C) snuggling it promotes the least deviation of the body angles from the neutral posture compared to backpack hanging low over the buttock and backpack worn in the middle back. Further on the basis of the experimental study and information collected from research papers, journals, internet and also govt. regulations and guidelines, measures were suggested for the children, parents, school authority and other concerned authorities on safe usage of the backpack.

Application of Vastu Shastra for house design in Jorhat City

Khumukcham Jenita

Vastu shastra is a traditional Hindu system of architecture which literally translates to "science of architecture." It is a science which deals with the management of cosmic energy in building and structures. The present study "Application of Vastu Shastra for house design in Jorhat City" was carried out with the objectives (1) To study the personal and demographic profile of the respondents, (2) To assess the knowledge level of respondents on Vastu Shastra for house design and (3) To study the application of principle of Vastu Shastra for house design.

A multistage purposive cum random sampling method was adopted for the study. Out of 19 wards in Jorhat municipality area 5 wards were selected randomly and 120 numbers of household were selected by applying Probability Proportional to Size (PPS) method. People who constructed their own home were the respondents for the present research study. Both interview and observation methods were used to elicit the information. Questionnaire was used as a tool for collection of data.

The study revealed that the respondents had knowledge score of 39.52 per cent was on kitchen which was followed by 31.25 per cent on dining room, 31.16 per cent on bedroom, 30.20 per cent on living room, 16.83 per cent on bathroom and 15.41 per cent for pooja ghar. Knowledge level of the respondents on Vastu shastra for house design was neither very good nor very poor. It was found that about 43.00 per cent of respondents had average knowledge whereas 37.00 per cent had poor knowledge and only 20.00 per cent respondents had good knowledge on orientation of rooms for house design.

The findings of the study also revealed that application index i.e. 27.14 per cent was found on kitchen area which was followed by 19.50 per cent on bedroom, 13.54 per cent on dining room, 11.25 per cent on living room, 5.80 per cent on bathroom and 4.86 per cent on pooja ghar. It was also observed that almost 56.00 per cent respondents had poor application whereas 36.00 per cent had average application and only a very meagre per cent (8.00%) had good application of Vastu principles for their house design.

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Comparison of both knowledge and application index of the respondents in all areas of house that is pooja ghar, kitchen, bedroom, dining room, living room and bathroom knowledge index was higher than application index. Both knowledge index (39.52%) and application index (27.14%) of the respondents were maximum in kitchen area.

Effect of advertisement on buying habits of college students of Jorhat city with special reference to cosmetic products

Pallavi Singh

Women have inherent love of beauty especially youngsters always have a tendency to look beautiful. Young women especially the college students don't hesitate to spend money on cosmetic products, they show great importance on personal grooming as a result the cosmetic industry is also growing everyday with the increasing interest of consumer and purchasing power. Therefore communication between the cosmetic industry and consumers has, of necessity become commercialized as it is impossible for any manufacturer to reach individual consumer on a person to person basis, in this circumstances the only method of communication is by advertising. Advertisement shapes the perception of consumers in the positive way, people can perceive the quality of the products by gathering the information through advertisement. Majority of cosmetic advertisement today share a common view that portrayed an "Idealized" view of beauty that has been forced on audiences so much that majority women aspire to this look. Keeping it in mind the present study was taken up "Effect of advertisement on buying habits of college students of Jorhat city with special reference to cosmetic products" with the objectives (1) to study the buying habits of college students in cosmetic products. (2) to find the effect of advertisement of cosmetic products on college students, and (3) to identify the relationship between type of advertisement and buying habits. For this study a total of 120 samples were selected from four different colleges of Jorhat district, Assam (30 students from each college) by simple random sampling and only female respondents were selected. Interview method was considered as an appropriate tool for the present study. The data were collected with the help of interview schedule, which was later serially arranged coded, tabulated and statistically analyzed. Information on demographic profile, effect of advertisement, buying habits were depicted such as frequency and percentage. Further Chi Square analysis was done to determine the association between selected variables. The samples selected were of the age group 17 years to 25 years and the study revealed that in case of

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Department : Family Resource Management

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all cosmetic products i.e. skin care products, hair care products, color cosmetics and fragrance product cent percent (100%) of the respondents used face wash, shampoo and lipsticks regularly. Majority of the respondents used to purchase cosmetic products as per their need. Majority of the respondents used to spend an amount of money in between (2000-3000) rupees to purchase cosmetic products. About (46.66 %) of the respondents reported they use cosmetic products for good looking. It was observed that most of the respondents i.e. (48.33 %) admitted that advertisement influence them to purchase the cosmetic products. Regarding the buying habit of the consumers the habit of checking the quality of cosmetic product ranked I followed by checking of expiry/manufacturing date rank II and reading the label thoroughly was ranked III. Mostly (80.33%) reported that there is a medium effect of advertisement on the respondents. Advertisement creates an interest among the students to buy the product. Among the features which are most influencing in advertisement are attributes of the product highlighted and message given in the advertisement. Further on the basis of the study and information collected from research papers, journals, and internet. Measures can be recommended for the marketers to understand what triggers a consumer's interest to purchase cosmetic products and also marketers can determine which element in advertising is most influencing to the consumer's.

Quality Evaluation of Beetroot Powder Incorporated Cakes

Jula Sarma

The present study entitled ‘‘Quality evaluation of beetroot powder incorporated cakes’’ has been carried out for dietary diversification as well as to enhance the nutritional quality of food product in general and in bakery products in particular. Beetroot has attained significance as a functional food due to its health promoting nutrients. The objectives of the study was to development of beetroot powder, to formulate and to standardize the beetroot powder incorporated cakes, to analyse the physico-chemical properties of the developed cakes and to determine the organoleptic properties and storage study of the developed cakes. The physico-chemical analysis of the beetroot powder as well as developed beetroot powder incorporated cakes were carried out by following standard procedures. The functional characteristics of beetroot powder was good in terms of water absorption capacity (4.53 g/g), oil absorption capacity (1.55g/g) and swelling capacity (6.24 ml/g). The L, a, b values where L* indicates lightness or darkness (0 = black, 100 = white), a* indicates the hue on the green-to-red axis (Negative value = greenness, positive value = redness), b* indicates the hue on the blue-to-yellow axis (Negative value = blueness, positive value = yellowness) of beetroot incorporated shortened cake are 36.17, 43.03 and 4.13 respectively. Similarly the L, a, b values where L* indicates lightness or darkness (0 = black, 100 = white), a* indicates the hue on the green-to-red axis (Negative value = greenness, positive value = redness), b* indicates the hue on the blue-to-yellow axis (Negative value = blueness, positive value = yellowness) of beetroot incorporated unshortened cake are 38.07, 41.23 and 2.17 respectively. The beetroot powder has enhanced nutritional quality such as protein (16.62 g/100g), crude fibre (11.08 g/100g), total mineral (9.27 g/100g), fat (1.19 g/100g), total carbohydrate (55.53 g/100g), Total antioxidant capacity (TAC) (4.53 g/100g), carotenoid (2.72 mg/100g) and betalain (8.44 mg/g). Three formulations of flour mix (refined wheat flour : beetroot powder) were developed viz S₁ (80:20), S₂ (75:25), S₃ (70:30) for making shortened cake and standardized. Likewise in similar level of incorporation i.e T₁ (80:20), T₂ (75:25), T₃

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Major Advisor : Dr. Ruma Bhattacharyya

(70:30) were developed for making unshortened cake and standardized. Acceptability trials of the developed shortened and unshortened cakes were conducted by a panel consisting of 10 members using 9-point hedonic scale. In the organoleptic attributes of beetroot powder incorporated shortened cake, S₂ (75:25) scored highest scores in terms of colour (7.8), appearance (7.8), taste (8.3), flavour (7.9), texture (8.5), consistency (7.9), overall acceptability (8.3). Amongst the unshortened, T₂ (75:25) scored highest in terms of colour (8.0), appearance (8.0), taste (7.8), flavour (8.1), texture (8.4), consistency (7.9) and overall acceptability (8.4). Thus on the basis of overall acceptability scores of the beetroot powder incorporated shortened cake S₂ (75:25) and unshortened cake T₂ (75:25) were taken for further analysis of physico-chemical properties. The developed cakes S₂ (75:25) and T₂ (75:25) recorded good physical properties as compared to the control S₀ (100:0) cake i.e volume (556.33 cc), density (0.6 kg/m³), weight loss (9.19 g), specific volume (1.52 cc/g) and also T₂ (75:25) recorded good physical properties as compared to the control T₀ (100:0) cake i.e volume (574.33 cc), density (0.5 kg/m³), weight loss (6.47 g), specific volume (2.33 cc/g) for each of the cakes respectively. The beetroot powder incorporated shortened cake had high nutritional value in terms of moisture (23.08 g/100g), crude protein (10.43 g/100g), crude fat (27.6 g/100g), total mineral, crude fibre (5.63 g/100g), total carbohydrate (24.27 g/100g), energy (387.2 kcal/100g), TAC (49.63 g/100g), carotenoid (0.08 mg/100g) and betalain (0.13 mg/g) as compared to the control S₀ (100:0) cake. The beetroot powder incorporated unshortened cake recorded physico-chemical attributes in terms of moisture (23.76 g/100g), crude protein (10.83 g/100g), crude fat (23.16 g/100g), total mineral (1.04 g/100g), crude fibre ((1.10 g/100g), total carbohydrate (40.83 g/100g), energy (373.5 kcal/100g), TAC (50.40 g/100g), carotenoid (0.07 mg/100g) and betalain (1.44 mg/g) as compared to the control cake. The developed beetroot powder incorporated cakes along with the control cake are stored for 1 month in Polypropylene+Polyethylene packets at ambient temperature for moisture, free fatty acid, peroxide value, betalain content and organoleptic attributes analysis. The scores in terms of moisture, free fatty acid, peroxide value and betalain content of the beetroot incorporated shortened cakes as recorded at 0 days were 23.27 g/100g, 0.08 mg KOH/g fat, 0.008 mEq/kg fat and 0.21 mg/g as well as 14th day were recorded as 15.73 g/100g, 0.25 mg KOH/g fat, 0.18 mEq/kg fat and 0.13 mg/g throughout the study period. Similarly the scores in terms of moisture, free fatty acid, peroxide value and betalain content of the beetroot incorporated unshortened cakes as recorded at 0 days were 23.63g/100g, 0.12 mg KOH/g fat, 0.09 mEq/kg fat and 0.28 mg/g as well as 14th day were recorded as 16.21 g/100g, 0.31 mg KOH/g fat, 0.20 mEq/kg fat and 0.13 mg/g throughout the study period. The storage study inferred that the mean scores of free fatty acid content and peroxide value increased significantly (p<0.05) as the storage days increased whereas the moisture content and the betalain content decreased significantly (p<0.05) as the storage days increased signifying that increased free fatty acid content, peroxide value and decreased moisture content and betalain content leads to

deterioration of product. The organoleptic traits of the developed beetroot powder incorporated cakes S₂ (75:25) and T₂ (75:25) was acceptable by the sensory panelists till 14 days of storage. Also fungus growth have been observed through visual observation. So the analysis have been carried out till 14 days. Also on comparison of the properties of beetroot powder incorporated shortened cake and beetroot powder incorporated unshortened cake, beetroot powder incorporated unshortened cake proved to be better in terms of nutritionally and organoleptically. Thus the study concluded that the beetroot powder incorporated shortened and unshortened cakes at the level of incorporation 75:25 (WF:BRP) was nutritionally high as well as overall acceptability was good across storage of 14 days. Beetroot powder as a potential source of good quality macro and micronutrients as well as phytonutrients enhances the quality of nutritional bakery products in general.

Impact of high protein high energy formulation on exercise performance in relation to strength and endurance capacity

Jyotishmita Konwar

The present investigation on “Impact of high protein high energy formulation on exercise performance in relation to strength and endurance capacity” was carried out with the objective to develop a high protein high energy food product, analysed nutritional and antioxidant content of the developed product and determining the *in-vivo* efficacy of the developed product in terms of strength, endurance capacity and muscle glycogen level as well as conducting shelf life studies across storage. In the present study the raw ingredient selected were according to the guidelines approved by Athlete’s Guide to sports supplements (AGSS, 2013) and Dietary Supplement Health and Education Act (DSHEA, 1994) which should be rich in protein mainly branched chain amino acid (valine, isoleucine, leucine), energy, crude fiber, fatty acid, minerals, inorganic nitrite, antioxidant, phytochemicals. For the present study the ingredients selected for development of high protein high energy bar were rich in nutrients as outlined by AGSS and DSHEA. Four formulations namely TS₁, TS₂, TS₃ and TS₄ were developed, out of four formulations was TS₄ high protein high energy bar (35:26:2.5:6:2.5:4:3.5:3.5:7:10) exhibited highest scores for all the sensory attributes in terms of colour (7.8±0.59), flavor (8.20±0.62), texture (7.53±0.48), appearance (7.86±0.51), taste (8.36±0.63) and overall acceptability score (8.0±0.39). The nutritive value of TS₄ was significantly highest (p<0.01) compared to the other test formulation. TS₄ had moisture content of (12.49±0.78g/100g), protein (12.76±0.23g/100g), fat (10.25±1.02g/100g) and ash (1.75±0.01g/100g), crude fibre (3.44±0.04g/100g), carbohydrate content of 59.31±1.90g/100g and energy (380.73±3.85 kcal/100 g) respectively. The iron, magnesium, calcium, zinc, phosphorous content of TS₄ was 3.81±0.076 mg/100g, 167.51±2.44 mg/100g, 78.66±1.58mg/100g, 2.13±0.24mg/100g, 282.01±1.70mg/100g respectively was significantly higher than other test bars. The free radical scavenging activity of TS₄ was highest (62%) compared to other test samples TS₁

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Department : Food Science and Nutrition

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(38%), TS₂ (45%), TS₃ (57%). TS₄ with highest acceptability score, nutritive value and free radical scavenging activity was selected for *in-vivo* studies. The impact of high protein high energy bar on exercise performance in relation to strength capacity in terms of running distance covered, running time taken was performed using rotarod test and endurance capacity was tested using as outlined by Shiotsuki *et al.* 2010 and Wang *et al.* 2012. For measuring the strength capacity of experimental rats rotarod test was performed to evaluate the motor coordination and balance of experimental rats in terms of time and distance covered and analysed by latency to fall time and speed at fall parameters. For measuring the endurance capacity a weight loaded swimming test was performed. In the weight loaded swimming the rats were loaded with aluminum knot in the tail (weight was loaded according to 5% of body weight of each experimental rat). The experimental rats were weighed and divided into five groups consisting of 6 rats in each group namely Control Group (Fed with 100% standard rat ration), Group I (fed with 100% high protein high energy bar), Group II (fed with 75% high protein high energy bar +25% standard rat ration), Group III (fed with 50% high protein high energy bar +50% standard rat ration), Group IV (fed with 25% high protein high energy bar +75% standard rat ration) for a period of 28 days. The weight of the experimental rats were measured by using electric weighing balance and marked them in tail, head and body for identification. The highest significant ($p < 0.05$) increase in body weight was found in Group I fed with 100% test diet from an initial weight of 134.11 ± 2.68 gm to 180.11 ± 2.52 gm at the end of the supplementation period. Measurement of strength capacity revealed that highest significant ($p < 0.05$) increase in running time taken to perform rotarod test by experimental rats was found to be high in Group I fed with 100% test diet from an initial value of 375.21 ± 2.42 sec to 715.37 ± 3.74 sec at 10 rpm, 350.41 ± 3.54 sec to 655.51 ± 5.64 sec 15 rpm, 301.14 ± 2.23 sec to 602.72 ± 3.34 sec at 20rpm respectively followed by significant ($p < 0.05$) increase in distance covered by experimental rats was found in Group I fed with 100% test diet from an initial value of 690.69 ± 2.64 cm to 698.98 ± 3.63 cm. Significant ($p < 0.05$) increase in swimming time taken to perform weight loaded swimming test by experimental rats was found highest in Group I fed with 100% test diet from an initial value of 2.46 ± 0.07 min to 6.95 ± 0.25 min at the end of the supplementation period. Significant ($p < 0.05$) decrease in exhaustion time was observed in Group I fed with 100% test diet from an initial value of 5.32 ± 0.06 min to 1.75 ± 0.09 min at the end of the supplementation period. The highest significant ($p < 0.05$) increase in muscle glycogen and liver glycogen content of experimental rats was found in Group I fed with 100% test diet was 43.00 ± 5.42 mmole/glucose unit and 42.59 ± 6.03 mmole/glucose unit at the end of the supplementation period of 28 days. The mean significant increase in haemoglobin level of experimental groups namely Group I, Group II, Group III and Group IV were 5.77 mg/dl, 3.36 mg/dl, 1.59 mg/dl, 1.45 mg/dl had significantly ($p < 0.05$) higher value when compared to the control group which had a mean increase of 1.02 mg/dl at the end of the supplementation of 28 days of period. Linear regression analysis of body parameters

including body weight, muscle weight, liver glycogen, haemoglobin level, liver weight on strength capacity of experimental rats revealed that 41.65 per cent of the total variability on the strength capacity was determined by liver glycogen content, 34.43 per cent of total variability on the strength capacity was determined by liver weight, 25.54 per cent of total variability on the strength capacity was determined by muscle glycogen content, 23.41 per cent of total variability on the strength capacity was determined by body weight, 22.54 per cent of total variability on the strength capacity was determined by haemoglobin level. Linear regression analysis of body parameters including body weight, muscle glycogen level, liver glycogen level, haemoglobin level, liver weight on endurance capacity of experimental rats revealed that 45.32 per cent of the total variability on the endurance capacity was determined by muscle glycogen content, 39.32 per cent of total variability on the endurance capacity was determined by liver glycogen content, 35.21 per cent of total variability on the endurance capacity was determined by liver weight, 28.32 per cent of total variability on the endurance capacity was determined by haemoglobin level, 25.12 per cent of total variability on the endurance capacity was determined by body weight. Storage studies of the developed high protein high energy bar were done by storing the product for 30 days in ambient temperature (35°C). Microbial analysis on 30th day, total plate count was found to be 3.15±0.21 log cfu/g, 3.19±0.03 log cfu/g, 3.24±0.31 log cfu/g, 3.26±0.53 log cfu/g in TS₁, TS₂, TS₃, TS₄ respectively. The highest total plate count was observed on 30th day. The microbial load of the present study were within the standard (less than 10 log cfu/gm) specified by Food Safety and Standard Authority of India indicating acceptability of the developed products up to period of one month. The peroxide values were within the standard specified by PFA (Prevention of Food Adulteration), 1991 (10 millimoles per kg fat) indicating acceptability of the developed products up to period of one month. Thus this can be concluded that the food products developed has proven to possess immense nutritional and functional properties in terms of energy, protein, crude fibre, minerals with potent antioxidant capacity and low carbohydrate. High energy high protein product was developed from locally available ingredients showed higher acceptability. From the present study, it can be concluded that high protein high energy supplementation which is rich in amino acids (leucine, isoleucine and valine), essential fatty acids and nitric oxide, minerals such as iron, zinc, magnesium and phosphorus and soluble fibres played an important role in physiological protection and performance elevation with strength and endurance exercise. Present study provided substantial evidence that supplementation of high protein high energy bar resulted in increase in liver and muscle glycogen storage which contributed to extending the running time and swimming time. The high protein high energy bar increased the activity of antioxidant enzymes and anti-fatigue activity by increasing haemoglobin level, liver and muscle glycogen depletion thereby elevating exercise performance. The present provided science-based evidence to support that high protein high energy could be a promising anti-fatigue agent and an ergogenic aid. The outcome of the present study can be

recommended to Ministry of food Processing Industries and Sports Authority of India to include the high protein high energy bar for popularization, consumption and improvement in sports performance by enhancing endurance and strength capacity of sports person. The nutrient rich high protein high energy bar can be included in different National sports Nutrition supplementation programme under Government of India to meet the nutritional requirement of the beneficiaries and to increase the nutritive value of the dietary intake of the sports persons.

Effect of processing on *in-vitro* starch digestibility and glycemic index of selected rice varieties of Assam

Laishram Maria Devi

Rice is one of the most widely consumed staple foods, especially in Asia. It accounts for 20 per cent of the world's dietary energy supply. As a major component of rice, starch plays an important role in human nutrition, and consequently its characterisation in rice variants is of high nutritional importance. To this, the present study estimated the *in-vitro* starch digestibility (resistant starch (RS), non-resistant starch (NRS) and total starch (TS)), available starch (AS), hydrolysis index (HI) and *in-vitro* glycemic index (GI) of different processing techniques. Ten red kernel rice varieties of Assam were analyzed for the effect of both raw rice flour and freshly cooked rice in dehusked rice and 6 per cent degree of polishing. Dehusked and polished rice yield were 68.33±0.38 to 75.23±0.19 per cent and 64.14±0.13 to 73.67±0.29 per cent, respectively. Head rice yield (HRY) and broken rice yield (BRY) of the dehusked rice varieties were 54.03±0.34 to 74.34±0.05 per cent and 0.68±0.06 to 14.55±0.32 per cent, respectively. Polishing of rice grains decreased HRY (41.76±0.40 to 68.39±0.09%) but increased BRY (2.05±0.11 to 22.52±0.41%). The dehusked samples had 17.64±0.11 to 19.17±0.04 g/100 g of RS, 61.19±0.07 to 66.28±0.19 g/100g of NRS and 80.01±0.11 to 85.02±0.20 g/100g of TS. Resistant starch decreased significantly ($p \leq 0.05$) on polishing as well as cooking, while NRS and TS increased significantly ($p \leq 0.05$) in polishing. However, TS decreased on cooking. Available starch, hydrolysis index and glycemic index of the dehusked rice samples were in the range of 51.80±0.14 to 89.57±0.51 per cent, 3.37±0.02 to 14.67±0.03 per cent and 41.91±0.03 to 50.99±0.11 per cent, respectively. Polishing of the rice samples showed no significant ($p \geq 0.05$) change in AS, HI and GI. Cooking significantly reduced AS, whereas HI and GI content increased significantly ($p \leq 0.05$) upon cooking. Therefore, polishing and cooking of rice grains had significant effect on the *in-vitro* starch digestibility and GI. In addition, varieties of *Jul* and *Kaoi Jamfri* had comparatively higher RS and lower GI, and thus can be recommended for popularization. Also, further research can be extended for analyzing the effect of degree of polishing and different cooking methods on starch digestibility and GI. Such nutritionally distinguished rice varieties could be used to develop rice based products and supplementary food mixes which have therapeutic values.

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Department : Food Science and Nutrition

Major Advisor : Dr. Pranati Das

Development and evaluation of fish powder incorporated ready to cook snacks

Mansi Tiwari

With recent advances, urbanization and change in life style pattern, there is shift from a diet dominated mainly by staples such as cereal, pulses, legumes, fruits and vegetables to processed foods. The snacks consumption today has increased to a greater extent. Most of the snacks are poor source of good quality protein and other nutrients. Therefore the present study was designed with the broad objective to standardize the process parameter for development of fish powder and their incorporation in ready to cook snacks. Small fish were used for the development of fish powder to enhance the utilization of small fish which are less preferred compared to large fish mainly because of its less market value and its pre processing being a tedious process. For the preparation of fish powder, fresh fish procured from market were washed and segregated on the basis of their species. The segregated fish species were separately dressed, blanched, minced, dried and powdered. The developed fish powder contain protein ranged from 55.15 ± 0.71 to 66.18 ± 0.31 per cent, fat from 13.73 ± 0.97 to 19.21 ± 0.45 per cent, total ash content from 13.64 ± 0.15 to 18.14 ± 0.69 per cent and carbohydrate from 5.72 ± 0.79 to 7.62 ± 0.17 per cent. The calcium, phosphorus and iron content of the developed fish powders ranged from 1782.00 ± 2.97 to 1850.34 ± 2.40 , 799.17 ± 15.04 to 1194.77 ± 16.65 and 12.53 ± 0.52 to 16.00 ± 1.29 mg/100g, respectively. Three ready to cook snacks i.e. fish wafer, fish crisps and fish flour mix were developed by incorporating fish powder at different level i.e. 10, 20 and 30 per cent. The developed products were evaluated in terms of their sensory characteristics by semi trained panellist. The developed ready to cook snacks were further analysed for their nutritional composition. The protein content in fish wafer, fish crisp and fish flour mix ranged from 8.07 ± 0.34 to 23.34 ± 0.43 ; 8.42 ± 0.65 to 25.10 ± 0.61 and 9.78 ± 0.10 to 27.08 ± 0.70 per cent, respectively. The content of fat in developed fish wafer, fish crisp and fish flour mix ranged from 1.08 ± 0.85 to 4.69 ± 0.78 , 0.25 ± 0.04 to 3.28 ± 0.07 and 0.56 ± 0.05 to 4.36 ± 0.21 per cent and total ash ranged from 3.67 ± 0.47 to 8.33 ± 0.30 , 3.36 ± 0.13 to 10.42 ± 0.19 and 3.10 ± 0.01 to 10.60 ± 0.17 , respectively. Storage studies of the developed ready to cook snacks were done by storing in different packaging materials

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under different storage condition across storage period of 60 days. With the advancement in storage period, moisture content, free fatty and peroxide value increased which was however within the standard limit indicting acceptability of the developed products up to a period of 2 months. An increase in the microbial load of the developed product across storage was also observed. Thus it can be concluded that incorporation of fish powder has improved the nutritional qualities of snacks. Further, it will contribute to enhanced utilization of fish and increase shelf life leading to fish availability throughout the year adding to global food and nutrition security.

Awareness and use of food label information by consumers of Jorhat, Assam

Monosweta Gracy Shaw

The present study entitled “Awareness and use of food label information by consumers of Jorhat, Assam” was undertaken to assess the awareness and use of food label information. The objectives of the study were to determine the level of awareness of consumers on pre packaged food labelling information, assess consumers’ use of food label information, analyze consumers’ attitude towards reading food labels and determine factors associated with reading of food label. To fulfil these objectives 400 respondents from 3 supermarkets, namely Big Bazaar, Viraat Bazaar and Vishal Mega mart and 3 departmental stores namely Pariwar food mart, Doss and co., and M.D.s store were taken. The respondents were of the age 18 years and above. Data on different parameters like consumers’ socio demographic profile was recorded using a self structured questionnaire. Awareness level on food label information of the consumer was recorded using a score card adopted from Priyadarshini (2014), consumers’ attitude on food label information was assessed using an attitude scale adopted and modified from Robert and Chandran (2017), use of food label information by the consumers was documented using a modified question module by Robert and Chandran (2017) and factors affecting reading of food label by consumers was recorded using a semi structured questionnaire by Dutta and Patel (2017). Socio-demographic data revealed 57 per cent of the consumers were female, 35 per cent of the age group 39-49 years, 69 per cent were graduates, 25.5 per cent were employed, 50.5 per cent were of high income group and 49 per cent shopped once a week. Determination of awareness level on food label information revealed that 43.75 per cent of the respondents were moderately aware. Association between socio demographic characteristics of consumers and awareness level on food label information revealed gender (p value=0.01, $r^2=+0.46$), education (p value=0.00, $r^2=+0.49$) and frequency of shopping (p value=0.04, $r^2=+0.57$) had significant association and positive correlation with awareness level. Consumers’ attitude on helpfulness of food label information in buying pre-packaged food revealed 92 per cent of the respondents to have a positive attitude, 94.5 per cent had a positive attitude on importance of nutrition label information,

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91 per cent had a positive attitude on trustworthiness on food label information. Assessment of use of food label information by consumers revealed 59.75 per cent of the respondents read food labels regularly, 51 per cent checked price of the pre packaged food, 46.75 per cent checked expiry dates on a food label, 79.75 per cent chose to buy products based on food label information, 76 per cent agreed to not buy products if there is no food label, 52.25 per cent compared food labels to make food choices. The main source of nutrition information for consumers was reported to be internet (75.25%) followed by family and friends (74.50%) and television (70.25%). The most sought nutrition information on pre packaged food was total calories (61.25%) followed by sugar (50.25%) followed by fats (50.25%) and cholesterol (49%). The motivation factor for most (79%) of the consumers to read food label information was price, the circumstance at which most 57.25 per cent of the consumers did not read food label information when they bought familiar foods and 56 per cent revealed that due to small fonts, they faced difficulty in reading food labels. It can be concluded that the awareness on food label information was moderate attributed to the socio demographic factors of consumers like gender roles, level of education and frequency of shopping pre packaged food and use of food label information by consumers was confined to reading price, expiry dates etc. and very less utilization of nutrition information. Consumer education on food label information, development of consumer guide and training of working staff at supermarkets and stores on food label information interpretation can be adopted to improve the present situation on awareness and use of food label information.

ASSESSMENT OF VITAMIN D STATUS IN WOMEN OF REPRODUCTIVE AGE: A CASE STUDY AMONG TEA PLANTATION WORKERS OF ASSAM

Priyanka Bhattacharyya

The present study was undertaken to assess the vitamin D status in women of reproductive age, working in the tea plantations of Assam. The main objective of the study was to assess the socio-demographic, biochemical and dietary parameters associated with vitamin D deficiency. To fulfil the objectives of the study, 384 working women belonging to the reproductive age (18-45 years) were purposively selected from two tea estates of Tinsukia district, viz Panitola tea estate and Dinjan tea estate. After screening the samples for presence of kidney and liver disorders, pregnancy and lactation, 250 samples were selected for the present study. Data on different parameters such as socio-demographic profile, lifestyle practices, sunning practices, anthropometric measurements, viz, height, weight, BMI, waist circumference and waist-hip ratio, biochemical assessment viz, serum vitamin D, serum calcium and serum alkaline phosphatase, morbidity profile and dietary intake was collected using standard procedure. Socio-economic data revealed that 55 per cent of the respondents were Hindu, 27 per cent were Muslim and 18 per cent were Christian. 62 per cent of the respondents were illiterate and 26 per cent studied upto primary school, 6 per cent studied upto HSLC and 4.8 per cent were HSLC passed. 56 per cent of the respondents belonged to joint families and 44 per cent belonged to nuclear families. 53 per cent of the respondents were involved in outdoor activities such as tea plucking, gardening, sweeping and 47 per cent were involved in indoor activities such as hospital ward cleaning, hospital catering. 100 per cent of the respondents were daily wage earners with a monthly income ranging from Rs 4000-Rs 5000, which categorised them in low socio-economic class, as per Kuppuswamy socio-economic scale, 2018. Data on lifestyle practices of the respondents revealed that 83 per cent were non-vegetarian and 17 per cent were vegetarian. 73 per cent the respondents were consumed tobacco and 51 per cent consumed alcohol. The sunning practice of the respondents revealed that 100 per cent of the respondents remained outdoors for 5 days a week. 53.20 per cent remained outdoors for 3 hours a day and 46.80 per cent remained outdoors for 30 minutes to 1

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hour. 43 per cent remained outdoors from 1.00 pm to 4.00 pm, 36.20 per cent remained outdoors from 10 am to 1 pm and 20.80 percent remained outdoors from 7 am to 10 am, according to their work shifts. Anthropometric measurements revealed that the height and weight of the respondents, irrespective of age, were below the ICMR reference for adult woman with a mean height of 153.20 ± 6.64 cm and mean weight of 43.84 ± 5.78 kg. Data on BMI indicated prevalence of underweight in 75.67 per cent of the respondents, as per WHO classification with a mean BMI of 18.00 ± 7.87 . Waist circumference and waist-hip ratio of the respondents were normal as per WHO reference for adult woman, with a mean waist circumference of 85.87 ± 4.32 cm and mean waist-hip ratio of 0.80 ± 1.25 , respectively. From the study, it was also observed that 42.60 per cent of the respondents had vitamin D deficiency, 38.6 per cent had vitamin D insufficiency and 18.8 per cent had vitamin D sufficiency as per reference by US Endocrine Society classification, with a mean serum vitamin D of 19.67 ± 7.81 ng/ml. In context to sunning practice, high prevalence of vitamin D deficiency was observed despite of adequate sun exposure with a mean serum vitamin D status of 18.97 ng/ml in respondents exposed to adequate sunlight. Mean serum vitamin D status of respondents with covered clothing style (covering face, head, hands, arms and legs) was 18.76 ng/ml, indicating significance influence of clothing pattern on vitamin D status ($p < 0.05$). In context to lifestyle practices, high prevalence of vitamin D was observed in tobacco and alcohol consumers. Mean serum vitamin D status of tobacco consumers was 19.87 ± 3.78 ng/ml and non-tobacco consumers was 32.65 ± 8.93 ng/ml, indicating significant influence of tobacco consumption on vitamin D status of the respondents ($p < 0.05$). Mean serum vitamin D status of alcohol consumers was 19.67 ± 5.43 ng/ml and non-alcohol consumers was 32.49 ± 9.02 ng/ml, indicating significant influence of alcohol consumption on serum vitamin D status ($p < 0.05$). Mean serum vitamin D status of respondents who were non-vegetarian was 18.67 ± 7.66 ng/ml and vegetarian was 19.93 ± 5.31 ng/ml, indicating prevalence of vitamin D deficiency irrespective of dietary habit. Correlation analysis revealed positive association between serum vitamin D status and anthropometric indices, indicating that low anthropometric indices were directly associated with decrease in serum vitamin D levels. Simple linear regression analysis indicated that 23.76 per cent of the total variability on the serum vitamin D status was determined by Body Mass Index (BMI), 15.75 per cent of the total variability was determined by the waist circumference (WC) and 13.64 per cent of the total variability was explained by the waist-hip ratio of the respondents, respectively. Serum calcium status of the respondents was low in irrespective of age group, with a lowest mean serum calcium status in the age group 36-40 years (6.9 ± 1.32 mg/dl), followed by age group 31-35 years (7.87 ± 4.51 mg/dl), 26-30 years (7.9 ± 6.32 mg/dl) and 20-25 years (8.11 ± 3.22 mg/dl), respectively. Serum alkaline phosphatase status of the respondents was high in all age groups. Highest mean serum alkaline phosphatase status in the age group 36-40 years (311.75 IU/l) followed by the age group 31-35 years (306.67 ± 23.71 IU/l), 26-30 years (304.11 ± 27.31 IU/l) and 20-25 years (296.31 ± 31.15 IU/l). Correlation

analysis revealed positive association between serum vitamin D status and serum calcium status ($r=0.077$), indicating decrease in serum calcium status led to decrease in serum vitamin D status. Negative association was observed between serum vitamin D status and serum alkaline phosphatase status($r=-0.162$), indicating increase in serum alkaline phosphatase led to decrease in serum vitamin D status. Data on episodes of morbidity among the respondents revealed that 87.43 per cent suffered from hypertension with a mean serum vitamin D status of 18.97 ± 4.56 ng/ml , 40 per cent suffered from diabetes mellitus with a mean serum vitamin D status of 19.53 ± 9.82 ng/ml , 31.70 per cent had cancer with a mean serum vitamin D status of 20.16 ± 9.93 , 86.43 per cent suffered from chronic body pain with a mean serum vitamin D status of 36.76 ± 4.13 ng/ml and 42.70 per cent had episodes of chronic fatigue with a mean serum vitamin D status of 25.78 ± 4.27 ng/ml, respectively. Data on the dietary intake of the respondents revealed that the food and nutrient intake were below the Recommended Dietary Allowance (RDA) and Balanced Dietary Recommendations (BDR) by ICMR,2017. Consumption of cereals among the respondents was deficit by 37.40 per cent, pulses by 35.04 per cent, green leafy vegetables by 8.49 per cent , other vegetables by 62.38 per cent, roots and tubers by 60.19 percent, fruits by 45.55 percent, meat/fish/poultry by 68.29 percent, oils and fats by 48.08 per cent and sugar and jiggery by 41.80 percent respectively, as compared to the standards determined by the National Institute of Nutrition, NIN, 2017. Consumption of energy by the respondents was deficit by 40.27 per cent, protein by 30.29 per cent, fat by 51.15 per cent, calcium by 60 per cent and iron by 29.71 per cent respectively, as per recommendations by National Institute of Nutrition, NIN, 2017. Vitamin D intake was deficit by 74 per cent as per recommendations by Institute of Medicine (2011). The low dietary intake was attributed to factors such as low economic status and reduced purchasing power, illiteracy leading to lack of awareness on nutrition and health and disparity in food distribution within the family. Correlation analysis revealed a significant positive association between serum vitamin D level and dietary intake of vitamin D and calcium($p<0.05$), indicating decrease in dietary intake of vitamin D and calcium led to the decrease in serum vitamin D status. It can be concluded that there was a high prevalence of vitamin D deficiency among the respondents which can be attributed to their low socio-economic status, illiteracy, lifestyle practices like smoking and alcohol consumption, presence of morbidity such as hypertension, diabetes and cancer, inadequacy in the dietary intake of vitamin D and calcium. Vitamin D status of the respondents can be improved by implementing supplementation programmes, increasing availability vitamin D fortified in Indian markets and conducting awareness programmes on the importance on improving lifestyle and dietary practices to prevent and manage vitamin D deficiency.

Effect of Processing on Nutrient Composition and Bioactive Components of Selected Rice Varieties of Assam

Senorita Gogoi

A study was carried out with the objective to determine the effect of processing on physico- chemical properties and bioactive compounds of selected red rice varieties of Assam. Seven red pigmented rice varieties were selected and procured from Krishi Vigyan Kendra, Silapathar, Dhemaji. A series of laboratory tests were performed on both the uncooked and cooked forms of dehusked and 6 per cent polished rice samples to find out the physico- chemical properties, mineral content and the bio- active compounds. The dehusked and polished rice yield of the selected red rice varieties was found to be in the range of 68.33 ± 0.52 to 75.23 ± 0.47 per cent and 64.14 ± 0.39 to 73.67 ± 0.69 per cent, respectively. Head rice yield (HRY) and broken rice yield (BRY) of the varieties ranged from 55.13 ± 0.99 to 73.93 ± 0.73 per cent and 0.93 ± 0.16 to 13.60 ± 0.58 per cent, respectively and polishing of the rice grains decreased HRY (40.82 ± 1.12 to 67.44 ± 1.23 per cent) but increased the BRY (2.96 ± 0.19 to 23.15 ± 1.06 per cent). Length, breadth, thickness and length/breadth ratio of the dehusked rice samples ranged from 5.00 ± 0.33 to 5.90 ± 0.32 mm, 2.10 ± 0.21 to 2.75 ± 0.35 mm, 1.59 ± 0.14 to 2.03 ± 0.02 mm and 1.89 ± 0.40 to 2.85 ± 0.36 , respectively. Thousand grain weight, volume and bulk density ranged from 13.46 ± 0.00 to 19.40 ± 0.00 g, 16.67 ± 0.29 to 25.83 ± 0.29 ml and 0.69 ± 0.01 to 0.88 ± 0.01 g/ml in the dehusked samples. The length, breadth, thickness, thousand grain weight and thousand grain volume of rice varieties significantly ($p \leq 0.05$) reduced on polishing, whereas the length/ breadth ratio and bulk density increased. Water absorption capacity (WAC), cooking time and grain elongation ratio of the dehusked rice samples ranged from 2.06 ± 0.16 to 2.77 ± 0.21 ml/g, 21.66 ± 1.53 min. to 38.33 ± 1.15 min. and 0.98 ± 0.01 to 1.14 ± 0.02 . Water absorption capacity and grain elongation ratio significantly ($p \leq 0.05$) increased whereas the CT decreased significantly ($p \leq 0.05$) on polishing. The dehusked samples had 11.64 ± 0.08 to 12.75 ± 0.04 g/100 g of moisture, 9.31 ± 0.00 to 13.50 ± 0.66 g/100 g of crude protein, 2.53 ± 0.09 to 3.71 ± 0.04 g/100 g of crude fat, 0.56 ± 0.01 to 0.81 ± 0.03 g/100 g of crude

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fibre, 1.24 ± 0.01 to 2.60 ± 0.03 g/100 g of total ash, 68.60 ± 1.44 to 73.87 ± 0.18 g/100 g of carbohydrate and 352.99 ± 0.80 to 361.86 ± 2.78 kcal/100 g of energy. The crude protein, crude fat, crude fibre and total ash content decreased significantly ($p \leq 0.05$) on polishing as well as cooking. The carbohydrate content significantly ($p \leq 0.05$) increased on polishing as well as cooking. The dehusked samples had iron, zinc, calcium, phosphorus and magnesium content in the range of 4.47 ± 0.18 to 12.46 ± 0.63 mg/100g, 1.41 ± 0.11 to 2.93 ± 0.05 mg/100 g, 9.96 ± 0.11 to 37.73 ± 0.58 mg/100g, 134.54 ± 3.44 to 221.57 ± 3.48 mg/100 g and 0.13 ± 0.01 to 1.21 ± 0.00 mg/100 g, respectively. Polishing significantly ($p \leq 0.05$) reduced the iron, zinc, calcium, phosphorus and magnesium content. Cooking of the rice samples showed no significant ($p \geq 0.05$) change in the iron, zinc, calcium content on cooking, while magnesium content reduced significantly ($p \leq 0.05$). No significant ($p \geq 0.05$) change in phosphorus content was seen in the dehusked samples, whereas the polished samples showed significant ($p \leq 0.05$) loss of phosphorus upon cooking. The bioactive compounds were determined in terms of total antioxidant capacity (TOA), total anthocyanin content (TAC), total phenolic content (TPC), total flavonoid content (TFC) and total carotenoid content (TCC) and were observed to significantly ($p \leq 0.05$) decreased on polishing as well as cooking. The TOA, TAC, TPC, TFC and TCC of the dehusked samples ranged from of 44.67 ± 0.45 to 81.08 ± 0.45 per cent, 11.35 ± 0.45 to 23.71 ± 0.94 mg/100 g, 46.13 ± 0.88 to 109.50 ± 0.64 mg GAE/100 g, 12.24 ± 1.19 to 39.23 ± 1.59 mg QE/100 g and 0.42 ± 0.02 to 1.85 ± 0.07 μ g/100 g, respectively. The present study provides the evidence that polishing and cooking of the rice grains has significant effect on the physical and nutrient quality of the rice varieties. The variety *Kaoi Jamfri* showed better mineral content and antioxidant capacity than rest of the varieties and can be recommended for popularization among rural and urban population. Further studies may be taken out to find out the degree of polishing at which maximum milling recovery and retention of nutrient takes place. The rice varieties may be used to formulate supplementary food mixes, develop rice based products. The unpolished rice varieties may be recommended for consumption to prevent nutrient deficiencies among the people. Further studies can be taken out to study the use of the rice bran to formulate functional food.

Wellness of Elderly: A comparative study of socially engaged and unengaged retired people

Huidrom Rinky Devi

The age of elderly comprises of the later part of our life, the period of life after youth and middle age with reference to deterioration (WHO, 2016). The deterioration brings changes in the person's active participation in different areas of life, role playing and role performance. Maintenance of strong social relationship and other social activities have been linked to wellness and thereby increase longevity. Wellness is an active process of becoming aware of and making choices for a healthy and fulfilling life.

The present study entitled "Wellness of Elderly: A comparative study of socially engaged and unengaged retired people" was undertaken with the following objectives:

1. To find out the characteristics of socially engaged and unengaged retired people
2. To study the levels of wellness of retired people
3. Comparison of wellness between socially engaged and unengaged retired people

A total of 100 (50 socially engaged retired people and 50 socially unengaged retired people) retired people from the age group of 60 to 70 years were selected purposively from the selected wards from the state of Manipur. A questionnaire was constructed to elicit the background information of the respondents. In order to find out the characteristics of socially engaged and unengaged retired respondents, self constructed questionnaires were administered. A structured standardized questionnaire named 'Wellness Self Assessment scale' developed by Princeton University (2018) was administered in order to assess the level of wellness of retired people.

The findings revealed that 34 per cent of socially engaged and 36 per cent of socially unengaged respondents were between the age of 60 to 65 years. Majority of the respondents were highly educated and belonged to middle income families. Majority (56%) of socially engaged respondents had membership in non government organizations. Socially unengaged respondents were not involved in any kind of organizations owing to their physical frailty (38%), unwillingness (14%) and responsibilities of grandchildren (20%). Less number of respondent were found in

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socially engaged and unengaged groups who had outstanding level of social (SE-86%, SUE-62%), emotional (SE-86%, SUE-82%) and spiritual (SE- 90%, SUE- 84%) wellness. Significant difference between socially engaged and unengaged respondents were found in the dimensions of intellectual (0.012), occupational (0.005), social (0.001) and spiritual (0.041) wellness. Percentage difference between socially engaged and socially unengaged was found to be highest (5%) in the dimension of social wellness. Among socially engaged respondents, less number of respondents of the age group of 60-65 years were found in outstanding level of social wellness (85.3%) while less number of respondents of the age group of 65-70 years were found in outstanding level of emotional (75%), social (87.5%) and spiritual (81.3%) wellness. Significant differences were also found between socially engaged male and socially unengaged male in the dimensions of intellectual (0.010), occupational (0.011) and social wellness (0.022) where less number of socially unengaged male were found in outstanding level of wellness in these dimensions. There was significant difference between socially engaged female and socially unengaged female in the dimension of social wellness (0.021) where a considerably less number of female respondents (47.4%) were found to have outstanding level of social wellness. It can be concluded that the involvement of elderly people in social organization, either in formal or informal groups, should be a must to lead a purposeful and meaningful life which contributes towards well being of human society.

Prevalence of bullying among adolescents

Irin Das

The present study has been undertaken to see the prevalence of bullying among adolescents in school. The primary objectives of the present study were to, (i) Assess the prevalence of bullying among adolescent in schools (ii) Assess the causes of bullying among adolescent in schools (iii) Find out the gender difference in attitude towards bullying among adolescent in schools. 118 number of school students from class 7 to 10 were selected from the co-educational schools of the Jorhat block from the Jorhat district of Assam. A questionnaire was prepared for collecting the background information and a standardized tool 'Bully Survey' was used for data collection. The questionnaire consisted of four parts. The first part elicits information on when the respondent was bullied, the second part assess information about when the respondent saw other students been bullied, the third part asks information about when the respondent bullied others and the fourth part contains information about the attitude of bullying among the adolescent. Their responses were coded and analyzed. The findings of the study revealed that majority 81.4 percent student were bullied by others, 92.4 percent students saw others who have been bullied and 72 percent student bullied others. One place where bullying mostly happened was in the academic class for all the cases when the respondent was bullied by others, saw others been bullied and bullied others. In all the situations when the respondent was bullied by others, saw others been bullied and bullied others, it was found that the average range was the highest which means the students were bullied quiet often in the schools. The way in which one got bullied by others was highest by calling names, when one saw others been bullied the highest was by making fun of them and when one bullied others the highest was by playing jokes on them. The respondents who were bullied by others and saw others been bullied were mostly bullied by boys in the same grade and who bullied others was mostly younger boys. When asked about whether bullying was a problem, it was found that when the respondent was bullied by others, saw others been bullied and bullied others, the adolescent revealed that they were facing problem from bullying at school. The respondents mostly felt sick when they were bullied by others and when the respondent

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saw others been bullied and when the respondent bullied others it made them feel bad or sad. The reasons for bullying in all the cases were due to one reason that is being fat. The attitude towards bullying ranged in average which reveals that adolescents have pro-bullying attitude. It was also found that there is no significant gender difference in attitude towards bullying among the adolescents in the school. Higher percent of the adolescents revealed that bullying was a problem in the schools and they also expressed that schools should worry and think about how to resolve this issue of bullying.

Enhancing Number Concepts of Preschool Children Through Musical Intervention

Jyotika Boruah

Child psychologists often regard pre-school age as crucial period of life. They pay considerable amount of attention to this phase of life because the child undergoes greatest development during this period. It is the time when skills are attained which acts as a foundation for all the subsequent years in the life-span. Therefore, children must be provided with stimulating and enriching learning environment to facilitate the learning process.

Research findings suggest that children tend to develop apprehension towards mathematics (Heibert, 1999), so increased attention should be provided to establish an exemplary foundation in the preschool years. Music could act as a stimulating tool in providing positive results in early childhood development and learning of mathematics. With this background the present study entitled, “Enhancing number concepts of preschool children through musical intervention” was undertaken in Jorhat district during 2018-2020. The study aimed at investigating the effectiveness of using musical activities for enhancement of number concepts in pre-school children. The objectives of the study were to assess the number concept attained by preschool children, to prepare and administer the music integrated activities on number concepts to children and finally to assess the number concepts formed after musical intervention.

The sample of the study constituted of twenty four children belonging to the age group of 3-4 years, who were selected through convenience and purposive sampling methods. The investigator developed activities which were self prepared to assess the number concepts developed by preschool children. The assessment was conducted on the five conceptual principles of number concepts given by Gelman and Galistell (1978). The prepared music integrated activities on number concepts were administered on the children. The activities were prepared following Orff Approach. The Orff Approach is an artistic concept, which integrates music, movements, action and speech as key elements of teaching mathematics for children.

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Pre and post-intervention assessment design was used to judge the effectiveness of the musical activities on the development of number concepts in children. From the pre-intervention assessment, it was revealed that most children could name numbers but the concept of cardinality was not attained by many of the children. Findings revealed that children improved in all the areas of number concepts after the musical intervention. However, it was also observed that all the concepts are not mastered at the same time by all the children.

Key words: Preschool children; number concept; musical intervention

Parent-adolescent disagreement in the use of social media

Kshiptimayee Patra

Social media is very popular among adolescents, as it allows them to connect with their families and friends. Adolescents spend most of their time on social media for making new friends, sharing their emotions and feelings. They feel more connected in the virtual world than in the real world and they start ignoring other activities and interact less with their real surroundings. As parents are the primary caregiver of their children therefore, they feel that using social media is a waste of time and they think that their children are wasting their precious time which would hamper in their carrier and future. Parents also think that due to more dependency on social media their adolescents are not able to focus on their important life activities. Whereas adolescents think that social media has given them the opportunity and the platform for developing their social skills, updating important events, sharing their creativity and ideas with their friends, and they believed that, they are benefited a lot from the different social media sites. As the perceptions of parents and adolescents are different from each other regarding the use of social media, there starts the disagreement between parents and adolescent regarding the use of social media. With this background the present study entitled, “Parent-adolescent disagreement in the use of social media” was undertaken during the calendar year 2018-2020 with the objectives as - to identify different social media sites used by adolescents, identify the reasons of disagreement between parents and adolescents for use of social media and to find out the gender differences in disagreement between parent and adolescent for use of social media.

By using multi-stage sampling procedure, sample of 118 numbers of adolescents and their respective parents, (236 samples) were selected from five schools of the Jorhat block from the Jorhat district of Assam. A self-constructed questionnaire was prepared to collect the required information from all the respondents. The findings revealed that the majority of the adolescents used WhatsApp among all social media sites and they spend 3-4 hours per day on social media. It was also found that in the

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areas of academic performance and socialization there was disagreement between parents and adolescents for use of social media, while in the area of health there was no disagreement between parents and adolescents for use of social media. It was also revealed from the findings that there was no significant gender difference in disagreement between parents and adolescents for use of social media. To overcome the disagreement between parents and adolescents regarding the use of social media, parents should be a good role model and help their adolescents to understand the value of face to face communication and also engage their adolescents with different kinds of extra-curricular activities as per their interest so that they can divert themselves from the urge of using social media.

A study on social maturity of adolescents in Manipur

Leishon Shangjam

Adolescence is the bridge between childhood and adulthood and it describes the social behaviour and characteristics. It is the period of development which create a number of social problems for a person and a period of challenges and opportunities, in which adolescents has great need for understanding and guidance. When an individual has the ability to respond to the environment in an appropriate manner then one shows social maturity. Adolescents grow into social maturity, when they learn to manage a group situation with skill and confidence with this background the present study entitled, "A study on social maturity of adolescents in Manipur" was undertaken during the year 2017-2019. The study was conducted to assess the social maturity of adolescents, to compare the social maturity of early and late adolescence, to find out the social maturity of adolescents with regard to gender. A total of 120 adolescents consisted of equal numbers of early and late adolescence and equal numbers of boys and girls were selected randomly from four schools of Ukhrol sub-division, Manipur. A questionnaire was prepared to collect the background information of the respondents. To measure the social maturity of adolescents, a structured standardized tool named 'Social Maturity Scale' developed by Dr.Nalini Rao (1971) revised in 2009 was used. The findings of the study revealed that majority of the adolescents were at average level maturity. It was also observed that a significant difference existed in social maturity between early adolescence and late adolescence. No gender difference existed in social maturity of adolescents.

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Selfie taking behaviour of college students

Pallavi

Technology is an essential part of our everyday life and it is difficult to ignore its impact on human's social and personal life. Technological advancements have brought forward significant change in many spheres of our life. Globally, the interests of people in gadgets like computers, mobile phones and internet have increased. The use of smart phones for self-photography which is popularly known as „Selfie“ has become a routine for college students after computer and internet. Selfies is described in the current study as a photograph taken by self with the use of smart phones. The present study was conducted to study the Selfie taking behavior of college students in Assam Agricultural University, Jorhat. The gender difference in Selfie taking behaviour and the reasons behind Selfie taking behaviour were also studied. The study was conducted in two colleges of Assam Agricultural University, Jorhat. A total of 203 numbers of respondents were selected for the purpose. Sample size was calculated by using Yamane's Formula and Probability Proportional to size (PPS). A self constructed questionnaire and interview method was used to elicit information. Collected data were analyzed using Frequency, percentage and Chi-square test. The findings of the study revealed that majority of the respondents spent less than 15 minutes per Selfie, took 1-3 numbers of Selfies on an average day and took Selfies occasionally. It was also found that majority of the respondents preferred evening time to take Selfies, preferred to have friends in Selfies, took head/face type of Selfies, attracted to take Selfies in famous places and preferred the emotional expression, „joy“ while taking Selfies. More number of respondents preferred WhatsApp to upload /share their Selfies; half of the respondents edit Selfies before posting and sometimes reload their Selfie after uploading to see new like and comments. More number of respondents felt upset when they see negative comments on their Selfie and majority of respondents never untagged themselves in group Selfies if not looking good. A significant difference was found between male and female respondents in „Persons or objects preferred in Selfies“ and „Edit Selfies before posting“. The environmental conditions were found to be the major reason for clicking Selfies by the respondents.

Key words: College students, Selfie, Selfie taking behavior

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Academic procrastination among students of Assam Agricultural University of Jorhat- An Explorative Study

Rashmi Rekha Gohain

Academic procrastination is a behavior that is very common among students. It involves knowing that individual's needs to finished the academic task before the assigned time but for one or another reason respondents fail to accomplished the task within the expected time frame. It is the practice of doing more pleasurable or less urgent tasks instead of more urgent ones. Individuals often promise themselves not to delay things until the last minute but it happens again. Such procrastination behaviors affect the student's actual performances in the learning process and lead to feelings of guilt, inadequacy, depression, and self-doubt. So understanding the delaying habit of the individual will facilitate them to overcome and cope up with academic procrastination behavior.

With this background, the present study entitled, —Academic procrastination among students of the Assam Agricultural University of Jorhat- An Explorative Study was undertaken during the calendar year 2018-2020. The study was conducted to assess the areas of academic procrastination among university students, to assess the reason that is contributing to academic procrastination among university students and to find out the gender difference in academic procrastination among university students.

A sample of 199 undergraduate students was selected from Assam Agricultural University using Solvin's formula ($N/1+Ne^2$), where N is the total population and e is the margin of error. A standard tool named —Procrastination Assessment Scale for Students (PASS) developed by Solomon & Rothblum (1984) was used to assess the academic procrastination of the students. In addition to that an interview schedule was prepared for collecting the background information of the respondents and various information related to academic procrastination.

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The findings revealed that in areas of procrastination majority 61.3 percent of the respondents had an average level of academic procrastination, as most of the respondents (63.81%) sometimes procrastinate in school activities in general also 65.32 percent of respondents sometimes face problem when they procrastinate in school activities in general. Findings also depicts that 49.74 percent definitely want to decrease the tendency to procrastinate in keeping up with weekly reading assignments. According to the results, it was found that respondents were high and low procrastinators due to various reasons such as 68.9 percent were high procrastinators as they waited until a classmate did his or hers so that he or she could give some advice (dependency). On the other hand, 72.8 percent were found to be low procrastinators in the task look forward to the excitement of doing the task at the last minute (risk-taking). It was also revealed from the findings that there was no gender difference in academic procrastination among university students.

Academic stress of boarding and non-boarding high school students in Dima Hasao district of Assam

Shalu Swati Agarwal

One has to undergo various challenges as they progress in their life, where stress becomes a common part. Today, stress is not only limited to adults or elderly people but even school going students are vulnerable to the concept of academic stress. It, therefore, becomes important to analyze the prevailing academic stress among students and understand them. With this background the present study entitled, “Academic stress of boarding and non-boarding high school students in Dima Hasao district of Assam” was undertaken during the calendar year 2017-2019. The study was conducted to find out the level of academic stress among high school students and to see the differences of boarding and non-boarding high school students in terms of academic stress. In addition to it, finding out the association between academic stress and demographic variables was also included in the objectives. A total of 104 high school students from Class IX and X were selected randomly as samples from seven schools. Both the boarding and non-boarding school students were selected equally for the study. A self-constructed questionnaire was prepared to elicit background information and academic stress of both the boarding and non-boarding school students. The collected data were coded and analyzed with the help of excel and SPSS. The findings from the present study revealed that majority of the high school students had average level of academic stress. The students were more directed towards average level of academic stress followed by high level of academic stress. However, it was found that there exist significant differences in the academic stress of boarding and non-boarding school students. It was found that the students with high level of academic stress was more among boarding school students as compared to non-boarding school students. The number of students with low level of academic stress was more among the non-boarding school students than those of boarding school students. It was also found that there is significant association between academic stress of high school students in relation to educational qualification of mothers and annual income of family.

Abstract of M.Sc. Thesis

Department : Human Development and Studies

Major Advisor : Dr. Tulika Borah

Parental stress in raising children with special needs – A study in Prerona, Jorhat

Sushmita Borah

Parenting stress is an experience of every parent in the parenting process. It is experienced by almost all parents in raising their children, but it is more increased in parents having children with special needs (CWSN). The birth of a child with special needs often bring changes in the life of the parents for which they might not be prepared and will have bigger challenges to overcome in future. The child may require special care, medication, supports and services. Besides that, parents need to face social isolation, neglect, criticisms etc which elevates their level of stress. It is important for the parents to reduce their level of stress, by using some coping strategies and making necessary adjustments which will help them to live a healthier life.

With this background the present study entitled, “Parental stress in raising children with special needs - A study in Prerona Jorhat” was undertaken during the calendar year 2017-2019 with the objectives as - to assess the level of stress in parents, factors causing stress and identify the coping strategies used by parents.

A sample of 80 parents was selected purposively from Prerona, situated at Cinnamara, Jorhat. Since these target group is difficult to be accessed, so Prerona was selected which is the only special school fully functional in Jorhat, where parents of children with special needs could be found. A standardized tool named ‘Parental Stress Scale (PSS)’ developed by Berry and Jones (1995) was used to assess the level of stress in parents. In addition to that an interview schedule was prepared, for collecting the background information, assessing the factors causing stress and identifying the coping strategies.

The findings revealed that majority of the parents had an average level of stress in raising their children with special needs. Majority of the parents were stressed on various child related factors such as self-help ability, behavioural problem, educational problem and also thinking about the future of the child. The other self related factors of parents such as taking care of the child after the death of parents caused stress in them. It

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Department : Human Development and Studies

Major Advisor : Dr. Sampritee Gogoi

was also found that majority of the parents tried to cope with stress by using one or more coping strategy. They coped with stress by taking assistance from institutions working with special children such as Prerona and tried to take professional help and support as and when required. Many of them had faith in God, they have accepted the reality and learnt to live with their children and adjust themselves according to their children's need.

Emotional Maturity of Adolescents in Intact Family and Single Parent Family

Tasso Puniya

Adolescence is a crucial period in an individual's life. It consists of both challenges and opportunities for growth, accompanied with issues like independence and self identity. Adolescent during this crucial period may come across various psychological and emotional challenges. So, proper instruction and supervision of emotions during this period becomes very important. Family being the first and the primary support system in adolescent's life, to a great extent can help the adolescent in overcoming these challenges and help them in building positive emotional approach towards life. The present study aimed to assess the emotional maturity of adolescent from intact family and single parent family, their differences in emotional maturity and also differences in emotional maturity in relation to their gender. A total of 104 samples were selected for the study consisting of equal number of respondents from both single-parent families and intact parent families from the age group of 13 to 16 years. The selected samples were equally distributed among genders for both the families in order to assess the gender difference. To elicit the background information of the respondents a self constructed questionnaire was prepared. The scale named Emotional Maturity Scale developed by Dr. Yashvir Singh and Dr. Mahesh Bhargava (2010) was administered for assessing the emotional maturity of adolescents. The findings of the study revealed a significant difference in the emotional maturity of adolescents in intact parent families and single parent families. It was found that none of the respondents from both the families were extremely emotionally mature and moderately emotionally mature. Majority of the respondents from intact parent families were found to be emotionally immature and majority of the respondents from single parent families were found to be extremely emotionally immature. The mean score of adolescents from single parent families were more in all dimensions of emotional maturity as compared to the adolescents from intact parent families. Further, it also revealed no significant difference in the emotional maturity of adolescents in relation to their gender.

Abstract of M.Sc. Thesis

Department : Human Development and Studies

Major Advisor : Dr. T. Borah

Extraction of fiber from gossypium arborium and evaluation of fiber for various end uses

Rikamchi Ch. Marak

Cotton stalks are a by-product of cotton farming and about two to three tones of cotton stalk are generated per hectare of land farmed. Therefore it is necessary to preserve the environment for sustainable development and economic upliftment of the country.

In the present study, the investigation was carried out on the possibilities of cotton stem fiber for future prospective of developing textile products. In this research, the fiber was successfully extracted from stems of the cotton plant (*Gossypium arborium*). Cotton stem is one of the agricultural wastes, commonly stems are disposed by burning after harvesting, which contributes to release harmful greenhouse gases that pollute the environment. The cotton plants used in the current study were collected from Tura, West Garo Hills Meghalaya. The collected plants from the farmer's field were evaluated for their morphological studies. The stalks were subjected to water retting followed by fiber extraction through manual decortications. Based on the highest yield percentage (31.2%) and quality of fiber by visual observation, 5% concentration for 45minute was considered as optimum duration for extraction of cotton stalk fiber. The fiber was dyed with natural dyes (marigold), after that the dyed fiber were assess for color fastness properties. Color measurement revealed that after wet processing treatments increased the WI and BI of the cotton fiber, while decreased the YI and color strength of the cotton fiber. Cotton stalk fibers have high cellulose (67.09%) and lignin (27.66%), but less ash content (3.06%) in case of retted fiber. The cotton stalk fibers have tensile strength of (3.48 g/tex) and the length of (3.41mm). The solubility percentage in different solvents such as cold water, hot water and dilute alkali were also tested. Among all the solvents dilute alkali showed the maximum solubility percentage in cotton fiber. SEM was done for the extracted fiber which depicted the complete removal of non-cellulosic material from fibers after wet processing treatment and cylindrical shape was clearly observed. The IR spectra were examined, highest peak was found 3367 cm⁻¹ corresponds to O-H stretching of hydrogen bond. The IR spectra show

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Department : Textiles and Apparel Designing

Major Advisor : Dr. Ava Rani Phukan

that the cellulose and hemicelluloses and waxy substances have been removed from the chemically treated cotton fibers. From the dyed cotton fibers, the different diversified items have been prepared. Subjective evaluations of the products were assessed through visual inspection. Using cotton stalks as a source for natural cellulose fibers has great potential for high value addition leading to higher income from cotton crops. This could help to make cotton cultivation competitive and suitable compared to the higher income generating bio-fuels crops.

Designing and construction of functional dresses for persons with special needs

Anakshree Borah

A study was planned to design and construct functional dresses for special person entitled “Designing and Construction of Functional Dresses for Persons with Special needs” with the following objectives such as to identify the clothing problems faced by orthopedically impaired person, to design functional garments with fashionable features for orthopedically impaired person and to assess the suitability and comfortability of the developed garments. A total of 100 orthopedically impaired respondents were taken to collect the information regarding their disabilities, existing dress patterns, problems faced by them and type of modification they want. It was found that maximum respondents i.e. 37 percent belongs to the age group of 31 years to 40 years, 61 percent were male, 63 percent respondents have nuclear family, majority of the respondents i.e. 67 percent were married, 31 percent were HS passed, 35 percent were self employed and 53 percent of the respondent’s family were earning in the range of Rs. more than 1 lakh. Again 67.21 percent male and 76.92 percent female were victim of accident. It was found that 52 percent had lower body, 37 percent had both upper and lower body and 11 percent had disability in the upper body. It was seen that 59 percent were using wheelchair, 21 percent were using other ways like help from others for mobility and 20 percent were using crutches. It was found that 43 percent had partial dressing ability.

After collecting the data the respondents were categorized into three different categories based on their disability and mobility devices used. The main clothing issues that emerged were related to fit, donning and doffing and difficulty using fasteners. Sixty designs of garments suitable for the type of disability were sketched and out of sixty, 10 designs were selected with the help of an evaluation proforma. The selected designs were constructed and respondents were allowed to wear the garments. An evaluation sheet was used to assess the suitability and comfortability of the constructed garments. It was found that constructed garments were suitable and comfortable for the special needs persons. The cost of the garments were calculated by considering the cost of material, cost of accessories used and labour cost.

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Department : Textiles and Apparel Designing

Major Advisor : Dr. Rickey Rani Boruah

Designing and construction of skirts for teenage girls

Anchie Maliva A. Sangma

A study was planned to design and construct skirts for teenagers of age group 18 - 19 years. The objectives were to standardize the body measurements required to construct basic skirt block, to develop design of skirts for teenagers, to construct skirts out of suitable fabrics based on preferences of teenagers and to assess the preferences of respondents regarding the constructed skirt.

One hundred samples of teenage girls (18 - 19 years) were selected to take body measurements from the Under Graduate class of Assam Agricultural University, Jorhat. A measurement sheet was prepared with all basic information and required measurements for construction of a skirt. After taking measurements the data were coded and analyzed carefully to find out the mode value of the measurements. The three numbers of basic skirt blocks were drafted by following instructions of Thomas (1993), Jindal (1998) and Sodhia (2005). The blocks were prepared by using the standard body measurements. The constructed basic skirts were tried on the body of teenage girl whose measurements were nearest to the mode value and fitting was observed under the supervision of major advisor. Out of the three basic skirt blocks, the block drafted by following the instruction given by Thomas (1993), gave a satisfactory result and it was used to construct the skirts of different designs. Total thirty numbers of designs were drawn on chart paper. To develop the designs, the investigator took the help of magazines, books, advertisement, etc. The skirt top was kept constant for all the skirts. On the chart paper the developed design of the skirts were colored so that they appear prominently. The thirty designs were displayed in front of teenage girls for their preferences. With the help of rank order eight designs were selected and constructed using suitable material. The constructed skirts were tried on the model to see the fitting of the skirts and photographs were taken for front and back view of the model. Again the preferences of teenagers were taken through interview schedule. The interview schedule covered the points like design, color combination, decoration, material used, fasteners used, finishes, fitting of the skirts etc. The rank orders of preferences of constructed skirts were found out. Data were coded and analyzed. The cost estimation of each skirt was found out.

Abstract of M.Sc. Thesis

Department : Textiles and Apparel Designing

Major Advisor : Dr. Bulbul Baruah

Extraction of sugarcane bagasse fibre for different end uses

Dilowar Hussain

The present study was carried out to investigate the possibility of utilizing sugarcane fibre for developing diversified products. Sugarcane bagasse, which remains after extraction of juice from sugarcane, is considered as an agricultural waste but, never-the-less is a good source of natural fibres. This investigation mainly focused on extraction of Sugarcane fibres and the effect of wet processing on the extracted fibres.

Sugarcane fibres were extracted by chemical extraction method and the extracted fibres were subjected to two wet processing treatments, i.e. scouring and bleaching. Various chemical and physical properties as well as solubility percentage of raw, scoured and bleached sugarcane fibres in different solvents were evaluated. Chemical constituents were found maximum in raw sugarcane fibres, followed by scoured and bleached sugarcane fibres. Solubility of bleached fibres was more in all the solvents as compared to raw and scoured fibres.

Morphological properties of sugarcane fibre were also found highest in raw fibres followed by scoured and bleached sugarcane fibres. Maximum mechanical properties of fibres were also observed in raw fibre and minimum were found in bleached fibre. The Infra-Red spectrum and Scanning Electron Microscope (SEM) test depicted the removal of non cellulosic material from fibres after wet processing treatment.

From the extracted fibre four different products were developed namely disposable plate, disposable bowl, paper bag and fibre reinforced composite board. Subjective evaluation of products regarding appearance, texture and suitability was assessed through visual inspection. All the developed items were found to be suitable based on their quality and their intended use.

Abstract of M.Sc. Thesis

Department : Textiles and Apparel Designing

Major Advisor : Dr. Satvinder Kaur

Exploration of non-conventional fibre bhindi (*Abelmoschus esculentus*) for textile application

Manashree Saikia

The present study was carried out to investigate the possibility of bhindi fibre for future prospective of developing textile products as it is envisaged that there may be global shortage of conventional natural fibres in the near future. In this context the exploration of non-conventional plants will be an appropriate step towards meeting the future demand of natural fibre. From last few years, people have started using agricultural waste fibres in the field of textile. Bhindi plant is also a source of natural fibre which is regarded as agricultural waste after harvesting of green seed pods. This investigation mainly focused on extraction techniques of fibre from bhindi plant as well as explored the possibility to use this fibre in textile field and develop yarn from bhindi and bhindi:jute blended yarn in different proportion such as 75:25 bhindi:jute, 50:50 bhindi:jute and 25:75 bhindi:jute.

Bhindi fibres were extracted from the waste stem part, using urea retting and subjected to scouring and bleaching to remove the non-cellulosic materials from bhindi fibre. Various chemical and physical properties as well as solubility percentage in different solvent like cold water, hot water and dilute alkali of raw, scoured and bleached bhindi fibre were evaluated. The chemical constituents like ash, lignin, fats and wax were found maximum in raw bhindi fibre and minimum was recorded in bleached bhindi fibre whereas the alpha-cellulose and moisture content was found maximum case of bleached bhindi fibre and minimum was showed in raw bhindi fibre. The bleached fibres revealed maximum solubility in cold water, hot water and dilute alkali. The length, diameter and wall thickness of bhindi fibre were found higher in raw bhindi fibre and lower in regards to bleached bhindi fibre.

The maximum tensile strength, elongation and density of fibres were also observed in raw bhindi fibre. The Infra-Red spectrum, Scanning Electron Microscope (SEM) and colour measurement test were also assessed in raw, scoured and bleached bhindi fibre. SEM view depicted the complete removal of non-cellulosic material from fibres after wet processing treatment and cylindrical shape of fibre was clearly observed.

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Department : Textiles and Apparel Designing

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The colour measurement revealed that wet processing treatments increased the whiteness index and brightness index of bhindi fibre while decreased the yellowness index and colour strength of bhindi fibre.

The treated bhindi fibres were subjected to spinning but due to the coarseness in the fibre, it produced yarn with low tenacity (2.85g/tex). Hence, blending with jute fibre was carried out in different proportion such as 75:25 bhindi:jute, 50:50 bhindi:jute and 25:75 bhindi:jute to produce quality yarn. The blending was done at carding stage. For all the yarns Z twist was incorporated where twist per inch and count was kept constant at 4 tpi and 10lb/spy respectively. After blending with jute fibre, the tenacity of yarns was increased. The highest tenacity was found in 25:75 bhindi:jute blended yarn (12.21g/tex). The maximum density was found in controlled bhindi yarn as compared to blended yarn. The elongation of yarn was found highest in controlled bhindi yarn (37%) and in regards to wicking height, highest was observed in controlled bhindi yarn (3.62cm). Later the fabrics were constructed with basket weave, using the controlled and blended yarn as weft yarn.

The woven fabrics were evaluated for different mechanical and functional properties such as fabric count, cover factor, cloth cover, thickness, crease recovery degree, stiffness, wicking height, air permeability and tearing strength. 25:75 bhindi-jute blended union fabric showed highest count (22warp×22weft). The thickness of the fabric was recorded as highest in controlled bhindi fabric (1.75mm) as compared to bhindi-jute blended union fabrics. For cover factor, higher value (2.2 warp ×2.2 weft) was observed in 25:75 bhindi-jute blended union fabric. The cloth cover was also found maximum (4.6) in 25:75 bhindi-jute blended union fabric. Regarding the crease recovery and stiffness, 25:75 bhindi-jute blended union fabric showed high crease recovery degree in both warp and weft direction (63.4°×60.4°) and controlled bhindi fabric showed maximum stiffness (8.02×9.48cm) in both warp and weft directions. The functional properties such as air permeability (60.31cm³/cm²/S) and wicking height (3.62cm) was found maximum in controlled bhindi fabric whereas tearing strength was found maximum in case of 25:75 bhindi-jute blended union fabric (77N).

From controlled bhindi and bhindi-jute blended union fabrics different furnishing items were developed. Subjective evaluation of fabrics and diversified products were assessed through visual inspection in regards to fabric appearance, texture, luster, handle and suitability of prepared products. All the developed items were found to be suitable based on their quality and their intended use.

It can be concluded from the above findings that bhindi fibre has tremendous potentiality to be used as a future textile fibre.

A study on extraction of underutilized plant fibre from pendulous sleeping hibiscus and evaluation of its physico-chemical properties

Mintu Hazarika

Plant fibers have great potential for their use in various innovative applications as an ecological, biodegradable and renewable resource with unique properties. It is one of the emerging and indispensable products of nature in the field of ecofriendly product. Due to the alarming rise of global warming issues and also industrialization and technological advancements has raised the need for development of innovative fibers especially from natural origin. The goal of the present study was to utilize the barks of pendulous sleeping hibiscus- an underutilized plant source for fiber extraction. This investigation mainly focused on optimization of fibre extraction process and to evaluate the physico-chemical properties of extracted fibers as well as study the effect of wet processing treatments on extracted fibres. In this investigation, fibres from pendulous sleeping hibiscus plant was extracted by using two retting method i.e. water and urea retting where maximum yield (8.4%) was found in water retted fibres. Various physical and chemical properties as well as solubility percentage of pendulous sleeping hibiscus fibres in different solvents were evaluated. The bleached fiber revealed with maximum solubility in cold water, hot water and dilute alkali solutions than retted fibers. Solubility (%) of urea retted fibres was more in all the solvents as compared to water retted fibres. All the physical properties showed satisfactory results in both water and urea retted fiber. On the other hand, chemical constituents like lignin, hemi-cellulose, ash, fat and wax of water retted fibers were found more (%) than the urea retted fiber except cellulose and moisture content. Later, fibers were subjected to different wet processing treatments such as scouring, bleaching and dyeing. Treated water retted and urea retted fibers were evaluated for their different physical properties such as length, diameter, wall thickness, bundle strength, elongation, fineness and density. In all the properties, fiber showed a decreasing trend except elongation, which was higher in water retted bleached fibers (3.65%). Colour measurements of water retted fibre in regards to

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whiteness index (15.37), brightness index (22.26) and yellowness index (33.45) showed higher than urea retted fibre. Wet processing treatments affects the dyability of extracted fibres also. It was observed that water retted bleached fiber showed maximum dye absorption percentage (47.74%) as compared to raw fiber. The Infra-Red spectrum and Scanning Electron Microscope (SEM) test were assessed for both untreated (Raw) and treated fibres. The IR spectrum depicted a significant reduction in the peak of treated fibres which might be due to the removal of non cellulosic material from fibres after wet processing treatment. Scanning electron microscopic view depicted that pendulous sleeping hibiscus fibre was tubular in shape with serrated outer lining. It was also observed that more extraneous substance were present in raw fibre as compared to treated fibre. The findings of the study revealed that, the pendulous sleeping hibiscus fiber has requisite properties as textile fibre which could be enhanced through subsequent wet processing treatments. As a new fibre, it has tremendous potentiality to be used as a new bast fiber, that will add a new arena in the future textile world.

SOFTENING OF ROSELLE BLENDED FABRIC FOR QUALITY IMPROVEMENT

Nicky Ayekpam

The present investigation entitled ‘Softening of Roselle Blended Fabric for Quality Improvement’ was carried out with an objective a) to selection and optimization of suitable softener on roselle and its blends, b) application of softener for roselle and its blends, c) evaluation and characterisation of treated fabrics. The study was conducted at Assam Agricultural University, Jorhat, Assam during 2018-2021. For the study pure roselle and roselle-ramie blended fabrics with three different blend ratios i.e., 25:75, 50:50 and 75:25 were prepared in plain weave structure. The prepared fabrics were subjected for softener treatment with cationic softeners. Softening of fabric is one of the most important finishing technologies in textile; it prevents the static cling and improved the qualities of the fabric. Base on the tensile strength and weight per unit area of the fabrics the optimization of softener concentration and time was carried out keeping the temperature and MLR constant. The controlled fabrics and fabrics treated with optimised parameters were further evaluated to assess the impact of softener on treated fabrics. All the fabrics were analysed in respect of structural, aesthetic, comfort, mechanical and analytical properties. The subjective evaluations of the fabrics were done by panel of P.G students (30 numbers) and assess in ranking methods. Further the data were statistically analysed by using ANOVA (factorial CRD). The result revealed that some structural properties of fabrics like cloth count, cloth factor, cloth thickness and weight per unit area were increased due to the softening treatment. The drape coefficient of the fabrics were reduced which inferred that the drapability of the fabrics has become better. The whiteness and brightness index of the treated fabrics were increased while the yellowness index was decreased. After the application of softener the wicking height and elongation were improved. Tensile strength and abrasion resistance was decreased confirming the softening effects after the treatments. After the application of softener the wicking height and elongation were enhanced. Aesthetic properties of fabrics namely crease recovery and bending length was decreased as well as the air permeability of the treated fabrics was reduced as compared to the controlled fabrics. The FT-IR and SEM analysis also showed the changes in the fabrics after the treatment. An improvement in texture and aesthetic qualities of the fabrics was also observed by majority of the respondents after softening treatment.

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Department : Textiles and Apparel Designing

Major Advisor : Dr. Binita B. Kalita

Impact of Enzymatic Treatment on Dyeing of Kenaf Yarn with Natural Dye

Runa Laila Parvin

In the textile industry, enzymes have found wide application for improving production methods and finishing. Pre treatment with enzyme has been found as a suitable and eco-friendly alternative to chemical processing for achieving desired softness in kenaf yarn. Enzymes treatment removed the protruding hairs on the surface, enhances dyeability and also makes the yarn more soften. Cellulase enzymes have become an efficient tool for finishing. Cellulase is widely used to prevent pilling and improve the smoothness and color brightness in a process popularly known as 'bio-polishing'. The very idea behind this research is to effective removal of surface hairs, improvement in physical properties, to study about whiteness index, brightness index, effect of enzyme on dyeing and colour fastness properties of enzyme treated yarn to further utilize the resulting yarn for different end uses. The application of enzyme on kenaf yarn is to aim to improved the physical as well as mechanical property and also to improve the dye absorbency of the yarn and enhances the colour fastness as well as physical properties of dyed yarns. The objectives of the research are to determine the impact of enzymatic pre-treatment on kenaf yarn and the dyeing behavior of the treated samples were analyzed. The physical and mechanical properties of the treated and untreated samples were compared to understand the effect of the enzyme treatment on the kenaf yarn. The retted kenaf yarns were bleached and treated with cellulase enzyme (acid cellulase and neutral cellulase) and their physical and mechanical properties were studied. Comparative analysis of enzyme treated the kenaf yarn in terms of Scanning Electron Microscopy (SEM) and FTIR techniques, the yarns were tested by Uster and SEM to determine their strength, elongation and structure. It was found that after the enzyme treatment, improvement in physical properties such as density, yarn diameter, wicking height etc and mechanical properties viz. tensile strength, elongation, evenness, absorbency and surface characteristics and whiteness index, brightness index and fastness properties were also improved as compared to untreated samples.

Abstract of M.Sc. Thesis

Department : Textiles and Apparel Designing

Major Advisor : Dr. Binita B. Kalita

Development of Lac Dye from Lac Insect *Kerria chinensis*, (Hemiptera:Kerriidae)

Saswati Rajkhowa

The present investigation entitled “Development of Lac Dye from Lac Insect *Kerria chinensis*, (Hemiptera:Kerriidae)” was conducted during the year 2018-20, to study about Lac dye extracted from species *K. Chinensis* with following objectives. 1. Standardization of dyeing conditions of scrapped Lac, *K. chinensis*. 2. Evaluation of dyed yarn. Natural dyes are emerging globally as eco-friendly colourant. The greater part of natural dyes are vegetable dye obtained from plant source but there are dyes also obtained from insects e.g. Lac Dye. Lac is an animal originated insect dye which is found in India. They can also produce variety shades of color. In this study, aqueous and acidic extraction method using water and HCl was employed for extraction of Lac dye from *K. chinensis*. Result showed that the optimum extraction was 2% and 10% at 60°C for 90 minutes. The natural colourant extracted from Lac insect (*Kerria chinensis*), was utilized for colouration of silk, wool and cotton yarns and their dyeing properties were investigated. The optimal conditions for silk, wool and cotton dyeing with Lac dye were carried out at 100°C for 45-60 minutes. Two different mordants such as alum and myrobalan were tried on silk, wool and cotton yarns at different concentrations with pre and post-mordanting method to assess the colour fastness properties of the dyed samples. Result showed that, mordant has a significant effect on the color of yarns and fastness properties were influenced by the type of mordants used. Lac dye showed burgundy to purple colour with mordant alum and orange to red orange colour with mordant myrobalan on silk and wool yarn. On cotton yarn Lac dye showed purple colour with mordant alum and peach colour with mordant myrobalan. Alum mordant showed more excellence with both colour fastness and physical properties of dyed yarn. Dyed silk and wool yarn exhibited the best colour fastness range from very fair to good with alum mordant followed by cotton yarn which showed fair to very fair with alum mordant. Myrobalan mordanted cotton yarn showed good crocking fastness results in both dry and wet condition. The silk and wool yarn samples dyed with alum was found

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Department : Textiles and Apparel Designing

Major Advisor : Dr. Rickey Rani Boruah

to be better than myrobalan in respect of tenacity (g/tex), wicking height (cm) and moisture regain (%). Cotton yarn samples mordanted with myrobalan showed highest density, wicking height and moisture regain. The myrobalan mordanted dyed silk yarn showed highest elongation and alum mordanted cotton yarn showed highest tenacity and elongation.

Extraction of fibre from *Ricinus communis* and evaluation of its physical and chemical properties

Trideep Bor Saikia

The present study was carried out to investigate the possibility of utilizing castor plant fibre for developing diversified environmental friendly products. Castor plant stems, which remain after harvesting the leaves and seeds, are considered as an agricultural waste but never used as a source of natural fibres. Efforts have been made in the present investigation to extract fibres from the sheaths peeled from the castor stems and subjecting it to wet processing treatments like scouring and bleaching for making diversified products.

Castor fibres were extracted by alkali extraction method and the extracted fibres were subjected to wet processing treatments, i.e. scouring and bleaching. Various morphological, physical, chemical properties as well as solubility percentage of raw along with scoured and bleached castor fibres in different solvents were evaluated. Morphological properties of the fibre were found to be highest in raw castor fibres as compared to scoured and bleached fibres. Physical properties except elongation were found to be highest in raw castor fibres. Elongations of the scoured and bleached fibres were found to be more than the raw fibres.

Chemical constituents except moisture content were found maximum in raw castor fibres, followed by scoured and bleached castor fibres. The moisture content was found maximum in scoured and bleached fibres. Solubility of scoured and bleached fibres were more in all the solvents as compared to raw fibres. Maximum mechanical properties of fibres were also observed in raw fibre and minimum were found in scoured and bleached fibre. The Infra-Red spectrum and Scanning Electron Microscope (SEM) test depicted the removal of non cellulosic material from the surface of the fibres after wet processing treatment.

From the extracted fibre five different products were developed namely coin purse, tea coaster, mobile purse, disposable plate and fibre reinforced composite board. All the developed items were found to be suitable based on their quality and their intended use.

Abstract of M.Sc. Thesis

Department : Textiles and Apparel Designing

Major Advisor : Dr. Ava Rani Phukan