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## **Ph.D (Agriculture)**

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- **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**

# **A Study on the Role of Bacterial-Fungal Interaction in the Production of Secondary Metabolites**

*Dibya Jyoti Hazarika*

Many bacteria inhabit eukaryotic organisms including plants, animals, insects as well as nematodes. Association of bacteria with fungi is an emerging area of research in infection biology, however, a very few strains of bacteria has been reported which can invade and reside within fungal hyphae. In this study, we have screened 65 fungal isolates for the presence of endofungal bacteria. The PCR and fluorescent microscopy based screening methods detected a bacterial isolate D1 within the hyphae of the fungus *Mucor irregularis* SS7. The bacterium was isolated from the fungal culture and identified as *Serratia marcescens* based on morphological, biochemical and 16s rRNA gene sequence similarity. Movement of the endofungal bacterium *Serratia marcescens* D1 along the aerial hyphae of *Mucor irregularis* SS7 was demonstrated using stereo microscopy. Interaction study of *Serratia marcescens* D1 against different Ascomycetes and Basidiomycetes revealed that *Serratia marcescens* was unable to invade and spread along the hyphae of tested Ascomycetes (except *Fusarium oxysporum*) and Basidiomycetes. Remarkably, *Serratia marcescens* spread over the culture of *F. oxysporum*, which resulted into killing of the mycelia.

The pigment produced by isolate D1 was extracted and purified using Thin Layer Chromatography. The purified pigment was further identified as prodigiosin using LC-MS. The pigment was tested for its inhibitory activity against different bacteria and fungi. Prodigiosin showed potent antibacterial activity against tested Gram positive bacteria, while activity against Gram negative bacteria was negligible. Prodigiosin also showed growth retardation activity against fungal pathogens. Role of prodigiosin in bacterial invasion into fungal hyphae was studied using fluorescent microscopy. Prodigiosin was able to create pore on the fungal cell membrane through which propidium iodide entered into prodigiosin treated hyphae. This result demonstrated the possible role of prodigiosin in the invasion of bacteria into fungal hyphae. Metabolite profiles of bacterial and fungal pure cultures, as well as the bacterial-fungal interaction

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cultures were studied using LC-MS. There were 11, 22 and 13 compounds produced exclusively in the bacterial pure culture, fungal pure culture, and bacterial-fungal interaction culture, respectively.

Transcriptomic changes in the fungal pure culture and bacteria treated culture was studied using RNA sequencing. A total of 926 fungal genes were found to be differentially expressed in the bacteria treated fungal cultures. Functional annotation revealed that these genes were involved in various biological and metabolic processes as well as many cellular components were also identified. Quantitative real time PCR also confirmed the differential expression of selected genes, supporting the transcriptome sequencing data. Genome mining identified the prodigiosin biosynthetic gene clusters in the *Serratia marcescens* reference genomes. Bacterial secretion system related genes that have possible role in the bacterial invasion into fungal hyphae were also identified in *Serratia marcescens*. Quantitative real time PCR suggested that there was constitutive expression of the prodigiosin biosynthetic genes. The qRT-PCR also confirmed that chitinase A, the effector protein of type II secretion system has no role in the invasion process. On the other hand, transcripts for the type VI secretion system (T6SS) effector murein lipoprotein, and a regulatory protein TssJ were significantly upregulated during the interaction process, suggesting the involvement of T6SS in the invasion process.

# **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 H<sub>2</sub>O<sub>2</sub> during drought stress. These transgenic lines showed better root architecture system such as

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root length, root 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.

# **Functional analysis of CEP-1/p53 targeted gene during mitochondrial ETC dysfunction in *C. elegans***

*Lipika Khataniar*

Without energy there is no life and Mitochondria provide 90% of the cell energy through oxidative phosphorylation in mitochondrial electron transport chain (mETC). Disruption of mitochondrial function leads to the re-adjustment of cellular metabolism necessary for both cell survival and death. Many mitochondrial diseases have been linked to mutation of both nuclear and mitochondrial genes that encode mitochondrial proteins. Mitochondria have been also heavily implicated in aging, age associated diseases and many metabolic diseases including cancer and diabetes. In model organisms such as worms, flies, and mice, specific point mutations or RNAi knockdowns directly affecting the electron transport chain (ETC) result in varying effects on development and longevity, ranging from developmental arrest and shortened survival to extended lifespan. In our study we have used soil nematode *C. elegans* as a model and one mitochondrial mutant strain *isp1(qm150)* with a defective complex- III (Reiske iron-sulfur protein) to study the effect of mitochondrial status on organism. The *C. elegans* CEP-1, which is the sole homolog of mammalian p53 family (p53, p63 and p73) is known to mediate the lifespan and developmental changes in worms with respect to mitochondrial dysfunction. CEP-1 targeted genes are involved in maintaining cellular homeostasis, lifespan, development and reproduction during mitochondrial stress. So we have identified and validated few CEP-1 target genes involved in mitochondrial mediated aging and development pathway. For that we checked the RNA expression level of the targeted genes and found that ETC dysfunction in *isp-1* mutants causes CEP-1 dependent change in lipid metabolism (*fat-2*, *asah-1*, *acs-2*), ROS(*sod-3*) and Iron homeostasis (*ferritin-1*) gene expression compared to WT. Among these *fat-2*, which encodes Delta-12 desaturase, is involved in the first step in the synthesis of PUFAs from MUFAs. So, lacking this activity would significantly reduce the PUFA and affect the fatty acid synthesis pathway. Thus, we chose *fat-2* to study its role during stress response and found that RNAi KD of *fat-2* is critical in growth, development, reproduction and lifespan of *C. elegans* both in WT and *isp-1* mutant. *Fat-2* KD affect

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the overall fatty acid synthesis pathway so we did fat staining using NIL RED to quantify the whole body fat. Compared to WT the *isp-1* mutant shows increased body fat in CEP-1 dependent manner and *fat-2* RNAi KD in *isp-1* mutant suppress body fat similar to *cep-1* level. This was further confirm using gas chromatography mass-spectrometry which shows significant difference in the relative quantification of fatty acids composition in *isp-1 fat-2* vs. *isp-1* control Moreover, *fat-2* RNAi KD cause deregulation of other fat metabolic genes such as *acs-2* and *fasn-1*.

# **A study on the microbiota of the jhum ecosystem: A biotechnological approach**

*Pompi Das*

*Jhum* or shifting cultivation system, predominant in the hilly regions of the North Eastern India was considered sustainable until the Jhumias abandoned the traditional practice in favour of intensive cultivation resulting in weakened resilience of the hill ecosystem. The present study attempted to evaluate the effect of burning and fallow periods on physicochemical and biological properties of the soil along with microbial structure and their functional properties. The results indicated significant differences in these parameters under the different conditions considered in this study. Although, the study indicated long fallow period (<8-10 yrs) as ideal for rejuvenation of the land, the soil in the long fallow period had accumulated toxic levels of Al ( $e^9530$  ppm) and Fe ( $e^{28949}$  ppm). Some of the native microbes isolated from *Jhum* cultivated soil not only had plant growth promoting abilities but also showed tolerance to high level of Al (10 mM) and Fe (6 mM). *In vitro* experiment with two isolates, *Bacillus cereus* (B1) and *Bacillus subtilis* (B9) isolated in the present study significantly enhanced seed germination in the upland rice variety *Haccha*. Further, pot culture experiment under shade net condition using the above isolates with different treatment conditions were effective in enhancing plant growth including the yield. Since, the *Jhum* soils are affected by abiotic stresses like presence of toxic levels of Al and Fe an attempt was made to study the effect of microbial remediation by using the isolate *Bacillus subtilis* B9 that had tolerance to high concentration of Al (10 mM). The isolate was inoculated to rhizosphere of the rice variety, *Ranjit* grown in pots. The treated plant (Al + *Bacillus subtilis*) showed significantly higher percentage of nitrogen and protein as well as chlorophyll content compared to control plants (Al). The RT-qPCR analysis indicated up regulation of aluminium tolerant genes *viz.*, *ALMT1*, *AIP* and *MATE* with 6.2, 4.3 and 8.3 fold increase respectively compared to control set of plants. The Al transporter genes *ASR1*, *ASR5*, *STAR1* and *STAR2* had 4.4, 8.8, 4.9 and 53.4 fold increased level of expression in roots of treated plants. The results of the experiment indicate that bioinoculum with aluminium tolerant properties can be used to alleviate Al

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stress tolerance in rice. Microbial reclamation through the application of Al and Fe tolerant plant growth promoting (PGP) microbes may aid in restoring soil health of shorter fallow period as observed from the present study.

# **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-D-erythritol 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 tissues (with maximal expression in node and

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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 semi-quantitative 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*, *OsbZIP 23*, *OsbZIP72*) 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 time points of dehydration stress whereas expression of ARC 10372 was prominent in

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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 F<sub>4</sub> 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 nontransgenic 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%, log2fold change $\geq$ 2) frequency of differentially expressed in the transgenic chickpea line. Only a small (34 upregulated) 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 which was expected because absolute synchronous growth and development even under a controlled environment are

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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.

# **Study of stress responsive genes in response to *PDH47* transgene in transgenic rice**

*Tran Ngoc He*

Rice productivity in many rainfed regions are often drastically affected and limited due to drought stress. Development of drought tolerant rice cultivars through transgenic approach is one of the solutions for drought stress. Several drought tolerant transgenic rice lines have been developed in our lab by introducing *PDH47* transgene mediated through *Agrobacterium* as well as particle bombardment methods. In the current study, whole transcriptome sequencing (RNA-Seq) approach was used to further study the effect of *PDH47* transgene through differential gene expression profiling to understand the underlying molecular mechanism in response to drought stress and unravel novel genetic regulatory mechanisms involved in stress response and tolerance in these transgenic lines. The major objective of the current study is to identify and analyze the differentially expressed stress responsive genes in transgenic rice during drought stress. T2 transgenic line no. D68/1 and untransformed (control) rice were grown under well-watered conditions in transgenic greenhouse until the plants reached vegetative stages (30 DAT-days after transplanting). Drought stress treatment was applied for 20 days (up to 50 DAT) till all the leaves of control plants became wilted and rolled. Whole transcriptome analysis of four leaves tissue samples (Transgenic line and Control plant: before and after drought stress) were performed by platform Illumina NextSeq 500 system using reagent Kit 300 cycles PE (paired-end) was used for identification of differentially expressed genes (DEGs). Bioinformatics tools were used for the classification and functional annotation of all DEGs. The RNA-Seq analysis generated a high transcriptional profiles response in transgenic genotype under normal and drought conditions with respect to untransformed rice, implying that due to the overexpressing *PDH47* transgene in transgenic caused wide-range gene expression changes, indicating that overexpression resulted in novel changes in expression for drought tolerance. In which, a total of 27,754 and 27,285 number of genes identified in high quality reads and revealed significant 942 and 475 DEGs in drought-stress and non-stress conditions for both in transgenic rice and untransformed rice, respectively. The DEGs comprised of 170 and 386 up-regulated and 772 and 89 down-regulated

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genes in transgenic rice and untransformed rice, respectively. The Heatmap hierarchical cluster analysis showed the differentially expressed genes levels of the top 50 up-regulation and 50 down-regulation of DEGs level between water deficiency and well-watered treatment both in transgenic rice and untransformed rice. The Venn diagram analysis revealed that 114 genes were exclusively up-regulated in transgenic rice and 56 genes were commonly up-regulated in transgenic rice and untransformed rice of which 21 genes showed higher expression in transgenic rice as compared to untransformed rice during drought stress. BLAST2GO and Gene Ontology analysis revealed the functions of the DEGs in transgenic rice under drought stress which significantly enriched in several important GO terms/categories that characterized for the specifically/commonly drought-induced genes in response to drought stress. These results suggested that the drought tolerance of transgenic was attributable to the enhanced expression of many up-regulated DEGs-related enzyme-encoding genes that contrast with untransformed rice. The up-regulated DEGs in transgenic rice categorized into eleven groups of genes related to drought stress responses: 1.LEAs, 2.DHNs, 3.TFs, 4.Helicases, 5.PRs and 6.Chitinases, 7.Unknown proteins, 8.Other function proteins, 9.CHO and hydrolase activity, 10.The transport and transporter activity and 11.The kinase activity. The KEGG pathway analysis indicated 10 pathways involved in drought stress response/tolerance among 17 metabolic pathways which related to up-regulated DEGs in transgenic rice under drought stress. Further, among 170 up-regulated DEGs in transgenic rice, eleven important abiotic stress response DEGs were selected for further analysis through qRT-PCR using the genes specific primers. Out of 11 genes only five genes *viz.* drought-induced S-like ribonuclease (OS09G0537700), outer envelope pore protein 16-2, chloroplastic (OS03G0305600), fibroin heavy chain precursor (OS08G0442900), protease inhibitor/seed storage (LTPL11) (OS12G0115050) and uncharacterized protein LOC9270608 (OS11G0533400) showed upregulation which were in agreement with the *in silico* (RNA-Seq) study. In conclusion, our results will be helpful in understanding a global view of gene expression/transcriptome profiling in transgenic rice expressing *PDH47* transgene under drought stress. The comprehensive gene expression profiles were through a number of specific genotypedependent drought-induced genes and genes with higher expression in transgenic genotype under normal and drought stress conditions which was responsible for drought tolerance in transgenic rice. We demonstrated that up-regulated DEGs under drought stress can serve as valuable resource for exploring the novel drought responsive genes and can support for investigating rice plant response during drought stress. This will also expand the opportunities for effectively improving drought stress response and tolerance in rice and may contribute in transgenic breeding efforts in development of new drought tolerant rice varieties. However, future line of research will be to study in more details about their functions based on crosstalk with other abiotic stresses in transgenic lines and/or in comparison with other crop plants.

# **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 period it was 17.35 per cent with major contribution of yield variability which was

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**Department: Agricultural Economics & FM**

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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.

## **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-CumResearch (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 preemergence; 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 P<sub>2</sub>O<sub>5</sub> (21.70 kg/ha) and available K<sub>2</sub>O (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 Tillage practices did not influence growth of weeds and *Sesbania aculeata*, but all weed management practices significantly

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**Abstract of Ph. D. thesis**

**Department: Agronomy**

**Major Adviser: Dr. Jayanta Deka**

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 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, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, 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.

## **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. Honey yield revealed significant difference between AI and NI colonies in May, July,

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**Abstract of Ph. D. thesis**

**Department: Entomology**

**Major Adviser: Dr. A. Rahman**

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  $4.10 \times 10^9$  cfu/ml and  $8.06 \times 10^6$  spores/mg whereas, it was 91.866 and 212.676 ppm, respectively for Azadirachtin. Similarly, the  $LC_{50}$  value for *B. bassiana* was  $1.367 \times 10^7$  cfu/ gm and  $4.473 \times 10^7$  spores/ml, respectively.

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**Major Adviser: Dr. D. K. Saikia**

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 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 ( $\pi$ ), 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.

# **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 of 5-7 members (62.50%), agricultural experience between 16-23 years (62.85%), and in

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**Department: Extension Education**

**Major Adviser: Dr. P. Mishra**

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.

## **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 number of fruits per tree ranged from 9 to 68 with an average of 26.25. The highest fruit

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**Abstract of Ph. D. thesis**

**Department: Horticulture**

**Major Adviser: Dr. Kartik Baruah**

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 was 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 IC 50 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.

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

*Prathana Gogoi*

With the new prominence on sustainable agriculture the interest in soil health is reawakening. Poor quality soils are generally vulnerable to weather variations throughout the growing season and which do not support optimum plant growth. Imbalanced and inappropriate use of chemical fertilizer affects soil fertility, crop yield and thus the income of the farmers. Soil testing plays a very important role in diagnosing the physical, chemical and biological properties of the soils and provides unswerving information about the exact amount of fertilizer dose required. So Soil Health Card scheme was initiated by the Government of India in February 2015 by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers' Welfare. In Assam 14, 53,358 no of cards were distributed which accounts to 53.82 per cent of the total 27 lakhs farm families. A total of 57,769 cards were distributed in Nagaon where present study was conducted. The present paper attempts to analyse the change in resource use pattern and its impact on farmers' income, factors affecting the use of Soil Health Card and to explore the problems and prospects associated with the use of Soil Health Card. The study was conducted in Nagaon district of Assam with 80 respondents. The primary data were collected by personal interview method during Feb.-March. Most of the respondents were between the age group 15 to 59 years with most of them having primary level of education. From the study it was found that there was difference in the resource use in rice cultivation under SHC users and SHC nonuser's farms which was supported by t-test. The change in some inputs like FYM, fertilizer irrigation were found to be significant and positive. The yield advantage of rice cultivation for Soil health card user was found to 16.07 per cent over rice cultivation of the soil health card non-user which may be due to the supply of the right amount of fertilizer need for the growth of the crop. With more education farmer, more training, more awareness and more experience in farming the adoption of soil health card was found to be increased. Although the cost of cultivation of rice for soil health

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**Abstract of Ph. D. thesis**

**Department: Horticulture**

**Major Adviser: Dr. Dilip Mahanta**

card user was comparatively more than the cost incurred by the soil health card non-user, but due to yield advantage the return over cost was more for the soil health card user. The gross returns obtained by soil health card user and soil health card non-user were Rs.78477.00 and 65868.00, respectively. The return over cost ratio for soil health card non-user was 1.65 and 1.85 for soil health card user. No technical advices after distribution of SHC were hampering the adoption of soil health card. Lack of awareness on the process of soil testing by grid system made the farmer hard to trust about the dose mentioned in the cards. The study concluded that the SHC scheme had a lofty scope of increasing the income of the farmer but the scheme could not bring substantial positive change in the Nagaon district of Assam in the initial years of its distribution because of low rate of adoption of the soil health cards, which solicit for mass awareness campaign using the concept of the judicious use of fertilizer as per dose recommended on the soil health card. The recommended dose should be given in regional or vernacular languages so that the farmers could easily understand the doses in the card. The farmers also should be given advisory services and training along with technical supervision on the use of soil health cards and make agriculture more sustainable and productive.

# **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: V<sub>1</sub>: pole and V<sub>2</sub>: dwarf), three levels of NPK (sub treatment: F<sub>1</sub>: 30-40-20, F<sub>2</sub>: 30-40-30 and F<sub>3</sub>: 40-40-40) and three levels of zinc sulphate spray (sub-sub treatment: Z<sub>0</sub>: 0ppm, Z<sub>25</sub>: 25ppm and Z<sub>50</sub>: 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<sup>-1</sup>) 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<sup>-1</sup>) were recorded as the highest and significant at (40-40-40 NPK kg ha<sup>-1</sup>) along with two zinc sulphate sprays.

While at the same level of fertilizer management practices i.e. (40-40-40 NPK kg ha<sup>-1</sup>) 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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**Abstract of Ph. D. thesis**

**Department: Horticulture**

**Major Adviser: 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 G 1 (Bamboo frame structure covered with fixed 200 micron UV film with top ventilated and 50% agro shade net as ceiling), G 2 (Bamboo frame structure with fixed 50% agro shade net as cladding material), G 3 (Bamboo frame structure covered with fixed 200 micron UV film with side removable and 50% agro shade net as ceiling), G 4 (Bamboo frame structure with fixed 50% agro shade net and 200 micron UV film as top covering) and G 5 (Bamboo frame structure with 200 micron UV film side removable and fixed 50% agro shade net as covering). The second factor comprised T 1 -1 tier (40 cm above the ground level) and T 2 -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 G 3 while the morning and afternoon relative humidity was highest in G 2 during 2017 and 2018, respectively. The average light intensity was highest in G 3 for both the years. Moreover, an average accumulated degree day irrespective of the microclimatic regimes was highest in G3. The results revealed that most of the growth characters were significantly influenced by growing structure and tier. Amongst the growing structures, G 1 was the best for

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**Abstract of Ph. D. thesis**

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**Major Adviser: Dr. Pradip Mahanta**

increasing the growth characters viz., plant height (45.26 cm), leaves per plant (11.65), leaf area per plant (569.61 cm<sup>2</sup>), 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, G 1 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, G 3 was the best for increasing the total chlorophyll content (0.30 mg/g) whereas G 1 for crop growth rate (0.15 g/m<sup>2</sup>/day), relative growth rate (0.07 g/g/day), net assimilation rate (0.21 g/m<sup>2</sup>/day) and dry matter production (15.85 g/plant). Similarly, T 2 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 cm<sup>2</sup>) and height of pseudobulb (24.13 cm). Regarding flower characters same results were found, T 2 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, T 2 was found to be better for total chlorophyll content in leaf (0.28 mg/g FW), crop growth rate (0.13 g/m<sup>2</sup>/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 G 1 T 2 followed by G 4 T 2 (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 G 1 condition. For flower and physiological characters mean microclimatic parameters calculated during 5 different phenophases viz., PP 1 (planting to bud visibility), PP 2 (planting to full bloom), PP 3 (bud visibility to opening of first floret), PP 4 (bud visibility to full bloom) and PP 5 (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 PP 1 and PP 4 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 PP 2 and negatively correlated with afternoon relative humidity at PP 4. However, crop growth rate negatively correlated with afternoon relative humidity at PP 4 and net assimilation rate with minimum temperature of PP 1. Dry matter production and relative growth rate was negatively correlated with minimum temperature at PP 4. Results of the regression analysis indicated that minimum temperature in PP 1 phase could predict the spikes per plant to an extent of 87%, light intensity and accumulated growing degree days in PP 5 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 PP 5 could together predict floral diameter to an extent of 89%. On the other hand, afternoon

relative humidity of PP 4 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 G 1 , G 2 , G 3 , G 4 and G 5 , respectively. G 1 showing the least root mean square error (0.206), followed by G 4 (0.218) which provides congenial microclimates for growing of *Dendrobium* orchids.

## **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(V<sub>1</sub>), A1(V<sub>2</sub>), DS-10(V<sub>3</sub>) and GS-10(V<sub>4</sub>); sub treatment was comprised of 5t FYM, 10-46-0 kg<sub>ha</sub><sup>-1</sup> (F<sub>1</sub>), 10t FYM, 10-46-10 kg<sub>ha</sub><sup>-1</sup> (F<sub>2</sub>), 10t FYM, 20-46-20 kg<sub>ha</sub><sup>-1</sup> (F<sub>3</sub>) and 10t FYM, 30-46-30 kg<sub>ha</sub><sup>-1</sup> (F<sub>4</sub>) and sub-sub treatment was dates of sowing: 10<sup>th</sup> October (S<sub>1</sub>), 24<sup>th</sup> October (S<sub>2</sub>), 7<sup>th</sup> November (S<sub>3</sub>), 21<sup>st</sup> November (S<sub>4</sub>), 5<sup>th</sup> December (S<sub>5</sub>) and 20<sup>th</sup> December (S<sub>6</sub>).

Growth, yield attributes, soil related and quality characters viz., plant height(cm), days to 50% flowering, pod plant<sup>-1</sup>, pod length (cm), pod diameter (cm), seed pod<sup>-1</sup>, shelling (%), pod yield (tha<sup>-1</sup>), duration (days), growing degree days, root nodules plant<sup>-1</sup>, total plant nitrogen (%), total plant phosphorus(%), total potash (%), TSS (<sup>0</sup> Brix), crude protein (%), soil organic carbon (%), soil available nitrogen (kg<sub>ha</sub><sup>-1</sup>), soil available phosphorus (kg<sub>ha</sub><sup>-1</sup>), soil <sup>available</sup> potash (kg<sub>ha</sub><sup>-1</sup>) 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 V<sub>4</sub>>V<sub>3</sub>>V<sub>2</sub>>V<sub>1</sub> 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 V<sub>4</sub>F 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 V<sub>1</sub>(58.73days), to maximum in V<sub>4</sub>(72.30days). Fertility level had a range of maturity at 68.08 to 68.29 days. Sowing dates showed significance as 911(S<sub>1</sub>), 915(S<sub>2</sub>), 915(S<sub>3</sub>), 915(S<sub>4</sub>), 916(S<sub>5</sub>) and 918(S<sub>6</sub>) during 2016-17 and the GDD was found significant as S<sub>1</sub><S<sub>2</sub>=S<sub>4</sub><S<sub>3</sub><S<sub>5</sub><S<sub>6</sub> during 2017-18 with values of GDD 916, 915, 913, 919, 918, 915, indicating the total accumulated heat was more or less similar

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irrespective of season but differed by duration. The best performer combination was V<sub>4</sub>F<sub>4</sub>S<sub>5</sub> (63.59%). Pod yield differed due to variety (6.76 tha<sup>-1</sup> to 7.61 tha<sup>-1</sup>), fertility level (5.60 tha<sup>-1</sup> to 8.21 tha<sup>-1</sup>) and the best combination was V<sub>4</sub>F<sub>4</sub>S<sub>5</sub> (10.21tha<sup>-1</sup>). Cost economics indicated the best B:C was 2.08 against V<sub>3</sub>F<sub>4</sub>S<sub>5</sub> i.e. variety DS-10 at sowing during 21<sup>st</sup> November and at fertility level of 10t FYM along with 30-46-30 kg NPK ha<sup>-1</sup>.

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

# **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

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on morphological, cultural, biochemical and 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.

# **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

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culture media (RH+SD+RB), which is usually used for rapid multiplication of *Beauveria bassiana*.

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.

# **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<sup>-1</sup> in case of winter rice and 100% RDF (chemical) in case of autumn rice (i.e. T7) showed the highest NH<sub>4</sub>-N, NO<sub>3</sub>-N and available N content in soil followed by the application of 50% RDF (chemical) + FYM @ 2.5 t ha<sup>-1</sup> 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 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

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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<sup>-1</sup> 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<sup>-1</sup> under T1 (unfertilized control) to 67.14 Mg ha<sup>-1</sup> under T3 (receiving FYM @2.5 t ha<sup>-1</sup> + chemical fertilizers). The soil C sequestration ranged between (-)2.77 Mg ha<sup>-1</sup> under T1 and 24.07 Mg ha<sup>-1</sup> 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<sup>-1</sup> + chemical fertilizers); whereas, fungal population was found maximum in case of T3 (receiving FYM @2.5 t ha<sup>-1</sup> + chemical fertilizers). Various 6 soil enzymes viz. dehydrogenase (DHD), phosphomonoesterase (PMEase), fluorescein 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 CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O 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 CO<sub>2</sub> and CH<sub>4</sub> 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, N<sub>2</sub>O 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 N<sub>2</sub>O emission peak was observed at 45 DAT in case of autumn rice (cv. Disang) under study. The highest emissions of CO<sub>2</sub> and CH<sub>4</sub> during winter crop (cv. Ranjit) were observed in case of T5 receiving rice stubbles @3.0 t ha<sup>-1</sup> + chemical fertilizers. In contrast, N<sub>2</sub>O 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 N<sub>2</sub>O emission was observed in case of T7 receiving Azolla @ 0.5 t ha<sup>-1</sup> + chemical fertilizers. In case of autumn rice (cv. Disang), the maximum emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O were recorded in T5 (receiving rice stubbles @3.0 t ha<sup>-1</sup> + chemical fertilizers). The lowest CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O 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 CO<sub>2</sub> had a positive and significant correlation with CH<sub>4</sub> ( $r=0.874^{**}$ ) and N<sub>2</sub>O ( $r=0.748^*$ ) emissions from the rice-rice cropping system. However, the correlation between the CH<sub>4</sub> and N<sub>2</sub>O emission was positive and non-significant ( $r=0.623$  NS) in this study. Significant and positive correlation of CO<sub>2</sub> and CH<sub>4</sub> 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 N<sub>2</sub>O emission with NH<sub>4</sub>-N, NO<sub>3</sub>-N and available N were found to be significant and positive; whereas, it was positive but non-significant 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 CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O 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<sup>-1</sup> 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<sup>-1</sup>), gross return (67.72 × 10<sup>3</sup> Rs. ha<sup>-1</sup>) and net return (39.79 × 10<sup>3</sup> Rs. ha<sup>-1</sup>) 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<sup>-1</sup> 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.

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

*Manoj Kumar 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 (T<sub>1</sub>), 50% recommended dose of fertilizer (RDF)+50% biofertilizer (BF) (T<sub>2</sub>), 50% RDF+50% Enriched Compost (EC) (T<sub>3</sub>), 100% RDF (T<sub>4</sub>), 100% BF (T<sub>5</sub>) and 100% EC (T<sub>6</sub>). 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 T<sub>3</sub> 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 (T<sub>6</sub>) treatment. Soil accumulation of Organic carbon (OC), N, P and K was found higher in T<sub>6</sub> treatment over T<sub>5</sub> 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 T<sub>4</sub> 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 (T<sub>3</sub>) recorded the highest bacterial population of 19.63 cfu x10<sup>5</sup>/g and 19.25 cfu x10<sup>5</sup>/g soil at flowering stages of rice and toria, respectively. The fungal population was 9.12 cfu x10<sup>5</sup>/g soil in rice and 8.88 cfu x10<sup>5</sup>/g soil in toria, respectively. The actinomycetes population was 45.75 cfu x10<sup>4</sup>/g soil in

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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.

# **Charge characteristics of soils under different land uses in relation to pedogenetic acidification process**

*Poonam Gogoi Konwar*

Soil samples from six profiles under different land uses *viz.* Rice, Upland vegetable, Tea plantation, Bamboo, Mixed tree plantation and Forest were collected from different areas of Jorhat district and studied for charge characteristics in relation to pedogenetic acidification processes of the soils. Total 28 no. of samples were processed and analyzed for all the relevant parameters pertaining to the study following standard procedures.

All profiles showed a dominant hue of 10YR for all the soils. The texture varied from sandy loam to clay loam and an increase in heaviness of texture along the depth was observed in all the profiles, except tea soils where texture was sandy clay loam throughout the entire profile. Higher bulk density was observed in surface soils and was ascribed to the high amount of sand. The soils were very strong to slightly acidic in reaction and  $\Delta\text{pH}$  values were negative in all the horizons indicating the presence of negative charge in the soils. The organic carbon of the soils varied from 0.11% under bamboo to 1.95% in forest soils with surface soils showing higher concentrations. The sum of bases were highest in surface soils and its concentration was greatly influenced by organic carbon content of the soils. Among all the exchangeable cations,  $\text{Ca}^{2+}$  was the dominant ion over  $\text{Mg}^{2+}$ ,  $\text{Na}^+$  and  $\text{K}^+$ . The CEC of the soils ranged from 6.5 to 9.4  $\text{cmol}(\text{p}^+) \text{kg}^{-1}$  and Percent Base Saturation (PBS) varied from 25.1 to 55.1 %.

The concentration of dithionite extractable  $\text{Fe}_d$  and  $\text{Al}_d$  varied from 10.90 to 35.60  $\text{g kg}^{-1}$  and 3.90 to 8.50  $\text{g kg}^{-1}$ , oxalate extractable  $\text{Fe}_o$  and  $\text{Al}_o$  ranged from 2.30 to 9.50  $\text{g kg}^{-1}$  and 1.60 to 5.90  $\text{g kg}^{-1}$  and pyrophosphate extractable  $\text{Fe}_p$  and  $\text{Al}_p$  ranged from 0.60 to 6.80  $\text{g kg}^{-1}$  and 0.40 to 2.40  $\text{g kg}^{-1}$ , respectively. The  $\text{Fe}_d$  and  $\text{Al}_d$  was found to have highest concentration in the soils, followed by  $\text{Fe}_o$  and  $\text{Al}_o$ ; and  $\text{Fe}_p$  and  $\text{Al}_p$  suggesting the dominance of crystalline fraction of iron and aluminium among other forms, due to more transformation of amorphous iron to crystalline form. The depth distribution of  $\text{Fe}_d$  was uniform and it increased down the profile similar to the pattern

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**Abstract of Ph. D. thesis**

**Department: Soil Science**

**Major Adviser: Dr. Samiron Dutta**

exhibited by clay.  $Al_d$  showed an irregular distribution trend throughout the profile. Both  $Fe_o$  and  $Al_o$  had high concentration in surface horizons of all the profiles and then showed a decreasing pattern.  $Fe_p$  followed the reverse pattern and decreased with depth in all the profiles. Soil under rice field was classified as Oxyaquic Dystrudepts and the rest of the soils are classified as Typic Dystrudepts.

The negative charge of the soils (CEC) was found to increase with the equilibrium pH of the soils and reverse was seen in case of positive charge (AEC). Increasing negative charge with pH was attributed to the variable nature of kaolinite, organic matter and presence of iron and aluminium oxides in the studied soils. The decrease of AEC with the increase in the pH of the soil was due to adsorption of  $H^+$  in the surfaces of crystalline as well as oxide minerals and organic matter. The positive net charge at low pH and negative charge at higher pH indicated that cation retention of the soils will be more than anion retention when soil pH is increased. The PZNC varied from 2.37 to 3.90 and lower values in surface horizons and rice soils was attributed to higher amount of organic matter in the surface horizon. The PZC ( $pH_0$ ) of the soils showed a narrow variation in its concentration range (2.88 to 4.42) indicating similar stage of pedogenic development of the soils. The  $pH_0$  values were below the normal pH of the soils and indicated the presence of net negative charge in the studied soils.

The major parameters indicating soil acidity *viz.* exchange acidity, total acidity, total potential acidity, pH-dependent acidity and hydrolytic acidity ranged from 1.12 to 2.59, 2.15 to 4.30, 7.40 to 11.20, 5.31 to 9.08 and 0.50 to 2.37  $cmol(p^+) kg^{-1}$ , respectively. The values of exchange acidity, total acidity and total potential acidity were highest in tea soils, whereas bamboo was found to have maximum concentration of pH-dependent acidity and hydrolytic acidity. In all the profiles, surface soils had higher values of acidities except bamboo where acidity was more in the lower horizons. The highest value of titratable acidity was 39.25  $cmol(p^+) kg^{-1}$  found in tea soils and maximum titratable alkalinity was 3.00  $cmol(p^+) kg^{-1}$  under mixed tree plantation. Higher titratable acidity in surface horizons was attributed to organic matter and uneven distribution of titratable alkalinity throughout the profile was due to partial monomerization of amorphous aluminium compounds.

Most prominent pedogenetic acidification processes dominating in the studied soils were the production of weak acids, production of low molecular weight organic acids, acid hydrolysis of amorphous oxides, reduction of acid neutralizing capacity of the soils and nutrient cycling. The soil properties which had the strongest influence on pedogenetic acidification processes and soil acidity components were clay, organic carbon, CEC and different forms of Fe and Al oxides which in turn affected the charge characteristics of the soils. PCA analysis of 18 important soil characters revealed five components accounting for 82.77 % of the total variance. Based on this analysis, four factors were identified that affect the charge properties and were termed as organo-metallic complexes, reserve acidity, active acidity and weathering factor. Cluster analysis (CA) support the finding of PCA.

The study revealed that the soil characters like clay, organic carbon, cation exchange capacity and different forms of iron and aluminium oxides appeared to have the most significant effect on the pedogenetic acidification processes as reflected in different components of soil acidity, which in turn affect the charge characteristics of the soils. The study also provided the evidences of the stage of pedogenetic development based on the charge characteristics. Soils under tea, bamboo and forest were at advanced stage of development as compared to soils under upland vegetable, mixed tree plantation and rice field which showed moderate development. All the soils contained variable charges and it increased with pH. The retention of cations and anions as evaluated from negative and positive charges respectively are affected by soil pH and therefore, management strategies could have major agronomical and environmental consequences. Thus, these characteristics could be used as useful tool for nutrient management in soils.

## **Ph.D (Veterinary Science)**

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- **Animal Biotechnology**
- **Animal Genetics and Breeding**
  - **Animal Nutrition**
- **Animal Reproduction, Gynaecology and Obstetrics**
  - **Anatomy and Histology**
    - **Biochemistry**
- **Clinical Medicine, Ethics and Jurisprudence**
  - **Epidemiology and Preventive Medicine**
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  - **Physiology**
  - **Public Health**
- **Surgery and Radiology**
- **Livestock Production and Management**
  - **Livestock Products Technology**
    - **Poultry Science**

# Genetic Studies on the Performance of HD-K75 Pigs

*Jyotishree Bayan*

Pig farming in India is primarily a small scale unorganized rural activity and is an integral part of diversified agriculture particularly in the tribal belt of the country and have been contributing to improve the livelihood of poor and socially weaker section of the society including the tribal people of India. Pig farming in Assam is rapidly gaining momentum in recent years as the farmers are finding it a profitable enterprise.

The present investigation was carried out on HD-K75 pigs (75% Hampshire inheritance and 25 % indigenous inheritance) that are bred and maintained in the All India Coordinated Research Project (AICRP) on pigs, ICAR, located at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022. The data were collected and compiled from the progenies of 44 sires and 114 dams maintained over a period of 6 years from 2012 to 2018.

The objective of the investigation were to study some important traits of growth and reproduction and the effect of various non-genetic factors influencing these traits, determine heritability, genetic correlation and phenotypic correlation of some important growth and reproduction traits, to construct linear, partial and multiple regression equations and to predict adult body weights based on early body weights.

Traits included in the study were body weights at birth, weaning, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> months of ages, and daily body weight gains during pre-weaning (birth to weaning) and post-weaning periods (from weaning to 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> month of ages), age at sexual maturity, gestation period, farrowing interval, litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning.

The overall mean body weight in HD-K75 pigs at birth, 1 month, weaning, 2 months, 3 months, 4 months, 6 months and 8 months of age were  $1.001 \pm 0.001$  kg,  $6.912 \pm 0.011$  kg,  $9.666 \pm 0.013$  kg,  $12.207 \pm 0.007$  kg,  $18.324 \pm 0.001$  kg,  $28.349 \pm 0.052$  kg,  $51.177 \pm 0.091$  kg and  $71.229 \pm 0.110$  kg respectively. The average daily body weight gains (ADG) in g during birth to weaning, weaning to 4<sup>th</sup> month, weaning to 6<sup>th</sup> month and weaning to 8<sup>th</sup> month of ages were  $206.299 \pm 0.311$ ,  $237.294 \pm 0.773$ ,  $299541 \pm 0.700$  and  $311.206 \pm 0.557$  respectively. Least-squares analysis of variance

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**Abstract of Ph. D. thesis**

**Department: Animal Genetics and Breeding**

**Major Adviser: Dr. Galib Uz Zaman**

revealed highly significant effect of season of birth, parity and sex on body weight at all ages and daily body weight gains at various stages of growth. Piglets born during winter season had higher body weight at birth, 1 month, 42 days, whereas piglets born during post-monsoon season had higher body weight at 2 months, 3 months, 4 months and 6 months of age and piglets born during monsoon season had higher body weight at 8 months of age. Pre-weaning ADG was higher in piglets born during monsoon season and lowest in animals born during pre-monsoon season. The ADG during 42 days to 4<sup>th</sup> month and 42 days to 6<sup>th</sup> month were found to be higher in piglets born during post-monsoon season and lowest in piglets born during pre-monsoon season. Piglets born in second parity had higher body weight at 3 months, 4 months, 6 months and 8 months whereas piglets born in third parity had higher body weight at birth and 1 month and piglets born in first parity had higher body weight at weaning and 2 months of age. Significantly higher ADG was found during pre-weaning period of growth in animals born in first parity. Further, the ADG from 42 days to 4<sup>th</sup> month, 42 days to 6<sup>th</sup> month and 42 days to 8<sup>th</sup> months of age were found to be higher in animals born in second parity and revealed significant difference with the animals of first and third parities. Males showed higher body weight and higher ADG than females in all stages of growth.

The  $h^2$  estimates for body weight and ADG at various stages of growth in the present study were moderate to high in most of the cases which indicated that the population under study possess good amount of additive genetic variance and there is scope of genetic improvement of the herd in terms of growth traits and ADG at various stages using adequate methods of selection by incorporating these estimates. The phenotypic correlations among body weights at various ages were moderate and positive in some cases and negative in some cases. The phenotypic correlations among ADG at various stages of growth were moderate and positive in some cases and negative in some cases. The genetic correlations among body weights at various ages of growth were low to high and positive in some cases and negative in some cases. The genetic correlations among ADG at various stages of growth were moderate and positive in some cases and negative in some cases.

The overall means for age at sexual maturity, gestation length and farrowing interval were found to be  $205.294 \pm 1.054$ ,  $112.70 \pm 0.119$  and  $216.781 \pm 2.565$  days respectively.

Effect of season of birth on age at sexual maturity was found to be non-significant as indicated by least square analysis of variance. Non-significant effect of season of birth and parity on gestation period was observed in the present study in HD-K75 pigs. Least-squares analysis of variance revealed significant difference between the various seasons under study in respect of farrowing interval. Sows that farrowed during post-monsoon season had significantly longer farrowing interval and differed significantly with other seasons and the shortest farrowing interval was observed in sows that farrowed during monsoon season. Least square analysis of variance revealed that the effect of parity on farrowing interval in the present study was non-significant.

The  $h^2$  estimates of age at sexual maturity, gestation length and farrowing interval for HD-K75 pigs was low to moderate in magnitude. The phenotypic correlation among the reproduction traits were found to be low and positive in most cases. The genetic correlation among the reproduction traits were found to be moderate and positive in most cases.

The overall means for litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning were found to be  $7.747 \pm 0.088$ ,  $7.556 \pm 0.093$  numbers and  $7.804 \pm 0.084$  and  $74.644 \pm 0.0886$  kg respectively.

Least-squares analysis of variance revealed significant effect of season of birth on litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning. Piglets born during pre-monsoon season showed highest litter size at birth and weaning. Piglets born during post-monsoon season and winter season showed highest litter weight at birth and litter weight at weaning. Further, litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning were found lowest during monsoon season. Least-squares analysis of variance revealed that parity had significant effect on litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning. Piglets born in third parity showed highest and piglets born in first parity showed lowest litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning respectively.

The  $h^2$  estimates of litter size at birth and litter size at weaning in HD-K75 pigs in the present study were found to be low in magnitude. The  $h^2$  estimates of litter weight at birth and litter weight at weaning were found to be medium in magnitude. The phenotypic correlations among the litter traits were found to be high and positive in most cases. The genetic correlations among the litter traits were found to be moderate to high and positive in most cases.

Prediction equations were developed using post-weaning body weights at 6 months ( $Y_1$ ) and 8 months ( $Y_2$ ) of ages as dependent variables based on pre-weaning body weights at birth ( $X_1$ ), 1 month ( $X_2$ ), 42 days ( $X_3$ ), 2 months ( $X_4$ ) and 3 months ( $X_5$ ) of age as independent variables in various combinations. For prediction of adult body weights on the basis of body weights at early ages in HD-K75 pigs, linear, partial and multiple regression equations were developed.

The linear regression equations for predicting body weights at 6 months of age had comparatively higher  $R^2$  values than 8 months of age in HD-K75 pigs, but were not found to be reliable as the  $R^2$  values were less than 60 %. The partial regression equations for predicting body weights at 8 months of age had comparatively higher  $R^2$  values than 6 months of age and were found to be more reliable. All the multiple regression equations developed to predict the adult body weight at 8 months of age can be reliably used when 3-5 independent variables are considered. Multiple regression equations developed to predict 8 month body weight showed highest reliability with  $R^2$  values ranging from 70.87 to 90.56 %. High  $R^2$  values indicates that the 8 month body weight can be predicted more efficiently than 6 month body weight. The multiple regression equations for predicting body weight at 8 months using 3 independent

variables *viz.* body weight at birth, 1 month and weaning showed high  $R^2$  value of 90.21 % which was found to be highly reliable and the best combination, though higher  $R^2$  values were obtained in multiple regression equations using 4 and 5 independent variables.

# **Morphological and Functional Characterization of Boar Spermatozoa on Incubation in Capacitating Media and Preservation**

*Arunima Das*

A total of 24 ejaculates comprising 6 ejaculates from each of four HD-K75 boars of 10-12 months age maintained at ICAR - All India Coordinated Research Project (AICRP) on Pig C.V.Sc, A.A.U., Khanapara, Guwahati are being selected for the present study. The semen was collected by simple fist method twice weekly to study the morphological and functional characterization of *in-vitro* capacitated and preserved boar spermatozoa. After initial evaluation (volume, concentration and initial motility), the fresh semen was split into three parts. One part of the semen was used for fresh semen evaluation, second for capacitation and the other for preservation. For capacitation, the semen was incubated in TALP and m-KRB media at 37°C for 5 hours. For preservation semen was extended (1:4) in BTS and GEPS extenders and held at 22°C for 4 hours. The extended semen was then preserved at 15°C in BOD incubator upto 120 hours.

The overall mean of strained volume of semen, initial motility, hyperactivated spermatozoa, sperm concentration, live spermatozoa, live acrosome reacted spermatozoa and per cent hypo-osmotic swelling test (HOST) was 220.65±5.34 ml, 83.29±0.92 per cent, 92.21±0.54 per cent, 270.87±2.94 million per ml, 90.82±0.83 per cent, 82.76±0.36 per cent and 65.06±0.27 per cent and the overall range being 150-265 ml, 78 to 95 per cent, 88 to 95 per cent, 245- 298 million per ml, 86 to 95, 79-86 and 62 to 78 per cent respectively. Sperms were suspended in TALP media and m-KRB media and incubated for 5 hours at 37°C for *in-vitro* capacitation and evaluation was carried out at 0, 3 and 5 hours of incubation. In the present study, the highest hyperactivated motility was observed at 3 hours of incubation, from 18.51% at 0 hour to 57.32% in TALP and 17.96% at 0 hour to 43.25% at 3 hour in m-KRB, the hyperactivated motility of spermatozoa increased significantly upto 3 hours then it decreased upto 44.72 in TALP and 43.25 at 5 hours of incubation. The overall mean live acrosome reacted spermatozoa per cent declined from 85.31% to 35.52% in TALP and 84.95% to 34.04% in m-KRB

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**Abstract of Ph. D. thesis**

**Department: Animal Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. P. M. Barua**

media, HOST reacted spermatozoa decreased from 68.49% to 53.37% in TALP and 67.54% to 51.41% in m-KRB, FITC-PSA(-ve) spermatozoa percentage increased from 0.17% to 13.92% in TALP and 0.17 % to 12.58% in m-KRB, total protein increased from 0.41mg/ml to 1.21 mg/ml in TALP and 0.44 mg/ml to 1.25 mg/ml in m-KRB, total cholesterol decreased from 31.58 mg/dL to 11.28 mg/dL in TALP and 32.24 mg/dL to 10.61 mg/dL in m-KRB, total phospholipid 61.90 mg/dL to 59.24 mg/dL in TALP and 62.15 mg/dL to 59.40 mg/dL in m-KRB. The overall mean values were found to be differed significantly ( $P<0.01$ ) between periods, while between media no significant difference was observed except in live acrosome reacted spermatozoa ( $P<0.05$ ) and HOST ( $P<0.01$ ). In preserved group, Semen was extended with BTS and GEPS extender (1:4), held at 22°C for 4 hours and preserved upto 120 hours at 15°C. The semen samples were evaluated at 0 (i.e. immediately after extension), 24, 48, 72, 96 and 120 hours of preservation. In the present investigation, the overall mean sperm motility showed a decline from 82.63% to 30.21% in BTS and 83.04% to 31.75% in GEPS, hyperactivated motility percentage decreased from 84.64% to 32.70% in BTS and 83.95% to 34.24% in GEPS and live spermatozoa decreased from 84.92% to 45.08% in BTS and 85.75% to 46.92 % in GEPS, live acrosome reacted decreased from 80.79% to 44.79% in BTS and 82.29% to 44.79% in GEPS, host reacted spermatozoa decreased from 61.64% to 36.09% in BTS and 60.62% to 34.20% in GEPS, FITC-PSA(-ve) spermatozoa increased from 0 to 13.17% in BTS and 0 to 12.58% in GEPS, total protein (g/dL) level increased from 1.39% to 2.01% in BTS and 1.32% to 2.02% in GEPS, total cholesterol (mg/dL) level decreased from 32.82 to 15.54 in BTS and 32.82 to 15.21 in GEPS and total phospholipid (mg/dL) level decreased from 62.03 to 60.90 in BTS and 62.31 to 60.24 in GEPS. The overall mean values were found to be differed significantly ( $P<0.01$ ) between periods, while between media significant difference ( $P<0.05$ ) was observed in sperm motility and HOST while, hyperactivated motility, live spermatozoa and live acrosome reacted spermatozoa were differed significantly higher ( $P<0.05$ ). The aim of the present study was to determine the nature of capacitation like changes during preservation by studying the morphological and functional characteristics of *in-vitro* capacitated and preserved boar spermatozoa. In the present study, the maximum *in-vitro* capacitation was observed at 3 hours of incubation at 37°C. While, changes of the boar spermatozoa after 72 hours of preservation in respect of acrosomal status, plasma membrane integrity, total protein, total cholesterol and FITC-PSA (-ve ) spermatozoa resembled with the changes of spermatozoa of *in-vitro* capacitated for 3 hours of incubation.

# Differential Expression of Certain Fertility Marker Genes in Yak Semen and Their Association with Yak Embryo Production

*Mokhtar Hussain*

Six healthy yak bulls of 3-5 years age and twenty four healthy cyclic female yaks, in their first to second lactation stage, aged 3 to 4.5 years, maintained at ICAR-NRC on Yak, Dirang were used to study the effect of seasons and additive in semen qualities, the expression pattern of certain fertility associated genes in yak semen, and their association with semen characteristics and embryo production. A total of 216 ejaculates collected by standard artificial vagina method were evaluated for volume, initial sperm motility, sperm concentration, live sperm, sperm abnormality, HOST-reacted sperm, acrosomal abnormality and intake acrosome in fresh semen in different seasons. Each ejaculates were split into two equal parts for fresh and frozen semen study, and the fresh semen part was divided into two parts for studying semen characteristics and mRNA gene expression, while the frozen part was divided into two parts to study the effect of additives in different stages of processing and freezing, and for mRNA gene expression studies.

All the parameters for fresh semen characteristics varied significantly ( $P<0.01$ ) between seasons and between animals, while live sperm (%) varied significantly ( $P<0.05$ ) between seasons. The interaction between season and animals was found to be non-significant except in live sperm (%) that varied significantly ( $P<0.05$ ), and acrosomal abnormality (%) and intake acrosome (%) that varied significantly ( $P<0.01$ ). The percentage of sperm motility, live sperm, HOST-reacted sperm and total acrosomal changes of yak semen differed significantly ( $P<0.01$ ) between additives and between the seasons, but no difference was observed in their interaction. The total acrosomal changes of yak semen showed interaction between additives and seasons after equilibration and thawing during processing and freezing. Better quality of fresh yak semen was obtained in the autumn season.

Freezing did not seemed to have any effect on *YWHAZ* gene expression but had significantly negative effect on the expression of *CATSPER2* gene during premonsoon, and a positive influence on *PRM1* gene expression in all the seasons. Autumn season

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**Abstract of Ph. D. thesis**

**Department: Animal Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. K. Ahmed**

appeared to have no influence on the expression of *YWHAZ* gene, but had a positive and negative influence on the expression of *CATSPER2* and *PRMI* gene, respectively. Winter season had a positive influence on the expression of *CATSPER2* and *YWHAZ* genes, and a negative influence in the expression of *PRMI* gene. All the three genes showed highly significant positive correlation with most of the characteristics of fresh semen viz. ejaculate volume, sperm motility, sperm concentration, live sperm count, HOST-reacted sperm and intact acrosome, and negative correlation with sperm abnormalities and total acrosomal changes in all the seasons.

Twenty four female yaks were synchronized by ovsynch protocol and following superovulatory treatment with Stimufol (@400 $\mu$ g and @200  $\mu$ g per animal) and Folligon (@1500 IU and @1000IU per animal) in two different doses, a hundred per cent oestrus response was observed in all the groups. The oestrus response, duration of estrus, number of CL and embryo recovered in yaks did not differ significantly between the different treatment groups and animals, but differed significantly ( $P < 0.01$ ) between the treatment and the onset of estrus. The highest number ( $3.50 \pm 0.65$ ) of excellent grade embryos were recovered from the animals treated with Folligon @ 1500 IU per animal. The progesterone concentrations differed significantly between treatment and between different days of observation in all animals of the group. The minimum concentration of progesterone of  $0.19 \pm 0.43$  ng/ml on the day of induced oestrus increased to maximum level of  $25.11 \pm 2.67$  ng/ml on the day 7th of induced oestrus.

# **Anatomical Study of The Post-Natal Development of Male Genital System of Pati Duck (*Anas platyrhynchos*) of Assam**

*Elizabeth VI Hmangaihzuai*

The present study was undertaken to elaborate certain gross anatomical, histomorphological, histochemical, ultrastructural, haematological and serum biochemical aspect of male genital organs of Pati duck (*Anas platyrhynchos*) of Assam during the postnatal development. Total 30 (thirty) numbers of apparently healthy Pati ducks (*Anas platyrhynchos*) were utilized for present study. The testis of Pati duck (*Anas platyrhynchos*) was located within the abdominal cavity. The organ was elongated rice-grain like in 1 month which changed to oval shaped in 20 weeks and bean shaped in 30 and 40 weeks. The epididymis was found on the dorso-medial aspect of testis. The epididymal duct of the testis continued as Vas deferens. The convoluted vas deferens tightly coiled in a zingzag pattern till 20 weeks and the convolutions loosened in 30 and 40 weeks. The vas deferens was translucent in 1 month and 6-8 weeks whereas in 30 and 40 weeks they were opaque white with presence of spermatozoa in the lumen. The phallus coiled in anti-clockwise direction from the base to the apex. The ejaculatory groove and sulcus divide the shaft into two lateral bodies. The length increased with age.

The testis of Pati duck (*Anas platyrhynchos*) had a capsule which had three parts viz., tunica serosa, tunica albugenia and tunica vasculosa. The thickness of the capsule of the testis gradually increased along the advancement of the age i.e. from 1 month to 40 week age group. The collagen, reticular, elastic and nerve fibers were observed within the capsule and as well the peritubular area of the seminiferous tubules. The thickness of the capsule and distribution of all the fibers increased along with the advancement of the age i.e. from 1 month to 40 week age group.

The parenchyma of the testis of the Pati duck (*Anas platyrhynchos*) consisted of complex and convoluted seminiferous tubules separated by interstitial connective tissue. No lobulation and mediastinum testis. The diameter as wells as layers of cell of the ST increased with age. One month and 6-8 weeks birds semiferous tubules were mainly composed of Sertoli cells, spermatogonium cells and vacuolated cells. In 20 weeks the cells were 3 to 5 layers consisting of spermatocyte along with other cells. The ST of 30

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**Abstract of Ph. D. thesis**

**Department: Veterinary Anatomy and Histology**

**Major Adviser: Dr. (Mrs.) Kabita Sarma**

and 40 weeks age groups had 8 to 17 layers of cells formed by different stages of spermatogenesis. The interstitial connective tissue decreased with increased in age. The epididymal region consisted of rete testis which was intracapsular and extracapsular, efferent duct with smooth and folded epithelium, collecting duct and epididymal duct having the same epithelial lining. The vas deferens diameter increased with age. Smooth epithelium at the cranial part and folded epithelium at caudal part. The phallus has a narrow lumen which was surrounded by a very large lymphatic space and vascular body. In the present histochemical study of male genital organ of Pati duck, the reaction of Alkaline Phosphatase enzyme decreased with age in the testis, moderate in the vas deferens and intense in the phallus. The reaction of the Acid Phosphatase moderate in the testis and vas deferens of all age group, while phallus had intense and moderate activity area. The Adenosine Tri Phosphatase (ATPase) activity increased with increased in age in the testis, weak activity in the vas deferens and phallus with intense and weak activity area.

Under TEM two types of leydig cells *viz.*, elongated and polygonal shaped was found, they contain numerous lipid droplets along with mitochondria and endoplasmic reticulum. Sertoli cell had large and irregularly shaped nucleus which had intranuclear cleft. The prominent nucleoli of sertoli cell nucleus had a very dense and moderately dense area. In the peritubular space layers of overlapping myoid cells was found. Within seminiferous tubules cellular detailed of spermatogenic cells were observed. Age related change observed with Testosterone hormone which increased with increased in age. T3 and T4 hormones were higher in younger age while Cortisol was higher in older groups. Among the haematological parameters significant changes was found in PCV, WBC, monocyte and neutrophils. ALP was the only serum enzyme which showed significant changes between age groups. Serum metabolites *viz.*, total protein, albumin and creatinine showed significant changes among the different age group.

# **Molecular Detection and Characterization of Foot and Mouth Disease Virus (FMDV) and Study of Cytokine Expression in Naturally Infected Local/Crossbred Cattle from Assam**

*Derhasar Brahma*

Foot and mouth disease (FMD) is a transboundary and the most contagious disease of cloven-hoofed animals including domestic and wild ruminants and pig, and has a great potential for causing severe economic loss due to loss of production and deprivation from international trade of animal products to FMD free countries. FMDV may occur in all the secretions and excretions of acutely infected animals, including expired air. Following recovery from the acute stage of infection, infectious virus may persist in the oropharynx of some ruminants (carriers), where live virus or viral RNA may continue to be recovered from oropharyngeal fluids and cells for upto 6 months or more. In this study, besides Sandwich ELISA, molecular detection and typing of FMDV was done using multiplex Reverse Transcription Polymerase Chain Reaction (mRT-PCR), Reverse Transcription Loop-mediated Isothermal Amplification (RT-LAMP) and SYBR Green real-time PCR targeting 3D gene. Isolation and molecular characterization of FMDV by sequencing was done. Also, study of expression of cytokines like interferon (IFN- $\alpha$ , IFN- $\beta$ , IFN- $\gamma$ ) as well as certain interleukins (IL-1 $\alpha$ , IL-1 $\beta$ , IL-2, IL-6, IL-10 and IL-12) and tumour necrosis factor (TNF- $\alpha$ ) was estimated at mRNA level by SYBR Green real-time PCR from whole blood (White Blood cells) samples during the natural infection and during the period of persistence. This study was carried out in a total of 129 animals, comprising of 93 crossbred (vaccinated) and 36 local (non-vaccinated) cattle and additionally 12 healthy in-contact animals were taken as control animals. For carrying out this study, Tissue (n=29), whole blood (n=36) and oropharyngeal fluid (n=190) samples were collected as per standard procedure in 50% glycerol, EDTA and 0.8 M PBS/transport media, respectively. OP fluid was collected from recovered animals until complete recovery (i.e. 1st, 3rd, 6<sup>th</sup> and 9th month) from FMD infection. All the RNA extractions were done using Qiagen RNA extraction kit. We found that, out of 29 tissue samples, 20 samples were positive for serotype O, 9

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**Abstract of Ph. D. thesis**

**Department: Veterinary Microbiology**

**Major Adviser: Dr. K. Sharma**

were positive for serotype A and none of the samples was positive for Asia-1 by the multiplex RT-PCR as well as RT-LAMP. FMDV could be detected in 86.21%, 100%, 100% and 100% of tissue samples by sandwich-ELISA, mRT-PCR, RT-LAMP and SYBR Green real-time PCR respectively. Sensitivity test was run using 10 fold serial dilution of RNA extracted from FMDV antigen and found that, the real-time PCR was more rapid and highly sensitive technique of all, secondly the RT-LAMP, followed by the mRT-PCR. From the follow-up cases of the FMD recovered cattle, 38 (23.75%), 47 (29.38%) and 49 (30.63%) OPF samples (n=178) were found to be positive for FMDV by the multiplex RT-PCR, RT-LAMP and SYBER Green real-time PCR respectively, indicating persistence (carriers). The SYBR green real-time PCR was very much useful for detection of persistence from the OPF samples. However, OPF (n=12) and blood (n=12) samples from all the healthy controls and blood (n=12) from persistent animals were negative for FMDV. All blood samples (100%, n=12) from the clinically FMD infected cattle were positive for FMDV. The persistence of FMDV in oropharyngeal region of cattle lasted for upto 3 to 4 months in most of the FMD infected cattle. Persistence in crossbred (vaccinated) cattle didn't last for more than 4 months. Only 2 Local non-vaccinated cattle (1.6%) was found to have persistence upto 6-7 months after infection. The overall number of persistent animals and the rate of persistence in cattle (n=129) at 1st month, 3rd month and 6<sup>th</sup> month were 32 (24.81%), 15 (11.26%) and 2 (1.6%) respectively, and was slightly higher in the local non-vaccinated compared to the crossbred vaccinated cattle. No statistical significance was observed between the two groups as the P value was found to be 0.23 (>0.05) and the Chi-square value was 5.57. The sequencing results showed that the Serotype O sequence (MZ501211-G-02-19, MZ501212-G-03-19 and MZ501213 Op) shared 98.81% identity with Pakistan isolate MN953620, 96.43% identity with India isolate KY579948.1 (Nagaland, submitted by RRC Assam) and 94.05% identity with India complete genome isolate MN983158.1; and the Serotype A sequence (MZ501214-Mg/01/19) shared 95.29% identity with Indian isolate HQ832583.1 and 94.24% identity with Bangladesh isolate KT982204. The identity range was 98.81%-96.43% and 95.29%-92.22% for type O and A respectively, based on the nucleotide sequence Blast search in NCBI. The multiple sequence alignment showed that there are some minor changes in the nucleotide sequences with the consensus sequences. There were nucleotide insertions in the 3953 and 3954 positions in two of the query sequences of FMDV type O. Whereas, in FMDV type A, there were nucleotide insertions at 3807, 3813-3815 and 3841 positions and deletions at 3771 and 3874 positions of the nucleotide sequences. The result from this study shows that cytokine genes had general trend of upregulation during acute infection and decreased level of expression or down regulation during persistence. Cytokines in blood were generally upregulated in both acute infection and persistence, but compared to acute, there was decreased mRNA level of expression of cytokines during persistence except the down regulation of IFN- $\beta$ , IL-2 and IL-6, whereas, all but IFN- $\alpha$  and IL-1 $\alpha$  were down regulated in OPF during persistence. These cytokines may have certain role in persistence of FMDV by suppression of immune response and also by having anti-

inflammatory or immunomodulatory response in carrier cattle. Thus, from this study, we can conclude that, molecular detection techniques are the most sensitive and specific techniques for detection of FMDV and particularly for diagnosis of persistence from OPF samples. Persistence occurred in 32 cattle (25%) after 1st month of the FMDV infection, out of which the proportion of local non-vaccinated cattle was slightly higher. And that cytokines may have a role in persistence of FMDV in cattle.

## **Ph.D (Home Science)**

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

# **Improvement of Health Condition of Rural Women of Assam through Intervention Programme on Nutrition and Hygiene**

*Ingita Gohain*

The study entitled “Improvement of Health Condition of Rural Women of Assam through Intervention Programme on Nutrition and Hygiene” was undertaken with the objectives: i) To assess the existing knowledge of the respondents on nutrition and hygiene. ii) To study the existing practices of the respondents on nutrition and hygiene. iii) To find out the relationship between knowledge of respondents with their practices. iv) To study the effect of intervention programme designed for the respondents on nutrition and hygiene in terms of gain in knowledge and adoption of practices. Nutrition and hygiene are the two important aspects of good health. Health of an individual depends on the type of nutrition that he/she takes and the hygienic habits performed in their day to day life. The present study was done in three districts of Assam, namely, Tinsukia, Nagaon and Barpeta with a total of 270 nos. of respondents belonging to reproductive age. They were selected randomly. The data were collected personally through interview schedule with the help of two knowledge checks. The findings of the study revealed that majority of respondents in all the three assessed districts were from middle age group (30-40 years). Most of the respondents were married, namely, Barpeta district (96.67 %) followed by Nagaon district (93.33 %) and Tinsukia district (90.00 %). Majority of the respondents (52.22 %) in Barpeta district had education up to high school level whereas, in Nagaon district, majority of the respondents (46.67 %) were ‘primary school passed’ and in Tinsukia district, a sizeable percent of respondents (31.11 %) were HSLC passed. Majority of the respondents (92.22 %) in Barpeta district and Tinsukia district (87.78 %) belonged to nuclear type of family, whereas in Nagaon district, almost half (53.33 %) of the respondent belonged to joint family and 42.22 percent belonged to nuclear family. Majority of the respondents belonged to small family, that is, up to 5 members, namely, Barpeta district (97.78 %), Nagaon district (60.00 %) and Tinsukia district (87.78 %). Majority of the respondents in the three districts had sometimes exposure to mass media, namely, Barpeta (94.44 %),

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**Abstract of Ph. D. thesis**

**Department: Extension and Communication Management**

**Major Adviser: Dr. (Mrs.) Juliana Sarmah**

Nagaon (85.56 %) and Tinsukia (68.89 %). Almost half of the respondents in Barpeta district (51.11 %) had a monthly income of Rs. 10,000 – Rs. 15,000 whereas majority of the respondents in Nagaon district (64.44 %) and Tinsukia district (71.11 %) had a monthly income of Rs. 5,000 – Rs. 10,000. Majority of respondents in all the districts under study had membership in one organization, that is, Barpeta (85.55 %), Nagaon (82.22 %) and Tinsukia (96.67 %). Majority of the respondents had ‘rare urban contact’, that is, Barpeta (64.44%) and Nagaon (93.33%). In Tinsukia district, majority (88.89%) of the respondents had occasional urban contact. 90.00 percent of respondents from Nagaon district had rarely contacted extension personnel followed by 61.11 percent (Barpeta district). In Tinsukia district, majority (67.78 %) of respondents had sometimes contacted the extension personnel. The results also revealed that in the three assessed districts, majority of the respondents did not attend training programme on nutrition and hygiene provided by any organization. Only a negligible percentage of respondents from Barpeta (7.78%) and Nagaon (4.44%) had received training on nutrition and hygiene. It was also found that only 14.44 percent of respondents had high level of knowledge on nutrition and only 17.04 percent belonged to high category of knowledge level on hygiene. Again, it was revealed that only 10.74 percent of respondents belonged to ‘good category’ of practice regarding nutrition and 20.74 percent of respondents belonged to ‘moderate category’ of practice on hygiene. The findings also revealed that there was positive and highly significant relationship between the knowledge of respondents with their practice regarding nutrition. It also revealed that there was positive and highly significant relationship between the knowledge of respondents with their practice regarding hygiene. Based on the existing level of knowledge and practice on nutrition and hygiene, Nagaon district was considered for administering Intervention Programme on nutrition and hygiene as Nagaon district had the highest percentage of respondents with low level of knowledge. A total of thirty (30) respondents were selected for the Intervention Programme from Nagaon district. The Intervention Programme comprised of Lecture cum Discussion, Method Demonstration and Docu-film show on nutrition and hygiene. Post exposure data was collected with the same knowledge checks from the thirty (30) respondents at two stages: immediately after the Intervention Programme to assess the gain in knowledge on nutrition and hygiene and after 15 days of intervention programme to assess the retention of knowledge and adoption of practices on nutrition and hygiene. It was found that, there was gain in mean knowledge score 29.54 (52.75 %) and mean retention score 22.74 (40.61 %) regarding nutrition. Again, there was gain in mean knowledge score 16.06 (53.33 %) and mean retention score 10.83 (36.10 %) regarding hygiene after respondent’s exposure to the Intervention Programme. The result also revealed that, there was an increase in mean adoption of practices score 5.27 (17.57 %) regarding nutrition after 15 days of Intervention Programme and mean adoption of practices score 7.7 (25.67 %) regarding hygiene which means that the respondents have adopted to some of the practices which were disseminated through the Intervention Programme.

## **Master of Science (Agriculture)**

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- **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**

# **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.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biochemistry**

**Major Adviser: Dr. Priyanka Das**

## **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  $\beta$ -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. Thirty-five (35) previously isolated fungal isolates were taken for the study. Preliminary plate screening of the isolates revealed xylanase activity in four isolates viz. *Lentinussquarrosulus*, *Fusariumoxysporum*, *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 7<sup>th</sup> day of inoculation in *Lentinussquarrosulus*, *Fusariumoxysporum*, whereas *Fusariumfujikuroi* and *Lentinussajor-caju* showed the highest xylanase activity on the 5<sup>th</sup> and 9<sup>th</sup> 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. *Fusariumoxysporum* showed the highest xylanase activity ( $28.71 \pm 0.11$  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 analysis indicated the presence of multiple subunits in the xylanase enzyme. Xylanase activity and stability were optimized in different pH and

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. R. C. Boro**

temperatures. All the samples are pH and temperature specific and highly stable at 5.0-6.0 pH and 20 o C-50 o C. Further studies with improved purification techniques will pave the way for purified xylanase enzyme that may be useful in different industrial purposes.

# **Nutritional and functional properties of sprouted mung beans**

*Manne Hemanth Kumar*

Mung bean/Green gram [*Vigna radiata* (L.) R. Wilczek] is a most widely grown crop next to chick pea and pigeon pea. Cooking and traditional processing like sprouting have been known to increase protein, minerals and protein digestibility. In the present investigation, nutritional and functional properties of sprouted mung bean seeds were analyzed. Mung bean seeds were sprouted for 24, 48, 72 and 96h under dark at 25°C ±2. The sprouted mung bean seeds were found varying significantly in different parameters studied. Sprout length of the sprouted mungbean ranged from 4.67 to 42.56mm and the highest sprouting rate was recorded at 96h sprouting period as 85.50%. Moisture content ranged from 10.70 to 84.09%, crude protein from 22.93 to 27.65%, crude fibre from 2.33 to 6.77% and ash content varied from 3.13 to 4.30% with an increasing nature from 0hr to 96h sprouting periods respectively while crude fat, starch, carbohydrate content significantly decreased from 2.20%, 47.41% and 69.42% to 0.84%, 39.67% and 60.44% respectively after 96h sprouting period. Sprouted mung beans were found rich in potassium which ranged from 810.18mg to 1121.43mg/100g, phosphorous ranged from 372.11 to 433.30mg/100g, calcium ranged from 73.23 to 101.25mg/100g and iron ranged from 6.92 to 10.66mg/100g. Sodium content increased from 5.02 to 16.17mg but decreased in 96h sprouting to 4.42mg/100g. Vitamin C ranged from 3.98 to 24.42mg, niacin ranged from 74.18µg to 999.28µg/g at 0h to 96h sprouting period respectively. Riboflavin content (2.19µg/g) increased upto 48h and then decreased to 0.01µg/g on further sprouting. Thiamine content increased from 50.94µg to 135.52µg/g and decreased to 13.02µg/g at 96h sprouting period. Protein digestibility had shown a significant increase during sprouting. Pepsin digestibility for 24h incubation showed higher (87.56%) digestibility than 2h incubation period (81.85%) whereas, trypsin digestibility showed lower digestibility (78.38%) than the pepsin digestibility. From the present study, it can be concluded that among the sprouted mung beans 96h sprouting period reported high content of nutritional and functional properties expect for fat, starch and carbohydrate where raw seeds reported high content, for thiamine and sodium 72h has recorded highest value and riboflavin reported highest value at 48h. Among the three varieties SGC-20 and SGC-16 had better nutritional quality as compared to IPM-02-3 and can be recommended for consumption as sprouts.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biochemistry**

**Major Adviser: Dr. Sunayana Rathi**

## **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

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. T. Nath**

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 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.

## ***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 the explant with ascorbic acid. Hence, for Bhimkol the *in vitro* regeneration protocol

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. Priyadarshini Bhorali**

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 *hptIII* 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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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. A. Baruah**

## ***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 3<sup>rd</sup> 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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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. Salvinder Singh**

# **Molecular Cloning and characterization of gene encoding eIF4E from Bhutjolokia (*Capsicum chinense* Jaqc.)**

*Sanjukta Singha*

“Bhutjolokia” (*Capsicum chinense* Jaqc.) also known as King chilly, belongs to solanacea family. It is well known for its high capsaicin content, refreshing aroma, palatability and medicinal properties. Productivity of this important cash crop is extensively hindered by different biotic and abiotic stress viruses. Viruses require components from the host cell to complete their replication cycles. Various studies shows that eIF4E(translation initiation factor) and its regulatory cellular proteins are manipulated during viral infections. Thus, abolishment of this interaction and understanding the mechanisms that control the development of natural viral resistance can be the basis for selection of new sources of resistance and for the intelligent design of engineered resistance that is broad-spectrum and durable. Therefore, the present study aims to clone and characterize the gene encoding eIF4E from *Capsicum chinense* Jaqc. The partial cDNA sequence of cceIF4E was amplified using designed degenerate primers, by aligning the complete sequences (CDS) of eIF4E gene of various plant species (viz. *Capsicum annum*, *Capsicum baccatum*) having similarity percentage > 80% . The amplified product obtained was sequenced. The sequence of 249 bp was obtained and a number of two gene specific primer pairs were designed. Amplified products with gene specific primers were sequenced having length of 309nt and 462nt respectively. Sequenced overlapping gene specific and degenerate primer products were aligned and end to end primer was designed with an expected product length of 700bp. Eluted amplified product was ligated in PGEMT easy vector. Chemically competent *E.coli* strain JM-109 cells were transformed with recombinant vector. Recombinant bacterial colonies were selected through blue-white screening. Colony PCR was performed to confirm the ligation of eIF4E gene sequence into vector followed by identification of 687bp long scaffold through sequencing. Functional and structural analysis was performed through CDD, ORF finder, conceptual translation in ExPASy, BLASTP, MSA, PSIPRED, Swiss-Modeller, PROCHECK, PROSA, GROMACS and MEGA6. It has been found that the obtained sequence has a conserved domain belongs to eIF4E super family that codes for 228 amino acid long stable protein with 11 alpha helices and 7 beta strands which closely relates with *C. annum*.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. Ratna Kalita**

## **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 CH<sub>2</sub>-CH<sub>2</sub> 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.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Biotechnology**

**Major Adviser: Dr. Basanta K. Borah**

# **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

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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. J. P. Hazarika**

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.

# **Impact of Agriclinc 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 "Agriclinc and Agribusiness Centres" was launched on 9<sup>th</sup> 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 Agriclinc 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 Agriclinc 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.

# **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. Dipanjan Kashyap**

## **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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**Abstract of M.Sc. thesis**

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**Major Adviser: Dr. R. S. Saikia**

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.

## **Impact of soil health Card scheme on Farmer's income in Nagaon district of Assam**

*Parthana Gogoi*

With the new prominence on sustainable agriculture the interest in soil health is reawakening. Poor quality soils are generally vulnerable to weather variations throughout the growing season and which do not support optimum plant growth. Imbalanced and inappropriate use of chemical fertilizer affects soil fertility, crop yield and thus the income of the farmers. Soil testing plays a very important role in diagnosing the physical, chemical and biological properties of the soils and provides unswerving information about the exact amount of fertilizer dose required. So Soil Health Card scheme was initiated by the Government of India in February 2015 by the Department of Agriculture & Co-operation under the Ministry of Agriculture and Farmers' Welfare. In Assam 14, 53,358 no of cards were distributed which accounts to 53.82 per cent of the total 27 lakhs farm families. A total of 57,769 cards were distributed in Nagaon where present study was conducted. The present paper attempts to analyse the change in resource use pattern and its impact on farmers' income, factors affecting the use of Soil Health Card and to explore the problems and prospects associated with the use of Soil Health Card. The study was conducted in Nagaon district of Assam with 80 respondents. The primary data were collected by personal interview method during Feb.-March. Most of the respondents were between the age group 15 to 59 years with most of them having primary level of education. From the study it was found that there was difference in the resource use in rice cultivation under SHC users and SHC nonuser's farms which was supported by t-test. The change in some inputs like FYM, fertilizer irrigation were found to be significant and positive. The yield advantage of rice cultivation for Soil health card user was found to 16.07 per cent over rice cultivation of the soil health card non-user which may be due to the supply of the right amount of fertilizer need for the growth of the crop. With more education farmer, more training, more awareness and more experience in farming the adoption of soil health card was found to be increased. Although the cost of cultivation of rice for soil health card user was comparatively more than the cost incurred by the soil health card non-user, but due to yield advantage the return over cost was more for the soil health card

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user. The gross returns obtained by soil health card user and soil health card non-user were Rs.78477.00 and 65868.00, respectively. The return over cost ratio for soil health card non-user was 1.65 and 1.85 for soil health card user. No technical advices after distribution of SHC were hampering the adoption of soil health card. Lack of awareness on the process of soil testing by grid system made the farmer hard to trust about the dose mentioned in the cards. The study concluded that the SHC scheme had a lofty scope of increasing the income of the farmer but the scheme could not bring substantial positive change in the Nagaon district of Assam in the initial years of its distribution because of low rate of adoption of the soil health cards, which solicit for mass awareness campaign using the concept of the judicious use of fertilizer as per dose recommended on the soil health card. The recommended dose should be given in regional or vernacular languages so that the farmers could easily understand the doses in the card. The farmers also should be given advisory services and training along with technical supervision on the use of soil health cards and make agriculture more sustainable and productive.

## **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. R. S. Saikia**

# **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. P. B. Gogoi**

## **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. J. P. Hazarika**

# **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. Riaz Abdul Halim**

## **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM**

**Major Adviser: Dr. J. P. Hazarika**

# **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 belerica*), 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

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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM (MBA)**

**Major Adviser: Dr. Nivedita Deka**

marketing channels were identified for the Assam Prakritik Udyog for their products. 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.

## **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.

# **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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**Abstract of M.Sc. thesis**

**Department: Agricultural Economics & FM (MBA)**

**Major Adviser: Dr. A. K. Das**

## **Effect of elevated CO<sub>2</sub> 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 CO<sub>2</sub> and temperature under different transplanting dates on growth and yield of rice variety Ranjit. The treatment composed of three CO<sub>2</sub>-temperature levels [T<sub>0</sub>: ambient temperature & ambient CO<sub>2</sub>, T<sub>1</sub>: elevated temperature (ambient +1°C) & elevated CO<sub>2</sub> (ambient+25% of ambient) and T<sub>2</sub>: elevated temperature (ambient +2°C) & elevated CO<sub>2</sub> (ambient + 50% of ambient)] and three dates of transplanting (D<sub>1</sub>: 25<sup>th</sup> June, D<sub>2</sub>: 10<sup>th</sup> July and D<sub>3</sub>: 25<sup>th</sup> July). The experiment was conducted in three CO<sub>2</sub> 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 CO<sub>2</sub>-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 T<sub>2</sub> and T<sub>1</sub> respectively compared to T<sub>0</sub> and by about 10 days and 5 days in D<sub>3</sub> and D<sub>2</sub> respectively compared to D<sub>1</sub>. 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 25<sup>th</sup> June onwards during vegetative, reproductive and maturity stages irrespective of CO<sub>2</sub>-Temperature treatments. Similarly, accumulated agro-climatic indices decreased under elevated CO<sub>2</sub>-Temperature during vegetative stage but increased during reproductive and ripening phases of the crop. Plant height and tiller number was recorded highest under T<sub>2</sub> followed by T<sub>1</sub> compared to T<sub>0</sub>, which decreased with delay in transplanting. Both plant height and number of tillers differed significantly in CO<sub>2</sub>-temperature treatment as well as dates of transplanting. Number of panicles hill<sup>-1</sup>, panicle length, number of filled grains panicle<sup>-1</sup> and 1000-grain weight were significantly influenced by elevated CO<sub>2</sub>-temperature levels and date of transplanting. Number of panicles was greater but filled grains panicle<sup>-1</sup> slightly reduced under T<sub>2</sub>. With respect to dates of transplanting, D<sub>2</sub> recorded higher number of

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panicles hill<sup>-1</sup> (17.9) and higher filled grains panicle<sup>-1</sup> (156.6). Higher grain yield (55.9g hill<sup>-1</sup>) attributed to higher number of panicles hill<sup>-1</sup> and filled grains panicle<sup>-1</sup> was observed under T<sub>2</sub> which was at par with T<sub>1</sub> and it was statistically significant over ambient. Grain yield significantly reduced (40.6g hill<sup>-1</sup>) when transplanting was delayed after 10<sup>th</sup> July. Similarly, straw yield and above ground biomass at harvest were significantly increased with CO<sub>2</sub>-temperature elevation but reduced with delay in transplanting. Though the interaction effect of CO<sub>2</sub>-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 CO<sub>2</sub>-temperature levels when transplanted on 10<sup>th</sup> 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 ( $P_1$  - 10<sup>th</sup> Nov,  $P_2$  - 20<sup>th</sup> Nov,  $P_3$  - 30<sup>th</sup> Nov and  $P_4$  - 10<sup>th</sup> Dec) in main plots and mulches ( $M_0$  - non mulch,  $M_1$  - water hyacinth and  $M_2$  - 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  $P_1$  recorded highest (83.3mm) soil moisture depth, followed by  $P_4$  (82.0 mm),  $P_2$  (81.8 mm) and  $P_3$  (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 evening as compared to non mulched treatment. No considerable difference in incident

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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 ( $386.77 \text{ g m}^{-2}$ ) and lowest in non-mulched ( $241.63 \text{ g m}^{-2}$ ). Highest average total dry matter accumulation was obtained in  $P_1$  ( $465.2 \text{ g m}^{-2}$ ) followed by  $P_2$  ( $431.6 \text{ g m}^{-2}$ ),  $P_3$  ( $309.6 \text{ g m}^{-2}$ ) and  $P_4$  ( $284.8 \text{ g m}^{-2}$ ). The tuber yield was found to be highest on  $P_1$  ( $135.6 \text{ q ha}^{-1}$ ) followed by  $P_2$  ( $118.3 \text{ q ha}^{-1}$ ),  $P_3$  ( $86.3 \text{ q ha}^{-1}$ ) and  $P_4$  ( $60.0 \text{ q ha}^{-1}$ ). The RUE for tuber yield was highest under water hyacinth ( $2.35 \text{ g MJ}^{-1}$ ) followed by black polythene ( $2.03 \text{ g MJ}^{-1}$ ) and non-mulched ( $1.67 \text{ g MJ}^{-1}$ ) 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  $R^2$  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 12 th SMW (19 th – 25 th March) to 41 st (8 th –14 th Oct) and 42 nd SMW( 15 th – 21 st Oct) in all the districts. The consecutive probability of occurrence of wet spell of two weeks is more than 50% from 13 th (26 th march – 1 st April) and 15 th SMW (9 th – 15 th April) onwards in Sivasagar and Golaghat, respectively whereas the such condition occurs from 12 th 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 (26 th – 28 th SMW), Sivasagar (25 th – 28 th ), Dibrugarh (23 rd – 31 st ) and Tinsukia (22 nd – 29 th , 31 st , 32 nd 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

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higher before 12 th SMW and after 42 nd SMW, but during monsoon season it was found to be very less which indicates that kharif crops can be grown without any supplemental irrigation. From the result of forward and backward accumulation method it was found that during pre –monsoon season there was accumulation of 75 mm rainfall within 13 th – 15 th SMW and 200mm rainfall within 16 th – 19 th SMW in all the districts which indicates that sowing of summer crops can be started within these weeks. During monsoon season the mean week for onset of rainy season was found to be within 23 rd – 24 th SMW for 75mm rainfall and 25 th – 26 th SMW for 200mm rainfall in the districts. The mean week for withdrawal of rainy season was found to be within 34 th – 37 th SMW (20 th Aug – 16 th Sept) for 300mm rainfall and 31 st to 35 th SMW (30 th Aug – 2 nd Sept) for 500mm rainfall for all the districts. Sowing of summer crops such as greengram, blackgram, ahu rice were suggested to complete within 12 th SMW onwards for all the districts. Nursery bed preparation for sali rice can be started as early as 18 th SMW in the district of Jorhat, Dibrugarh and Tinsukia. Sowing of kharif greengram blackgram could be started after 34 th SMW and rabi crops and sowing of vegetables could be started after 40 th 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 (Epan). 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 Epan 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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## **Regional Disparities of Selected Fruit Crops in Tamil Nadu**

*Ananth. R*

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 Adviser: 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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**Abstract of M.Sc. thesis**

**Department: Agricultural Statistics**

**Major Adviser: Dr. Hemanta Saikia**

## **Response of baby corn (*Zea mays* L.) to lime and manures**

*Abdul Rahman Munib*

A field experiment entitled ‘Response of baby corn (*Zea mays* L.) to lime and manures’ was carried out in the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during summer season of 2019. The treatment consisted of seven different sources of nutrients viz., T1: Control, T2: Enriched compost, EC (2.5 t/ha) , T3: FYM (2.5 t/ha) , T4: Lime (50% LR) + FYM (2.5 t/ha) + ash (2.5 kg/ha), T5: Lime (50% LR) + EC (2.5 t/ha) + ash (2.5 kg/ha) , T6: EC (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 days after sowing (DAS) and T7: FYM (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 DAS . The experiment was laid out in a randomized block design (RBD) with four replications with objectives to study the performance of baby corn under nutrient management practices through lime and manures and to evaluate the effect of lime and manures in baby corn under rain-fed condition. . The soil of the experimental site was sandy loam in texture, medium in available N (285.36 kgha-1), P2O5 (22.85 kgha-1) and K2O (138.04 kgha-1) and organic carbon (0.62%) with pH value of 5.2. The baby corn variety “G-5414” was used. Sowing of seeds was done manually at a spacing of 45 cm x 20 cm on 20th March 2019 and harvesting by picking was started on 30th May 2019 and completed on 17th June 2019. The rainfall received during the crop season was only 680 mm. The weekly average maximum temperature ranged from 24.9 to 32.9°C and minimum temperature 16.0C to 26.1°C, respectively. Experimental findings revealed that the treatment, T6 consisting of application of EC (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 (DAS) recorded the highest values for all growth characters in terms of plant height, number of leaves per plant and dry matter accumulation and yield attributing characters viz. number of cobs /plant, length of cob, and weight of individual cob, both with husk and without husk. In case of cob yield with husk, corn yield and green fodder yield, the treatment with application of EC (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 (DAS) i.e. (T6) recorded the highest value of 42.88 q/ha, 6.63 q/ha and 24.62 t/ha, respectively which were significantly higher than all other treatments. The nutrient (NPK) uptake of baby corn was found to be the highest

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**Major Adviser: Dr. Kalyan Pathak**

under the treatment with application of EC (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 DAS (T6) followed by application of FYM (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 DAS (T7). In terms of economics, the highest gross return ( . 1, 96,150.00 ha-1) and Net return ( 1,57,590.00 ha-1) were recorded with application of EC @ (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 days after sowing whereas with application of FYM @ (2.5 t/ha) + Lime (25kg/ha) + ash (2.5 kg/ha) mixture at sowing and 30 days after sowing registered the highest benefit -cost ratio(4.86 ).

## **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-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively, application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively + 1.25t/ha vermicompost and application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, 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), P<sub>2</sub>O<sub>5</sub> (20.40 kg/ha) and available K<sub>2</sub>O (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-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, 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 N<sub>3</sub>. 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 N<sub>3</sub>. The highest seed yield (1249.99 kg/ha), stover yield (2046.76 kg/ha) was thus recorded with this treatment.

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**Abstract of M.Sc. thesis**

**Department: Agronomy**

**Major Adviser: Dr. J. K. Choudhary**

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 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.*, I<sub>0</sub>-Rain-fed, I<sub>1</sub>-Mulching with rice straw @5t/ha, I<sub>2</sub>- One irrigation at 50% flowering, I<sub>3</sub> - One irrigation at 50% flowering + mulching with rice straw @5t/ha and I<sub>4</sub>- Two Irrigations at 50% flowering and at pod development stages and three levels of integrated nutrient management practices *viz.*, N<sub>1</sub>- Recommended dose of fertilizers (RDF), N<sub>2</sub> - 50% N of RDF + 50% N as FYM and N<sub>3</sub> - 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 P<sub>2</sub>O<sub>5</sub> (22.95 kg/ha) and available K<sub>2</sub>O (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.

## **Performance of baby corn varieties under different levels of fertilizers during summer season**

*Dhabanita Medhi*

A field experiment entitled 'Performance of baby corn varieties under different levels of fertilizers during summer season' was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *summer* season of 2018 to find out a suitable variety and a suitable fertilizer dose required for baby corn cultivation. The experiment consisted of three baby corn varieties *viz.*, VL Baby corn-1(V<sub>1</sub>), CMVL Baby corn -2(V<sub>2</sub>) and G-5414(V<sub>3</sub>) and four fertilizer levels *viz.*, 60-40-40 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha (F<sub>1</sub>), 75-50-50 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha (F<sub>2</sub>), 90-60-60 N- P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha (F<sub>3</sub>) and 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha (F<sub>4</sub>). The treatments were laid out in split plot design and replicated thrice with varieties in the main plot and fertilizer levels in the sub-plot. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH- 5.15), medium in organic carbon (0.68%), low in available N (198.19 kg/ha), medium in available P<sub>2</sub>O<sub>5</sub> (27.48kg/ha) and available K<sub>2</sub>O (158.23 kg/ha).

Experimental findings revealed that among the three varieties tested, CMVL Baby corn -2 recorded the highest plant height which was at par with G-5414. VL Baby corn -1 took lesser days for tasseling, silking and harvest initiation compared to G-5414 and CMVL Baby corn -2. Number of cobs per plant, cob girth and weight of each cob with and without husk was higher for G-5414 whereas cob length was higher for CMVL Baby corn-2. Cob yield both with and without husk was the highest for G-5414 i.e. 86.07 q/ha and 18.78 q/ha respectively, whereas CMVL Baby corn-2 recorded the highest green fodder yield (247.02 q/ha) which was at par with G-5414 (244.96 q/ha). The total N, P and K uptake was recorded the highest for G-5414.

Application of different levels of fertilizer doses showed significant effect on plant height which was recorded the highest with the application of 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha. The number of green leaves, dry matter production and LAI as well as yield attributing characters like number of cobs per plant, length and weight of the cob with and without husk as well as cob yield with husk (89.07 q/ha) and without husk (18.39 q/ha) and green fodder yield (249.99 q/ha) were recorded the highest with the

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application of 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha but was at par with the application of 90-60-60 N- P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha. The highest nutrient content and total uptake was obtained with the application of 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha which was at par with 90-60-60 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha. Application of 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha recorded significantly higher available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O (kg/ha) in the soil after harvest over rest of the treatments.

In terms of economics, the highest gross returns (₹174746.62), net returns (₹139895.63) and B: C ratio (4.01) were recorded with the variety G-5414. Application of 105-70-70 N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha resulted in the highest gross return (₹172153.87) and net return (₹135190.60) but the highest B: C ratio (3.73) was obtained from treatment 90-60-60 N- P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O kg/ha.

## **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.*, 20<sup>th</sup> February (D<sub>1</sub>), 2<sup>nd</sup> March (D<sub>2</sub>), 12<sup>th</sup> March (D<sub>3</sub>), 22<sup>nd</sup> March (D<sub>4</sub>) in main plot and four planting geometry practices *viz.*, 40 cm x 20 cm (S<sub>1</sub>), 40 cm x 25 cm (S<sub>2</sub>), 45 cm x 20 cm (S<sub>3</sub>), 45 cm x 25 cm (S<sub>4</sub>), 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 P<sub>2</sub>O<sub>5</sub> (25.36 kg/ha), available K<sub>2</sub>O (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 2<sup>nd</sup> 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 12<sup>th</sup> 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, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O (kg/ha) status of soil after harvest.

In terms of economics, among all the dates of sowing, the 2<sup>nd</sup> 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 12<sup>th</sup> 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.

## **Estimation of Crop Water Footprint in Jorhat District of Assam**

*Grety 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 ETgreen and ETblue of water footprint was calculated using CROPWAT 8.0 model. After that WFgreen, WFblue and WFGrey 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 WFgreen and WFblue analysis. WFgreen in cubic meter per ton was found to be the highest in winter rice and lowest in tomato among all the crops. WFblue was recorded highest for tea. WFgreen 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 WFblue was recorded the highest in pea and lowest in tomato. WFblue 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 m<sup>3</sup>/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.

# **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* (P 1 ), *Pseudomonas fluorescens* (P 2 ) and no inoculation (P 3 ) and four weed management practices viz., Pretilachlor @ 0.75 kg/ha (W 1 ), Pretilachlor @ 0.75 kg/ha followed by 1 hand weeding at 30 DAS (W 2 ), three hand weedings at 15, 30 & 45 DAS (W 3 ) and weedy check (W 4 ). 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), P 2 O 5 (22.28 kg/ha) and K 2 O (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*. 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

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in three hand weeding done at 15, 30 & 45 DAS. Better growth and yield attributing characters of rice with three hand weeding 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 weeding at 15, 30 & 45 DAS. The combination of *Pseudomonas fluorescens* with either three hand weeding 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.

## **Nutrient and weed management in rainfed toria by organic methods**

*Prostuti Borah*

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), P<sub>2</sub>O<sub>5</sub> (21.87 kg/ha) and K<sub>2</sub>O (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 attributing characters of rainfed toria improved significantly with this treatment which

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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).

## **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 weedings 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 unioloides*, 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/m<sup>2</sup> and plant height at all growth stages compared to dry seeding. Similarly, wet seeding recorded significantly highest yield attributes i.e. number of panicles/m<sup>2</sup> (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 pre-emergence 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).

## **Organic weed management in aromatic rice under two different systems of establishment**

*Yerradoddi Sindhu Sree*

A field experiment on organic weed management in aromatic rice under two different systems of establishment was carried out during sali season of 2019 in organic block of Instructional-cum-Research farm of Assam Agricultural University, Jorhat to study the effects of different organic weed management practices on weed dynamics, growth and yield of aromatic rice (cv Kola Joha). The experiment was laid out in split-plot design with three replications. The treatment consisted of two systems of establishment viz., transplanting and direct seeded (wet seeding) method in the main plot and five organic weed management practices viz., weedy check, hand weeding at 20 and 40 DAT/DAS, weeding with rotary weeder at 20 and 40 DAT/DAS, weeding with cono weeder at 20 and 40 DAT/DAS and intercropping of dhaincha and incorporation at 40 DAT/DAS in the sub-plots. The soils of the experimental site was sandy loam in texture with pH 5.9, medium in organic carbon (0.58%), low in available N (242.5 kg ha<sup>-1</sup>), low in available P<sub>2</sub>O<sub>5</sub> (18.60 kg ha<sup>-1</sup>) and medium in available K<sub>2</sub>O (140.6 kg ha<sup>-1</sup>). Total rainfall received during the crop growth period was 1445.8 mm distributed in 63 rainy days. The experimental field was infested with different types of grasses viz., *Echinochloa crusgalli*, *Eragrostis japonica*, sedges viz., *Cyperus iria*, *Cyperus difformis* and broad leaved weeds viz., *Acmella paniculata*, *Hydrolea zeylanica*, *Ludwigia hyssopifolia*. The density and dry weight of weeds were found significantly lesser in transplanting method which resulted significantly lower N, P and K content and uptake by weeds as compared to direct seeded (wet seeding) rice. The growth parameters viz., plant height, number of leaves, plant dry matter m<sup>-2</sup> and yield attributing characters viz., number of tillers m<sup>-2</sup> (207), panicle length, panicle weight, number of filled grains per panicle, test weight as well as grain yield (18.17 q ha<sup>-1</sup>) and straw yield (22.4 q ha<sup>-1</sup>) were significantly higher under transplanting system as compared to direct seeded (wet seeding) rice. Different organic weed management practices significantly influenced the weed density and weed dry weight; N, P and K content and uptake by the weeds and rice crop as well as growth, yield attributes and yield of aromatic rice. Significantly lesser weed density, weed dry weight, N, P and K

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content and uptake by weeds were recorded with hand weeding at 20 and 40 DAT/DAS. Nitrogen content in rice grain and straw was significantly highest with intercropping of dhaincha and incorporation at 40 DAT/DAS whereas P and K content; N, P and K uptake was found highest with hand weeding at 20 and 40 DAT/DAS. The significantly highest number of effective tillers m<sup>-2</sup> (231), grain yield (21.95 q ha<sup>-1</sup>) and straw yield (35.03 q ha<sup>-1</sup>) were recorded with hand weeding at 20 and 40 DAT/DAS. The interaction between organic weed management and systems of establishment was found significant in respect of weed density, dry matter, number of effective tillers m<sup>-2</sup>, nutrient content and uptake, grain yield and straw yield. The highest yield (27.50 q ha<sup>-1</sup>) and net return (₹ . 90356.00 ha<sup>-1</sup>) was recorded with hand weeding at 20 and 40 DAT under transplanted method of establishment. However, due to comparatively lower cost of cultivation, the highest B: C (2.61) ratio was obtained with intercropping of dhaincha and incorporation at 40 DAT under transplanted method of establishment with a grain yield (22.4 q ha<sup>-1</sup>).

## **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 36°C, 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, Titabar in 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 bombo 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 1-3.50°C over the ambient temperature and minimum temperature had increased by 0.5-1.50°C. 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 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

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**Department: Crop Physiology**

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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, IET 26760, 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  $\mu\text{M}$  Al and 100  $\mu\text{M}$  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  $\mu\text{M}$  Al ( $T_1$ ), 200  $\mu\text{M}$  Al ( $T_2$ ), and 300  $\mu\text{M}$  Al ( $T_3$ ) along with a control ( $T_0$ ) 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, photosynthesis 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 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 Al in the present investigation.

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**Major Adviser: Dr. P. C. Dey**

## **Nutritional composition of some commonly available aquatic edible insects of Assam**

*Mintu Sarmah*

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.

## **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%), 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

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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 Borah*

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 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

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**Major Adviser: Dr. Sundar Barman**

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 Effectiveness of Skill Training of Rural Youth (STRY) Programme Implemented by KVKs in Assam**

*Darpan Kumar 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.

## **Assessment of farmers' income in paddy based farming systems: a study in Jorhat district of Assam**

*Gajendra N. G*

Paddy based farming system has a vast scope in improving the productivity and profitability of farms and also reducing the maximum utilization of off-farm inputs by way of effective recycling of on-farm resources. Several researches have been taken up by various scientists on farming systems in different parts of the country and outside to access its affects on productivity, profitability, income generation, and employment generation. In order to improve the socio-economic conditions, paddy based farming system is considered as a suitable option as it helps them to increase their income level on sustainable basis and employment opportunity around the year. The present study was carried out to find out the income level in paddy based farming systems, in Jorhat district of Assam where two sub-divisions were randomly selected for the study. The review of literature was collected from international, national and regional/state sources. An interview schedule was followed consisting of both respondents based on the objectives of research. In particular cases, relevant measurement techniques/ scales were selected for scoring the data. From the study it was revealed that among 13 paddy based farming systems the farming system 9 (Paddy+Vegetables+Cow+Goat+Chicken+ Duck+Piggery) had highest income level with an average income of Rs 120547 and farming system 11 (Paddy+ Cow +Chicken+Goat+Pigeon) had lowest income level of Rs 23529 – Rs71312 with an average income of Rs 47421. It was revealed that there is a significant relationship between income level of farmers with age, family size, operational landholding, extension contact, Mass media exposure, cropping intensity and degree of commercialization. And it was also observed 6 other farming systems and study revealed that among 7 categories of constraints, Quality of road is poor to the nearest market from transport related constraints, Lack of knowledge on

integration aspects of sub systems from the extension constraints, Non-availability of labour from economic constraints, Shortage of water by the end of the season from technical constraints, Lack of composite credit facilities from credit related constraints, Lack of

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organized milk marketing facilities in the village from the market related constraints and flood from biological constraints are considered as most important problems faced by farmers in the study area. So if some of the attributes of the farmers were enhanced to an optimum level it will improve the income level of the respondents in paddy based farming systems.

## **Paddy Farmers' Perspective Towards Sustainable Practices in Agriculture: A Study in Tinsukia District of Assam**

*Moukham Wakhet*

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 had medium level of extension contact. 60.83 per cent of the respondents had medium

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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.

# **Performance of gerbera (*Gerbera hybrida*) as influenced by gibberellic acid and microbial consortium (biofertilizer) in a naturally ventilated polyhouse**

*Aanmona Bora*

An investigation was carried out to study the performance of gerbera (*Gerbera hybrida*) as influenced by gibberellic acid and microbial consortium (biofertilizer) in a naturally ventilated polyhouse, in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, during the period of 2018-19. The experiment was laid out with nine treatments replicated thrice in Randomized Block Design. The treatments were T1 (NPK (19-19-19) @ 2g/L of water/week), T2 (T1 + Microbial consortium), T3 (T2 + 50 ppm GA3), T4 (T2 +100 ppm GA3), T5 (T2 +150 ppm GA3), T6 (T1 + 50 ppm GA3), T7 (T1 +100 ppm GA3), T8 (T1 +150 ppm GA3), T9 (Microbial consortium). The data analysis over the period of investigation revealed that growth, flowering and yield characters were significantly influenced by the application of different treatments. Most of the growth, flowering and yield characters were found highest in T4 and T5. The highest plant height of 48.93 cm and 48.90 cm, highest 29.69 and 29.4 number of leaves, least duration to ten leaf emergence stage 59.4 days and 59.9 days, was observed for T4 and T5 respectively, which were at par. While, the highest leaf area of 4507.34 cm<sup>2</sup>, leaf area index of 2.15 and suckers per plant of 2.89 were recorded from treatment T4. Highest flower diameter of 11.66 cm was recorded in the treatment T4. This trend was reflected in disc diameter (1.89 cm), length (69.9 cm) and diameter of the flower stalk (0.83 cm), flowers per plant (14.83), least days to flower bud visibility (78.67 days), flower bud opening from bud visibility (21.46 days) and days taken to full bloom from bud opening (19.13 days). Likewise, the longest duration of flowering from 1st bloom to the last bloom (161.1 days), highest fresh weight (40.56 g) and dry weight of flower (13.55 g), self life (25.11 days) and vase life (14.73 days), were also found in T4. Among the physiological parameters, the highest total chlorophyll content and leaf area duration were recorded in T4. Highest net assimilation rate and leaf relative water content were recorded for treatment T4 and T5.

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**Abstract of M.Sc. thesis**

**Department: Horticulture**

**Major Adviser: Dr. Madhumita Choudhury Talukdar**

# **Nutrient budgeting of NPK doses for sweet pepper (*Capsium 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 N<sub>1</sub> (80 kg/ha), N<sub>2</sub> (100 kg/ha) and N<sub>3</sub> (120 kg/ha); three phosphorus levels i.e. P<sub>1</sub>(40 kg/ha), P<sub>2</sub>(60 kg/ha) and P<sub>3</sub>(80 kg/ha) and three potash levels i.e. K<sub>1</sub> (40 kg/ha), K<sub>2</sub>(60 kg/ha) and K<sub>3</sub>(80 kg/ha).

The mean performance of growth and yield parameters revealed that N<sub>3</sub> 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 N<sub>1</sub> 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, P<sub>3</sub> 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 P<sub>2</sub> had recorded the highest total sugar content (104.04 mg/100 g) and shelf life (17.27 days). In respect of potassium levels, K<sub>3</sub> had recorded with the highest seeds per fruit (261.85), 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).

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**Abstract of M.Sc. thesis**

**Department: Horticulture**

**Major Adviser: Dr. Luchon Saikia**

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.

## 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% agros shade 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<sup>-1</sup> 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%).

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 +

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**Abstract of M.Sc. thesis**

**Department: Horticulture**

**Major Adviser: Dr. Preeti Hatibarua**

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%).

# **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. *i.e.* 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. The shape and surface of the seeds was found to be ovate and warty. The length and weight of the seeds

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**Abstract of M.Sc. thesis**

**Department: Horticulture (BNCA)**

**Major Adviser: Dr. (Mrs.) S. Langthasa**

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 (16.08 $\mu$ g/ 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.

## **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 (T<sub>1</sub>), retention of two sprouts (T<sub>2</sub>), retention of three sprouts (T<sub>3</sub>), retention of four sprouts (T<sub>4</sub>) and control, without pruning (T<sub>5</sub>).

The morpho-physiological parameters, phenological characters, yield and quality parameters were significantly influenced by pruning treatments. Among the pruning treatments, T<sub>3</sub> 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 cm<sup>2</sup> and 6670.78 cm<sup>2</sup> 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 T<sub>1</sub> treatment. Among the physiological parameters, relative leaf water content (76.99%) and leaf chlorophyll content index (29.29) recorded significantly higher values under T<sub>3</sub> treatment. In the same treatment of T<sub>3</sub>, 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, T<sub>3</sub> recorded significantly higher vitamin A (223.61 IU) in fruits while ascorbic acid (15.84 mg/100g) was found significantly higher in T<sub>1</sub>.

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**Abstract of M.Sc. thesis**

**Department: Horticulture (BNCA)**

**Major Adviser: Dr. B. P. Gautam**

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 (T<sub>3</sub>) 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.

## **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 (T<sub>1</sub>), ripening with ripe tomato (T<sub>2</sub>), ripening with paddy straw (T<sub>3</sub>), ripening in covered pit without smoke (T<sub>4</sub>), ripening with Calcium carbide (T<sub>5</sub>) and ripening naturally at room temperature (T<sub>6</sub>). 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 (T<sub>2</sub>) 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 (T<sub>5</sub>) 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 T<sub>3</sub> (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 aroma (8.01) and taste (7.88) were highest in fruits ripened with tomato (T<sub>2</sub>) than the

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**Abstract of M.Sc. thesis**

**Department: Horticulture (BNCA)**

**Major Adviser: Dr. (Mrs.) Supriya Langthasa**

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.

## **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 colour in upper portion of petiole, while 75 per cent of the cultivars were found to have

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**Abstract of M.Sc. thesis**

**Department: Horticulture**

**Major Adviser: Dr. S. Alam**

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.

## **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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**Abstract of M.Sc. thesis**

**Department: Horticulture (FST)**

**Major Adviser: Dr. S. Alam**

## **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 Chetiangoan, 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 LD<sub>50</sub> values at 48 h, 72 h and 96 h.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Gitanjali Devi**

# **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.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Bina B. Gogoi**

## **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 µg/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 ( $1.57 \text{ m}^{-1} \text{ mg}^{-1} \text{ protein}$ ) followed by Bahadur sub-1 ( $1.51 \text{ m}^{-1} \text{ mg}^{-1} \text{ protein}$ ) and minimum in Sambha mashuri ( $0.16 \text{ m}^{-1} \text{ mg}^{-1} \text{ protein}$ ).

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. N. Borgohain**

## **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 was observed for chaffs per panicle followed by grains per panicle, spikelet sterility (%),

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**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. U. C. Kalita**

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.

# **Performance evaluation and Genetic analysis in Indian mustard [*Brassica juncea* (L.) Czern. & Coss.]**

*Debashmita Mohanty*

Indian mustard (*Brassica juncea* L. Czern & Coss) is an annual growing oilseed crop. It is the source of one of the major edible oils in India. In Assam, early maturing mustard varieties are preferred so that it can be accommodated in a rice based cropping system under rainfed condition and it can act as a source of income for the marginal and small farmers in rainfed area. An ideal plant type is having increased branch number, pods per plant, and seeds per pod, seed size etc. further increase in yield could result from increase in biomass and harvest index. So the improvement of all yield attributing characters will simultaneously lead to increase in yield. Breeding programmes in mustard are aimed at improvement of agronomic performance, shorter duration, higher branching, lower foot length, resistance to biotic and abiotic stresses, and finally to maximize yield and quality traits. In the present study the genetic variability and character interrelationship between 12 Indian mustard genotypes was assessed. A biparental mating programme was also conducted by selecting 100 parent plants from the F4 generation of the cross DRMR-150-35×TM-2 (JM 13-6) and variation among these crosses was studied. The pooled analysis of variance for 15 morphological traits and 1 biochemical trait exhibited significant variation for 12 traits. High GCV, PCV coupled with high genetic advance was observed in secondary branch number and seed yield per plant. In the correlation studies the characters plant height, secondary branch no, main shoot length, no of siliquae on main shoot, biological yield per plant and harvest index exhibited significant positive correlation with seed yield. The study of path analysis revealed that the characters secondary branch no, main shoot length, no of siliquae on main shoot, biological yield and oil content had positive direct effect on seed yield whereas plant height and harvest index showing negative direct effect. On the basis of correlation studies 7 characters with significant positive correlations with yield were selected for development of selection indices. Maximum selection efficiency was observed when all the 7 characters were included in the selection index. Highest

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**Major Adviser: Dr. Rumjhum G. Phukan**

selection scores was exhibited by the cross TM-106×TM-2. In the analysis of variance for BIP population it was observed that significant variation was there for 11 characters among 50 crosses. The character foot length exhibited highest PCV, GCV, heritability and genetic advance. Further studies on additive genetic variance revealed that the same character foot length exhibiting highest additive genetic variance as well as higher narrow sense heritability.

## **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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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Bhaswati Sarmah**

## **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 polymorphism among genotypes. Per cent polymorphism ranged from 25.67% to 82.00% with an average

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**Major Adviser: Dr. R. N. Sarma**

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.

## **Nutrient management for broccoli quality seed production in Assam**

*Pratiksha Gogoi*

Nutrient management for broccoli quality seed production in Assam ABSTRACT  
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 associated

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**Abstract of M.Sc. thesis**

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**Major Adviser: Dr. Meghali Barua**

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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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Sharmila Dutta Deka**

# **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 agents showed high values for the characters namely field emergence, 100 seed weight

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics (SST)**

**Major Adviser: Dr. Prakash Bora**

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.

## **Enhancing biocontrol potential of *Trichoderma viride* with micronutrients against *Colletotrichum capsici***

***Bhanushree 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 ZnSO<sub>4</sub> 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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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: Dr. D. K. Sarmah**

# **Assessment of microbial diversity of tomato plants and their relationship with bacterial wilt disease caused by *Ralstonia solanacearu***

*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* than *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 consortia 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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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: 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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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: 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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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: Dr. L. C. Bora**

## **Comparative efficacy of different microbe based biopesticides on major pathogens**

*Mehjebin 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  $2.0 \times 10^5$ ,  $1.0 \times 10^5$ ,  $1.0 \times 10^5$ ,  $3.0 \times 10^7$ ,  $1.3 \times 10^9$ ,  $6.5 \times 10^8$ ,  $8.0 \times 10^8$  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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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: Dr. P. K. Borah**

# 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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**Major Adviser: Dr. P. K. Borah**

# **Development of RNA based vaccine against potato virus Y (PVY) infecting Potato (*Solanum tuberosum*)**

*Routhu Gowtham Kumar*

Double-stranded RNA (dsRNA), when exogenously applied, was proven as a potent means for virus control. It is hypothesized that the exogenously applied dsRNA mimics the viral RNA intermediate, which is involved in viral replication, and thereby triggers RNAi. Based on these concepts of RNAi in plants, coat protein (CP) gene of Potato virus Y (PVY) was targeted, in such a way that the plant virus was unable to replicate in the plant cytoplasm. In the present study, we aimed at investigating whether exogenous application of dsRNAs corresponding to the viral genes of PVY could suppress viral titers in potato. The specific objectives of the study was to develop a dsRNA construct for PVY resistance in Potato and a proof of concept studies for PVY silencing in potato using dsRNA assay strategy. For performing this research PVY infected potato leaf tissue samples were collected from some potato growing locations of Jorhat district and PVY was successfully detected by two step Reverse Transcriptase PCR (RT- PCR) by using coat protein gene specific primers. The coat protein gene (CP gene) was successfully isolated and cloned into pTZ57R/T vector and transformed into DH5 $\alpha$  *E.coli* cells. The cloning was confirmed by Restriction digestion analysis and the PVY was confirmed by sequencing. The NCBI and Blast analyses showed 95% similarity with other sequences of the world. Two methods of dsRNA production were successfully employed in this study. In the first method, using a two-step PCR followed by *in vitro* transcription protocol, dsRNA molecules for CP gene of PVY were efficiently produced. In the second method large scale production of PVY coat protein gene specific dsRNA was produced using *E. coli* with T7 RNA polymerase. For the bioassay, potato tubers were sown in plastic pots and kept inside green house. Plantlets of 15 days old were inoculated with PVY in combination with dsRNA\_CP (treatment 1: Vaccinated) and PVY (treatment 2: non-vaccinated). Two experiments were conducted in replication for the bioassay test on determining efficacy of produced PVY specific dsRNA. The expression of PVY coat protein gene in the vaccinated and non-vaccinated

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plants was analysed by conventional semiquantitative PCR. Results signified that, when dsRNA exogenously applied on the leaves of potato along with virus PVY, the viral replication was reduced. Further the results revealed the height of the vaccinated plants were enhanced, whereas the non-vaccinated plants were showing stunted growth and had non-reproductive growth habit. In conclusion, our results revealed that the exogenous application of a crude extract of bacterially-expressed dsRNA molecules derived from PVY coat protein gene, caused considerable reduction in PVY infection, and allowed a better vegetative plant growth. The RNA-based vaccination approach reported here could enhance effectiveness of plant protection schemes for potato plants in nurseries and fields against PVY.

## **Storage rot of Ginger in Assam and its management with botanicals**

*Sonal Kumar*

The present investigation was carried out to study the pathogens associated with storage rot of ginger and management of the disease with botanicals. Survey under three agro-climatic zones (Upper Brahmaputra Valley zone, Hill Zone and Lower Brahmaputra Valley Zone) of Assam revealed that, altogether three fungi and one bacterium were involved in causing the disease. The microbes have been identified as *Fusarium redolens*, *Fusarium oxysporum*, *Pythium aphanidermatum* and *Ralstonia solanacearum* based on morphogenetic characterization. In the study of management of disease with botanicals, ten botanicals (*Acorus calamus*, *Allamanda cathartica*, *Allium cepa*, *Allium sativum*, *Curcuma longa*, *Datura wrightii*, *Lasia spinosa*, *Laurus nobilis*, *Ocimum sanctum* and *piper betle*) were evaluated against the pathogens. Aqueous extracts (20%) of *Allium sativum*, *Allamanda cathartica* and *Laurus nobilis* significantly inhibited the growth of fungal pathogens whereas only *A. sativum* was effective against bacteria. These three most effective botanicals were further tested at four different concentrations (5, 10, 15 and 20 per cent) and exhibited highest inhibition of 92.22, 94.44 per cent and 11.6 mm against *F. oxysporum*, *P. aphanidermatum* and *R. solanacearum* respectively at 20 per cent concentration. The efficiency of botanicals (20%) was also tested in vivo and lowest disease index of storage rot and weight loss of rhizome was recorded with *A. sativum* with 46.38 and 44.85 per cent respectively.

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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  $\mu\text{g/ml/min}$ ), followed by PAL (2.425 $\mu\text{g/ml/min}$ ), PPO (1.770  $\mu\text{g/ml/min}$ ) and  $\beta$  1,3 glucanase (1.005 $\mu\text{g/ml/min}$ ) in plants treated with Biogreen under field condition.

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# **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 kutcha 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. 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%),

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spinning of silk (48.33%) and preparation of hank (66.67%). A positive and significant relationship was found between sericulture 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.

## **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.

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## **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.

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## **Nutritional ability and economic characters of eri silkworm (*Samia ricini*) donovaneco-races on different food plant**

*Shilpi Devi Bora*

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 good quality cocoons in this region. Borduar eco-race is more suitable, as the

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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 eco-race. 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 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

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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.

## **Pedogenic characterization and potentiality evaluation of some soils of Kamrup district of Assam under different landforms**

*Kumari Monalisa*

The present investigation was undertaken in Kamrup district of Assam in order to study the physical and chemical properties of soils and to evaluate the potentiality of soils under different landforms. Five different landforms viz., low hill (P1), monadnock (P2), piedmont plain (P3), alluvial plain (P4) and flood plain (P5) were identified using Survey of India toposheet (1: 50,000) and FCC of satellite imagery of IRS P6. Five representative profile samples were collected from these five landforms. The study area experienced a mean annual rainfall of 1664.8 mm and mean annual temperature of 25.2°C. The soil temperature and moisture regime were *hyperthermic* and *udic*, respectively.

A distinct soil landform relationship was observed for the study area. Soil colour varied from grayish brown to yellowish red at the surface and very pale brown to yellowish red at the sub surface with dominant hue of 5YR in low hill, 7.5YR in monadnock and piedmont plain and 10YR in alluvial plain and flood plain. The values ranged from 4 to 7 and chroma varied between 1 to 8. A textural variation ranging from loam to clay loam was observed in surface soils and sandy to clay loam was observed in sub surface soils. Sand, silt and clay contents in these soils varied from 22.5 to 92.6, 3.3 to 63.9 and 4.1 to 35.8 per cent, respectively. Higher clay content was recorded in piedmont plain soils (35.8 per cent). Organic carbon content in the soil varied from 0.12 to 2.07 per cent, showing decreasing trend with depth with some exceptions in piedmont plain and flood plain soils. Soil pH varied from 4.4 to 6.8. Higher pH was recorded for alluvial plain and flood plain soils as compared to the other three landforms. The cation exchange capacity (CEC) varied from 3.50 to 17.00 cmol (p<sup>+</sup>) kg<sup>-1</sup> soil. Highest value was recorded in piedmont plain soils. Among the basic cations, Ca<sup>2+</sup> was the dominant cation. RPD and RHD values were used for studying the pedogenic development of the soils. The RHD values in different soils varied from 1 to 11 and RPD ratings varied from 1 to 12. Highest RPD value was recorded for piedmont plain soils (P3) and lowest value was recorded for flood plain soils (P5). Soils were classified as *Typic Dystrudepts* (P1 and P2), *Fluventic*

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*Dystrudepts* (P3), *Typic Epiaquepts* (P4) and *Aquic Udifluvents* (P5). Among the pedogenic iron and aluminium oxides, dithionite extractable iron ( $Fe_d$ ) and aluminium ( $Al_d$ ) content was highest followed by oxalate extractable forms ( $Fe_o$  and  $Al_o$ ) and pyrophosphate extractable forms ( $Fe_p$  and  $Al_p$ ) in all the soils. Value of degree of activation ( $Fe_o/Fe_d$ ) was lowest in P3, which indicates that piedmont plain soils are relatively well developed as compared to the others.

For crop production, the productivity of the soils were found to be average with productivity index value of 25.99, 28.88 and 34.20 for low hill (P1), monadnock (P2) and piedmont plain (P3), respectively. Productivity of the alluvial plain soils and flood plain soils was found to be good with productivity index value of 51.98 and 36.39, respectively. The potential productivity of P1, P2, P3 and P5 soils was found to be good and for P4, it was found to be excellent. The co-efficient of improvement (CI) values indicated that the productivity of the soils can be increased to maximum extent of 2.08, 1.88, 1.50, 1.25 and 1.56 for P1, P2, P3, P4 and P5, respectively.

## **Distribution of plant nutrients in soil profile under different land use systems**

*Meghna Saikia*

Five soil profiles were collected from Jorhat and Golaghat districts under different land use systems viz., Rice, bamboo plantation, vegetable growing area, tea plantation and natural forest to study the distribution of nutrients in the soil profile. The soils were grey to reddish yellow in colour and silty loam to clay in texture. Bulk density and particle density ranged from 1.24 Mg m<sup>-3</sup> to 1.55 Mg m<sup>-3</sup> and 2.46 Mg m<sup>-3</sup> to 2.10 Mg m<sup>-3</sup> respectively. Whereas porosity of the studied soils ranged from 26.54 to 48.55 per cent. Soils were extremely acidic to strongly acidic with a pH range of 4.2 to 5.4. Exchange acidity and Total potential acidity of the soils ranged from 0.44 to 3.57 cmol (p+) kg<sup>-1</sup> and 17.30 cmol (p+) kg<sup>-1</sup> to 6.20 cmol (p+) kg<sup>-1</sup> respectively. The pH dependent acidity was found to range from 5.76 to 15.18 cmol (p+) kg<sup>-1</sup>. Organic carbon content of the soil was low to high ranging from 0.12 per cent to 1.40 per cent. Ca<sup>2+</sup> was found to be dominant over Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> and CEC varied from 10.9 cmol (p+) kg<sup>-1</sup> to 9.3 cmol (p+) kg<sup>-1</sup> while base saturation from 27.2 to 46.1 per cent. Based on the morphological and physico - chemical properties of the soils rice soils were classified as Typic Epiaqualfs, tea soils as Ultic hapludalfs, forest soils as Typic Dystrudepts and soils under vegetable and bamboo as Oxyaquic Dystrudepts at subgroup level. The available N, P and K status of the soils ranged from 462.5 kg ha<sup>-1</sup> to 65.7 kg ha<sup>-1</sup>, 15.5 kg ha<sup>-1</sup> to 3.8 kg ha<sup>-1</sup> and 35.0 kg ha<sup>-1</sup> to 262.8 kg ha<sup>-1</sup> respectively. The sulphur content of the soils ranged from 26.8 mg kg<sup>-1</sup> to 5.6 mg kg<sup>-1</sup>. The DTPA- Fe, Mn, Zn and HWS- B of the studied soils was found to range from 32.7 mg kg<sup>-1</sup> to 97.40 mg kg<sup>-1</sup>, 1.90 mg kg<sup>-1</sup> to 13.50 mg kg<sup>-1</sup>, 0.14 mg kg<sup>-1</sup> to 0.77 mg kg<sup>-1</sup> and 0.11 mg kg<sup>-1</sup> to 0.81 mg kg<sup>-1</sup> respectively. The carbon stocks for the whole profile was found to be maximum in forest (133.6 Mg ha<sup>-1</sup>) followed by tea (132.8 Mg ha<sup>-1</sup>), rice (129.4 Mg ha<sup>-1</sup>), vegetable (83.1 Mg ha<sup>-1</sup>) with the minimum value of 55.9 Mg ha<sup>-1</sup> in bamboo and cumulative carbon stock (0-100 cm) was maximum in rice (104.8 Mg ha<sup>-1</sup>) followed by tea (96.3 Mg ha<sup>-1</sup>), forest (95.1 Mg ha<sup>-1</sup>), vegetable (66.6 Mg ha<sup>-1</sup>) and bamboo (55.7 Mg ha<sup>-1</sup>) Similarly, the Primary major nutrient stock (N, P, K) was found to be maximum in forest (4057.4 Kg ha<sup>-1</sup>) followed by rice (3598.7 Kg ha

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-1), tea (3030.6 Kg ha<sup>-1</sup>), vegetable (3206 Kg ha<sup>-1</sup>) and bamboo (2077.5 Kg ha<sup>-1</sup>). When 0- 100 cm of the profile was considered, the maximum Primary major nutrient stock was also found in forest (2919.1 Kg ha<sup>-1</sup>) but followed by vegetable (2399.2 Kg ha<sup>-1</sup>), rice (2303.4 Kg ha<sup>-1</sup>), tea (2211.4 Kg ha<sup>-1</sup>) and bamboo (1676.2 Kg ha<sup>-1</sup>). The maximum secondary major nutrients (Ca, Mg, S) stock in case of whole profile was found to be maximum in rice (14754.6 Kg ha<sup>-1</sup>) followed by forest (14054.8 Kg ha<sup>-1</sup>), tea (12058.9 Kg ha<sup>-1</sup>), vegetable (9134.4Kg ha<sup>-1</sup>) and bamboo (7831.1 Kg ha<sup>-1</sup>). When 0- 100 cm of the profile was considered, the maximum carbon stock was again found in rice (9035 Kg ha<sup>-1</sup>) followed by forest (8828.2 Kg ha<sup>-1</sup>), tea (6350.1 Kg ha<sup>-1</sup>), bamboo (6129.3 Kg ha<sup>-1</sup>) and vegetable (5972 Kg ha<sup>-1</sup>). The maximum micro nutrient stock (Fe, Mn, Zn, B) in case of whole profile was found in rice (1901.2 Kg ha<sup>-1</sup>) followed by tea (1560.9 Kg ha<sup>-1</sup>), vegetable (1240.7 Kg ha<sup>-1</sup>), forest (1209.4 Kgha<sup>-1</sup>) and bamboo (1058.4 Kg ha<sup>-1</sup>). When 0- 100 cm of the profile was considered, the maximum carbon stock was found to be higher in case of the Alfisols as compared to Inceptisols. The total nutrient stock of profile (0-100 cm) revealed that rice and forest soils contained same amount of nutrient stock up to one metre depth of the soils followed by vegetable and tea plantation and Bamboo. If the total nutrient stock of profile (0-100 cm) was considered in soil order basis by taking the average of two alfisols and three inceptisols, then it was high in alfisols than inceptisols. The contribution of A horizon towards the total profile was found to be maximum in case of vegetable (18%) followed by rice (15%), forest (12%), tea (11%) and bamboo (11%). The contribution of surface (0-20 cm) and subsurface (20-100 cm) towards the total nutrient stock of 0-100 cm depth showed that the surface layer of forest soils contributed maximum (23%) which was closely followed by vegetable (22%) and bamboo (21%). Surface layer contribution was equal in case of rice and tea (17%). There was no difference in contribution of A and B horizon to the total nutrient stock of the profile in alfisols and inceptisols but contribution of the surface layer (0-20 cm) was found higher in inceptisols than alfisols. The impact of land use systems was noticed primarily in organic matter content and nutrient content because of difference in management systems and recycling process of nutrients. The major soil forming processes identified in the area are humification, eluviation, illuviation, lessivage, acidification, leaching and littering. PCA identified four groups of components and accounted for 85.77 % of the total variance. The first component (PC1) exhibited higher loading with sand, silt, pH, organic carbon, exchangeable Al, exchange acidity along with N, P, Zn and B. The second component (PC2) showed high loading with clay, bulk density, CEC along with Ca and Mg. The third component (PC3) manifested high positive loadings with TPA, PBS along with Fe and Mn. The fourth component (PC4) displayed only K and S with high positive loading.

## **Enrichment of Maize grains with Zinc through Agronomic Biofortification**

*Narendra Kr. 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 ZnSO<sub>4</sub> viz. 20,40,60,80 and 100 kg ZnSO<sub>4</sub> 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 ZnSO<sub>4</sub> /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 ZnSO<sub>4</sub> /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 ZnSO<sub>4</sub> /ha (S) + (F) application. Soluble protein, crude protein and starch content increased with the increase in Zn concentration. Zinc concentration of post harvest soil was found highest in the treatment 100 kg ZnSO<sub>4</sub> /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

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**Abstract of M.Sc. thesis**

**Department: Soil Science**

**Major Adviser: Dr. Gayatri Goswami Kandali**

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.

## **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 phyllosphericmethlyotrophic bacteria associated with various crops for their plant growth promoting characteristics. Methyloprophs are a group of microorganisms that have the ability to utilize C<sub>1</sub> 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 phyllosphericmethlyotrophic 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  $\text{mg g}^{-1}$ . 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, spinach and frenchbean showed nitrate reduction. The isolate M13 showed positive

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**Major Adviser: Dr. Anjuma Gayan**

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 VogesProskauer'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 P<sub>2</sub>O<sub>5</sub>, available K<sub>2</sub>O, 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.

## **Master of Fishery Science**

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- **Aquaculture**
- **Aquatic Environment Management (AEM)**
  - **Fish Processing Technology (FPT)**
- **Fisherise Respurce Management (FRM)**

## **Assessment of growth, haematological and histological changes of *Sperata seenghala* through replacement of fish meal with chicken viscera**

*Bubul Sainary*

In the present study, a 90 days experiment was conducted to evaluate the growth performance, haematological and histological changes of *Sperata seenghala* feeding experimental diet through replacement of dietary fish meal was done with chicken viscera meal. Four experimental diets were prepared to containing 0% (diet CVM0), 30% (diet CVM30), 50% (diet CVM50) and 100% (diet CVM100) of chicken viscera meal (CVM), as fish meal (FM) replacement. Diet CVM0, without chicken viscera acted average weight  $9.12 \pm 0.24$  g) were fed twice daily as control diet. Experimental fish (initial @ 3% body weight to apparent satiation with the experimental diets. At the end of the experiment, the survival rate was found above 90 % in all the treatments with value ranging  $94.44 \pm 1.11\%$ . Fish fed with diet CVM30 showed significantly the highest weight gain percentage ( $1202.72 \pm 32.68$  %) than that of fish fed diet CVM0 ( $1072.17 \pm 6.79\%$ ), CVM50 ( $971.30 \pm 50.35\%$ ) and CVM100 ( $746.53 \pm 17.81\%$ ). Final weight (range 75.82 - 118.26 g), specific growth rate (range 1.89 - 2.32%/day), protein efficiency ratio (range 1.46 - 2.55) and net yield (range 631.44 - 1031.10 kg/ha) was significantly higher in fish fed with diet CVM30 ( $P < 0.05$ ). The feed conversion ratio (range 1.31 - 1.91) tends to decrease with increase in level of chicken viscera meal, ensuring that this protein is as valuable for the experimental fishes. However, the condition factor of the fishes (range 0.97 - 0.99) during the experimental period showed no significant difference ( $P > 0.05$ ) among the different treatments. The haematological studies showed higher BC ( $2.93 \pm 0.02$  million/mm<sup>3</sup>), WBC ( $7.67 \pm 0.12$  thousands/mm<sup>3</sup>) and haemoglobin ( $4.81 \pm 0.07$  g/dl) in the fish fed CVM30 than that of fish fed with control feed. However, the content in RBC, WBC and haemoglobin decreased with higher inclusion level of chicken viscera meal. The histological examination of liver and intestine tissue of the experimental diet fed fishes in all treatments revealed no major histological abnormalities. The study demonstrated that 30% fish meal could be replaced by chicken viscera meal in the diet of *Sperata seenghala* without negative effects on growth, haematology and histological changes.

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**Abstract of M.Sc. thesis**

**Department: Aquaculture**

**Major Adviser: Dr. Dipak Kr. Sarmah**

# **Assessment of Environmental Health of River Kopili, Central Brahmaputra Valley Zone**

*Dipanka Nath*

Kopili is one of the main rivers of Central Brahmaputra Valley and it is also one of the most important Southern tributaries of the mighty River Brahmaputra. This present study assessed the physico-chemical and biological profile of water of river Kopili. Water, Sediment and Plankton samples were collected for twelve consecutive months (March 2018-February 2019) from the three sampling stations of the river at regular monthly intervals. Water parameters like Surface Water Temperature, Turbidity, pH, Dissolved Oxygen, Electrical Conductivity, TDS, COD, BOD<sub>3</sub>, Nitrate, Nitrite, Total Ammonia, Soluble Inorganic Phosphate etc. were determined by using different standard methods. The range of some important parameters were Surface Water temperature (20-32 °C), Turbidity (6.5-133.6 NTU), Dissolved oxygen (2.88-11.03 mgL<sup>-1</sup>), pH (6.30 -7.92), Total Dissolved Solids (37.1-97.2 mgL<sup>-1</sup>), Total Alkalinity (4-54 mgL<sup>-1</sup>), Total Hardness (22.02-125.12 mgL<sup>-1</sup>), BOD<sub>3</sub> (0.42-9.94 mgL<sup>-1</sup>), COD (0.80-16.90 mgL<sup>-1</sup>), Nitrate (0.008-0.476 mgL<sup>-1</sup>), Phosphate (0.006-0.374 mgL<sup>-1</sup>), Sediment pH (5.99-7.69), Sediment Organic Carbon (0.48-2.41%), Sediment Organic Matter (0.83-4.16%), Available Sediment Nitrogen (401-417 kg ha<sup>-1</sup>), Available Sediment Phosphorus (5.49-9.51 kg ha<sup>-1</sup>) and Available Sediment Potassium (81.49-485.51 kg ha<sup>-1</sup>) were recorded. A total of 24 different genera of plankton groups were recorded from the study stations of river Kopili. Among these 7 belongs to 5 Chlorophyceae, 5 to Bacillariophyceae, 4 were Cyanophyceae, 2 Rotifera, 3 Cladocera and 3 Copepoda. Plankton density was poor in river Kopili and ranged between 35 and 90 units l<sup>-1</sup> during the study period.

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**Abstract of M.Sc. thesis**

**Department: Aquatic Environment Management**

**Major Adviser: Dr. Rajdeep Dutta**

## **Productivity and aquatic diversity studies of damalbeel of morigaon district of Assam**

*Nabamika Sonowal*

The present study was conducted for one year (march, 2018 to february, 2019) to assess the water quality parameters, sediment parameters, floral and faunal diversity of a floodplain wetland (*Damalbeel*), which is located in Morigaon district of Assam. *Damalbeel* is an open water body with a water spread area of about 15 ha. 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). Water, sediment and plankton samples were collected on a monthly interval for twelve consecutive months (March, 2018 - February, 2019) from the three sampling stations of the beel. Water and sediment parameters were determined by using standard methods. The range of some important parameters were: surface water temperature from 18.83 to 31.50°C, turbidity from 1.65 to 4.83 NTU, water pH from 6.44 to 7.58, dissolved oxygen from 2.33 to 6.13 mg l<sup>-1</sup>, total alkalinity from 18.00 to 29.33 mg l<sup>-1</sup>, hardness from 17.34 to 36.37 mg l<sup>-1</sup>, free carbon dioxide from 5.04 to 14.25 mg l<sup>-1</sup>, nitrate from 0.02 to 0.06 mg l<sup>-1</sup>, phosphate from 0.05 to 0.26 mg l<sup>-1</sup>, total ammonia from 0.35 to 1.24 mg l<sup>-1</sup>, sediment pH from 4.79 to 6.76, organic carbon from 16.64 to 24.71 %, available nitrogen from 280.93 to 436.38 kg ha<sup>-1</sup> and available phosphorus from 22.90 to 51.51 kg ha<sup>-1</sup>. A total of 25 different phytoplankton genera belonging to 14 families and 14 zooplankton genera belonging to 9 families were recorded from the beel. The average gross primary productivity and net primary productivity were varied from 135.31 to 684.80 mg C m<sup>-3</sup> hr<sup>-1</sup> and 78.75 to 591.17 mg C m<sup>-3</sup> hr<sup>-1</sup>. The beel recorded 33 fish species belonging to 7 orders, 15 families and 23 genera. The rich fish diversity of the beel was mainly represented by Cypriniformes and Siluriformes. Commercial fish species from the beel recorded were *Labeo rohita*, *L. gonius*, *L. calbasu*, *L. bata*, *Wallago attu*, *Sparataseenghala*, *Chitalachitala* etc. Miscellaneous fish group (e.g. predatory, weed and ornamental fish species) was represented with dominated species *Puntius* spp., *Channa* spp., *Colisa* spp. and *Mystus* spp. which contributed less amount to the total landings of the beel.

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**Abstract of M.Sc. thesis**

**Department: Aquatic Environment Management**

**Major Adviser: Dr. S.K. Bhagawati**

## **Assessment of limnological profile of 77 no. Dandua beel of Morigaon district, Central Brahmaputra Valley Zone**

*Neeta Beypi*

The study revealed limnological profile of 77 water. The study revealed no. Danduabeel as surface temperature (19-33.5°C), moderate turbidity values (1.8-22.3 NTU), alkaline pH (7.1-8.4), rich D.O. (4.06-11.12 mg l<sup>-1</sup>), low total alkalinity (26-49 mg l<sup>-1</sup>), (25.02-80.08 mg l<sup>-1</sup>), low soft to moderately hard water (0.010-0.081 mg l<sup>-1</sup>), free CO<sub>2</sub>: (nil-4.24 mg l<sup>-1</sup>), low values of nitrate-nitrogen concentration poor concentration of nitrite nitrogen (0.012-0.210 mg l<sup>-1</sup>), low total ammonia concentration (0.19-0.90 mg l<sup>-1</sup>), poor values of soluble inorganic phosphate (0.039-0.247 mg l<sup>-1</sup>), acidic sediment pH (4.17-6.16), moderate level of organic carbon (1.25-3.35%), moderate level of organic matter (2.15-5.77%), high level of available sediment nitrogen (279-425 kg ha<sup>-1</sup>), Phosphorous (18.7-51.6 kg ha<sup>-1</sup>) and Potassium (156.4-320.6 kg ha<sup>-1</sup>). A total of 44 different genera of plankton were recorded from the study stations of 77 no. Danduabeel which comprised of Chlorophyceae (17 genera), Bacillariophyceae (5 genera), Cyanophyceae (5 genera), Euglenophyceae (2 genera), Dinophyceae (1 genera), Copepoda (5 genera), Cladocera (5 genera) and Rotifera (4 genera). Maximum phytoplankton diversity was recorded during pre-monsoon and minimum in monsoon season while maximum zooplankton diversity was estimated during winter season and minimum in monsoon season. The study revealed that 77 no. Danduabeel was moderately infested by aquatic macrophytes covering an average area of 31.41% of the beel. The aquatic macrophytes mainly comprised of free-floating type (dominated by *Eichhornia crassipes*) (average area of infestation 12%), submerged type (average area of infestation 10.25%), marginal type (average area of infestation 4.91%) and emergent type (average area of infestation 4.25%). In terms of nutrient concentration, the wetland may be classified as oligotrophic while the other physico-chemical parameters were mostly found to be in the suitable ranges for growth of fishes.

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**Abstract of M.Sc. thesis**

**Department: Aquatic Environment Management**

**Major Adviser: Dr. Rajdeep Dutta**

# **Studies on Food and Feeding Habits and Reproductive Biology of *Labeo bata* (Hamilton, 1822)**

*Miss Mandakini Deuri*

The present study was undertaken to study the food and feeding habits and reproductive biology of *Labeo bata* (Hamilton, 1822) from the river Kolong, Kakotigoan Chapormukh, Nagaon, Assam, from May, 2018 to April, 2019. Results obtained showed that the Gastro-somatic index (GSI) was highest in February ( $1.735 + 0.102$ ) and lowest in August ( $0.125 + 0.021$ ). The Relative length of gut (RLG) value was maximum in February ( $5.744 + 0.204$ ) and minimum in August ( $4.041 \pm 0.046$ ). Gut content analysis during the experimental period showed that *Labeo bata* feeds mainly on green algae and diatoms, which were observed round the year in good quantity in the gastrointestinal tract of the fish. Percentage composition of the food items showed that green algae, diatoms and bluegreen algae constituted 28.81%, 19.67% and 11.48% respectively in the gut. The percentage of secondary food was found to comprise 17.21% while the amount of zooplankton and unidentified matter were 15.99% and 6.87% respectively of the total food content. It can be concluded that the fish can be classified as a herbivore and bottom feeder according to its mouth position and gut content analysis. The overall sex ratio (M: F) was 1:1.6 (chi square=15.907,  $P < 0.05$ ), indicating predominance of females over males. Maximum value of Gonado Somatic Index (GSI) were observed in the month of June for both males ( $2.991 + 0.194$ ) and females ( $18.005 + 0.688$ ). These results along with histological analysis show that the *Labeo bata* breeds during the months of June-July. The average fecundity determined was  $72119.25 + 3357.56$  ova/ fish. The average size at first sexual maturity was found to be 18.50 cm in female and 15.50 cm in male, indicating that males mature earlier than females. Based on histological studies, the ovarian stages were divided into seven distinct stages of development. The relationship between total length (TL) and Total weight (TW) of *Labeo bata* were calculated and the length-weight relationship was found to be  $W = 0.136 L^{2.979}$ ,  $W = 0.139 L^{2.945}$  and  $W = 0.142 L^{2.936}$  for male, female and pooled data respectively. The correlation coefficient (r) was found to be

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**Abstract of M.Sc. thesis**

**Department: Fisheries Resource Management**

**Major Adviser: Dr. Jiten Sarma**

0.965 for both males and females and 0.967 for pooled data. The 'b' value differed significantly ( $P < 0.05$ ) from the value of '3' indicating negative allometric growth of the fish. For all the sexes, the highest condition factor (K) values formed the peak in the month of June and declined subsequently during the months of September to December followed by an increasing trend from January.

# **Assessment of Acute Toxicity in Zebrafish (*Danio rerio* Hamilton, 1822) Exposed to Butyle Hydroxytoluene (BHT)**

*Raktim Sarmah*

The synthetic antioxidant 3,5 -di-tert-butyl-4-hydroxy-toluene (BHT) is widely used as an additive in the food, cosmetic and plastic industries to increase the tenability of food and plastic for the 70 years. BHT is degraded to 3,5-di-tert-butyl-4-hydroxybenzaldehyde (BHT-CHO) in mammals, as well as in the natural environment. The average daily intake of BHT for human being is estimated to be 0.3 mg/kg body weight. Even though it is considered safe for human at an authorized level, its ubiquitous presence in the aquatic environment and the controversial toxicological data are of great concern for human as well as aquatic life. Therefore, a full assessment was done in this study with the vertebrate model zebrafish (*Danio rerio*) with its various life stages. The study in the adult stage of zebrafish during acute exposure of BHT i.e. LC<sub>50</sub> value for 96 hrs. found out to be 4.033 mg/L indicating the compound to be 'moderately toxic'. Numerous abnormal behaviors are also observed in the above LC<sub>50</sub> concentrations. Histological analysis from the lethal (4 mg L<sup>-1</sup>) and sublethal (2 mg L<sup>-1</sup>) concentrations showed massive damages in gills and liver subjected to multiple organ failure leading to death. The results of the acute toxicity (LC<sub>50</sub>) for 96 hours exposure during the embryogenic stage calculated to be 4.388 mg L<sup>-1</sup> and the effective concentration (EC<sub>50</sub>) for 96 hours to be 1.375 mg L<sup>-1</sup>. The reduced heart rate from the sub-lethal concentrations indicate the chemical to be a probable cardiotoxic agent but a further study is to be needed for confirmation. The Teratogenic Index (TI) calculated to be 3.19 which implies the compound may be a probable teratogen. The current study opens a lot of further scope for research for its acute as well as chronic affect.

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**Abstract of M.Sc. thesis**

**Department: Fisheries Resource Management**

**Major Adviser: Dr. S.K. Bhagawati**

## **Master of Science (Home Science)**

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

# **Knowledge of Anganwadi workers (AWWs) for rendering Nutrition and Health Education service under ICDS scheme in Karbianglong District of Assam**

*Semson Engleng*

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 also had less knowledge on importance of milk consumption during pregnancy and also

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**Abstract of M.Sc. thesis**

**Department: Extension and Communication Management**

**Major Adviser: Dr. Juliana Sarmah**

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 of food (73.00%), voting in the election (66.00%), taking part in social events (44.00%),

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**Abstract of M.Sc. thesis**

**Department: Extension and Communication Management**

**Major Adviser: Dr. Sayanika Borah**

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).

## **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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**Abstract of M.Sc. thesis**

**Department: Family Recourse Management**

**Major Adviser: Dr. Moonty Baruah**

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.

# **Impact of high protein high energy formulation on exercise performance in relation to strength and endurance capacity**

*Jyotismita 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 TS<sub>1</sub>, TS<sub>2</sub>, TS<sub>3</sub> and TS<sub>4</sub> were developed, out of four formulations was TS<sub>4</sub> 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 TS<sub>4</sub> was significantly highest (p<0.01) compared to the other test formulation. TS<sub>4</sub> 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 TS<sub>4</sub> 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 TS<sub>4</sub> was highest (62%) compared to other test samples TS<sub>1</sub>

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**Abstract of M.Sc. thesis**

**Department: Food Science & Nutrition**

**Major Adviser: Dr. Mamoni Das**

(38%), TS<sub>2</sub> (45%), TS<sub>3</sub> (57%). TS<sub>4</sub> 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  $134.11 \pm 2.68$  gm to  $180.11 \pm 2.52$  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  $375.21 \pm 2.42$  sec to  $715.37 \pm 3.74$  sec at 10 rpm,  $350.41 \pm 3.54$  sec to  $655.51 \pm 5.64$  sec 15 rpm,  $301.14 \pm 2.23$  sec to  $602.72 \pm 3.34$  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  $690.69 \pm 2.64$  cm to  $698.98 \pm 3.63$  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  $2.46 \pm 0.07$  min to  $6.95 \pm 0.25$  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  $5.32 \pm 0.06$  min to  $1.75 \pm 0.09$  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  $43.00 \pm 5.42$  mmole/glucose unit and  $42.59 \pm 6.03$  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 30<sup>th</sup> 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 TS<sub>1</sub>, TS<sub>2</sub>, TS<sub>3</sub>, TS<sub>4</sub> respectively. The highest total plate count was observed on 30<sup>th</sup> 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.

# **Assessment of Vitamin D deficiency among tea plantation workers : A case study among women in reproductive age**

*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, biochemical assessments, morbidity profile and dietary intake was collected using standard procedure. The respondents were heterogeneous in terms of religion. Majority of them were illiterate. The respondents were involved in outdoor as well as indoor activities. Cent 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 Kuppaswamy socio-economic scale, 2018. Majority of the respondents were non-vegetarian and most of them were involved in alcohol and tobacco consumption. The height and weight of the respondents, irrespective of age, were below the ICMR reference for adult woman with a mean height of  $153.20 \pm 6.64$  cm and mean weight of  $43.84 \pm 5.78$  kg. BMI indicated prevalence of underweight in 75.67 per cent of the respondent. Waist circumference and waist-hip ratio of the respondents were normal as per WHO reference for adult woman. 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. In context to sunning practice, high prevalence of vitamin D deficiency was observed despite of adequate sun exposure. 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 ( $p < 0.05$ ). High prevalence of vitamin D was observed in tobacco and alcohol consumers, indicating significant influence of tobacco consumption on vitamin D status of the respondents ( $p < 0.05$ ). Significant influence of alcohol consumption on serum vitamin D status

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**Abstract of M.Sc. thesis**

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( $p < 0.05$ ) was observed. Positive association between serum vitamin D status and anthropometric indices was observed. Serum calcium status of the respondents was low in irrespective of age group. Serum alkaline phosphatase status of the respondents was high in all age groups. Positive association between serum vitamin D status and serum calcium status ( $r = 0.077$ ) was observed. Negative association was observed between serum vitamin D status and serum alkaline phosphatase status ( $r = 0.162$ ). Prevalence of vitamin D deficiency was observed in different morbidity conditions such as hypertension, diabetes mellitus, cancer, chronic body pain and chronic fatigue. The food and nutrient intake were below the Recommended Dietary Allowance (RDA) and Balanced Dietary Recommendations (BDR) by ICMR, 2017. 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.

## **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 attitude on importance of nutrition label information, 91 per cent had a positive attitude

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**Abstract of M.Sc. thesis**

**Department: Food Science & Nutrition**

**Major Adviser: Dr. Ruma Bhattacharyya**

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.

# **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 Ukhul 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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**Abstract of M.Sc. thesis**

**Department: Human Development and Family Studies**

**Major Adviser: Dr. S. Gogoi**

# **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.

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**Abstract of M.Sc. thesis**

**Department: Human Development and Family Studies**

**Major Adviser: Dr. Tulika Borah**

# **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.

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**Abstract of M.Sc. thesis**

**Department: Textile and Apparel Designation**

**Major Adviser: Dr. Bulbul Baruah**

## **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. The colour measurement revealed that wet processing treatments increased the

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**Abstract of M.Sc. thesis**

**Department: Textile and Apparel Designation**

**Major Adviser: Dr. Nabaneeta Gogoi**

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 (60.31cm<sup>3</sup>/cm<sup>2</sup>/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.

## **Application of natural plant sources to impart fragrance on textiles**

*Munmee Gogoi*

Nowadays textile materials have been found in application in the field of aroma finish using essential oil. By this application environment friendly ingredients are impregnated to the fabric. Recent researches show that textiles have increased their use so far in the field of application of aroma finish. A series of researches are aimed towards development of aroma embedded textile material for sustainability, environmental consciousness and consumer well being. The present study was on “Application of natural plant sources to impart fragrance on textiles,” and the objectives was □ Selection of natural aromatic plants and extraction of aroma using a suitable technique, □ Pretreatment of wool, cotton and silk fabric and subsequent application of natural aroma □ To standardize the process of essential oils application to prepare aroma fabrics □ Characterization of aroma imparted fabrics using various analytical methods and assessment of aroma durability of treated fabrics. For the present study three plant sources viz., citronella, lemongrass and patchouli and cotton, silk and wool fabric were selected for the experiment. For the extraction of oil solvent extraction method was used. Among the three plants, yield percentage of oil was highest in lemongrass plant followed by citronella and patchouli. Pre testing was done to investigate the suitability of oil on different fabric. All the three fabric were treated with three different oils and were assessed by as rated by respondent. From the pre test citronella oil was found suitable for silk fabric, lemongrass oil for wool fabric and patchouli oil for cotton fabric. Aroma was applied to the fabric with and without binder by using acrylic for cotton, Chitosan for wool and silicon for silk fabric. Application of aroma was done using exhaust method. After that treated fabrics were passed between the rollers of the pneumatic padding mangle at a pressure of 100 expressions and dried at a constant temperature of 60°C and drying duration was 2 minutes and 2 min of curing time. To optimize the process four different concentration of oil, binder and material to liquor ratio were selected and other variables such as temperature and time duration was remain constant. Optimizations of treated fabrics were done on the basis of retention of aroma after washing and abrasion. The optimum condition for cotton and

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**Abstract of M.Sc. thesis**

**Department: Textile and Apparel Designation**

**Major Adviser: Dr. B. B. Kalita**

silk fabrics were 20%, concentration of oil, 0.25% binder and 1:10 MLR with constant temperature of 70 0 C and 30 minutes of time period, while the optimum concentration for wool fabric was 15% concentration of oil, 0.25% binder and 1:10 MLR with constant temperature of 70 0 C and 30 minutes of time period. After application of aroma, fabrics were tested for structural, mechanical and comfort properties. Moreover, SEM and FTIR evaluation were also carried out to find out surface analysis and to identify structural changes in the spectrum. From this study it was found that the all the fabrics treated with and without binder retained their aroma up to 10 cycles of washing, 100 cycles of abrasion and 10 cycles of ironing as rated by respondents. The structural properties fabric count, fabric weight and fabric thickness of the entire aroma treated fabric were enhanced. The mechanical properties such as tensile strength, elongation and tearing strength of cotton fabric treated with binder was found maximum as compared to without binder and control. It was also observed that the mechanical properties of silk and wool fabrics treated with binder were exhibited higher tensile strength, elongation and tearing strength as compare to the fabric treated without binder. Again it was noticed that the comfort properties of treated fabrics were slightly decreased as compared to control samples. The air permeability of all the fabric treated without binder was found maximum as compared to with binder. The entire aroma treated fabric with binder depicted a decreasing trend in wicking height as compared to fabric treated without binder. The SEM analysis of cotton fiber showed the typical twist structure while in aroma treated fabric without binder exhibited the slightly swelling of fiber and with binder showed the presence of acrylic binder over the surface of cotton fabric. The untreated sample of silk fiber showed the typical cylindrical structure of silk fiber while fabric treated without and with binder showed the oil absorbency and coating of silicon binder over the surface of silk fabric. The wool fiber illustrated the distinct scale structure of wool while the fabric treated without binder displayed the swelling of fiber and fabric treated with binder revealed invisible scale structure due to the coating of Chitosan over the fiber surface. The application of patchouli oil and acrylic has bought structural changes in the spectrum of treated cotton fabrics. The two spectra of cotton fabric treated with and without binder look basically same, and it is very hard to notice any differences between these two spectra. In case of silk fiber it was found that the structural changes in the spectrum was observed after application of citronella oil and silicon binder. The treatment also reduced the intensity of peak of silk fiber. The application of lemongrass oil and Chitosan binder has bought structural changes in the spectrum of wool fiber. Due to Chitosan treatment, the sharp peak became slightly broader and the treatment also reduced the intensity of peak some peak of wool fiber. Considering the above aroma retention conditions and different properties it can be conclude that fabric treated without binder showed better result as compared to fabric treated with binder. Therefore, it can be recommended that fabric treated without binder successfully applied to all the fabrics till 10 cycles of washing, 100 cycles of abrasion and 10 cycles of ironing.

## **Master of Science (Veterinary)**

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

# **Evaluation of Pagn-Based Peptide(s) in Combination with Vi-Capsular Antigen as Vaccine Candidate for *Salmonella* Typhi**

*Puranpurna Goswami*

The present study was undertaken with a view to select the peptides representing the most potent B-cell and T-cell epitopes in the extracellular loops of PagN protein, synthesize them and evaluate their immunogenicity and protective efficacy either alone or in combination with Vi-polysaccharide in a mouse model against *Salmonella* Typhi. For this, the most potent B-cell and T-cell epitopes were selected using Ellipro and DiscoTope tools of IEDB resources and were chemically synthesized.

For immunogenicity study, the synthetic peptides of PagN protein in combination with Vi-polysaccharide were injected intraperitoneally in three different combinations, viz., 10µg of Vi-polysaccharide, 10µg of Vi-polysaccharide +100µg of each peptides, and 100µg each of all the peptides, into each of the six mice of Groups 2, 3 and 4, respectively, while the mice in Group 1 were kept as the control. Indirect ELISA was carried out to monitor the immune response against the peptides and Vi-polysaccharide.

The antibody titre against the synthetic peptides and Vi-polysaccharides showed a significant rise in all the three immunized groups (Groups 2, 3 and 4) as compared to the control group from day 7 till day 42. A significant rise in antibody titre was observed in both the Groups 3 and 4 in respect of the synthetic peptides, which sustained till the end of the study (till 42<sup>nd</sup> day of the experiment). In respect of Vi-polysaccharide, it was observed that there was a significant rise of antibody titre in both the Groups 2 and 3 with higher antibody response in group 3 (peptides +Vi-polysaccharide).

All the mice in different experimental groups were challenged with a lethal dose of *Salmonella* Typhi on the 42<sup>nd</sup> day post-primary immunization and observed for 10 days. All the animals in the control group started showing the symptoms suggestive of salmonellosis and died within 3 days of infection while the group of mice immunized with Peptides + Vi-polysaccharide (Group 3), showed complete protection (100%)

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**Abstract of M.Sc. thesis**

**Department: Animal Biotechnology**

**Major Adviser: Dr. Deep Prakash Saikia**

against *the challenge infection*. The groups vaccinated with the combination of all the peptides (Group 4) and Vi-polysaccharide(Group 2) showed 83.33 percent protection against *S. Typhi*.

The present study showed that the Peptides+Vi-polysaccharide combination may be a very potential vaccine candidate against *S. Typhi*. However, this needs further exploration particularly in respect of its protective efficacy against heterologous challenges, determination of the appropriate time of booster vaccination, and the effect of individual peptides on humoral and cell-mediated immune responses.

## **Molecular characterization of Lactobacilli isolated from indigenous ducks of Assam and *in vitro* assessment of their probiotic activity**

*Samiso Kramsapi*

Probiotic being an important bacteria to keep gut healthy are considered as good and helpful bacteria. The present study was mainly undertaken with a view to see if there is presence of good probiotics in Duck gut and if good probiotic candidate could be obtained from different isolates, isolated from faecal samples of cloaca of Duck. Samples were collected from different regions of Assam *viz* Hamren, Barpeta, Beltola, Hojai, Diphu, Karimganj, Kohora, Nagoan, Nalbari, Phuloni, Sivasagar, Sonapur etc from the cloaca of indigenous Ducks of Assam and brought in transport medium i.e Cary Blaire Media. Samples were process and inoculated in MRS broth for isolation of Lactobacillus with overnight incubation, which were further streaked in MRS Media Plate subsequently to obtain pure colonies.

The suspected pure colonies were preliminary identified by studying their Morphology through Gram staining, followed by Biochemical Test like sugar fermentation, Catalase Test which were followed again by PCR. PCR +ve samples were further tested for *In vitro* probiotic activity test for selection of good probiotic candidate. Different *In vitro* probiotic activity test include tolerance to low pH, tolerance to bile, lysozyme tolerance test, Autoaggregation, Cell surface Hydrophobicity, Antimicrobial activity test and Antibiotic sensitivity test.

Out of 320, 122 samples which were PCR +ve were tested for In-Vitro probiotic activity, where 15 samples could surpass low pH tolerance test at pH 2 & pH 2.5, being the main selection test for obtaining good probiotic candidate. The 15 isolates which tolerated low pH test were further tested for other test like Bile, Lysozymes tolerance test and adhesion test like Autoaggregation and Cell surface Hydrophobicity and then followed by Antimicrobial activity test, followed by Antibiotic sensitivity or susceptibility test.

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**Department: Animal Biotechnology**

**Major Adviser: Dr. Rupan Dutta**

Altogether 8 samples could surpass all the test, which were further sent for Molecular characterization by outsourcing where 7 were identified as *Lactobacillus Reuteri* & other 1 isolates as *Lactobacillus fermentation*. *L. Reuteri*, being the common or predominant probiotic Isolates obtained in other Poultry also found to be predominant probiotic isolate in Ducks too while *L. fermentation*, which are mainly found in fermented products could also be recovered from Duck faecal sample collected from cloaca. The 8 probiotic candidate which surpass all the *In vitro* probiotic activity test could be used as a future probiotic candidate only if further study undertaken with inclusion of *In vitro* Test.

# **Performance Evaluation and Polymorphism Profiling of Fecundity Genes in Indigenous Sheep of Meghalaya**

*Dimpi Khanikar*

The present investigation was carried out on Indigenous sheep of Meghalaya covering Nongrum, Thynroit and Mawjrong villages of East Khasi Hills district and Mawthungkper, Marang and Jaidoh villages of West Khasi Hills district of Meghalaya. The different objectives of the present investigation were to study body weights and body measurements at different ages, to study important traits of reproduction, to study different wool characteristics and to identify polymorphism of fecundity genes. A total of 567 animals were utilised to study body weight and morphometric traits; 77 animals were utilised to study reproductive traits and 38 animals were utilized to study wool traits. 50 randomly chosen ewes were utilized to study polymorphism of fecundity genes. The overall least-squares means (LSM) for body weight of Indigenous sheep of Meghalaya at birth, 3 months, 6 months and 12 months were found to be  $2.917 \pm 0.017$ ,  $12.149 \pm 0.056$ ,  $15.074 \pm 0.055$  and  $20.217 \pm 0.050$  kg respectively. The males and the sheep belonging to East Khasi Hills revealed significantly higher body weight in all ages compared to females and the sheep belonging to West Khasi Hills. The LSM for body lengths, height at withers, chest girth, neck girth, head length, head breadth, ear length and tail length were recorded as  $38.79 \pm 0.081$ ,  $37.956 \pm 0.088$ ,  $46.130 \pm 0.086$ ,  $23.802 \pm 0.087$ ,  $10.640 \pm 0.068$ ,  $7.104 \pm 0.063$ ,  $7.865 \pm 0.059$  and  $11.891 \pm 0.060$  cm at birth;  $46.19 \pm 0.055$ ,  $47.115 \pm 0.056$ ,  $56.49 \pm 0.047$ ,  $29.330 \pm 0.056$ ,  $12.337 \pm 0.045$ ,  $8.899 \pm 0.039$ ,  $8.814 \pm 0.042$  and  $14.065 \pm 0.035$  cm at 3 months;  $52.25 \pm 0.097$ ,  $54.663 \pm 0.051$ ,  $61.52 \pm 0.072$ ,  $31.364 \pm 0.057$ ,  $13.723 \pm 0.046$ ,  $8.706 \pm 0.045$ ,  $8.837 \pm 0.041$  and  $15.070 \pm 0.032$  cm at 6 months and  $56.19 \pm 0.031$ ,  $57.053 \pm 0.061$ ,  $72.48 \pm 0.104$ ,  $36.189 \pm 0.044$ ,  $14.989 \pm 0.033$ ,  $10.809 \pm 0.033$ ,  $10.281 \pm 0.031$  and  $14.937 \pm 0.029$  cm at 12 months of age. The overall least-squares means for horn length at 12 months of age in the present study was recorded as  $7.305 \pm 0.079$  cm. Significant effect of sex was observed on body length, chest girth, height at withers, neck girth, head breadth and ear length where males showed higher averages compared to females at different ages. The sheep belonging to

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**Abstract of M.Sc. thesis**

**Department: Animal Genetics & Breeding**

**Major Adviser: Dr. Arundhati Phookan**

East Khasi Hills showed significantly higher body length, chest girth, height at withers, neck girth, head length, head breadth, ear length and tail length than sheep of West Khasi Hills at different ages with the exception of higher value of neck girth at birth for sheep belonging to West Khasi Hills. The LSM for age at first fertile service (AFFS), age at first oestrus (AFO), oestrus cycle duration (OC), age at first lambing (AFL), lambing interval (LI), service period (SP), litter size (LS) and lifetime lamb production (LLP) were  $389.37 \pm 0.134$  days,  $370.052 \pm 0.802$  days,  $16.494 \pm 0.058$  days,  $540.123 \pm 0.128$  days,  $408.005 \pm 9.527$  days,  $256.432 \pm 8.961$  days,  $1.259 \pm 0.051$  nos. and  $3.584 \pm 0.091$  nos. respectively. The LSM for staple length, fibre length, fibre diameter and medullation percentage were  $6.016 \pm 0.029$  cm,  $57.899 \pm 0.134$  mm,  $57.899 \pm 0.134$   $\mu$  and  $50.974 \pm 1.042$  % respectively. Female sheep revealed significantly higher fibre length, fibre diameter and medullation percentage than males. The sheep belonging to East Khasi Hills showed significantly higher values for all wool characteristics except medullation percentage than the sheep of West Khasi Hills. PCR-RFLP analysis of fecundity genes *viz.* *FecB*, *FecG* and *FecX*; revealed polymorphism in *FecB* and *FecX* genes. However, *FecG* gene was found to be monomorphic. In case of *Fec B*, the genotypic frequency and allelic frequency were 0.28, 0.78 and 0.64, 0.36 for AA, AB, A and B respectively. In case of *FecX*, the genotypic and allelic frequency were 0.10, 0.90 and 0.55, 0.45 for AA, AB and A, B respectively. The population under study was not in Hardy-Weinberg Equilibrium for *FecB* and *FecX* gene.

# **Performance of HD-K75 in the Original Nucleus Herd *Vis A Vis* Public and Private Sectors of Organised Pig Farm**

*Eyangshuman Das*

The investigation was carried out on HD-K75. The data pertaining to 889 animals from third crop of 14<sup>th</sup>, 15<sup>th</sup>, 16<sup>th</sup> and 17<sup>th</sup> generation born to 103 dams and 35 sires maintained at ICAR- All India Co-ordinate Research Project (AICRP) on pig, Assam Agricultural University (AAU) Khanapara, Guwahati. The data was also collected for 1657 progenies of same genetic group maintained from various government, private and medium pig farms of different districts of the state of Assam, constitute the materials for the study.

The least-squares means (LSM) for body weights of HD-K75 were  $0.994 \pm 0.002$ ,  $9.845 \pm 0.009$ ,  $12.140 \pm 0.019$ ,  $27.821 \pm 0.033$ ,  $48.038 \pm 0.037$  and  $74.972 \pm 0.027$  kg at birth, at weaning (42 days), 2 month, 4 month, 6 month and 8 months of age respectively. The least-squares means for daily body weight gain in HD-K75 were  $210.765 \pm 0.194$ ,  $328.937 \pm 0.141$  and  $308.248 \pm 0.113$  g during the period from birth to weaning, weaning to 8 months and birth to 8 months of age respectively. The least-squares means for age at first fertile service, age at first farrowing, litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning in HD-K75 were  $241.153 \pm 1.770$  days,  $354.678 \pm 1.777$  days,  $8.733 \pm 0.111$ ,  $8.684 \pm 0.083$  kg,  $8.483 \pm 0.131$  and  $83.417 \pm 1.166$  kg respectively.

The average body weight at birth and at weaning of HD-K75 pigs in organized public farms, organized private farms and medium farms were  $0.998 \pm 0.003$ ,  $1.022 \pm 0.003$  and  $1.024 \pm 0.003$  kg and  $9.868 \pm 0.027$ ,  $9.986 \pm 0.011$  and  $10.015 \pm 0.143$  kg respectively. In the corresponding farms the average daily body weight gain during the period from birth to weaning were  $211.052 \pm 0.025$ ,  $213.299 \pm 0.009$  and  $214.010 \pm 0.011$  g respectively.

The age at first fertile service (days) were found to be  $249.074 \pm 0.782$ ,  $243.635 \pm 0.848$  and  $246.355 \pm 0.688$  in organized public farms, organized private farms and medium farms respectively and corresponding values for age at first farrowing

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(days) were  $362.864 \pm 0.771$ ,  $354.141 \pm 3.582$  and  $360.177 \pm 0.688$ . The average litter size at birth, litter weight at birth (kg), litter size at weaning and litter weight at weaning (kg) were obtained as  $7.851 \pm 0.229$ ,  $7.835 \pm 0.192$ ,  $7.160 \pm 0.184$  and  $70.655 \pm 1.733$  respectively in organized public farms;  $7.858 \pm 0.224$ ,  $8.037 \pm 0.183$ ,  $8.037 \pm 0.183$  and  $70.214 \pm 1.769$  respectively in organized private farms and  $7.844 \pm 0.226$ ,  $8.031 \pm 0.178$ ,  $7.244 \pm 0.198$  and  $72.328 \pm 1.879$  respectively in medium farms.

It was found that the generation of the animals had highly significant ( $P < 0.01$ ) effect on body weight at different ages except at 6 month of age where the effect was non significant and it was also observed that effect of generation was highly significant on average daily body weight gain during different period of growth.

In this study the effect of sex was found to be highly significant ( $P < 0.01$ ) for body weight at different ages of growth and average daily body weight gain during different periods of growth.

It was found that the generation of the animals had highly significant ( $P < 0.01$ ) effect on first fertile service, age at first farrowing, litter size at birth and litter weight at birth, whereas effect of generation was significant ( $P < 0.05$ ) for litter weight at weaning and non significant for litter size at birth.

The heritability ( $h^2$ ) estimate for body weight at different ages and daily body weight gain were lower and the standard errors were higher in most of the cases.

The heritability ( $h^2$ ) estimate for the reproductive traits were also found to be low to moderate with high standard errors.

The phenotypic and genetic correlation coefficient among the body weight at different ages found to be positive except the correlation related to 8 months of age and the genetic correlation between birth with 8 month. The phenotypic and genetic correlation for daily body weight gain was found to be positive and ranged from low to high.

The phenotypic and genetic correlations among reproductive traits were estimated and were found to be moderate to high with high standard errors in most of the cases and in the other cases the correlation was found to be negative.

The  $R^2$  value was found to be high for all linear regression equations that were developed on the basis of body length, height at withers and chest girth for male and females, whereas, the  $R^2$  value was found to be low for linear regression equations that were developed on the basis of height at withers and chest girth for the males and females together.

The multiple regression equations were developed on the basis of two linear body measurements at a time such as body length and height at withers, body length and chest girth and height at withers and chest girth. Another set of multiple regression equation was developed on the basis of body length, height at withers and chest girth for males, females and male and female together. The  $R^2$  values for all the multiple regression equations were high.

## **Performance of Siri Cattle of Sikkim Under Field Condition**

*Tenzing Lobsang Bhutia*

A total of 190 (64 male and 126 female) Siri cattle constituted the materials of the study and considered for morphometric measurements. Out of which, 114 (40 male +74 female) from West Sikkim and 76 (24 male +52 female) from East Sikkim districts of Sikkim respectively. The reproduction and production traits were collected from 104 cows and out of which 64 from West Sikkim and 40 from East Sikkim districts. In order to study the milk constituents, 87 milk samples were collected from 45 and 42 Siri cows of West Sikkim and East Sikkim districts respectively from the 8 different villages from West Sikkim (5) and East Sikkim (3) district. The data obtained were classified according to location, sex and lactation order. The overall least-squares means for the body length, height at withers, heart girth, pouch girth, head length, eye to eye space, horn tip circumference, horn mid circumference, horn base circumference, space between horns, horn length, udder length, udder breadth, teat length front left, teat length front right, teat length rear left, teat length rear right, teat diameter front left, teat diameter front right, teat diameter rear left and teat diameter rear right were  $115.24 \pm 0.24$  cm,  $126.56 \pm 0.31$  cm,  $160.96 \pm 0.31$  cm,  $168.33 \pm 0.26$  cm,  $41.32 \pm 0.14$  cm,  $18.99 \pm 0.11$  cm,  $8.40 \pm 0.07$  cm,  $11.01 \pm 0.08$  cm,  $14.79 \pm 0.08$  cm,  $16.89 \pm 0.10$  cm,  $17.64 \pm 0.12$  cm,  $27.73 \pm 0.16$  cm,  $30.57 \pm 0.13$  cm,  $5.31 \pm 0.11$  cm,  $5.36 \pm 0.12$  cm,  $4.46 \pm 0.10$  cm,  $4.48 \pm 0.10$  cm,  $6.20 \pm 6.40$  cm,  $5.91 \pm 0.08$  cm,  $4.98 \pm 0.07$  cm and  $5.03 \pm 0.08$  cm respectively. Sex and location had significant effect on various morphometric measurements under body measurements, head and horn measurements and teat measurements. The most predominant coat colour was found to be black and white (46.84 per cent), black (22.42 per cent) brown (18.42 per cent) and brown and white (12.63 per cent). Animals were found to have black switch (62.11 per cent) and white switch (37.89 per cent), black muzzle (77.89 per cent) and albino muzzle (22.11 per cent) and hooves colour were black (81.05 per cent) and white (18.95 per cent). Various udder shapes recorded were found to be bowl (42.06 per cent), round (15.87 per cent), bath (15.08 per cent), flat (14.29 per cent) and goat (12.70 per cent). For teat the various shapes recorded were as follows: cylindrical (50.79 per cent), funnel (30.16 per cent) and

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pear (19.05 per cent). The least-squares means for reproductive traits age, at first fertile service, age at first calving, gestation period, service period and inter-calving period of Siri cattle of Sikkim was found to be  $1209.35 \pm 5.96$  days,  $1492.25 \pm 6.37$  days,  $286.43 \pm 0.34$  days,  $196.97 \pm 0.63$  days and  $483.80 \pm 0.64$  days respectively. The least-squares means for various productive traits, lactation length, lactation milk yield, dry period, peak yield and days to attain peak yield of Siri cattle of Sikkim was found to be  $225.30 \pm 0.36$  days,  $671.86 \pm 2.64$  kg,  $258.01 \pm 0.43$  days,  $3.30 \pm 0.02$  kg and  $60.72 \pm 0.33$  days. Location had non-significant effect on all the reproductive and productive traits except lactation milk yield and dry period. Lactation order had significant effect on all the reproductive and productive traits except age at first fertile service, age at first calving, gestation period and days to attain peak yield. The milk constituents of Siri cattle of Sikkim in the present study fat, solid not fat, protein and total solids was found to be  $5.36 \pm 0.14$  per cent,  $8.44 \pm 0.08$  percent,  $2.99 \pm 0.05$  per cent and  $13.80 \pm 0.82$  per cent. No significant effect of location on the milk constituents was observed in the present study.

## Performance of Indigenous Sheep of Assam

*Pinky Saikia*

The present investigation was undertaken on the indigenous sheep of Assam to evaluate their performance potential available in their breeding habitat. Informations were collected from 8 districts of Assam to study their growth traits, reproductive traits, the effect of some non-genetic factors on performance traits, carcass traits and genetic polymorphism of candidate gene for growth and fecundity traits *viz.*, *IGF1* and *GDF9*, *BMP15* and *BMP4* respectively. Data on 1287 animals for growth traits, 387 animals for reproductive traits, 50 animals for carcass traits and 193 animals for molecular genetic analysis belonging to Dhubri, Barpeta, Darrang, Kamrup, Bongaigaon, Goalpara, Kokrajhar and Nalbari districts were utilized for the present study. The data obtained were classified according to sex, season of birth, season of lambing and parity.

The overall least-squares means for body weight at birth, 3 months, 6 months, 9 months, 12 months and adult body weight (>12 months) were found to be  $0.936 \pm 0.12$  kg,  $5.196 \pm 0.11$  kg,  $7.949 \pm 0.15$  kg,  $10.636 \pm 0.12$  kg,  $13.399 \pm 0.25$  kg and  $17.695 \pm 0.27$  kg respectively. The corresponding values for male and female sheep were recorded as  $0.966 \pm 0.12$  kg and  $0.906 \pm 0.10$  kg;  $5.351 \pm 0.16$  kg and  $5.040 \pm 0.14$  kg;  $8.194 \pm 0.21$  kg and  $7.703 \pm 0.13$  kg;  $11.091 \pm 0.11$  kg and  $10.181 \pm 0.16$  kg;  $13.907 \pm 0.25$  kg and  $12.892 \pm 0.15$  kg;  $17.960 \pm 0.29$  kg and  $16.829 \pm 0.19$  kg at birth, 3, 6, 9, 12 months and as adult bodyweight respectively. Highly significant effect ( $P < 0.01$ ) of sex of the animal was found on body weight at all the ages. It was observed that the males were heavier than the females.

The least-squares means for body weight pertaining to S1, S2, S3 and S4 were found to be  $0.959 \pm 0.11$  kg,  $0.923 \pm 0.07$  kg,  $0.937 \pm 0.09$  kg and  $0.925 \pm 0.08$  kg at birth;  $5.261 \pm 0.12$  kg,  $5.185 \pm 0.15$  kg,  $5.163 \pm 0.18$  kg and  $5.175 \pm 0.11$  kg at 3 months;  $8.017 \pm 0.16$  kg,  $8.008 \pm 0.20$  kg,  $7.861 \pm 0.15$  kg and  $7.849 \pm 0.21$  kg at 6 months;  $10.657 \pm 0.12$  kg,  $10.401 \pm 0.08$  kg,  $10.940 \pm 0.12$  kg and  $10.546 \pm 0.08$  kg at 9 months;  $13.374 \pm 0.14$  kg,  $13.365 \pm 0.11$  kg,  $13.814 \pm 0.24$  kg and  $13.305 \pm 0.16$  kg at 12 months ;  $17.230 \pm 0.20$  kg,  $17.355 \pm 0.31$  kg,  $17.811 \pm 0.38$  kg and  $17.282 \pm 0.26$  kg as adult body weight respectively. Season of birth exerted highly significant effect ( $P < 0.01$ ) on body weight at birth, 6 months, 9 months and 12 months. However, season

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**Department: Animal Genetics & Breeding**

**Major Adviser: Dr. Farzin Akhtar**

of birth had non-significant effect on 3 months body weight and significant effect ( $P < 0.05$ ) on adult body weight.

The overall least-squares means for age at sexual maturity (ASM), age at first lambing (AFL) and lifetime lamb production (LLP) were noted as  $235.559 \pm 2.46$  days,  $384.142 \pm 2.46$  days and  $10.118 \pm 0.25$  respectively. The Least-squares means for ASM, AFL and LLP pertaining to S1, S2, S3, S4 and P1, P2, P3, P4 were found to be  $234.921 \pm 1.96$  days,  $232.256 \pm 2.53$  days,  $236.200 \pm 3.63$  days,  $233.208 \pm 2.45$  days and  $238.027 \pm 1.82$  days,  $231.192 \pm 3.54$  days,  $226.243 \pm 3.80$  days,  $249.178 \pm 3.34$  days;  $387.504 \pm 2.55$  days,  $380.839 \pm 2.53$  days,  $384.783 \pm 2.75$  days,  $381.791 \pm 2.45$  days and  $386.610 \pm 1.43$  days,  $379.775 \pm 2.65$  days,  $374.826 \pm 2.51$  days,  $397.761 \pm 4.10$  days; and  $10.177 \pm 0.19$ ,  $10.076 \pm 0.11$ ,  $10.186 \pm 0.13$ ,  $10.031 \pm 0.11$  and  $10.251 \pm 0.21$ ,  $9.819 \pm 0.18$ ,  $9.391 \pm 0.23$ ,  $11.011 \pm 0.38$  respectively. Season of lambing had non-significant effect on age at sexual maturity, age at first lambing and lifetime lamb production. However, parity exerted significant effect ( $P < 0.05$ ) on age at sexual maturity and age at first lambing but showed non-significant effect on lifetime lamb production.

The mean lamb size in indigenous sheep of Assam was found to be 2.1 with type of lambing as singlet (29.71 per cent), twin (52.19 per cent), triplet (17.06 per cent) and quadruplet (1.04 per cent).

The overall least-squares means for age at slaughter, weight at slaughter, hot carcass weight (HCW) and dressing percentage (DP%) were recorded as  $7.286 \pm 0.12$  months,  $9.852 \pm 0.25$  kg,  $4.634 \pm 0.13$  kg and  $47.024 \pm 0.14\%$  respectively. The corresponding values for male and female sheep were recorded as  $7.210 \pm 0.13$  months and  $7.400 \pm 0.15$  months;  $10.030 \pm 0.26$  kg and  $9.674 \pm 0.22$  kg;  $4.741 \pm 0.12$  kg and  $4.528 \pm 0.14$  kg;  $47.080 \pm 0.15\%$  and  $46.968 \pm 0.18\%$  for age at slaughter, weight at slaughter, hot carcass weight and dressing percentage respectively. The least-squares analysis of variance revealed that the influence of sex showed non-significant effect on age at slaughter, weight at slaughter, hot carcass weight and dressing percentage.

Amplification of *IGF1*, *GDF9*, *BMP15* and *BMP4* genes using selective primers resulted in generation of 505 bp, 462 bp, 356 bp and 517 bp DNA fragments respectively. PCR-RFLP analysis of *IGF1*, *GDF9* and *BMP15* gene using *HaeIII*, *HhaI* and *HinfI* restriction enzymes revealed monomorphic banding patterns. However, SNP was detected in case of *IGF1* and *BMP15* genes. PCR-RFLP analysis of *BMP4* gene with *HaeIII*, showed polymorphic banding pattern. Three genotypes viz., AA, AB and BB were obtained. AA genotype yielded one fragment (517 bp), AB genotype yielded three fragments (175, 342 and 517 bp) and BB genotype yielded two fragments (175 and 342 bp). The frequencies of A and B alleles were found to be 0.32 and 0.68 respectively and the genotypic frequencies of *BMP4* gene were found to be 0.06, 0.52 and 0.42 for AA, AB and BB genotypes respectively. The calculated chi-square ( $\chi^2$ ) value was found to be non-significant at 1 d.f. and hence indicated that the population under study was in Hardy-Weinberg Equilibrium for *BMP4* gene.

In *IGF1* gene the sequence variation in terms of nucleotide was observed in 403, 416, 427, 430, 433, 542, 550, 553, 638, 677, 680, 716, 719 and 762<sup>nd</sup> position. Upon restriction mapping of the partial sequence of *IGF1* gene, the restriction site for *HaeIII* was found to be in 451, 533, 545 and 685<sup>th</sup> position. No sequence variation in terms of nucleotide was observed in *GDF9* gene. Upon restriction mapping of the partial sequence of *GDF9* gene, the restriction site for *HhaI* was observed in 2067<sup>th</sup> position. In case of *BMP15* gene nucleotide sequence variation was observed in 1900, 1919, 1950, 1964, 2025, 2066, 2084, 2114 and 2115<sup>th</sup> position. The restriction site for *HinfI* restriction enzyme was found to be in 1825<sup>th</sup> position. In *BMP4* gene, sequence variation in terms of nucleotide was observed in 1888 and 1991<sup>st</sup> position. Upon restriction mapping of the partial sequence of *BMP4* gene, the restriction site for *HaeIII* was found to be in 1812<sup>nd</sup> position.

All the sequences of the *IGF1*, *GDF9*, *BMP15* and *BMP4* genes showed 99-100% similarity among all the sequenced samples irrespective of variation in kid size and growth.

The present study indicated that indigenous sheep of Assam is a small sized animal having high fecundity and reproductive efficiency with excellent meat producing ability. The information obtained on body weight, and reproductive performance of indigenous sheep of Assam under their native field condition can be utilized for their further improvement. Variation present in the traits under study suggested that there is scope to improve these sheep through selection. Presence of polymorphism in *BMP4* gene in indigenous sheep of Assam opens interesting prospects for future selective breeding programme, especially based on marker-assisted selection.

# Genetic Studies on Growth Performance of Crossbred Pigs

*Racy Rongpi*

The present study was carried out in 1025 piglets belonging to two genetic groups viz. Hampshire crossbred and crossbred of Tamworth and Desi (TND) pigs that were being bred and maintained at the Regional Pig Breeding Farm, Kyrdemkulai, Meghalaya. Performance records of 379 and 646 piglets born to 136 gilts/dams and 25 sires belonging to the two genetic groups during the year 2016-2019 were studied with a view to assess the genetic and phenotypic parameters of growth traits viz. body weights at different ages and daily body weight gains during pre-weaning and post-weaning periods.

The overall least-squares means for body weight(kg) at birth, 4th week, 8th week, 12th week, 16th week, 20th week and 24th week of age were found to be  $1.247 \pm 0.007$ ,  $5.615 \pm 0.013$ ,  $11.302 \pm 0.032$ ,  $17.246 \pm 0.029$ ,  $23.349 \pm 0.053$ ,  $30.584 \pm 0.064$  and  $38.528 \pm 0.057$  respectively. The overall least-squares means (LSM) for daily body weight gain during the period from birth to 8thweek, 8thto 24thweek and birth to 24thweek of growth period were found to be  $179.532 \pm 0.528$ ,  $243.0.20 \pm 0.462$  and  $221.866 \pm 0.335$  respectively.

The least-squares analysis of variance showed highly significant effect of genetic group on body weight at all ages except at 12thand 16thweek of age. Significantly higher body weight was observed in Hampshire crossbred pigs. The least squares analysis of variance for effect of genetic group on daily body weight gain showed highly significant difference between 8thto 16thweek and birth to 24thweek of growth period. Significantly higher daily body weight gain was observed in Hampshire crossbred pigs.

The effect ofsex was found to be significant at all stages of growth in respect of body weight and daily body weight gains.

The least squares analysis of variance showed non-significant effect of season on body weight at all ages except at 20thweek (between Season 1 and Season 3) and 24thweek (between all the 3 seasons) of age. Piglets born during May to October month (Season 2) maintained significantly higher body weights than the animals born during

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February to March (Season 1) and December to January (Season 3). The least squares analysis of variance showed significant effect of season on daily body weight gain during various stages of growth except during birth to 8thweek growth period.

The heritability estimates of body weight at birth, 4thweek, 8thweek, 12thweek, 16thweek, 20thweek and 24thweek of age were found as  $0.392\pm 0.128$ ,  $0.104\pm 0.009$ ,  $0.268\pm 0.016$ ,  $0.408\pm 0.022$ ,  $0.338\pm 0.020$ ,  $0.130\pm 0.013$  and  $0.940\pm 0.042$  respectively. The heritability estimates of daily body weight gain during birth to 8thweek, 8thto 24thweek and birth to 24thweek growth period were found as  $0.288\pm 0.020$ ,  $0.980\pm 0.044$  and  $0.844\pm 0.040$  respectively.

The estimates of phenotypic correlation coefficients among body weight at birth with 4<sup>th</sup> week, 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age were found as  $0.056\pm 0.034$ ,  $0.080\pm 0.033$ ,  $0.271\pm 0.032$ ,  $0.316\pm 0.031$ ,  $0.081\pm 0.036$  and  $0.061\pm 0.037$  respectively; between body weight at 4<sup>th</sup> week with 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week as  $0.274\pm 0.032$ ,  $0.322\pm 0.030$ ,  $0.350\pm 0.029$ ,  $0.376\pm 0.031$  and  $0.169\pm 0.036$  respectively; between body weight at 8th week with 12thweek, 16thweek, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.288\pm 0.031$ ,  $0.550\pm 0.024$ ,  $0.542\pm 0.025$  and  $0.132\pm 0.036$  respectively; between body weight at 12<sup>th</sup> week with 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.488\pm 0.026$ ,  $0.481\pm 0.028$  and  $0.095\pm 0.035$  respectively; between body weight at 16<sup>th</sup> week with 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.488\pm 0.027$  and  $0.179\pm 0.036$  respectively and between body weight at 20<sup>th</sup> week with 24<sup>th</sup> week of age as  $0.125\pm 0.028$ . The estimates of phenotypic correlation coefficients among daily body weight gain during birth to 8<sup>th</sup> week with 8<sup>th</sup> to 24<sup>th</sup> week, 8<sup>th</sup> to 24<sup>th</sup> week with birth to 24<sup>th</sup> week and birth to 8<sup>th</sup> week with birth to 24thweek were found as  $-0.182\pm 0.036$ ,  $0.425\pm 0.030$  and  $0.813\pm 0.012$  respectively.

The estimates of genetic correlation coefficients among body weights at birth with 4<sup>th</sup> week, 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age were found as  $0.259\pm 0.019$ ,  $0.125\pm 0.014$ ,  $0.700\pm 0.006$ ,  $0.594\pm 0.009$ ,  $0.130\pm 0.002$  and  $0.170\pm 0.010$  respectively; among body weight at 4<sup>th</sup> week with 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.286\pm 0.003$ ,  $0.389\pm 0.003$ ,  $-0.107\pm 0.004$ ,  $0.502\pm 0.005$  and  $0.146\pm 0.003$  respectively; among body weight at 8<sup>th</sup> week with 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.078\pm 0.002$ ,  $0.137\pm 0.002$ ,  $-0.055\pm 0.004$  and  $0.192\pm 0.002$  respectively, among body weight at 12<sup>th</sup> week with 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.214\pm 0.002$ ,  $0.589\pm 0.003$  and  $0.119\pm 0.005$  respectively; among body weight at 12<sup>th</sup> week with 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.101\pm 0.004$  and  $0.257\pm 0.004$  respectively and among body weight at 20<sup>th</sup> week with 24<sup>th</sup> week of age as  $0.294\pm 0.002$ . The estimates of genetic correlation coefficients among daily body weight gain during birth to 8thweek with 8<sup>th</sup> to 24<sup>th</sup> week, 8<sup>th</sup> to 24<sup>th</sup> week with birth to 24<sup>th</sup> week and birth to 8<sup>th</sup> week with birth to 24<sup>th</sup> week growth period were found as  $0.052\pm 0.003$ ,  $0.526\pm 0.002$  and  $0.077\pm 0.002$  respectively.

# **Performance of Binjharपुरi Cattle in its Breeding Tract**

*Shrabanee Nayak*

The present study was conducted on 507 lactation records of Binjharपुरi cows from different clusters namely Chandramu, Chatishdehil, Ratlanga, Rudrapur, Sujapur in the Jajpur district of Odisha. The data were first analysed by least-squares variance technique of fitting constants to estimate the mean performance and the effect of genetic and non-genetic factors on production, reproduction, production efficiency and milk quality traits. The least-squares mean for production traits were estimated as lactation milk yield  $974.490 \pm 6.788$  kg, average daily milk yield  $3.557 \pm 0.023$  kg, Peak milk yield  $4.633 \pm 0.0213$  kg, days to attain peak milk yield  $59.225 \pm 0.298$  days, monthly milk yield  $84.280 \pm 0.372$  kg, lactation length  $274.444 \pm 1.249$  days and dry period  $121.913 \pm 0.611$  days for overall lactations. Non-significant influence of location was found on peak yield, significant effect on days to attain peak yield and rest of the production traits had highly significant relationship with location. The lactation order had highly significant effect on all production traits. Season of calving had highly significant influence on lactation milk yield and average daily milk yield, while it had significant effect on lactation length and non-significant influence on rest of the production traits. The sex of calf showed nonsignificant influence on all the production traits. The average age of Binjharपुरi heifers at first calving was observed to be  $1452.332 \pm 10.160$  days. The least-squares mean and standard error for different reproduction traits from overall lactations are  $115.061 \pm 1.106$  days for service period,  $281.296 \pm 0.193$  days for gestation period,  $396.357 \pm 1.088$  days for calving interval. The location had highly significant influence on service period, calving interval, age at first calving with exception of gestation period having nonsignificant effect. The lactation order had highly significant effect on service period and calving interval while significant effect on gestation period. The season of calving had highly significant effect on service period, calving interval and non-significant influence on rest of the reproduction traits. The sex of calf had non-significant influence on all the reproduction traits. The present investigation was also carried out on different compositional parameters of milk expressed in different traits like fat per cent, solid-notfat per cent,

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total solids per cent, protein per cent and finally the density which were estimated to be  $5.503 \pm 0.087$  per cent,  $8.004 \pm 0.124$  per cent,  $13.507 \pm 0.121$  per cent,  $3.379 \pm 0.066$  per cent and  $26.981 \pm 0.411$  respectively. The least-squares analysis of variance revealed highly significant influence of lactation order on fat per cent, solid-notfat per cent, total solids per cent where as significant effect on protein per cent and nonsignificant effect on density of the milk of Binjharpuri cows. The reports on production efficiency traits viz., milk yield per day of first lactation length (MY/FLL), milk yield per day of first calving interval (MY/FCI) and milk yield per day of age at second calving (MY/ASC) were found to be  $3.352 \pm 0.051$  kg/day,  $2.188 \pm 0.031$  kg/day and  $0.475 \pm 0.007$  kg/day respectively. The MY/ASC and MY/FLL were significantly affected by the location while no significant effect of location was observed in case of MY/FCI. The season of calving showed highly significant effect on all the production efficiency traits. The variation of the traits showed no significant difference due to sex of calf.

# **Certain Productive and Reproductive Performance of Sahiwal Cattle Under Organized Farm Condition of Assam**

*Upasana Baruah*

Sahiwal breed of cattle is best known among the farmers and breeders for its outstanding capacity to produce a large quantity of milk. The original habitat of this milch breed falls in the Sahiwal area in the Montgomery district of Punjab in Pakistan. This study aims to examine the performance of the breed outside its breeding tract, mainly in the high humid conditions of North East India, in particular Assam.

The present study was carried out in Sahiwal cattle farm, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati by utilizing a total of 43 numbers of animals including 18 numbers of adult Sahiwal cows and 25 numbers of calves.

The major objectives of the present study were to study the production and reproduction traits of Sahiwal cow; to study the persistency of their first lactation milk yield; to study the percentages of different milk constituents in Sahiwal milk; to study the growth performance of Sahiwal calves from birth to six months of age at monthly interval.

The Least Squares Analysis of Variance Technique of Harvey (1975) as suitable for non-orthogonal data was used to study the effects of various genetic and non-genetic factors on different economic traits. To make a pair-wise comparison among the means, Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was used wherever significant differences among different levels of factors were observed.

The least-squares means for average daily milk yield, average total lactation milk yield, peak milk yield, first lactation milk yield was found as  $3.30 \pm 0.13$  kg,  $697.94 \pm 43.58$  kg,  $10.09 \pm 0.58$  kg,  $1541.00 \pm 161.77$  kg, respectively.

The lactation order and period of milking had a highly significant effect ( $P < 0.01$ ) on the average daily milk yield. The lactation order did not show any significant effect but the period of milking had a significant effect on the average total milk yield ( $P < 0.05$ ). Lactation order had no significant influence on the peak milk yield and the first lactation milk yield.

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The first lactational length and first dry period were calculated out with simple average analysis and reported as  $274.83 \pm 14.48$  days and  $254.33 \pm 49.54$  days, respectively. The coefficients of variation for the above two mentioned traits were 18.25% and 67.47%, respectively.

The overall means for age at sexual maturity, age at first fertile service, age at first calving, first service period, first gestation length and first inter calving period were reported as  $892.89 \pm 43.20$  days,  $1044.79 \pm 37.16$  days,  $1236.79 \pm 92.83$  days,  $153.21 \pm 21.60$  days,  $283.00 \pm 1.44$  days,  $532.42 \pm 51.24$  days, respectively. The coefficient of variation for this mentioned traits were 20.53%, 13.31%, 28.08%, 52.76%, 1.90% and 33.34%, respectively.

# **A Comparative Study on the Performance of Broiler Chickens on Feeding Diets Containing Essential Oil, Antibiotic and Probiotic**

*Baishali Shil*

An experiment was conducted to study the performance of broiler chicken fed diet supplemented with antibiotic, probiotic and clove oil. One hundred eighty (n=180) day old broilers chicks of Ven Cobb 400 strain were distributed randomly into 4 groups (T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) having 45 chicks in each group on the basis of their body weight. Each group divided into three replicates of 15 chicks in each. The control group was fed with standard pre-starter, starter and finisher rations, computed by using common feed ingredients to meet the nutrient requirement as per BIS (2007) for broiler chicken and other three groups (T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) were offered the same standard ration of the control group but supplemented with the zinc bacitracin antibiotic, multi-strain probiotic and clove essential oil in feed as follows: T<sub>1</sub> (ZincBacitracin@55mg/kg), T<sub>2</sub> (Probiotic@150mg/kg) and T<sub>3</sub> (Clove oil@400ppm).

The result of the experiment showed significantly (p<0.05) higher body weight, total weight gain, total feed intake and overall FCR in the groups T<sub>3</sub> and T<sub>2</sub> than the control and T<sub>1</sub> groups. Broiler performance efficiency index was found better in T<sub>3</sub> and T<sub>2</sub> groups. Digestibility of DM and EE, metabolizability of CP and nitrogen retention were significantly improved (p<0.05) in the treatment groups than control. Significant difference (p<0.05) was observed in the level of Glucose in T<sub>3</sub> group whereas, serum protein, albumin, globulin and A: G ratio did not differ significantly (p>0.05) among the groups. Supplemented groups T<sub>3</sub> and T<sub>2</sub> showed significant (p<0.05) better Cholesterol level in comparison to control and T<sub>1</sub>. Whereas, no significant difference (p>0.05) was recorded in the serum ALT and AST activity. Dressing percentage and prime cuts percentage were significantly better (p<0.05) in the treatment groups than control. Whereas, no significant difference (p>0.05) was recorded in the carcass characteristics viz., giblet weight and lymphoid organs weight. Abdominal fat was noted significantly lower (p<0.05) in the T<sub>3</sub> and T<sub>2</sub> groups than T<sub>1</sub> and control groups. Protein percentage of meat is significantly higher in the treatment groups, whereas fat percentage is lower in

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T<sub>3</sub> and T<sub>2</sub> groups as compared to control and T<sub>1</sub>. The study revealed that the supplementation of multi-strain probiotic @ 150mg and clove oil @400ppm increased the profit for broiler production. On the basis of above experimental findings, supplementation of clove oil @400ppm was found to be better on the growth performance of broiler chicken.

# **Certain Productive and Reproductive Performance of Sahiwal Cattle Under Organized Farm Condition of Assam**

*Gagan Bhuyan*

An experiment was conducted to investigate the effects of iron nano particles (Ferric phosphate NPs) at different doses on growth, feed conversion efficiency, nutrient utilization, haematological as well as biochemical parameters and immune system of growing pigs. A total of 36 weaned piglets of Large White Yorkshire of average  $16.82 \pm 1.78$  to  $17.30 \pm 2.05$  kg body weight of above two months of age irrespective of sex were selected from ICAR-NRC on Pig, Rani, Guwahati -781131 which were bred, born and raised at the NRCP, Rani pig farm complex. The piglets were randomly allotted to four treatments of nine piglets with three replicates of three piglets in each group on the basis of body weight. Assigned four experimental treatment groups were the T0 (100mg inorganic iron as  $\text{FeSO}_4$ ), T1 (100mg organic iron as iron methionine), T2 (100mg nano iron as ferric phosphate) and T3 (50mg nano iron as ferric phosphate). The basal diet was prepared as per the recommendation of NRC (2012). The feeding trial was conducted for a period of 90 days. At the end of the trial, the average body weight growth were  $51.54 \pm 2.16$ ,  $53.43 \pm 2.62$ ,  $54.69 \pm 2.01$  and  $51.87 \pm 1.42$  kg and the average total weight gains were  $34.65 \pm 0.85$ ,  $35.96 \pm 0.98$ ,  $37.58 \pm 1.02$  and  $34.78 \pm 0.90$  kg for T0, T1, T2 and T3 groups, respectively. Although there were no significant difference in body weight among the treatment groups, a linearly increasing body weight was observed in T2 as compared to other three groups. In body weight gain, it was observed that 60 days onwards, there existed significant difference between T1 and T2 with other two groups ( $P < 0.05$  for 60 and 75 days,  $P < 0.01$  for 90 days). The rate of average feed conversion efficiency of the experimental groups were found to be  $4.92 \pm 0.16$ ,  $4.74 \pm 0.12$ ,  $4.53 \pm 0.13$  and  $4.92 \pm 0.12$  for T0, T1, T2 and T3 groups, respectively where significant difference ( $P < 0.05$ ) existed between T2 and other three groups on 75th day. On 90th day, T2 and T3 differed significantly with T0 and T3 but no significant difference existed between T2 and T3 ( $P < 0.05$ ).

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The digestibility coefficient of DM, OM, EE and CF did not differ ( $P>0.05$ ) significantly among the treatment groups. Nano iron @ 100mg/kg of diet offered group (T2) showed the highest CP digestibility among all. The digestibility of soluble carbohydrate (NFE) was significantly higher in both T2 and T3 group where nano iron was offered in the diet @ 100, 50 mg per kg of diet respectively in comparison to inorganic Fe (T0) and organic Fe (T1) treated group. Significantly ( $P<0.05$ ) highest nitrogen retention was recorded in nano iron @ 100mg/kg of diet offered group as compared to T0 and T3 although no significant difference ( $P>0.05$ ) was observed in the said group (T2) with organic iron provided group (T1). Nitrogen voided was significantly lower in T1 and T2 than the other two groups. Further, it was observed that T2 showed the highest Fe retention and lowest excretion followed by T1, T0 and T3. In terms of haematological profile, higher Hb, RBC and PCV value was observed in group provided with nano iron @ 100 mg as compared to other three groups. Concentration of red blood cells (RBC) was the lowest ( $P<0.01$ ) in nano iron @ 50mg provided group. However, the other blood parameter like lymphocyte count, monocyte count, eosinophil count, basophil count, neutrophil count and platelet count were not affected by source of dietary iron fortification. The study revealed that nano Fe @ 100mg/kg of diet results in higher serum iron in comparison with organic iron and inorganic iron supplementation. The concentration of blood glucose was found within normal physiological range in all experimental groups and involvement of nano iron @ 100mg/kg of diet resulted higher level of blood glucose in T2 group. T2 showed the significantly higher ( $P<0.01$ ) serum protein, serum albumin value followed by T1, T0 and T3. Other value like globulin, A:G, AST, ALT, BUN showed no significant ( $P>0.05$ ) difference in overall mean value among the treatments. It was observed that T2 and T1 had a significantly ( $P<0.05$ ) higher antibody titers on 14th day than T0 and T3 reflecting better humoral immune response against SRBC (Sheep-Red blood Cells). The phytohemagglutination (skin challenge) test revealed better cell mediated immune response in T2 as compared to other three groups. So, the present study reflects that ferric phosphate nano particles @ 100mg/kg of diet improves growth, FCR, protein and carbohydrate metabolism in grower pig in comparison to inorganic iron ( $\text{FeSO}_4$ ) and organic iron (Methio-chelated) @ 100mg. Increasing the dietary nano iron level in feed have positive effect in haematological parameter like Hb, RBC, PCV, Albumin value without any detrimental changes in the biological marker like AST, ALT, BUN. Further, supplementation of ferric phosphate NPs @ 100mg/kg of diet may have positive effect on the immune system of the body. Thus, the present study reveals that supplementation of ferric phosphate NPs @ 100mg/kg of diet improves the overall growth performance and immunity without any adverse effect on animal's health.

## **Growth Performance of Beetal Kids Feeding on High Plan of Nutrition Under Stall Fed Condition**

*Pallab Borah*

An experiment was conducted to study the growth performance of Beetal goat feeding on different plan of nutrition under stall fed condition. Twelve weaned male Beetal kids with an average body weight of 12.20- 12.82 kg were divided randomly on the basis of live weight into three experimental groups (C, T<sub>1</sub> and T<sub>2</sub>) of four animal each. All group were offered a mixture of green fodder (Para and Napier in 1:1 ratio on DM basis) and respective concentrate mixture i.e., (C, T<sub>1</sub> and T<sub>2</sub>) to the kids of group C, T<sub>1</sub> and T<sub>2</sub> respectively to meet the DM, DCP and TDN requirement at 100, 110 and 120 percent of ICAR (2013) feeding standard for growing kids.

Weighed quantity of concentrate mixture and grasses in the ratio of 60:40 on DM basis were offered daily to meet the nutrient requirements (DM, DCP and TDN) for growing kids gaining @ 75g daily as per ICAR (2013) feeding standard. Rations were adjusted at fortnightly intervals along with change in live weight.

The feeding trial was conducted for a period of 84 days. A digestion trial was conducted for 5 days duration using four animals from each group during the last week of the experiment. Sample of feed offered, residues, faeces were collected and analyzed for proximate composition and fibre content. Blood samples were collected from each animal at initial (0) day and every fortnight interval for six fortnight. At the end efficiency of feed utilization and economics of feeding was calculated.

The fortnightly gain in body weight did not significantly differ among the groups in the 1<sup>st</sup>, 2<sup>nd</sup> and 6<sup>th</sup> fortnight. However, significant difference was observed among the groups at 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> fortnight. Significantly higher ( $p < 0.05$ ) gain in body weight was observed in kids of T<sub>1</sub> and T<sub>2</sub> groups as compared to the group C in 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> fortnights. No, significant difference was observed between group T<sub>1</sub> and T<sub>2</sub>.

The total gain in body weight in kids during entire feeding trial in group C, T<sub>1</sub> and T<sub>2</sub> were  $5.82 \pm 0.22$ ,  $6.28 \pm 0.43$  and  $7.03 \pm 0.36$  kg, respectively. Statistically no significant difference was observed among the groups in respect of total gain in body weight of the experimental kids during entire feeding trial.

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**Abstract of M.Sc. thesis**

**Department: Animal Nutrition**

**Major Adviser: Dr. G. Saikia**

The average daily gain in body weight in group C, T<sub>1</sub> and T<sub>2</sub> were 69.28±2.96, 74.76±2.57 and 83.69±4.46 g/day, respectively. Significantly (<0.001) higher ADG were observed in T<sub>2</sub> group as compared to control group. However, no significant difference was observed between group C and T<sub>1</sub>, and group T<sub>1</sub> and T<sub>2</sub>.

The feed conversion efficiency (on DM basis) in the experimental kids of different groups during entire feeding trial were 6.28±0.63, 6.13±0.39 and 6.36±0.58 in group C, T<sub>1</sub> and T<sub>2</sub>, respectively. No Significant (p> 0.05) difference was observed among the groups in respect of FCE during entire feeding trial.

The dry matter intake per 100 kg body weight of experimental kids were 3.16±0.25, 3.44±0.17 and 3.60±0.10 kg in groups C, T<sub>1</sub> and T<sub>2</sub>, respectively. The dry matter intake per kg metabolic body size of the experimental kids were 65.14±2.53, 71.38±1.46 and 75.35±3.15 g in group C, T<sub>1</sub> and T<sub>2</sub>, respectively.

The digestibility coefficient of DM, OM, CP, EE, CF, NFE, NDF and ADF in group C were 57.54±1.91, 63.70±3.78, 73.00±3.62, 74.65±1.80, 53.42±2.35, 73.78±1.79, 58.65±4.38 and 46.41±1.92 percent, respectively, for group T<sub>1</sub> were 63.99±2.77, 76.55±3.48, 81.03±4.02, 77.31±1.55, 56.41±2.79, 79.52±3.01, 64.11±2.58 and 52.00±3.28 percent, respectively and for group T<sub>2</sub> were 67.00±1.50, 77.90±4.40, 84.94±2.57, 78.41±3.00, 55.46±1.74, 86.58±1.75, 64.65±1.89 and 50.94±1.70 percent, respectively. No significant difference was observed among the groups in respect of digestibility coefficient of Ether Extract, Crude Fibre, Nitrogen Free Extract, Neutral Detergent Fibre and Acid Detergent Fibre. However, significant difference (p<0.05) were observed among the groups in respect of digestibility coefficient of dry matter, Crude protein and organic matter. The digestibility coefficient of DM, CP and OM was significantly (p<0.05) higher in group T<sub>2</sub> as compared to group C and group T<sub>1</sub>.

All the experimental kids of different group received DM, CP, DCP and TDN in 100 percent of the requirement suggested by ICAR (2013) standard. The nutritive value of composite ration in term of CP, DCP and TDN were 16.18±1.02, 11.81±1.08 and 68.02±3.22 percent in group C, 17.79±0.54, 12.75±0.67 and 74.82±2.40 percent in group T<sub>1</sub> and 18.90±0.21, 14.05±0.32 and 81.33±2.96 percent in group T<sub>2</sub>, respectively.

No significant (p>0.05) variation was observed among the groups in respect of value of Blood Urea Nitrogen, Protein, Albumin, Blood Cholesterol, Creatinine, AST and ALT. But significant (p<0.05) difference was observed among the groups in respect of the values of glucose at all six fortnight where values were significantly higher in group T<sub>1</sub> and T<sub>2</sub> as compare to group C.

The cost of feed per kg live weight gain was found to be Rs.135.80±3.77, 139.00±3.79 and 146.37±2.50 in group C, T<sub>1</sub> and T<sub>2</sub>, respectively.

From the results of the present experiment it could be concluded that 100% of ICAR (2013) recommendation of DCP and TDN for growing kids were appropriate for satisfactory growth performance of Beetal kids under stall fed condition. However, for more growth performance, Beetal kids may be reared on higher protein and energy level upto 120% of ICAR (2013) recommendation under stall fed condition in the agro-

climatic condition of Assam and NE region. More elaborative feeding trial with large number of animal is required for ascertain accurate results.

## **Effect of Partial Replacement of Concentrate by Feeding Dried Azolla (*Azolla caroliniana*) on Growth Performance of Crossbred Calves**

*Sunita Kalita*

Eighteen crossbred calves of about 6 to 7 months old weighing average 71.12 kg were randomly distributed into 3 groups of six animals in each group as T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> by using completely randomized block design (CRD). The control group T<sub>0</sub> fed with conventional feed comprising concentrate mixture, green grass (Napier) and paddy straw. The treatment groups were fed with dried Azolla (*Azolla caroliniana*) at 10% (T<sub>1</sub>) and 20% (T<sub>2</sub>) level by replacing concentrate mixture and with same green grass (Napier) and paddy straw. The concentrate mixture of the three treatment groups contains 20.20, 20.24 and 20.34 percent CP and 72.75, 72.07 and 71.70 percent TDN in T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group respectively. At the end of the experimental period of 90 days, a metabolism trial was conducted for 5 days.

The mean daily gain and total gain in body weight of T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group differed significantly (P<0.0001) among the groups of the experimental calves and highest in T<sub>2</sub> group followed by T<sub>1</sub> and T<sub>0</sub>. The feed conversion efficiency was 8.15±0.34, 7.90±0.27 and 7.78±0.21 in T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group respectively which had non significant difference (P>0.05) among the groups. DM intake was highest in the T<sub>2</sub> group followed by T<sub>1</sub> and T<sub>0</sub> (P<0.05). Digestibility coefficient of DM, OM, CF, EE, NFE, NDF and ADF had non significant difference among the groups (P>0.05), however digestibility of CP differed significantly (P<0.05) among the groups having highest digestibility in T<sub>2</sub> and lowest in T<sub>0</sub> group. All the animals in different treatment group were in positive balance of nitrogen, calcium and phosphorus. Plane of nutrition revealed that protein and energy received by the different treatment groups of animals were adequate as per ICAR requirement (2013).

The blood constituent viz. blood glucose, total serum protein was within the normal range and highest concentration was observed in T<sub>2</sub> (P<0.05) group and at 90<sup>th</sup> day of experimental period (P<0.0001). The lowest blood urea nitrogen level was in T<sub>2</sub> (P<0.0001) group and at 90<sup>th</sup> day of the experimental period (P<0.0001). The cost of

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**Abstract of M.Sc. thesis**

**Department: Animal Nutrition**

**Major Adviser: Dr. (Mrs.) Lakhyajyoti Borah**

feeding per kg live weight gain was lowest in T<sub>2</sub> (Rs.78.14) in comparison to T<sub>1</sub> (Rs. 85.12) and T<sub>0</sub> (Rs. 96.67).

The present study revealed that the dried *Azolla caroliniana* upto 20% level in replacement of concentrate mixture can be fed to crossbred calves without any adverse effect to economize the ration.

# **Fertility Status in Relation to the Physico-Biochemical Properties of Cervico-Vaginal Mucus, Serum Minerals Andhormonal Profile in Lakhimi Cattle**

*Bhaskarjyoti Kalita*

The present study was undertaken to find out the fertility status in relation to the physico-biochemical properties of cervico-vaginal mucus, serum minerals (Calcium, Phosphorus and Sodium) and hormone levels (estrogen and progesterone) at estrus. Eighteen apparently healthy Lakhimi cows (G1) and eighteen Lakhimi heifers (G2) were selected for the investigation. The concentration of minerals in cervico-vaginal mucus and serum were estimated by spectrophotometer using commercial kits. In cows having clear, thin, alkaline (pH=7.36±0.08) cervico-vaginal mucus with higher spinnbarkeit value (11.41±0.49 cm), and typical fern pattern were observed to be more fertile. In heifers having clear, thin, alkaline (pH= 7.27±0.07) cervico-vaginal mucus with higher spinbarkeit value (12.10±0.33 cm) and showing typical fern pattern appeared to favour conception.

The mean concentration of calcium, phosphorus and sodium in the cervicovaginal mucus of conceived and non conceived animals of G1 group were 11.31±0.26 and 11.75±0.41mg/dl, 2.14±0.03 and 1.55±0.09 mg/dl, 175.25±3.84 and 162.71±2.54 mEq/L, respectively. The mean±SE of respective parameters in heifers (G2) were 12.51±0.33 and 14.05 ±0.23 mg/dl, 2.01±0.06 and 1.43±0.13 mg/dl, 172.05±6.86 and 122.67±7.61 mEq/L. Significantly higher (P<0.01) phosphorus and sodium, and lower (P<0.01) calcium concentrations in cervico-vaginal mucus of conceived animals from both the groups were observed in sustaining favorable environment for conception. Mean ± SE concentration of serum calcium, phosphorus and sodium in G1 animals were 9.58±0.20 and 8.35±0.20 mg/dl, 4.09±0.05 and 3.51±0.10 mg/dl, 139.69±1.23 and 133.01±1.31 mEq/L in conceived and non-conceived animals, respectively; while they were 10.75±0.14 and 10.11±0.16 mg/dl, 4.11±0.04 and 3.92±0.08 mg/dl, 134.53±1.04 and 130.14±0.66 mEq/L for G2 group. The mean ± SE

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**Abstract of M.Sc. thesis**

**Department: Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. D. K. Sarma**

value of estrogen in the serum of conceived ( $10.34 \pm 0.30$  pg/ml) and non-conceived ( $8.97 \pm 0.25$  pg/ml) animals of G1 group differed significantly ( $p < 0.01$ ). Moreover, the estrogen values in G2 group also differed significantly ( $p < 0.01$ ) between the conceived ( $10.29 \pm 0.24$  pg/ml) and non-conceived ( $9.26 \pm 0.28$  pg/ml). However, the serum progesterone levels in both G1 and G2 groups differed non-significantly between the conceived and non-conceived animals.

Based on the results of present study, it could be concluded that the physicochemical properties of cervico-vaginal mucus could be considered as indicators of fertility in Lakhimi cows and heifers.

## **Effect of Commercial Extender and Curcumin as Additive on Quality of Frozen Beetal Buck Semen**

*Bhubaneswar Sahoo*

Forty pooled ejaculates from five Beetal bucks maintained at Goat Research Station, A.A.U., Burnihat collected by artificial vagina method were used to study the effect of commercial extender and curcumin as additive on quality of frozen Beetal buck semen. Twenty pooled ejaculates in experiment I were used to study the effect of two commercial extenders (Bioxcell and Optixcell) on quality of unwashed frozen buck semen taking Tris extender in washed semen as control. In experiment II, using the best extender of Optixcell remaining twenty pooled ejaculates were used for studying the effect of two concentrations (0.25 mM and 0.5 mM) of curcumin and 2 mM vitamin E (control) as additives on quality of frozen semen. Freezing of semen was done in French mini straws by rapid horizontal vapour freezing technique.

The post thaw percentages of sperm motility, live sperm, intact acrosome, HOST-reacted sperm and extracellular ALT and AST activities differed significantly ( $P < 0.0001$ ) between Optixcell, Bioxcell and Tris extenders, but did not differ significantly between extenders for DNA-damaged sperm. On critical difference test mean sperm motility and HOST-reacted sperm after freezing were significantly ( $P < 0.05$ ) higher in Optixcell extender than in Bioxcell and Tris extenders, and also in Tris extender than that in Bioxcell extender. The live sperm and intact acrosome after freezing were significantly ( $P < 0.05$ ) higher in Optixcell and Tris extenders than that in Bioxcell extender. The mean values of extracellular release of ALT and AST after freezing were significantly ( $P < 0.05$ ) lower in semen frozen with Optixcell extender than that with Bioxcell and Tris extenders, and also with Tris than that with Bioxcell extender.

On freezing of unwashed Beetal buck semen in commercial Optixcell extender containing two concentrations (0.25 mM and 0.5 mM) of Curcumin and 2 mM Vitamin E (control), the sperm motility, live sperm and extracellular ALT and AST activities differed significantly ( $P = 0.0073$ ;  $0.0007$ ;  $0.0022$ ;  $< 0.0001$ ), but did not differ significantly for incidence of intact acrosome, HOST-reacted sperm and DNA-damaged sperm between additives. Critical difference test revealed that the mean sperm motility

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**Abstract of M.Sc. thesis**

**Department: Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. Sudip Sinha**

and live sperm after freezing were significantly ( $P < 0.05$ ) higher in Optixcell extender containing 0.25 mM Curcumin and 2 mM Vitamin E than that in 0.5 mM Curcumin, difference between the former two being non-significant. The extracellular ALT activity was significantly ( $P < 0.05$ ) lower in semen frozen with Optixcell extender containing 2.0 mM vitamin E and 0.25 mM curcumin than that with 0.5 mM curcumin while no significant difference in the parameter was observed between the former two additives. The extracellular release of AST was significantly ( $P < 0.05$ ) lower for 2 mM vitamin E than that for 0.25 mM and 0.5 mM of curcumin, and also for 0.25 mM curcumin than for 0.5 mM curcumin.

Based on post thaw parameters studied commercial Optixcell extender was found to be superior to Bioxcell and Tris extenders for cryopreservation of Beetal buck semen, and supplementing 0.25 mM curcumin in the extender was found to be at par with 2 mM vitamin E in improving post thaw semen quality as compared to 0.5 mM curcumin.

## **Induction of Postpartum Oestrus in *Lakhimi* Cow Through Hormonal and Nutritional Interventions**

*Chahidur Rahman*

The present investigation was conducted to study the incidence of postpartum anoestrus, changes in certain hormonal and biochemical profiles and to evolve a suitable therapeutic regime for addressing postpartum anoestrus in *Lakhimi* cattle. After screening of 500 *Lakhimi* cows from different villages of Hajo and Boko area of Kamrup (R) district, Assam a total of 42 *Lakhimi* cows having history of more than 90 days postpartum anoestricity and after confirmation of anoestrus by per-rectal examination and ultrasonography were selected for the study to record the effect of hormonal and nutritional interventions and divided randomly into seven groups comprising six animals in each group *i.e.* Group A, B, C, D, E, F and G. Group A to F received different hormonal and nutritional treatment regimes where group G served as untreated control group. The different treatment regimes studied were Hydroxyprogesterone caproate + eCG, Clomiphene citrate alone, Clomiphene citrate + Mineral mixture, GnRH analogue alone, GnRH analogue + Mineral mixture and Mineral mixture alone. The response to different regimes was studied based on oestrus response, mean interval from the end of treatment to onset of oestrus and conception rate. The blood biochemical constituents, *viz.* serum oestrogen, progesterone, calcium and phosphorus were estimated on the day of treatment, day of induced oestrus and day 20 of breeding.

The study revealed that out of 500 *Lakhimi* cows the incidence of postpartum anoestrus was found to be 20.60 per cent.

Out of six treatment regimes for addressing postpartum anoestricity, Clomiphene citrate + Mineral mixture administration regime brought about the highest oestrus induction response and conception rate based on treated animals. In the present study the shortest interval from end of treatment to onset of oestrus was found to be in Hydroxyprogesterone caproate + eCG treated group and the longest in GnRH analogue alone.

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**Major Adviser: Dr. Manjyoti Bhuyan**

In the cows treated with different treatment regimes the serum oestrogen level increased significantly on day of induced oestrus and then decreased on day 20 of breeding. On the other hand, serum progesterone level remained at basal level on day of induced oestrus and then increased significantly on day 20 of breeding in the pregnant cows. The serum calcium and phosphorus level did not differ significantly between various treatment regimes.

## **Effect of additives on quality of boar semen during preservation at 15°C**

*Mebanshan N. Lyngdoh*

From four experimental Hampshire crossbred boars, 48 ejaculates were collected once weekly by Gloved hand method, 12 ejaculates from each of the four boars maintained at the All India Coordinated Research Project (AICRP) on Pig, College of Veterinary Science, Khanapara, Guwahati were used in the present experiment to study the effect of three additives *i.e.* Butylated Hydroxy Toluene (BHT),  $\alpha$ -tocopherol (Vitamin E) and Curcumin on the quality of boar semen and also to evaluate the best concentration out of three *i.e.* 50  $\mu$ M, 100  $\mu$ M and 200  $\mu$ M during preservation in BOD incubator for 216 hours at 15°C.

There was no significant difference in initial motility between the boars but the volume of gel mass, the strained volume, total ejaculate volume, sperm concentration, and live sperm count, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between the boars. The highest overall mean percentage of motile spermatozoa, intact acrosome and HOST reacted spermatozoa was observed to be attained by semen extended in Modena extender containing BHT as the additive.

The mean sperm motility, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between additives and preservation period. Out of the three additives, BHT was found to be the best followed by Vitamin E based on sperm motility, intact acrosome and HOST.

The highest overall mean percentage of motile spermatozoa, intact acrosome and HOST reacted spermatozoa was observed to be attained by semen extended in Modena extender containing BHT of concentration 100 $\mu$ M.

The mean sperm motility, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between additives and preservation periods. It was observed that the percentage of sperm motility, intact acrosome and HOST reacted spermatozoa declined significantly ( $P < 0.05$ ) with the increase in hour of preservation irrespective of additives.

Out of the three concentrations, 100  $\mu$ M was found to be the best followed by 50  $\mu$ M based on Marginal average sperm motility, intact acrosome and HOST.

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**Abstract of M.Sc. thesis**

**Department: Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. Manjyoti Bhuyan**

A total of thirty eight pigs were inseminated with 80 ml of semen extended with Modena containing 100  $\mu$ M of BHT that was held for 4 hours at 22°C and subsequently preserved up to 216 hours at 15°C in a BOD incubator. The number of females inseminated using fresh diluted semen and semen preserved for 96, 120, 144, 168, 192 and 216 hours of preservation was 17, 4, 7, 4, 2, 2 and 2 respectively and the conception rate was worked out to be 82.35, 75, 71, 50, 0, 0, 0 respectively.

# **Metagenomics of Uterine Bacteria of Repeat Breeder Cows and Therapeutic Management of Endometritis**

*Sabera Islam Chowdhury*

The present study was conducted on 610 dairy animals with a view to study the incidence and etiology and metagenomics of uterine bacteria of repeat breeding animals and comparative efficacy of intrauterine treatment of endometritis. The incidence of reproductive disorders of dairy cattle was 42.95 per cent. The incidence of different reproductive disorder out of the total reproductive disorders were anestrus (24.04%), uterine prolapse (4.58%), cervico-vaginal prolapse (2.29%), dystocia (6.87%) and repeat breeding (62.21%). The incidence of various reproductive disorders out of total number of animal examined were anestrus (10.32%), uterine prolapsed (1.96%), cervico-vaginal prolapse (0.98%), dystocia (2.95%) and repeat breeding(26.72%).The incidence of anatomical, functional, infectious and managerial cause of repeat breeding in dairy cattle were 1.22, 29.44, 33.74 and 35.58 per cent, respectively. The incidence of repeat breeding in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> parity out of the total animals examined having reproductive disorder was found to be 16.41, 20.61 and 25.19 per cent , respectively. Higher incidence of repeat breeding was observed in animals of 3<sup>rd</sup> and above parity. The incidence of repeat breeding in age group of  $\leq 3$  yrs, 4-5 yrs and  $\geq 6$  yrs out of total repeat breeder animals were 20.85, 34.35 and 44.70 per cent, respectively and out of total reproductive disorder it was found to be 12.97, 21.37 and 27.86 per cent, respectively. Highest incidence of repeat breeder was recorded in  $\geq 6$  yrs age group. Taxonomic profiling of the bacterial metagenome of uterine lavage of repeat breeding animals after amplification of V<sub>3</sub> and V<sub>4</sub> regions of bacterial 16S rRNA gene and sequencing by using Next Generation sequencing technology revealed presence of eleven bacterial phyla and they were *Proteobacteria* (33.76%), *Firmicutes* (27.04%), *Bacteroidetes* (14.91%), *Actinobacteria* (14.85%), *Fusobacteria* (3.94%), *Tenericutes* (3.72%), *Spirochaetes* (0.54%), *Synergistetes* (0.53%), *Verrucomicrobia* (0.49%), *Porphyromonas* (0.16%) and *Cyanobacteria* (0.05%). The different organisms isolated from uterine lavages were *Escherichia coli* (35.71%), *Streptococcus* sp. (28.57%),

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**Abstract of M.Sc. thesis**

**Department: Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. Kutubuddin Ahmed**

*Staphylococcus* sp.(14.28%), *Klebsiella* sp.(7.14%) and *Pseudomonas* sp. (14.28%).The overall mean bacterial load of the nine uterine samples was 12533.33 with a range from 1900 to 63000.The samples positive for single isolate and more than one isolates were 21.42 and 50.00 per cent, respectively. The overall sensitivity of 14 bacterial isolates to Levofloxacin, Cefotaxim, Metronidazole, Amoxicillin, Ceftriaxone and Tetracycline were 85.71, 28.57, 35.71, 21.43, 71.43 and 28.57 per cent, respectively. *E.coli* LPS (100ug), proteolytic enzymes (Trypsin-8mg, Chymotrypsin-8mg, Papain-4mg, Tocopherol-120mg and Retinopalmitate-58mg +20ml normal saline) and Lenovo-AP (Levofloxacin+ Ornidazole+ Alpha Tocopherol) were administered intrauterine in endometritic animals. The percentage of PMN cell of 4.9, 5.2 and 4.4 before treatment reduced to 2.2, 2.3 and 1.6 per cent in subsequent estrus after treatment with *E.coli* LPS, proteolytic enzymes and Lenovo AP, respectively. All the animals were positive before treatment and negative after treatment for white side test. Insemination was carried out in the subsequent estrus and the conception rate was 50.00, 60.00 and 60.00 per cent in cows treated with *E.coli* LPS, proteolytic enzymes and Lenovo AP, respectively.

## **Effect of Preservation on Quality of HD-K75 Boar Semen and its Molecular Evaluation**

*Surabhi Basumatary*

A total of 24 ejaculates, 6 ejaculates from each of four HD-K75 boars of 10-12 months age maintained at ICAR – All India Coordinated Research Project (AICRP) on Pig, C. V. Sc., A.A.U., Khanapara, Guwahati, are being selected for the present study. The semen was collected by simple fist method once weekly, to study the effect of three different extenders on the quality of boar semen during preservation. After initial evaluation (volume, concentration and initial motility), fresh semen was split into three parts, extended (1:4) with BTS, GEPS and MODENA extenders and hold at 22°C for 4 hours. Then extended semen was incubated at 15°C in BOD incubator upto 120 hours and evaluated for sperm motility, Hyperactivated spermatozoa, live spermatozoa, live acrosome reacted spermatozoa, HOST reacted spermatozoa, DNA integrity and expression pattern of stress and apoptotic related gene at 0, 24, 48, 72, 96 and 120 hours of preservation.

The mean percentage of sperm motility differed significantly ( $P<0.01$ ) between BTS, GEPS and MODENA extenders at 0, 24, 48, 72, 96 and 120 hours of preservation. The mean percentage of sperm motility at each hours of preservation differed significantly ( $P<0.01$ ) between GEPS and MODENA extenders but not between BTS and GEPS extenders. Irrespective of extender there was significant difference ( $P<0.01$ ) between 0, 24, 48, 72, 96 and 120 hours of preservation. Mean sperm motility in MODENA was comparatively higher than BTS and GEPS extender at each hour of preservation.

The mean per cent hyperactivated spermatozoa did not differed significantly between BTS, GEPS and MODENA extender at 0 hours of preservation. However, at 24, 48, 72, 96 and 120 hours significant difference ( $P<0.01$ ) was observed between GEPS and MODENA extender while no significant difference between BTS and GEPS extender. At different hours of preservation it was found significantly differed ( $P<0.01$ ). It was also found that the mean hyperactivated spermatozoa in MODENA extender was comparatively higher than BTS and GEPS at each hour of preservation. Moreover, the overall mean value also tends to decrease with increase in hours of preservation.

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**Abstract of M.Sc. thesis**

**Department: Reproduction, Gynaecology and Obstetrics**

**Major Adviser: Dr. P. M. Barua**

The mean percentage of live spermatozoa at 0 and 24 hours did not differ significantly between BTS, GEPS and MODENA extenders. However, at 48, 72, 96 and 120 hours of preservation significant difference was observed ( $P < 0.01$ ) between GEPS and MODENA extender, but not between BTS and GEPS extender. Irrespective of extender it was found that there exist significant difference ( $P < 0.01$ ) between 0, 24, 48, 72, 96 and 120 hours of preservation. The mean per cent of sperm motility was found to be higher in MODENA as compared to BTS and GEPS at all hour of preservation.

The mean percentage of live acrosome reacted spermatozoa differed significantly ( $P < 0.01$ ) between GEPS and MODENA and BTS and MODENA extenders at different hours of preservation. However, in GEPS and BTS the findings at 48 and 72 hour and 96 and 120 hour were in close conformity. In MODENA extender, observations in 0, 24 and 48 hours were close to each other. On critical difference test (Duncan method) the means of live acrosome reacted spermatozoa in MODENA extender was significantly ( $P < 0.01$ ) higher than that of BTS and GEPS at 0, 24, 48, 72, 96 and 120 hours of preservation. Between hours of preservation the means of live acrosome reacted spermatozoa was nonsignificant in BTS, GEPS and MODENA extender. The means of live acrosome reacted spermatozoa at 72 hours of preservation was  $65.79 \pm 1.51$ ,  $66.67 \pm 1.42$  and  $67.54 \pm 1.53$  in BTS, GEPS and MODENA respectively.

The mean percentage of HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between BTS, GEPS and MODENA extender at 48, 72 and 96 hours of preservation. But at all hours of preservation it was higher in MODENA extender as compared to BTS and GEPS. There was significant difference ( $P < 0.01$ ) of HOST reacted spermatozoa at each hour of preservation in BTS, GEPS and MODENA extender. Moreover, overall mean of GEPS and BTS extender was in close proximity to each other. Again, the mean HOST reacted spermatozoa in GEPS extender at 96 and 120 hours were close to each other and the findings of GEPS exceeds that of MODENA and BTS.

The percentage of DNA integrity revealed that in BTS, GEPS and MODENA extender there is no spermatozoa with damaged DNA from 0 to 72 hours of preservation. However, at 96 and 120 hours 0.50% of damaged spermatozoa was observed in BTS extender. It was also found that at 96 hours there was no DNA damaged spermatozoa in GEPS and MODENA but at 120 hours 1.00% DNA damaged spermatozoa was observed in GEPS extender. Further no DNA damaged spermatozoa was observed in MODENA extender from 0 to 120 hours of preservation period.

The mean relative expression of *HSP70* gene in terms of fold change within preservation period was elucidated that at 0, 24 and 48 hours of preservation the expression of *HSP70* gene differed significantly ( $P < 0.01$ ) in BTS extender. In GEPS and MODENA, significant difference ( $P < 0.01$ ) was observed only at 0 and 24 hours of preservation. On critical difference test (Duncan method) the relative expression of *HSP70* gene in BTS, GEPS and MODENA was found to differ significantly ( $P < 0.01$ ) at 24 hours of preservation, with GEPS having the highest expression of *HSP70* gene

followed by MODENA than BTS extender. However, it was observed that at 0, 48, 72, 96 and 120 hours of preservation no significant difference was observed between BTS, GEPS and MODENA extenders.

The mean fold change in relative expression of *Cas3* gene in BTS, GEPS and MODENA extender differed significantly ( $P < 0.01$ ) at 0, 72 and 96 hours of preservation. On 24, 48 and 120 hours of preservation there was significant difference between BTS and GEPS and BTS and MODENA extenders, but no significant difference was observed between GEPS and MODENA extender. In BTS extender the means of expression of apoptotic gene differed significantly ( $P < 0.01$ ) in between hours of preservation. However no significant difference was observed in GEPS at 48 and 72 hours of preservation and in MODENA at 0 and 120 hours of preservation. The overall fold change value of expression of apoptotic gene was found to be higher in BTS extender followed by MODENA and GEPS.

# **Comparative Anatomical, Haemato-Biochemical and Hormonal Studies on the Female Reproductive System of Kamrupa Variety and Indigenous Chicken (*Gallus domesticus*) of Assam During Different Stages of Laying**

*Mansil M. Sangma*

The present study was conducted on 36 numbers of apparently healthy female chicken which were divided into two groups as Experimental Group A (indigenous chicken of Assam) and Experimental Group B {Kamrupa variety, AICRP (PB)} which were further divided into 3 sub-groups viz., pre-laying, laying and post-laying birds. Forty (40) apparently healthy chicks of each group were raised from day old to maturity and sexing was done after the sexual characteristics were visible and utilized for research purpose. Comparative gross anatomical and histomorphological, histochemical, ultrastructural, hormonal and biochemical parameters were undertaken.

Average weight of entire reproductive system of Kamrupa variety ( $58.24 \pm 8.47$  gm) was significantly higher than indigenous chicken of Assam ( $27.28 \pm 4.25$  gm,  $p < .001$ ). Average weight of the ovary of Kamrupa (laying:  $54.91 \pm 4.92$  gm; post laying:  $6.53 \pm 0.33$  gm) was significantly higher than that indigenous one (laying:  $29.2 \pm 0.76$  gm; post-laying:  $2.26 \pm 0.24$  gm,  $p < 0.05$ ).

Relative mean length of the oviduct of Kamrupa variety (laying:  $753.73 \pm 4.25$  mm; post-laying:  $576.49 \pm 5.27$  mm) was significantly greater than indigenous chicken of Assam (laying:  $358.91 \pm 3.63$  mm; post-laying:  $278.84 \pm 15.48$  mm,  $p < 0.05$ ) respectively. Average diameter of infundibulum of Kamrupa variety (laying:  $4.48 \pm 0.22$  mm; post-laying:  $4.38 \pm 0.04$  mm) was significantly higher than that of indigenous chicken of Assam (laying:  $1.74 \pm 0.08$  mm; post-laying:  $1.9 \pm 0.29$  mm,  $p < 0.05$ ). However, the mean diameter in vagina during post-laying period ( $4.98 \pm 0.15$  mm) of indigenous chicken was significantly greater than Kamrupa variety ( $3.61 \pm 0.18$  mm,  $p < 0.05$ ). The mean diameter was also significantly different within different laying periods in magnum of the indigenous chicken and the vagina of Kamrupa variety ( $p < 0.05$ ).

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**Abstract of M.Sc. thesis**

**Department: Veterinary Anatomy and Histology**

**Major Adviser: Dr. Kamal Behari Dev Choudhury**

Histological section of ovary of both the indigenous chicken and Kamrupa variety consisted of an outer cortex and inner medulla, which were intermingled during the early pre-laying stages. However, cortex and medulla were distinctly differentiated during laying period in all the groups. The ovarian medulla was surrounded by elongated bands of smooth muscle along with the presence of connective tissues, blood vessels and fibroblasts in the medulla with aggregation of nerve cells (Ganglion).

The entire oviduct was lined by pseudostratified ciliated columnar epithelium however, the luminal surface of the funnel and tubular part of the infundibulum was lined prominently by ciliated simple columnar epithelium with numerous goblet cells. Relative average height of the epithelium was significantly different during the laying and post-laying period in infundibulum, pre-laying and post-laying period of magnum, laying period of uterus, pre-laying and laying period of isthmus, laying and post-laying period of vagina between the two experimental groups ( $p < 0.05$ ). The average height of the epithelium was also significantly different within the infundibulum of indigenous chicken, magnum of both the varieties, isthmus of Kamrupa and the vagina of Kamrupa variety ( $p < 0.05$ ). Comparative mean height of the glandular epithelium of magnum, isthmus and uterus was highly significant at  $p < 0.05$ , within and between all the experimental groups. The sperm host glands (SHG) were present maximum in indigenous chicken of Assam in uterus and vagina during laying period. Lining epithelium of SHG was cuboidal to columnar.

Histochemically, the intensity for ALP increased from pre-laying to laying period and reduced towards post-laying period. The ACP decreased from pre-laying to post laying period. The ATP activity increased during the laying period. PAS activity was highest in the epithelium of infundibulum and vagina while the rest of the oviduct showed moderate activity during laying. However, PAS activity was more in vaginal epithelium of indigenous chicken of Assam.

Scanning electron microscopic (SEM) study of the infundibulum revealed distinct primary and secondary folding lined by long cilia among the non-ciliated epithelium in both the indigenous chicken of Assam and Kamrupa variety. SEM study of magnum revealed the presence of thick folding which were lined by ciliated epithelium and numerous opening of glands in pre laying, laying and post laying birds in all the experimental groups. The cilia were studded with numerous secretory products which was also observed in uterus and vagina. The isthmus in SEM showed some parallel primary folds with evidence of secondary folding in all the experimental groups. In cross sectional view, the tunica sub-mucosa of isthmus and uterus showed numerous connective tissue in all the experimental groups. The SEM revealed that uterus of Kamrupa variety and indigenous chicken showed numerous thick folds. In the laying Kamrupa variety it was observed that the surface epithelium was constituted with numerous ciliated epithelium with numerous openings of uterine glands. The SEM of vagina revealed longitudinal primary and secondary folds.

Average serum estrogen and progesterone levels were significantly different within the group ( $p < 0.05$ ), however estrogen, progesterone and cortisol were statistically

insignificant between the groups with an exception to cortisol which was significantly higher ( $p < 0.05$ ) in indigenous chicken  $12.13 \pm 3.29$  nmol/L than the Kamrupa variety  $3.54 \pm 0.82$  nmol/L respectively.

The average serum total protein level was significantly higher in indigenous chicken than that of Kamrupa during the pre-laying period, ( $p < 0.05$ ). The same was true within the indigenous chicken at the different stages of laying ( $p < 0.05$ ). The mean serum glucose level was highest in the laying period in indigenous chicken and then decreased significantly ( $p < 0.05$ ) in the post laying period. But in Kamrupa variety there was significant ( $p < 0.01$ ) decrease in the laying period in comparison to the pre laying period. Similarly, serum phosphorus level was significantly different during the different stages of laying within the indigenous chicken ( $p < 0.05$ ). The serum cholesterol level was also significantly different during the post-laying period between the two experimental groups ( $p < 0.05$ ) and also during the different stages of laying within both the groups. The serum calcium level was significantly different ( $p < 0.05$ ) during the pre-laying period, between the two experimental groups and during the different stages of laying within the indigenous chicken. The mean 25 OH Vitamin D in the Kamrupa variety was significantly higher than the indigenous chicken of Assam during all the stages of the laying period ( $p < 0.05$ ) and the highest being observed during the post-laying period in Kamrupa variety ( $134.28 \pm 1.33$  ng/dl).

Relative mean hematological parameters revealed significant differences in respect of WBC count and MCV within the Kamrupa variety ( $p < 0.05$ ). Similar differences in lymphocyte percentage, RBC count, MCHC and Hb levels were recorded in both the experimental groups. Significant difference in WBC count was observed during the post-laying period, eosinophil percentage during laying period, MCV during post-laying, MCHC and Hb during the pre-laying and post-laying period between the experimental groups ( $p < 0.05$ ).

From the above study it can be concluded that the age at first laying in indigenous chicken under intensive management system was less than Kamrupa variety, however the cortisol level which showed stress was more in the indigenous chicken of Assam. Further, it can be concluded that the performance was better in Kamrupa variety in terms of gross parameters, lining epithelial thickness with certain blood biochemical constituents and hormonal parameters.

# **Effect of tolR Deletion Mutation on Release of OMV of *Salmonella typhimurium* and Evaluation of Nano – and Microparticles Conjugated Vaccines**

*Anisha Sultana*

*Salmonella enterica* serovar Typhimurium is a gram-negative, rod shaped, facultatively anaerobic bacteria which is responsible for invasive nontyphoidal Salmonellosis. Outer membrane vesicles (OMVs) are the bacterial nanovesicles which are released by Gram-negative bacteria. The OMVs serve an attractive and powerful vaccine platform that can induce both humoral and cell-mediated immune responses. The yield of OMVs are required to be high for commercially making them more profitable for vaccine production. However, most of the wild type strains of *Salmonella* Typhimurium are inefficient in release of large quantities of OMVs due to the linkage and attachment of bacterial outer membrane with the inner cell wall membrane of *Salmonella* by tolR protein. The genetic alteration of the standard strain of *Salmonella* Typhimurium can increase the production of OMVs. In the present study, this alteration was accomplished by disruption of the Tol-Pal system, through knockout of the tolR gene of *Salmonella* Typhimurium MTCC -98 strain. After successful deletion of the tolR gene of *Salmonella* Typhimurium, the yield of OMVs were determined in terms of protein concentration from both the mutant strain and wild type strain of *Salmonella* Typhimurium in mg per litre of BHI broth. The mutant strain showed a significantly ( $p < 0.05$ ) higher yield of OMVs compared to the wild type strain in terms of protein concentration. However, the significant variation was observed in the protein profile in terms of band intensity in the OMVs isolated from tolR gene deleted mutant and wild type strain of *Salmonella* Typhimurium.

The conjugation of outer membrane vesicles with chitosan nanoparticles, poly (anhydride) nanoparticles and poly-lactide co-glycolide microparticles was carried out in different conditions of pH, temperature and nanoparticles/microparticles to OMV ratio. The optimized conditions were determined in terms of entrapment efficiency of OMV using response surface method (RSM). The optimized conditions were found at

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**Abstract of M.Sc. thesis**

**Department: Veterinary Biochemistry**

**Major Adviser: Dr. (Mrs.) Rita Nath**

pH of 7.0 and temperature of 24°C for poly (anhydride) nanoparticles, ratio of 1:10 (nanoparticle:OMV) and 1:9 (microparticle:OMV) for chitosan nanoparticles and polylactide co-glycolide microparticles in terms of OMV entrapment efficiency. The pH and temperature in the range of 6.5 to 7.5 and 20°C to 25°C did not have any influence on the OMV entrapment efficiency of chitosan nanoparticles and poly (anhydride) nanoparticles.

The optimized conditions did not alter the OMV protein profile in SDS-PAGE and immunogenic potential in mice.

# Otitis in Dog and Its Therapeutic Management

*Arpana Barua*

The present study entitled “**Otitis in dog and its therapeutic management**” was undertaken w.e.f. 1st August’2019 to 31st July’2020 with the objective to study the prevalence of otitis in dogs and to investigate the fundamental etiological agent responsible for the condition along with therapeutic regimen based on antibiotic sensitivity test. The prevalence of otitis in dog was 2.11% with higher occurrence in Labrador breed (16.07%) with males (56.25%) being predominantly affected and in age group above 4- 6 years (30.36%). Clinical signs associated with otitis were ear puritus, restlessness, head shaking, pawing at the ear, tilting of affected ear, circling, purulent discharge, pain on palpation, swelling, foul smell, hyperaemia, and hyperpigmentation. The bacterial causative organisms isolated from otitic dogs were Coagulase positive *Staphylococcus* species (35.48 %) followed by *Escherichia coli* (22.58%), *Streptococcus* species (14.51%), coagulase negative *Staphylococcus* species (9.68%), *Pseudomonas* species (6.45 %). The fungal causative organisms were *Malassezia pachydermatis* (16.07%) and *Candida* species (2.67%). The antibiotic sensitivity test for coagulase positive *Staphylococcus* species revealed highest sensitive to Ceftriaxone & tazobactam (100.00%), Coagulase negative *Staphylococcus* species to Ceftriaxone & tazobactam and Enrofloxacin (100.00%), *Streptococcus* species to Enrofloxacin & Ofloxacin (88.88%); however Gram negative organisms like *Escherichia coli* and *Pseudomonas* species revealed highest sensitivity to Enrofloxacin (100.00%). Dogs treated with Enrofloxacin ear drop alone showed highest clinical improvement followed by Ofloxacin and Gentamicin. Combined therapy using Ofloxacin ear drop, parenteral Ceftriaxone & tazobactam and Itraconazole orally showed faster recovery in the treatment of otitis in dog.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Clinical Medicine, Ethics & Jurisprudence**

**Major Adviser: Dr. Ditul Barman**

## **Anthelmintic Activity of *Acorus calamus* Rhizome Extract Against *Haemonchus* Species in Goats**

*Champa Sharma*

The present investigation was carried out with the view to study the anthelmintic activity of *Acorus calamus* rhizome extract against *Haemonchus* species in goats. *Haemonchus contortus* worms were found to be the predominant worm in the goat population of the farm.

The qualitative phytochemical analysis of hydroethanolic extract of *Acorus calamus* rhizome revealed the presence of terpenoids, steroid, diterpenes, flavonoids, tannin, glycoside, saponin and phenolic compound.

In *in-vitro* study, *Haemonchus* worms were exposed to different concentration of hydroethanolic and aqueous extract of *Acorus calamus* rhizome. The hydroethanolic extract was found to be more effective against *Haemonchus contortus* than aqueous extract. A dose dependant anthelmintic activity was exhibited by rhizome extract and highest efficacy was observed at 1000 µg/ml.

The goats positive for *Haemonchosis* showed a significant decrease in Hb, PCV, TEC, total serum protein, albumin A:G ration and serum iron and a significant increase in TLC, neutrophil and eosinophil percentage and liver enzymes (ALT and AST).

*In-vivo* anthelmintic study of hydroethanolic extract of *Acorus calamus* rhizome @ 500 mg/kg b.wt. orally (two doses, 0 day and 21<sup>st</sup> day) and fenbendazole @ 5 mg/ kg b.wt. orally were given to *Haemonchus* infected goats. EPG count, haemato-biochemical parameters and clinical improvement were evaluated on '0', 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup> and 28<sup>th</sup> day post treatment. In Group I, EPG became 0 on 28<sup>th</sup> day after administration of second dose on 21<sup>st</sup> day. In Group II, treated with fenbendazole, EPG count became 0 on 7<sup>th</sup> day. Haematological parameters showed increase in Hb, PCV, TEC, lymphocyte % and decrease in TLC, neutrophil and eosinophil % post treatment and biochemical analysis showed increase in values of TSP, Serum Albumin, A:G ratio and Serum Iron after treatment. Globulin, ALT and AST values decreased significantly post treatment.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Clinical Medicine, Ethics & Jurisprudence**

**Major Adviser: Dr. Bendangla Changkija**

On the basis of reduction of EPG count and haemato-biochemical changes, the therapeutic efficacy of hydroethanolic extract of *Acorus calamus* rhizome was 100% on 28<sup>th</sup> day post treatment with administration of second dose orally on 21<sup>st</sup> day. Fenbendazole showed a higher efficacy with 100% reduction of EPG on 7<sup>th</sup> day post treatment.

## **Osteomalacia : Its Diagnosis and Management in Dairy Cows**

*Gunajit Barman*

A total of 325 dairy cows of private dairy farms in and around Guwahati city and Instructional Livestock Farm, College of veterinary science, Assam Agricultural University, Khanapara, Guwahati-22 were screened and 23 cows were confirmed positive for osteomalacia on the basis of clinical symptoms and biochemical parameters. The prevalence of Osteomalacia was recorded 7.08 per cent with the highest distribution in the age group of >6-9 years (47.82%), followed by >3-6 years (34.78%), >9 years (13.04%) and < 3 years (4.35%). The highest distribution of osteomalacia was found between 4th-6th lactation and lowest in >6th lactation.

The clinical symptoms of osteomalacia recorded in this present study were lordosis, kyphosis, bowing of legs, difficulty in getting up, reduced body conditions. The positive cows showed low levels of serum calcium (7.60 to 8.90 mg/dl), phosphorus (1.82 to 3.76 mg/dl) and vitamin D3 (15.31 to 31.72 ng/ml) and high rise of serum alkaline phosphatase enzyme (182.9 to 286.2 Unit/L). The hock angles were also lower than the healthy animals.

In the therapeutic trial the treatment regimen for cows of group A, that were administered buffered phosphorus injection @ 25 ml intravenously to each animals followed by calcium, phosphorus and vitamin D3 supplementation (Calphos D3 bolus) @ 1 bolus twice daily for 30 days was found to be more effective than the others.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Clinical Medicine, Ethics & Jurisprudence**

**Major Adviser: Dr. B. C. Baishya**

# **Haemoprotozoal Diseases of Cat and Its Therapeutic Management**

*Pooja Kapil Marwaha*

The present study entitled “Haemoprotozoal diseases of cat and its therapeutic management” was conducted for a period of 12 months, from June 2019 to May 2020, with the objectives to study the prevalence of haemoprotozoal infection in domestic cats, haemato-biochemical alterations in affected cats and to formulate an effective therapeutic regimen for the most prevalent haemoprotozoal infection in cat.

Prevalence was determined based on direct microscopy and confirmed via PCR. *Babesia* spp. were the only haemoprotozoa that were detected in the present study. The study revealed a 3.74% prevalence of babesiosis in hospital registered cat cases, and the incidence based on number of cases screened was found to be 10.4%. Age-wise distribution showed the highest incidence in cats over 2 years of age (34.62%) and lowest in cats from 13-24 months (15.38%). Season-wise distribution showed highest incidence in pre-monsoon and winter season (30.77%) and lowest in the post-monsoon season (15.38%).

The most prominent clinical signs associated with babesiosis in domestic cats were weakness, fever, anorexia, inappetence, jaundice, diarrhoea, dehydration including pale pink and papery white mucous membranes. A rare manifestation of babesiosis (cerebral form) was observed in 2 affected animals, where nervous symptoms were seen.

Haematology revealed significant anemia with a significant ( $p < 0.05$ ) decrease in the haemoglobin value, total erythrocyte count and thrombocyte count, and a marked elevation of total leucocyte count. Biochemistry revealed a significant ( $p < 0.05$ ) elevation in the levels of liver enzymes (ALT and AST) as well as indirect, direct and total bilirubin, indicating hepatic damage.

Treatment response was evaluated based on microscopic examination, haemato-biochemical alterations and clinical recovery using mean clinical score. Based on these parameters, the combined therapy of diminazene diaceturate showed a superior efficacy in the treatment of babesiosis in domestic cats when compared to diminazene diaceturate alone.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Clinical Medicine, Ethics & Jurisprudence**

**Major Adviser: Dr. T. C. Dutta**

## **Management of Clostridial Infection with Special Reference to *Clostridium perfringens* in Asiatic Elephant (*Elephas maximus*) in Assam**

*Ashit Chakraborty*

Clostridial infection is an anaerobic Gram +ve bacterial disease of both wild and captive elephant. This organism is generally recorded in deep seated wound infection. A total number of 40 elephants were examined during the study period with 10 wild and 30 captive elephants. 8 numbers of *Clostridium perfringens* were isolated from different types of sample which were found to be positive for *cpa* gene after PCR analysis confirming the isolates to be of *Clostridium perfringens* Type A with highest prevalence from Intestinal content (50.00%) and one number of *Clostridium difficile* was isolated from faecal sample which was found to be positive for *gluD* gene with a prevalence of 4.16 per cent.

The prevalence of Clostridial infection in wild elephant was 20.00 per cent and in captive elephant 23.33 per cent with the overall prevalence of 22.50 per cent. The prevalence of Clostridial infection as per spatial distribution in captive elephant of Forest Department (Govt. of Assam) was 23.33 per cent. However, in wild the highest prevalence was recorded in Rani Forest Reserve. Season-wise the prevalence was higher during rainy season (40.00%) and lower in summer (13.33%). Age-wise prevalence was highest in less than 10 years of age group (40.00%) and lower in age group above 51 years (10.00%). Sex-wise the prevalence was found to be highest in wild male elephants (50.00%).

There was an increase in total leucocyte count (TLC), neutrophil and monocyte level with decreased level was observed in haemoglobin (Hb), red blood cell (RBC) and packed cell volume (PCV) in Clostridial infected elephants. *Clostridium perfringens* and *Clostridium difficile* were the two *Clostridial* species, isolated from different samples. The antibiogram test showed highest sensitivity to Enrofloxacin, Cefotaxime and Gentamicin whereas partial resistance to Ceftriaxone and Tazobactam, Tetracycline.

Therapeutic management of deep-seated wound infection was done with potassium permanganate solution (1 : 1000) and dressed with povidone iodine (5%)

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**Abstract of M.Sc. thesis**

**Department: Veterinary Epidemiology and Preventive Medicine**

**Major Adviser: Dr. G. Mahato**

solution. Topical antiseptic cream (Charmil ointment) was applied over the wound for 10-15 days along with Enrofloxacin (Flobac SA) injection. Vitamin B complex (Conciplex) and meloxicam (Melonex) injection was given as a supportive therapy. The elephants showed recovery within 20-24 days. The *Clostridium difficile* isolated from faeces of the affected elephant was rendered treatment with Cefotaxime (Taxim) injection. Intalyte, Vitamin B complex (Conciplex) and meloxicam (Melonex), and iron (Ferritas) injection was given as supportive therapy. Unfortunately the calf died during the course of treatment due to several other concurrent infections.

# **Epidemiology and Economic Impact of Rabies in Animals of Kamrup Metro District of Assam and West District of Tripura**

*Bishal Debbarma*

Rabies is a neglected tropical fatal viral zoonosis caused by *Lyssavirus* genus of *Rhabdoviridae* family, mostly mediated by dog-bites. It is 100 per cent preventable by timely and appropriate post-exposure prophylaxis (PEP). Globally 60,000 people die from canine-mediated rabies annually. India reports approximately 30 per cent of global burden annually. The economic impact of rabies on farmers includes the post-exposure expenses of vaccination and/or losses due to livestock mortality. In the present study, post-mortem brain tissue samples were collected from three different locations as per OIE for diagnosis of rabies using Lateral Flow Assay (LFA) kit, and confirmed by Direct Fluorescent Antibody Technique to determine the incidence of rabies. The economic impact was analysed on disability-adjusted life years (DALYs) and total cost of PEP of dog-bite cases from the retrospective data for five years. The incidence of rabies was 76.47 per cent in animals in the present study. Species-wise, canines (76.92%) had the highest incidence of rabies followed by bovine (15.38%) and caprine (7.69%). Retrospective study for five years (2016-2020) revealed 1093 and 1735 dog-bite cases in the Veterinary Clinical Complex (VCC), CVSc, AAU, Khanapara and the State Veterinary Hospital (SVH), Chenikuthi, Kamrup Metro of Assam, respectively. On the other hand, 655 dog-bite cases were recorded in the State Veterinary Hospital (SVH), Abhoynagar, West district of Tripura during 2019 and 2020. The incidence of dog-bite cases were recorded highest in 2019 in all the three hospitals. Month-wise, August and October recorded the highest dog-bite cases. Gender-wise, dog-bite cases were higher in males (57.63%) than females (43.37%). The cost of PEP per dog-bite case was estimated at Rs. 215-703, Rs. 171-536 and Rs. 161-610 for VCC, SVH (Chenikuthi) and SVH (Abhoynagar) respectively. For 4-dose regimen (Essen regimen) PEP, the cost per dog-bite case ranged from Rs. 860-2,812, Rs. 684-2,144 and Rs. 644-2,440 for the same hospitals, respectively. The total cost of 4-dose regimen PEP for the VCC ranged between Rs. 939,980-3,073,516 while for the SVH, Chenikuthi, it ranged

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**Abstract of M.Sc. thesis**

**Department: Veterinary Epidemiology and Preventive Medicine**

**Major Adviser: Dr. (Mrs.) Jyoti B. Dutta**

between Rs. 1,186,740-3,716,960 for the years under study. On the other hand, 4-dose regimen PEP cost for the SVH, Abhoynagar, it ranged between Rs. 421,820-1,598,200 for two years (2019-2020). The disability-adjusted life years (DALY) for 2019 was between 6200-6210 days in bovine, 35,469-35,559 days in canine and 4,740-4,750 days in caprine with 11 mortalities. The DALY for 2020 ranged between 7112.5-7122.5 days in bovine and 3800-3810 days in canine with 2 mortalities due to rabies. Estimating the actual burden of rabies is a priority for devising control and prevention strategies.

# **Tick Infestation in Dogs: Its Epidemiology and Therapeutic Management**

*Dhritismita Boruah*

Tick infestation is a common problem in dogs, causing itching, irritation, rashes leading to some self-inflicted traumas. Severe infestation causes anemia, weight loss and even death due to consumption of large quantity of blood. More significantly they carry and spread blood borne infection both in human and animals. In the study period 10315 numbers of dogs were screened and tick infestation was recorded in 45 numbers of dogs. The prevalence of tick infestation in dog was recorded 0.43%.

In the present study age-wise prevalence was highest in 1 to 3 years (0.69%) age group. Sex-wise prevalence of tick infestation were more in males (0.63%) than in females (0.20%) and breed-wise prevalence was recorded highest in the Non- Descript dogs (0.80%). Highest prevalence (0.65%) was recorded in monsoon season.

The most common clinical sign associated with tick infestation is pruritus which is present in 100% of the cases. As per the distribution of ticks on different body regions of dogs, ear was found to be the most common site for attachment of ticks. The only species of tick found in the present study is the *Rhipicephalus sanguineus* tick, i.e. the brown dog tick.

The haemato-biochemical alterations in tick infested dogs revealed a significant decrease in the vales of Haemoglobin, TEC, PCV and MCV and an increase in the TLC values when compared to apparently healthy dogs.

For therapeutic management of tick infestation in dogs, treatment were given to 18 dogs which were divided into 3 groups, Group I, Group II and Group III containing 6 dogs in each groups using three acaricides, i.e. Fipronil, Amitraz and Selamectin topically for a period of 30 days. Group III (Selamectin) was found to be most suitable and effective acaricide against tick infestation.

In an attempt to detect *Babesia* DNA in tick vectors, pooled tick samples were taken from 16 different dogs and were subjected to PCR and ticks from 2 dogs were found to harbor the *Babesia* DNA.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Epidemiology and Preventive Medicine**

**Major Adviser: Dr. Deepa Lahkar**

## ***Escherichia coli* Associated Diarrhoea in Calves and Its Management**

***Gautam Ramjibhai Parikh***

The present investigation was carried out for isolation and identification of *E. coli* and the virulence genes associated with pathogenic *E. coli*, haemato-biochemical alterations, *in vitro* antibiogram as well as therapeutic management of diarrhoeic calves. A total of 153 faecal swabs were screened from various cattle farms located in and around Guwahati of which, 78 samples showed positive for *E. coli* with a prevalence of 50.98 per cent. The highest prevalence was recorded in 0-15 (26.14%) followed by 16-30 (22.87%), 31-45 (1.31%), and 46-60 (0.65%) days old calves, respectively. Breed-wise, the highest prevalence was recorded in jersey cross followed by Holstein Friesian-cross and Sahiwal calves. Male calves showed higher prevalence of *E. coli* associated diarrhoea as compared to female calves.

Estimation of pathogenic genes *viz. stx1, stx2, est, elt and eaeA* through PCR out of 25 random *E. coli* isolates showed that 28.00 per cent and 24.00 per cent of the isolates possessed *stx1* and *stx2* genes, respectively. None of the other samples carried *est, elt and eaeA* genes.

Haemato-biochemical parameter in treatment trial revealed significant increase in Hb, PCV, TEC, TLC, TSP, Cl- and decrease in glucose and Na<sup>+</sup> in diarrhoeic calves in comparison to apparently healthy control.

Ciprofloxacin, norfloxacin and ofloxacin were highly sensitive (100%) to *E. coli* isolates whereas, ceftriaxone, amoxicillin, ampicillin, oxytetracycline, doxycycline hydrochloride and tetracycline showed resistance. Ciprofloxacin @ 10mg per kg body weight along with GutLyte-GS+orally twice daily for 5 days was found to be most suitable (100%) therapy on the basis of clinical recovery as well as improvement in the haemato-biochemical parameters.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Epidemiology and Preventive Medicine**

**Major Adviser: Dr. Mrinal Kr. Nath**

# **Assessment of Ethno-Veterinary Practices and Its Relevance for Livestock and Poultry in Majuli District of Assam**

*Migom Mili*

An investigation was undertaken to study the assessment of ethno-veterinary practices and its relevance for livestock and poultry in Majuli district of Assam. Two development blocks-Ujani block and Namani block of Majuli district were selected as the area of study. The traditional healers of the study area were identified through participatory mode involving the village headman, village elders and rural field level workers of Government departments in agriculture and allied sectors. To identify and document the plants used for feeding and treatment of Livestock and Poultry birds, a semi-structured interview schedule having close ended as well as open ended questions was constructed in consultation with the experts in the relevant field and studying available literature. Data in relevance to this study was collected from the identified traditional healers personally in their home. All data were recorded after taking Prior Informed Consent (PIC) from the traditional healers which is attached. Demographic details about the healers were collected and plants used for treatment were listed out.

For selecting the farmer respondents, farmers from two development blocks namely Ujani Majuli Block and Namoni Majuli Block of Majuli district, were selected purposively and from each block, five villages were again selected purposively for data collection. From each village, ten farmers were selected as respondents through snow ball sampling technique making the total sample size 100. Farmer having at least 2 to 3 livestock and few poultry birds in their backyard were considered as a respondent. A structured interview schedule was used for collection of data in regards to the socio-personal, economic and other dependent variables under study. The data were collected by the researcher personally by using a pre-tested valid and reliable interview schedules. The data thus collected were subjected to statistical analysis like percentage, frequency, mean, SD, and ethnobotanical indices like Use Value (UV), Fidelity Level (FL) and Relative Frequency of Citation (RFC). The research study revealed that majority (71.42 per cent) of the traditional healers of both the blocks belonged to middle (37-70 years)

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age category and majority (54.76 per cent) had nuclear families with family size ranging from 4-8 members. Majority (73.80 per cent) of the healers had medium level of educational qualification and had medium level in the traits like social participation (59.52 per cent). They possessed medium sized land holding (3.74 – 12.76 acres), medium herd size (2.77-10.21 nos.) and had experiences in traditional healing practices since last 12-38 years. Majority (78.57 per cent) of them had medium level of mass media exposure and extension contact. In respect of their occupation, majority (92.86 per cent) of the healers were involved in agriculture along with animal husbandry with an average annual earning of Rs. 58,619.05 and average annual income from livestock and agriculture of Rs. 42047.62. Information related to the plants used by the healers was collected and their ethnobotanical indices were calculated. a total of 102 plants species belonging to 57 families were documented in the current study. Among the identified plants, Fabaceae plant families had the highest number of 7 species, followed by 6 species of Zingiberaceae and 5 species Rutaceae and Lamiaceae, 4 species of Rubiaceae and 3 species of Areaceae, Poaceae, Malvaceae, Convolvulaceae, Piperaceae and Moraceae. Two plant species from each of Myrtaceae, Apocynaceae, Lauraceae Apiaceae, Amaryllidaceae, Vitaceae, Asteraceae, Oxalidaceae, Menispermaceae, Amaranthaceae and Solanaceae families were also identified which were used for treatment of various ailments. One species of plant belonging to each of the Papaveraceae, Gentianaceae, Anacardiaceae, Cucurbitaceae, Plantaginaceae, Dennstaedtiaceae, Urticaceae, Asphodelaceae, Bignoniaceae, Rosaceae, Rhizophoraceae, Euphorbiaceae, Cappraceae, Punicaceae, Musaceae, Caesalpiniaceae, Cannibinaceae, Dilleniaceae, Lythraceae, Rhamnaceae, Cyperaceae, Theaceae, Araceae, Oleaceae, Clusiaceae, Meliaceae, Caricaceae, Saururaceae, Thelypteridaceae, Combretaceae, Bromeliaceae, Asparagaceae, Phyllantaceae, Pedaliaceae and Scrophulariaceae families were also used for various purposes. *Paederia foetida*, *Rubus moluccanus*, *Crateva magna*, *Curcuma domestica* and *Spondius pinnata* of the families Rubiaceae, Rosaceae, Cappraceae, Zingiberaceae and Anacardiaceae respectively had the highest used values (UV) of 0.11 each. *Citrus limon* of Rutaceae family and *Carallia brachiata* of Rhizophoraceae family had the highest RFC value (1). *Carallia brachiata* and *Citrus limon* of the families Rhizophoraceae and Rutaceae respectively, had the highest fidelity level (FL) of 100 per cent.

Majority (66.00 per cent) of the livestock farmers of both the blocks belonged to middle age group (38-55 years) and 50.00 per cent resided as nuclear family and another 50.00 per cent as joint family with family size ranging from 4-8 members. Majority (52.00 per cent) of the farmers had medium level of educational qualification with medium level of social participation (55.00 per cent), had medium sized land holding (5.26 – 10.90 acres) and herd size (4-24 nos.). About 51.00 per cent of them had medium level of mass media exposure and 99.00 per cent had medium level of extension contact. In respect of their occupation majority (100.00 per cent) of the farmers were involved in agriculture along with animal husbandry with an average annual earning of Rs. 52470.00 and average income from livestock of Rs. 10760.00. It

was found that majority of the farmers of Ujani Majuli block had medium level of perception (56.00 per cent), followed by high perception level (24.00 per cent) and low level of perception (20.00 per cent). In case of the farmers of Namani Majuli block, majority of them had medium level of perception (52.00 per cent), followed by low perception level (32.00 per cent) and high level of perception (16.00 per cent). In relational analysis it was revealed that age of livestock farmers in case of Namani Majuli block was positive and highly significant correlation ( $r=0.537^{**}$ ,  $P<0.01$ ) with the perception toward Ethno-veterinary practices, whereas in case of Ujani Majuli block farmers, it failed to attain the statistical level of significance ( $r=-0.097$ , NS). Family size in case of the farmers of Namani Majuli block was positive and highly significantly correlated ( $r=0.579^{**}$ ,  $P<0.01$ ) with the perception toward Ethno-veterinary practices, where as in case of Ujani Majuli farmers, it was negative and failed to attain the statistical level of significance ( $r=-0.243$ , NS). The level of education of the farmers of Namani Majuli block was negative and highly significant correlation ( $r=-0.664^{**}$ ,  $P<0.01$ ) with the perception towards Ethno-veterinary, where as in case of Ujani Majuli block farmers, it failed to attain the statistical level of significance ( $r=0.207$ , NS). The herd size had positive and highly significant correlation in Namani Majuli block farmers ( $r=0.409^{**}$ ,  $P<0.01$ ) with perception towards Ethno-veterinary practices, where as in case of the farmers of Ujani Majuli, it was negative and non significant ( $r=-0.022$ , NS). For the pooled data, it failed to attain the statistical level of significance ( $r=0.0163$ , NS). Income from livestock had significant correlation in Namani Majuli farmers ( $r=0.349^{*}$ ,  $P<0.05$ ) with perceptions towards Ethno-veterinary practices, where as in case of Ujani Majuli farmers, it was negative and failed to attain the statistical level of significance ( $r=-0.046$ , NS). Total annual income in case of Namani Majuli farmer was found to be positive and significant ( $r=0.287^{*}$   $P<0.05$ ) with the perceptions towards Ethno-veterinary practices, where as in case of Ujani Majuli it failed to attain statistical level of significance ( $r=0.131$ , NS). Land holdings, mass media exposure and extension contact of the farmers of both the block failed to attain statistical level of significance with the perception towards Ethno-veterinary practices.

## Effect of Feeding Practices on the Performance of Crossbred Kids

*Biswajyoti Das*

Sixteen weaned crossbred kids of 4 months old were randomly assigned to two groups of eight kids each *viz.* Control (C) and Treatment (T) keeping equal number sexes. The C group received 1/3<sup>rd</sup> concentrate on DM basis with *ad-libitum* chopped roughages *i.e.* Para (*Brachiaria mutica*) and Napier (*Pennisetum purpureum*) grasses separately. The kids in T group received total mixed ration (TMR) prepared by thoroughly mixing the same concentrate and chopped roughages in the ratio of 1:3 on DM basis and fed *ad libitum* twice daily. The average initial body weight was 7.09±0.67 and 7.29±0.30 kg, in C and T groups, respectively.

The average body weight at 5<sup>th</sup> fortnight was 10.95±0.47 and 12.14±0.20 kg and at 6<sup>th</sup> fortnight was 12.15±0.46 and 13.79±0.18 kg, in C and T groups, respectively. There was highly significant ( $P<0.01$ ) difference between the two groups in respect of average body weight of kids. The average total body weight gain during 6<sup>th</sup> fortnight was 1.20±0.12 and 1.65±0.10 kg and average daily body weight gain was 0.086±0.01 and 0.118±0.01 kg, in C and T groups, respectively. There was highly significant effect of treatment ( $P<0.01$ ) on the body weight gain of crossbred kids.

The average height at withers at 5<sup>th</sup> fortnight was 43.85±2.36 and 48.50±0.50 cm and at 6<sup>th</sup> fortnight was 45.10±2.53 and 50.10±0.64 cm in C and T groups, respectively. The average body length at 5<sup>th</sup> fortnight was 42.63±2.19 and 46.11±0.41 cm and at 6<sup>th</sup> fortnight 44.48±2.07 and 48.69±0.66 cm, in C and T groups, respectively. The average chest girth at 5<sup>th</sup> fortnight was 44.34±2.02 and 49.01±0.63 cm and at 6<sup>th</sup> fortnight 46.40±2.11 and 50.54±0.39 cm, in C and T groups, respectively. There was significant ( $P<0.05$ ) effect of treatment on height at wither and body length and the highly significant ( $P<0.01$ ) effect of treatment on chest girth of crossbred kids. The correlation of body weight with height at wither, body length and chest girth was highly significant. The highest correlation was observed between body weight and chest girth *i.e.* 0.86 and 0.90 in C and T groups, respectively.

The average DM intake during 5<sup>th</sup> fortnight was 6.16±0.68 and 6.58±0.17 kg and during 6<sup>th</sup> fortnight were 6.58 ± 0.69 and 6.86 ± 0.19 kg in C and T groups,

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respectively. The average daily DM intake at 5<sup>th</sup> fortnight was 0.44±0.05 and 0.47±0.01 kg and 6<sup>th</sup> fortnight 0.47±0.05 and 0.49±0.03 kg in C and T groups, respectively. The overall daily DM intake during entire period of experiment was 0.40±0.02 and 0.44±0.05 kg in C and T groups, respectively. There was highly significant ( $P<0.01$ ) difference of DM intake between C and T groups. The significant difference in DM intake was found from 1<sup>st</sup> to 6<sup>th</sup> fortnight. The overall feed conversion ratio (FCR) was 6.93±1.42 and 5.95±0.96 in C and T groups, respectively. There was significant effect of treatment on FCR of crossbred kids.

The average value of digestibility coefficient of dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extracts (NFE) and organic matter (OM) in crossbred kids was 60.32±0.48 and 62.16±0.15, 72.28±0.48 and 75.81±0.54, 68.54±0.62 and 69.08±0.78, 55.24±0.54 and 59.73±0.36, 59.98±0.58 and 62.38±0.35, 60.57±0.85 and 67.02±1.14 for control and treatment groups, respectively. The t-test showed highly significant difference ( $P<0.01$ ) between the two groups for DM, CP, CF, NFE and OM but in case of EE, it was non-significant difference ( $P>0.05$ ) between the two groups.

The cost of feeding per kids per day was higher in T (Rs. 6.23) group than the C group (Rs.5.59). But the cost per kg body weight was lower in T group (Rs. 77.96) than the C (Rs. 92.79) group.

The crossbred kids on TMR feeding led to significant increased in the body weight and body weight gain along with improvement in skeletal growth. Moreover feed cost per kg body weight gain was also less on TMR feeding. Therefore, goat keepers may practice TMR feeding instead of conventional separate feeding for obtaining more profit.

## **Effect of Challenge Feeding on Theproduction Performance of Crossbred Cows**

*Poonam Das*

An experiment of challenge feeding was conducted on two groups of crossbred cows, control and treatment with 6 cows in each group through feeding of high concentrate ration for a period of 16 weeks. The concentrate was fed as per the experimental feeding schedule while roughage was allowed *ad. libitum*. The objectives of the study were to study the effect of challenge feeding on their production performances of colostrum yield, milk yield, milk composition; peri-parturient health problems; blood parameters of Ca, P, Hb, total protein, glucose and cortisol; cost of challenge feeding and growth performance of the calves born

The overall average weekly feed intake were  $90.526 \pm 2.293$  kg and  $95.587 \pm 1.64$  kg in control and treatment groups respectively and was significantly higher ( $p < 0.01$ ) in the treatment group. Analysis of variance revealed significant effect of both treatment and week on feed intake of the experimental cows while their interaction revealed no significant effect.

The overall colostrum yield were  $3.467 \pm 0.093$  kg and  $3.900 \pm 0.111$  kg and the overall milk yield were  $76.375 \pm 2.925$  and  $93.083 \pm 3.931$  kg in control and treatment group respectively. The cows of treatment group produced significantly ( $p < .01$ ) higher average colostrums and milk yield than the control group. Analysis of variance table revealed significant effect of group and period on colostrum and milk yield while group  $\times$  period interaction did not have any significant effect.

The overall values of the different milk composition(%) in control and treatment groups were as: fat,  $4.515 \pm 0.376$  and  $4.546 \pm 0.275$ ; protein,  $3.508 \pm 0.094$  and  $3.590 \pm 0.118$ ; lactose,  $5.419 \pm 0.149$  and  $5.365 \pm 0.106$  as well as solids-not-fat (SNF),  $9.277 \pm 0.152$  and  $9.479 \pm 0.244$  respectively. Analysis of variance of the data revealed non-significant effect of challenge feeding on fat, protein, lactose and SNF percentage of milk.

The overall values of blood calcium (mg/dl) during pre and post partum period in control and treatment group were  $10.536 \pm 0.236$  and  $10.592 \pm 0.173$  respectively. The corresponding average values of blood phosphorus (mg/dl) were  $5.268 \pm 0.276$  and

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5.681±0.229 in control and treatment groups respectively. On Statistical analysis non significant difference between groups was observed. But both calcium and phosphorus levels in blood differed significantly ( $p<0.01$ ) during prepartum and postpartum in both control and treatment group.

The overall average values of haematological parameters during pre and postpartum period in control and treatment group respectively were as: Hb (g/dl), 10.917 ±0.412 and 11.192±0.359; total protein (g/dl), 6.809±0.293 and 6.5±0.293 and glucose(mg/dl), 77.734 ± 4.084 and 63.567±8.971 .Result of analysis of variance indicated non significant effect of challenge feeding on Hb, total protein and glucose in blood .

The average of cortisol (nmol/L) during prepartum and postpartum in control and treatment group were 26.653 ±0.704 and 21.021±0.626 respectively. .Result of analysis of variance revealed that the level of cortisol differed significantly and was significantly ( $p<0.01$ ) low in the treatment group than the control group.

There was no any incidence of pre partum nor post partum disease observed in the cows of the control and treatment groups during the entire period of the experiment.

Total post partum feed cost (Rs.) were 23538.08 and 24557.18 in control and treatment group respectively with Rs. 1248.52 extra cost of feed during pre partum in treatment group. The average daily feed cost (Rs.) were 420.32 and 460.81; average daily milk yield (kg) were 10.91 and 13.29; daily return from milk (Rs.) were 600.05 and 730.95; feed cost per kg of milk production (Rs.) were 38.53 and 34.67. There was an additional daily income of (Rs.) 51.30.

The overall average body weight (kg) of the calves during the experimental period were recorded as 35.181±2.106 and 41.290±1.493 for control and treatment group respectively and revealed highly significant effect ( $p<0.01$ ) of challenge feeding on body weight of the calves.

# **Growth and Carcass Characteristics of Indigenous Sheep of Assam Reared under Different Feeding Systems**

*Sakil Ahmed*

Eighteen healthy indigenous weaned male lambs of Assam of similar age and body weight were allocated to three experimental groups of T<sub>1</sub> T<sub>2</sub> and T<sub>3</sub> with 6 lambs in each group and were reared for a period of 8 fortnights(112 days) under three different feeding systems of i) Grazing(T<sub>1</sub>),ii) Grazing and concentrate supplementation (T<sub>2</sub>) and iii)Stall feeding of green grass and concentrate supplementation(T<sub>3</sub>). The concentrate supplement contained 16% CP and 75%TDN and was fed @ 1% of the body weight of the lambs daily during the experimental period.

The average initial and final body weight at 8<sup>th</sup> fortnight of the lambs were 5.38±0.25 and 8.87±0.28 kg, 5.34±0.27 and 5.38±0.27 kg and 10.92±0.31 and 5.38±0.27 kg and 12.57±0.13 kg respectively in T<sub>1</sub>,T<sub>2</sub>and T<sub>3</sub> groups. The corresponding average body weight gains of the experimental lambs were 0.44±0.01,0.70±0.02 and 0.88±0.02 kg in T<sub>1</sub>,T<sub>2</sub>and T<sub>3</sub> groups. Analysis of variance revealed that both the fortnightly body weight and body weight gain differed significantly (P<0.01) among themselves.

The overall mean values of the linear body measurements (cm) in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups respectively were: 34.94±0.60; 37.54±0.76 and 38.71±0.80 cm. for body length; 37.34±0.49; 37.73±0.63 and 38.76±0.72 cm for height at wither; 46.33±0.59; 46.73±0.79 and 48.39±0.84 cm for chest girth; 14.00±0.25; 14.43±0.42 and 15.57±0.52 cm for neck girth; 10.79±0.20; 10.85±0.26 and 11.11±0.26 cm for tail length; 11.39±0.15; 11.03±0.19 and 11.29±0.19cm for head length; 7.18±0.07; 7.13±0.09 and 7.52±0.15 cm. for head breadth; 6.84±0.09; 7.14±0.13 and 7.66±0.18 cm for ear length and 2.87±0.13, 2.88 ±0.09 and 2.91±0.31cm for horn length. All the conformation traits increased linearly from 1<sup>st</sup> to 8<sup>th</sup> fortnight with advancement of age. Correlation analysis revealed body length, height at wither and chest girth to significantly and positively increase with corresponding increase in body weight in all the three treatments. Analysis of variance of the data revealed significant (P<0.01) effect of treatment on the conformation traits.

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The average physiological parameters of the experimental lambs in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups respectively were as: respiration rate, 19.04±0.08, 19.10±0.08 and 18.78±0.09 breaths per minute; pulse rate, 75.07±0.14, 75.28±0.13 and 74.73±0.14 beats per minute and rectal temperature, 101.56±0.02, 101.57±0.01, 101.55±0.0°F. Analysis of variance revealed significant effect of treatment on respiration rate (P<0.05) and pulse rate (P<0.01) but did not have significant effect on rectal temperature of the experimental lambs. In respect of respiration and pulse rate, the stall fed group (T<sub>3</sub>) lambs showed significantly lower respiration and pulse rate than the lambs of T<sub>1</sub> and T<sub>2</sub> groups

The average values of carcass parameters were as: pre-slaughter weight (kg), 8.87±0.28, 10.92±0.31 and 12.57±0.13; slaughter weight (kg), 8.19±0.25, 10.08±0.28 and 11.53±0.12; carcass weight (kg), 4.14±0.14, 5.30±0.15 and 6.33±0.06 and dressing percentage (%), 46.67±0.19, 48.53±0.25 and 50.36±0.26; carcass length (cm), 49.32±0.29, 50.98±0.33 and 52.30±0.29; back fat thickness (mm), 1.25±0.03, 1.38±0.04 and 1.56±0.06 and Loin eye area (cm<sup>2</sup>), 5.09±0.17, 6.08±0.21 and 7.09±0.13 in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively. In respect of yield of whole sale cuts, neck and shoulder (kg), 0.91±0.12, 1.31±0.04 and 1.54±0.01; breast and fore shank (kg), 0.63±0.02, 0.81±0.02 and 0.97±0.01; rack (kg), 0.61±0.02, 0.77±0.02 and 0.93±0.0; loin and flank (kg), 0.55±0.02, 0.70±0.02 and 0.84±0.01 and Legs (kg), 1.33±0.04, 1.70±0.05 and 2.03±0.02 with a total weight (kg) of whole sale cuts, 4.13±0.14 (46.56%), 5.29±0.05 (48.44%) and 6.31±0.05 (50.20%) in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively. Different by-products yield in the treatment groups were as: blood (lit.), 0.68±0.03, 0.85±0.02 and 1.04±0.01; head (kg), 0.57±0.02, 0.70±0.02 and 0.81±0.01; skin, 0.82±0.03, 1.02±0.03 and 1.29±0.02; empty GIT (kg), 0.74±0.02, 0.74±0.02 and 1.06±0.01; lungs and trachea (kg), 0.19±0.00, 0.23±0.01 and 0.27±0.01; pancreas (kg), 0.02±0.00, 0.03±0.00 and 0.03±0.00; spleen (kg), 0.03±0.00, 0.04±0.00 and 0.04±0.00; kidneys (kg), 0.05±0.00, 0.06±0.00 and 0.07±0.00; liver (kg), 0.18±0.00, 0.23±0.00 and 0.27±0.00; heart (kg), 0.09±0.00, 0.11±0.00 and 0.13±0.00; testis (kg), 0.08±0.00, 0.09±0.00 and 0.17±0.11 in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively. The total byproducts yield and their respective percentages shown in the parentheses were 3.44±0.11 (38.78%), 4.26±0.12 (39.01%) and 5.11±0.06 (40.65%) respectively in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups. The average percent values of proximate composition (%) were as moisture, 76.41±0.08, 75.44±0.09 and 73.34±0.08; protein, 17.44±0.08, 18.37±0.08 and 19.57±0.06; fat, 3.83±0.15, 4.41±0.09 and 6.31±0.08 and total ash, 0.90±0.05, 1.00±0.00 and 1.01±0.00 in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups respectively. Analysis of variance revealed significant (P<0.01) effect of treatment on the carcass characteristics parameters. .

The economic analysis of feeding the lambs revealed that the cost of concentrate per lamb during the experimental period was nil in T<sub>1</sub> while it was Rs. 221.39 and 279.97 in T<sub>2</sub> and T<sub>3</sub> groups respectively. The total body weight gain and total yield of mutton and byproducts were highest in T<sub>3</sub> followed by T<sub>2</sub> and T<sub>1</sub> groups. The corresponding values were, body weight gain, 7.068, 5.606 and 3.481 kg; mutton, 6.325, 5.300 and 4.141 kg and giblet, 0.473, 0.398 and 0.320 kg in T<sub>3</sub>, T<sub>2</sub> and T<sub>1</sub> groups respectively. Sale price of mutton was Rs.600/kg and for heart, liver and kidneys

together were Rs. 650/kg. Head, empty GIT and skin were sold on lump sum amount of Rs. 175.00 . In this way, total money (Rs) received was highest in T<sub>3</sub> group (4277.45) followed by T<sub>2</sub> (3613.70) and T<sub>1</sub> (2867.60) group. There were an increased receipt of (Rs.) 1409.85 and 746.10 respectively in T<sub>3</sub> and T<sub>2</sub> groups over T<sub>1</sub> group. The corresponding money(minus feed cost) received in these two groups were (Rs.) 1129.88 and 524.71 in T<sub>3</sub> and T<sub>2</sub> groups of lamb respectively indicating stall feeding (T<sub>3</sub>) of the lambs to be more economic and remunerative than grazing with supplementation (T<sub>2</sub>) and only grazing of the lambs (T<sub>1</sub>).

## **Effects of Dietary Protein Level During Transition Period of Crossbred Heifers**

*Shams Uz Zaman*

In the present experiment was conducted to study the effect of dietary protein level on the performance of crossbred heifers during the transition period. The trial was done in the Instructional Livestock Farm (Cattle) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022. Twelve (12) pregnant crossbred heifers were selected in the advance stage of pregnancy form the above farm on the basis of available records. All the twelve (12) animals were divided into two groups 21 days prior to calving *viz.* Treatment No.1 (T1) and Treatment No. 2 (T2) consisting six (6) animals in each group. The T1 group was provided concentrate ration having 18 per cent CP and 70 per cent TDN and the T2 group was provided concentrate ration having 22 per cent CP and 70 per cent TDN during the transition period (ICAR, 2013). During prepartum, both the groups were fed concentrate ration @ 1.5 kg/day/animal in two divided doses and forage was given *ad libitum* and during postpartum, both the group was provided concentrate ration @ 1.5 kg/day/animal plus 1 kg concentrate per 2.5 kg of milk production in two divided doses and *ad libitum* feeding of forage was practiced.

The overall average daily DM intake during prepartum and postpartum was  $6.76 \pm 0.24$  and  $10.39 \pm 0.35$  kg in T1 and  $6.93 \pm 0.21$  and  $11.45 \pm 0.38$  kg in T2 groups. The overall average DM intake during postpartum period differed significantly between T1 and T2 groups, which may be due to increased palatability of feed in T2 than T1 group. The overall DM intake during postpartum was significantly more than prepartum period. The overall average body weight during prepartum and postpartum was  $331.62 \pm 2.20$  and  $312.95 \pm 1.46$  kg in T1 and  $348.54 \pm 2.40$  and  $322.54 \pm 1.47$  kg in T2 groups, respectively. There was highly significant ( $P < 0.01$ ) difference of average body weight between T1 and T2 groups. The overall body weight during postpartum was significantly less than the prepartum which was due to loss of body weight at calving and loss for milk production. The overall average BCS during prepartum was  $3.42 \pm 0.04$  and  $3.47 \pm 0.03$  and during postpartum was  $2.88 \pm 0.05$  and  $3.28 \pm 0.04$  in T1 and T2

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groups, respectively. The average BCS was significantly decreased during postpartum than the prepartum due to calving and lactation in both the group.

The overall average daily respiration rate was  $27.24 \pm 0.29$  and  $27.02 \pm 0.23$  per minute in T1 group and  $27.92 \pm 0.80$  and  $27.84 \pm 0.43$  per minute in T2 group during prepartum and postpartum period, respectively. The afternoon respiration rate was significantly ( $P < 0.01$ ) higher than the morning respiration rate both in prepartum and postpartum period. The overall average daily pulse rate was  $75.23 \pm 0.71$  and  $72.63 \pm 1.13$  per minute in T1 group and  $75.98 \pm 0.18$  and  $73.32 \pm 0.23$  per minute in T2 group during prepartum and postpartum periods, respectively. The overall pulse rate during prepartum ( $75.61 \pm 0.37$  per minute) was significantly higher than the postpartum ( $72.98 \pm 0.69$  per minute), which was due to increased maternal pulse rate at late gestation. In the present study, the afternoon pulse rate was significantly ( $P < 0.01$ ) higher than the morning pulse rate. The overall average rectal temperature during prepartum and postpartum periods were  $101.50 \pm 0.05$  and  $101.72 \pm 0.03$  °F, respectively. The afternoon rectal temperature was significantly ( $P < 0.01$ ) higher than the morning.

The haemoglobin concentration during prepartum and postpartum was  $11.87 \pm 0.26$  and  $10.43 \pm 0.49$  g/dl in T1 group and  $12.18 \pm 0.23$  and  $10.78 \pm 0.37$  g/dl in T2 group, respectively (Table 4.14). The overall average haemoglobin concentration during prepartum  $12.03 \pm 0.17$  g/dl was significantly higher than postpartum  $10.61 \pm 0.29$  g/dl. The average total blood protein concentration during prepartum and postpartum was  $6.85 \pm 0.14$  and  $7.40 \pm 0.12$  g/dl in T1 group and  $6.85 \pm 0.17$  and  $7.55 \pm 0.10$  g/dl in T2 group, respectively.

The overall average total blood protein concentration during postpartum  $7.48 \pm 0.08$  g/dl was significantly higher than the prepartum  $6.85 \pm 0.11$  g/dl. The overall average blood glucose concentration was significantly higher in T2 ( $45.89 \pm 2.04$  mg/dl) group than the T1 ( $43.12 \pm 1.46$  mg/dl) group. The overall average blood glucose concentration during prepartum ( $50.22 \pm 0.79$  mg/dl) was significantly higher than the postpartum ( $38.79 \pm 0.30$  mg/dl) period. The blood calcium concentration during prepartum and postpartum was  $7.67 \pm 0.23$  and  $7.24 \pm 0.21$  mg/dl in T1 group and  $8.04 \pm 0.29$  and  $7.31 \pm 0.23$  mg/dl in T2 group, respectively. The overall average blood calcium concentration during prepartum ( $7.86 \pm 0.19$  mg/dl) was significantly higher than postpartum ( $7.28 \pm 0.15$  mg/dl) period. The overall average blood phosphorus concentration between T1 ( $6.37 \pm 0.16$  mg/dl) and T2 ( $6.50 \pm 0.16$  mg/dl) groups did not differ significantly. The overall average blood cortisol concentration was significantly higher in T2 ( $26.87 \pm 0.64$  nmol/L) than T1 ( $25.41 \pm 0.40$  nmol/L) group. The overall average blood cortisol concentration during prepartum ( $26.48 \pm 0.49$  nmol/L) was significantly higher than the postpartum ( $24.81 \pm 0.32$  nmol/L) period. The overall average urine pH during prepartum and postpartum was  $7.50 \pm 0.02$  and  $7.52 \pm 0.03$  in T1 group and  $7.55 \pm 0.02$  and  $7.55 \pm 0.02$  in T2 group, respectively. There was no significant difference due to treatment and period.

The average birth weight of calves was found to be  $21.00 \pm 1.92$  kg and  $24.33 \pm 1.20$  kg in T1 and T2 groups, respectively; which did not differ significantly. The

overall average daily colostrum yield was  $5.67 \pm 0.34$  and  $6.17 \pm 0.38$  kg in T1 and T2 groups, respectively. The overall average daily colostrum yield increased significantly from 1st day to 4th day. The average daily milk yield was significantly higher in T2 ( $12.43 \pm 0.47$  kg) than T1 group ( $10.95 \pm 0.43$  kg). The overall average daily milk yield increased significantly from 1st week to 3rd week.

# **Carcass and Meat Quality Characteristics of *Kamrupa* Chicken**

*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.

Pysico-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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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 5<sup>th</sup> 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 Soy Protein Isolate and Inulin on Certain Quality Characteristics of Low-Fat Duck Meat Sausages**

*Sushmita Moirangthem*

Low fat duck meat sausages were prepared by replacing the added fat percent in the formulations with soy protein isolate (SPI) and inulin (I) along with other non- meat ingredients to find out the best formulation which can be stored for reasonable time at refrigeration temperature without affecting its physico-chemical, organoleptic and microbiological qualities. The formulations prepared were - Control (0% SPI and I), T<sub>1</sub> (2.5% I), T<sub>2</sub> (2.5% SPI) and T<sub>3</sub> (2.5% SPI + 2.5% I). Total five batches of duck meat sausages of each formulation were prepared. The raw sausages were cooked in water maintained at 80 - 85°C temperature for 45 minutes. Thereafter, the cooked sausages were packed and stored under refrigeration and evaluated for various quality traits *viz.*, Physico-chemical, Proximate Composition, Calorie Value, Organoleptic Qualities, Microbiological Qualities. In addition to these the cost of production/kg was also calculated out.

Emulsion stability (ES) and cooking yield were significantly ( $p < 0.01$ ) higher in treated formulations with SPI and I compared to the control. The pH value differed significantly between the control and treated formulations and also there was significant ( $p < 0.01$ ) increase in pH values during storage up to 15<sup>th</sup> days. The highest water activity ( $a_w$ ) was recorded in T<sub>3</sub> sample and the lowest values in control sample. Irrespective of the control and treated formulations the water activity ( $a_w$ ) decreased significantly ( $p < 0.01$ ) during the storage period. The TBARS values were significantly ( $p < 0.01$ ) lower in the treated formulations as compared to the control. However, TBARS values increased significantly ( $p < 0.01$ ) during the storage period both in control and treated products. The tyrosine values did not differ significantly between the control and treated formulations although there was significant ( $p < 0.01$ ) increase in tyrosine values during the storage period. Proximate composition of the study revealed significant ( $p < 0.01$ ) increase in the moisture content and percent crude protein while ash content showed no significant ( $p > 0.05$ ) difference. On the contrary, the percent ether extract decreased

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significantly ( $p < 0.01$ ) from the control to the treated groups. The study revealed a significant ( $p < 0.01$ ) decrease in the calorie value from the control to the treated groups. The colour profile revealed no significant difference in all the parameters *i.e.* lightness, redness and yellowness. The texture profile analysis revealed non-significant differences in all the parameters *i.e.* springiness, cohesiveness, chewiness and resilience except in hardness scores that revealed significantly ( $p < 0.01$ ) increasing trend from control to the treated formulations. The taste panel evaluation studies showed a significantly ( $p < 0.01$ ) increasing trend in all the eating quality parameters *i.e.* appearance, colour, flavour, texture, juiciness, overall acceptability. The TVC showed a significant decrease in the treated groups however there was a significant increase in the bacterial load during the storage till day 15<sup>th</sup>. The count was within acceptable limit till day 10. The TVPBC showed a significant ( $p < 0.01$ ) increase in bacterial load from day 5 to 15<sup>th</sup> day of storage. Colititre counts were negative for all the product formulations during storage up to 15<sup>th</sup> day. Cost of production was marginally higher in treatment formulations than the control product.

Based on the results obtained in the study, it might be concluded that low fat duck meat sausages could be prepared satisfactorily by replacing fat with of soy protein isolate and inulin at the rate of 2.5% of each, without adversely affecting the quality of the products.

# **Isolation And Characterization Of Bacteriophages And Their Lytic Effects On Multidrug Resistant *Escherichia coli* Strains From Pig**

*Adwitiya Das*

The present study was conducted with a view of isolation and characterization of bacteriophages and study their lytic effects on multidrug resistant *Escherichia coli* strains from pig.

Using host bacteria *Escherichia coli* ATCC 43888, 12 (46.15%) bacteriophages were isolated from a total 26 pig shed effluents collected from different sources viz: ICAR-AICRP/MSP on Pig, College of Veterinary Science, Assam Agricultural University, Khanapara (n=15), ICAR National Research Centre on Pig, Rani, (n=07) and unorganized pig farms (n=04). Statistical analysis interpreted that isolation by preliminary methods like turbidity reduction test (50%), streak plate test (30.76%) and spot test (46.15%) were equally efficient. Transmission electron microscopy confirmed the presence of phages. Plaque morphology of these 12 isolated phages varied from small sized pin headed, clear plaques to large sized diffused plaques ranging from 0.1 mm to 3 mm. Phages appear to have dissimilar profiles of the nucleic acid fragments generated by digestion of their DNA with restriction enzymes like NdeI, SspI, EcoRV, EcoRI, TaqI and HindIII. However, digestion pattern was more distinct with HindIII restriction enzyme.

The present study showed that 92 (90.2%) out of 102 rectal swab samples from diarrheic piglets yielded *E. coli* from different sources like 41 (91.12%) out of 45 samples collected from ICAR AICRP/MSP on Pig, College of Veterinary Science, Assam Agricultural University, Khanapara and 32 (88.89%) out of 36 samples collected from ICAR-National Research Centre on Pig, Rani, Guwahati, Assam while 19 (90.48 %) out of 21 samples collected from different unorganized farms. For pathotyping of the *E. coli* isolates by multiplex Polymerase Chain Reaction (mPCR), a total of 92 strains of *E. coli* were examined for the presence of stx1, est1, elt1 and eaeA gene using standard primers. The study revealed that 25 isolates were positive for stx1 gene (27.17%), 18 for est1 gene (19.56%), 6 for elt1 gene (6.52%), 3 for presence of both genes est1 and elt1 (3.26%) and 12 for eaeA gene (13.04%).

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Determination of antibiotic sensitivity on the *E. coli* (n=92) isolates revealed that the highest percentage (71.74%) of the *E. coli* isolates were resistant to tetracycline and least percentage of the *E. coli* isolates (4.34%) were resistant to imipenem. Study of lytic effects of the 12 phages on the 46 number of Multi Drug Resistant (MDR) *E. coli* isolates revealed that the 12 phages could exhibit lytic effects on 20 number of MDR *E. coli* isolates out of the total 46 MDR *E. coli* isolates tested. The present study showed the presence of *E. coli* specific phages in pig shed effluents; *E. coli* in piglet diarrhoea having different virulent genes and multidrug resistant *E. coli*. The in-vitro lytic effects of phages on virulent MDR *E. coli* isolates from piglet diarrhoea in the present study has opened up future scope on the application of phages in clinical cases of piglet diarrhoea caused primarily by pathogenic MDR *E. coli* and further characterization of the phages isolated from pig shed effluents.

# **Thermoadaptation of A Newcastle Disease Virus Isolate From Duck and Its Immunogenic Potential**

*Sangeeta Das*

Newcastle disease (ND) is a highly infectious and contagious viral disease of poultry having significant economic impact on production due to the soaring morbidity and mortality associated with it. The effective measure to curb the economic menace of ND is by only biosecurity measures and effective vaccination. To date, a number of effective live vaccines are extensively used for ND control. It is important to note here that most, if not all, of these live vaccines are heat labile and require storage at a temperature range of 2-80C at all times to maintain their efficacy, which is challenging under village conditions or remote areas that are often beyond the reach of the cold chain. Addressing the need of thermostable vaccine development, in the present study an attempt was made to thermoadapt a lentogenic ND virus (NDV) isolate from duck (As/Km/19/44) and evaluate its immunogenic potential.

In the present study, the NDV isolate was adapted in Vero cells by supplementing the culture media with exogenous proteases: 10% allantoic fluid and acetylated trypsin (2.5µg/ml). The Vero cell adapted As/Km/19/44 was assessed for thermostability by subjecting the isolate at 250C, 400C and 560C directly for different time intervals. Initially, the isolate retained 50% haemagglutinin (HA) activity and infectivity for 60 and 30 mins at 250C and 400C respectively. However, the isolate lost its HA activity and infectivity at 560C within 5 mins.

In the present study, thermoadaptation of the Vero cell adapted As/Km/19/44 was done by selective heat treatment. For this, the Vero cell adapted NDV isolate was exposed to 10 thermal cycles i.e treatment at 400C for 30 mins followed by 10 passages in Vero cells. After 10 thermal cycles, the Vero cell adapted NDV isolate was able to withstand for a period of 2 hours at 400 C and 15 mins at 560 C. The haemagglutinin neuraminidase (*HN*) gene sequences of the Vero cell adapted NDV (prior thermal exposure), 5th and 10th passage thermoadapted NDV were analysed for assessing the molecular changes, if any, induced during thermoadaptation. In the present study, the 10th passage thermoadapted NDV had nucleotide substitution at position 87(C→T), 317(C→A) and 512(G→T) with its counterpart untreated Vero cell adapted NDV

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sequence which resulted in substitution of the amino acid alanine (A) with glutamic acid (E) at position 317(A→E) and glycine (G) with valine (V) at position 512(G→V). However, nucleotide substitution at position 87(C→T) did not lead to any substitution of the amino acid Valine (V). Thus, nucleotide substitution within the *HN* gene might have contributed to thermostability of the isolate.

In the present study, inexpensive chemical stabilizers were used to further thermally stabilize the 10th passage thermoadapted NDV isolate. Following chemical stabilization with a mixture of 10% (W/V) Pullulan, 0.5 M Trehalose and 45mg/ml Inulin, the thermoadapted NDV was able to withstand 50% HA activity and infectivity for up to 5 days at 40°C and 18 hours at 56°C. Moreover, the reconstituted virus sample could tolerate 400C for 120 mins and 15 mins after exposure at 560C. Finally, the 10th passaged thermoadapted and chemically stabilized As/Km/19/44 were administered by intraocular route to experimental chicks with a standard dose of 106 EID50 per chick to evaluate their immunogenic potential and compared with the conventional Lasota vaccine strain. The HI log<sub>2</sub> and I-ELISA log<sub>10</sub> antibody titers in the serum samples of the experimental chicks at different days post immunization revealed that there was no significant difference (P<0.01) between the immune response of thermoadapted As/Km/19/44 and the conventional Lasota vaccine strain.

The present study revealed that the thermoadapted lentogenic NDV isolate was found to be equally immunogenic in eliciting immune response with conventional LaSota vaccine strain and therefore, the thermoadapted lentogenic NDV may be explored further as a potential alternative to the currently available lentogenic NDV vaccine to ensure better effectiveness of ND vaccine in developing countries, especially in remote areas with minimum cold chains.

## **Tick and Mite Infestation in Dog in and Around Guwahati, Assam**

*Pratik Bhowmik*

A total of 582 dogs of different breed, age group, sex and categories were examined for presence of ticks and mites in and around Guwahati, Assam for a period of one calendar year from March 2019 to February 2020. The overall prevalence of tick was 58.76 per cent (342/582). The prevalence of *Demodex* sp. was found 19.75 per cent (115/582) and *Sarcoptes scabiei* var. *canis* was 1.89 per cent (11/582), respectively. *Rhipicephalus sanguineus*, was the only tick species found in the study. Morphometric study of *Demodex* revealed highest mean body length in *Demodex injai* followed by *D.canis* and *D.cornei*. Breed-wise prevalence of tick was recorded highest in Mongrels (75.00%). Sex-wise, prevalence in male dogs was higher (70.10%) than the females (47.42%). Age-wise, highest prevalence was recorded in dogs below 1 year (89.38 %). Season-wise, highest prevalence was recorded during monsoon season (70.79%). Category-wise, highest prevalence was recorded in stray dogs (92.77%). *Demodex* sp. and *Sarcoptes scabiei* var. *canis* were recorded highest in Labrador retriever (42.72%) and in German shepherd (7.24%) breeds of dog, respectively. Sex-wise, prevalence of both mite species was more in male (*Demodex* sp. 23.02% and *Sarcoptes scabiei* var. *canis* 2.40%) than the female dogs (*Demodex* sp. 16.49% and *Sarcoptes scabiei* var. *canis* 1.37%). Like-wise, the prevalence of both the mite species was higher in dogs below 1 year age (*Demodex* sp. 32.74% and *Sarcoptes scabiei* var. *canis* 2.65%) than dogs above 1 year age (*Demodex* sp. 11.51% and *Sarcoptes scabiei* var. *canis* 1.40%). Season-wise, prevalence of *Demodex* sp. and *Sarcoptes scabiei* var. *canis* was highest in pre-monsoon (25.30%) and in winter (4.72%), respectively. Category-wise, prevalence of both the mite species was more in stray dogs (*Demodex* sp. 35.54% and *Sarcoptes scabiei* var. *canis* 4.81%). Polymerase Chain Reaction (PCR) analysis confirmed the identification of *Rhipicephalus sanguineus* tick and *Demodex* sp. mite. Histopathologically, formation of pouch-like structures along with aggregation of infiltrating leukocytes were observed in the tick infested skin area. In the skin section infested with mite, large numbers of infiltrating cells in the epidermal areas with cross section of mites in the hair follicle were seen.

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**Major Adviser: Dr. Ranjit Neog**

## **Etiopathology of Bacterial Diarrhoea in Dogs with Special Reference to *Escherichia coli***

*Farhin Aktar Choudhury*

The present investigation was conducted to study the occurrence and etiology of bacterial diarrhoea in dogs for a period of one year from March 2019 to February 2020, with special reference to *Escherichia coli*. A total of 138 dogs with history of diarrhoea were examined and screened by simplex polymerase chain reaction (PCR) for the common enteropathogens, including Canine parvo virus (CPV). The organisms that were screened include *E. coli* encoding various virulence factors associated with pathogroups such as– STEC (*stx1* and *stx2*), EPEC (*eaeA*), and ETEC (*elt* and *est*), *C. perfringens* – alpha (*cpa*), *C. difficile* (*gluD*) and CPV-VP-2 gene of the canine parvovirus. Ninety-two samples which were biochemically and morphologically positive for *E. coli* were screened for presence of virulent factors of which fifty-seven samples were positive for at least one virulence factor gene. Enteropathogenic *E. coli* (EPEC) were the most frequently (40.35%) detected pathovar. 17 (29.82%) and 10 (17.54%) isolates were positive for Shiga toxin-producing *E. coli* (STEC) strains and contained the toxin genes *stx1* and *stx2* respectively. 8.77% and 3.51% were positive for heat labile (*elt*) and heat stable (*est*) enterotoxin genes. Out of 52 morphologically positive samples, 32 (94.12 %) were positive for *C. perfringens* – alpha (*cpa*) toxin, and two (5.88 %) for *C. difficile* (*gluD*) gene. Dogs suspected of CPV infection were subjected to PCR for molecular diagnosis, targeting the CPV-VP-2 gene of canine parvovirus with amplicon size of 583bp.

The present study recorded highest occurrence of diarrhoea in the younger age group, i.e. 0-3 months (53.62%). The puppies in the age group 0 to 3 months were highly infected with *E. coli* (59.46%). A very little seasonal variation was recorded in occurrence of diarrhoea. It was observed occurrence of diarrhoea was slightly higher in males than in females.

Hematological studies revealed significant decrease in the Hb, PCV, TEC, MCH and MCHC in dogs affected with diarrhoea, significant increase was also noticed in neutrophil and eosinophil count. A non-significant increase in WBC and lymphocytes were also noticed and a non significant decrease in thrombocyte and monocyte count

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was observed. Biochemical analysis revealed significant increase in ALT, AST and BUN level with significant decrease in glucose, protein, albumin, Na, K and Cl. A nonsignificant increase was observed in creatinine along with a non-significant decrease in P and Ca was observed.

The clinical signs observed in dogs were anorexia, vomiting, fever, dehydration, weakness or lethargy and most commonly acute diarrhoea. In new-born puppies sometimes the symptoms shown were acute and the only symptom observed was weakness and death. Gross examination revealed congested and haemorrhagic gastric mucosa, haemorrhagic and ulcerative enteritis. The cut section of the kidneys showed congestion and hemorrhage in the medullary region. In some dogs, the kidneys were pale. The histopathological study revealed congestion and haemorrhage in most of the organs. The consistent histopathological lesion in the small intestine of the diarrhoeic dogs were degeneration, necrosis and sloughing of the mucosal epithelium. There was infiltration of the inflammatory cells into the lamina propria. Large numbers of Gramnegative bacilli (red stained) indicating *E. coli* were attached at the tip of the villus. Kidney showed generalized congestion and haemorrhage throughout the parenchyma. There was increase cellularity in the glomerulus associated with swelling of the glomerular tuft. Changes in the mesenteric lymph node consisted of diffuse haemorrhage throughout the cortex, medulla and also in the subcapsular space.

The Pathogenicity test of virulent genes of *E. coli* and *Clostridium* spp. detected from diarrheagenic dogs were tested in adult albino mice. Variable pathogenicity of *E. coli* pathotypes were observed in the present study. The *eaeA* and *stx1* gene was found to be highly pathogenic, causing diarrhoea and death within 24 hours and 48 hours of the inoculation in 100% of the mice, while *stx2* was found to be moderately pathogenic causing mortality in only 50% of the mice inoculated. The *cpa* gene of *C. perfringens* caused 50% mortality while *gluD* gene of *C. difficile* caused mortality in only 33.33% of the mice.

In the present study, the role and the intensity of intestinal alkaline phosphatase and acid phosphatase activity were studied. In dog with enteritis the mucosa of the intestine was found to be sloughed off and activity was also found to be negative or minimal.

# **Pathology and Molecular Detection of Classical Swine Fever (CSF) and Its Association with Porcine Circovirus Associated Disease (PCVAD) in Pig**

*Karthikan. S*

Sero-prevalence of Classical Swine Fever virus (CSFV) and Porcine Circovirus 2 (PCV2) was investigated in 22 different districts under six (6) agro-climatic zones of Assam at various times during the period from 1st February, 2019 to 30th June, 2020. Out of total 402 serum samples tested, 78 (19.40%) and 124 (30.84%) samples showed seropositivity for CSFV and PCV2 antibodies alone respectively. However, 91 (22.64%) samples showed sero-positivity for both CSFV and PCV2 antibodies. Agro-climatic zone wise, Upper Brahmaputra and North Bank Plain zone recorded highest sero-positivity (26.92%) for CSFV, followed by Central Brahmaputra Valley (17.95%), Lower Brahmaputra (12.82%), Barak Valley (7.69%) and Hill zone (7.69%). For PCV2, Barak Valley (26.61%) recorded highest sero-positivity, followed by Lower Brahmaputra (21.77%), Central Brahmaputra Valley zone (17.74%) and Hill zone (17.74%), North Bank Plain zone (9.68%) and Upper Brahmaputra (6.45%). In co-infection, North Bank Plain zone registered highest sero-positivity (27.47%), followed by Lower Brahmaputra (19.78%), Central Brahmaputra Valley (18.68%), Upper Brahmaputra (15.38%), Hill zone (12.08%) and Barak Valley (6.59%). Breed-wise, highest sero-positivity for CSFV was recorded in crossbred (48.72%) followed by Large White Yorkshire (30.77%), Indigenous (12.82%), Hampshire (6.41%) and Duroc (1.28%). Highest sero-positivity for PCV2 was shown by crossbred (54.84%), followed by Large White Yorkshire (23.39%), Indigenous (9.68%), Duroc (8.87%) and Hampshire (3.23%). In co-infection, crossbred (50.54%) showed highest sero-positivity, followed by Large White Yorkshire (30.76%), Indigenous pigs (12.08%), Duroc (4.39%) and Hampshire (2.19%). Age-wise, highest sero-positivity for CSFV was recorded in the 3-12 months old (73.08%), followed by 1-2 years old (19.23%), 0-3 months old (6.41%) and above 2 years old (1.28%). Pigs of 3-12 months old animals (64.52%) showed highest sero-positivity for PCV2, followed by 1-2 years old

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**Major Adviser: Dr. Biswajit Dutta**

(24.19%), 0-3 months old (7.26%) and above 2 years old (4.03%). Highest seropositivity for co-infection was recorded in the 3-12 months old (78.02%), followed by 1-2 years old (12.08%), 0-3 months old (6.59%) and above 2 years old (3.29%). Sex-wise, both males (50%) and females (50%) showed equal seropositivity for CSFV. Highest seropositivity for PCV2 was recorded in females (53.23%) than males (46.77%). In co-infection, males showed slightly higher positivity (50.54%) than females (49.45%). Season-wise, highest seropositivity for CSFV was recorded in monsoon (70.51%), followed by pre-monsoon (15.38%), post-monsoon (10.26%) and winter (3.85%). Highest seropositivity for PCV2 was recorded in monsoon (50.81%), followed by post-monsoon (18.55%), pre-monsoon (16.13%) and winter (14.52%). Highest seropositivity for co-infection was recorded in monsoon (70.32%) followed by pre-monsoon (14.28%), post-monsoon (13.18%) and winter (2.19%).

Clinically, most of the CSF affected pigs showed high fever (103°-105°F), depression, staggering gait, difficulty in breathing, conjunctivitis, ocular discharge, huddling together, erythematous purple skin discoloration in the back of the ear, ventral abdomen and in the medial side of the legs. In Porcine circovirus associated disease (PCVAD), observed signs were wasting of muscle, icterus and unthriftiness and less frequently labored breathing, diarrhoea and anorexia. Grossly, animals affected with CSF showed multiple petechiation in the skin of the ventral abdominal region and in the medial side of legs. No skin lesions were seen in PCVAD and co-infection. In CSF, gastric mucosa showed focal to diffuse areas of haemorrhage with thickening of the gastric mucosa. No gastric lesions could be seen in PCVAD. However, haemorrhagic gastritis was seen in co-infection. In CSF, the intestinal mucosa showed linear haemorrhages. In PCVAD, intestine showed congestion of serosa and pin point haemorrhages. However, in co-infection also, intestine showed haemorrhagic enteritis. Ascites was observed only in CSF. In CSF, the hepatic parenchyma showed focal to diffuse areas of necrosis, but, no gross alterations could be seen in PCVAD. However in co-infection, liver showed focal areas of necrosis. Splenomegaly and splenic infarction were seen in CSF and co-infection. However no gross alterations in spleen could be observed in PCVAD. Lymph nodes showed congestion, enlargement and haemorrhages in CSF, PCVAD as well as in co-infection. In CSF, kidneys showed petechial haemorrhages, giving the appearance of “turkey egg”. In PCVAD, focal areas of necrosis and haemorrhages could be seen in kidneys. However, in co-infection, kidneys showed diffuse petechial haemorrhages. Hydrothorax was commonly observed in PCVAD. In CSF, lung parenchyma showed varying degrees of consolidation. In PCVAD also, the lungs were congested, edematous, haemorrhagic, non-collapsed, tan discoloured and consolidated. In co-infection, lungs showed haemorrhages, tan discoloration, edema and non-collapsing in consistency and sometimes suppurative pneumonia. In CSF, the cardiac parenchyma showed congestion of the blood vessels in the epicardium with mild to moderate petechial haemorrhages. But no gross alterations could be observed in PCVAD. However in co-infection, heart showed congestion of the blood vessels as well as petechial and ecchymotic haemorrhages on the epicardium. In

CSF, palatine tonsils showed enlargement and congestion. However, no gross alterations could be seen in PCVAD and co-infection. Brain showed congestion of cerebral blood vessels in both CSF, PCVAD as well as in co-infection.

Microscopically, in CSF, the intestinal mucosa showed catarrhal enteritis, ulceration of the intestinal villi with depletion of lymphocytes from the Peyer's patches. In PCVAD also, intestine showed mild to moderate catarrhal enteritis and atrophy of the intestinal villi. In co-infection, intestine showed haemorrhagic enteritis and hyperplasia of the goblet cells. In CSF, liver showed congestion of central vein with focal areas of necrosis. In PCVAD, liver showed lympho-histiocytic inflammatory infiltration in portal zones. In co-infection, the hepatic parenchyma showed cytoplasmic vacuolation, nuclear degeneration and mild haemorrhage in the hepatic parenchyma. In CSF, the splenic parenchyma showed depletion of lymphocytes from the splenic corpuscles. In PCVAD, the presence of basophilic intracytoplasmic inclusion bodies in the splenic lymphocytes could be seen. In co-infection, spleen showed depletion of lymphocytes from the lymphoid follicles, aggregation of histiocytes and eosinophilic necrotic debris. In CSF, the lymph nodes showed congestion of the capillaries with focal areas of haemorrhages and depletion of lymphocytes. Similar alterations were recorded in PCVAD and coinfection. In CSF, the renal parenchyma showed focal to diffuse areas of coagulative necrosis, cystic dilatation and subcapsular haemorrhages. In PCVAD, kidneys showed haemorrhages in Bowman's space as well as in the interstitium and presence of intracytoplasmic basophilic inclusion bodies in the tubular epithelium. In co-infection, kidneys showed extravasation of RBCs into the interstitial spaces, coagulative necrosis of the tubular epithelium and proliferation of fibrous connective tissues. In CSF, lung parenchyma showed thickening of interalveolar septa, bronchiolar hyperplasia, and serous exudation. In PCVAD, lungs showed peribronchial and perialveolar fibrosis, formation of multinucleate giant cells in the thickened interalveolar walls and presence basophilic intracytoplasmic inclusion bodies in alveolar macrophages. In co-infection, lungs showed alveolar emphysema, congestion and sero-fibrinous exudation. In CSF, the cardiac muscle showed various stages of degeneration, congestion, haemorrhages. In PCVAD, degeneration, haemorrhages and focal areas of necrosis could be seen in heart. However, in co-infection, the cardiac muscle showed haemorrhages with focal to diffuse areas of necrosis and thickening of tunica adventitia of blood vessels. In CSF, tonsils showed lymphoidal depletion with or without infiltration of macrophages. However, in PCVAD and co-infection, no microscopic alterations could be seen. In CSF, brain showed cerebral congestion and perivascular cuffing. Apart from mild to moderate congestion, no specific alterations could be seen in PCVAD and co-infection.

Out of the total 115 tissue samples collected from six (6) districts of Assam viz. Kamrup (R), Kamrup (M), Dhemaji, Lakhimpur, Nalbari and Mangaldai, 5 samples (4.34%) were positive for CSFV alone; 11 samples (9.56%) for PCV2 alone; 13 samples (11.30%) for co-infection in PCR.

# **Pathomorphology and Molecular Detection of Duck Virus Enteritis Virus (DVEv) Infection in Assam**

*Krishna Kalita*

In the present study, a total of 465 serum samples were tested for detection of Duck Enteritis Virus (DEV) antibodies from 11 districts of Assam under different agro-climatic zones. Out of the total samples tested, 44.51 percent showed sero-positivity by i-ELISA. Among the different age groups, the highest sero-positivity was recorded in adults (59.90%), followed by growers (29.46%) and ducklings (10.62%). Among different breeds of ducks, the highest sero-positivity was recorded in Pati ducks (29.95%), followed by Indian Runner (22.22%), White Pekin (17.87%), Nageswari (16.42%) and Khaki Campbel (13.52%). Health status-wise, 40.70 percent sero-positivity was recorded in adult ducks followed by growers (35.39%) and ducklings (23.89%) from ailing flock. In apparently healthy flock, adult ducks had sero-positivity of 42.55 percent followed by growers (37.23%) and ducklings (20.21%). Season-wise, the highest prevalence was recorded in pre-monsoon season (38.64%) followed by post-monsoon (30.43%), winter (21.25%) and monsoon (9.66%) season.

During the period of study, a total of nineteen (19) outbreaks of Duck Virus Enteritis (DVE) were recorded, with a morbidity and cause specific mortality of 50.33 percent and 66.40 percent respectively. Age-wise the highest mortality was recorded in adults (76.70%) followed by growers (60.14%) and ducklings (51.18%). Among different breeds, the highest mortality was recorded in Indian Runner (80.39%) followed by White Pekin (65.44%), Pati ducks (62.97%) and Khaki Campbel (54.79%). Season-wise, the highest mortality was recorded in monsoon (89.88%) followed by pre-monsoon (67.65%), post-monsoon (44.39%) and winter (31.97%).

The DEV affected ducks showed emaciation, dehydration, ruffled feather, soiled vent, greenish watery diarrhoea etc. However, sometimes adult ducks showed corneal opacity, leg paralysis, drooping of wings and opisthonous condition.

The gross alterations were predominantly seen in the oesophagus, large intestine, small intestine, liver and heart. Apart from these, sometimes mild to moderate alterations were observed in brain, trachea, proventriculus, kidney, spleen, bursa of

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pathology**

**Major Adviser: Dr. Biswajit Dutta**

Fabricius and thymus. The mucosa of the oesophagus showed formation of mild to moderately thick whitish loosely adhered pseudomembranous plaque. The intestine showed annular band as intensely reddened ring due to haemorrhages. The liver showed hepatomegaly with mild to moderate congestion and fatty change and sometimes focal to diffuse areas of necrosis. Heart showed petechial and ecchymotic haemorrhages on the epicardium and myocardium, which gave the heart a characteristic “paint brush” appearance. Kidney showed mild to moderate congestion and petechial haemorrhages on the surface of capsule. The spleen showed the presence of whitish necrotic foci in the capsular surface. The thymus showed atrophy with multiple focal to ecchymotic haemorrhages. The bursa of Fabricius, trachea and brain showed mild to moderate congestion.

Microscopically, the oesophageal mucosa showed degeneration and necrosis of the stratified squamous epithelium. In most of the cases the oesophageal mucosa showed attachment of diphtheritic membrane to the mucosa. The pseudomembrane was mainly composed of degenerated and necrosed epithelium, fibrins and inflammatory cells. The sub-mucosa showed extravasation of RBCs from the capillaries with mild to moderate congestion of submucosal blood vessel. Cytoplasmic vacoulation in the sub-mucosal glandular epithelium with fragmentation of the nuclear materials were observed. In some cases, intra-nuclear eosinophilic inclusion body could be seen in the glandular epithelium. The intestine showed necrosis and sloughing of mucosal epithelial cells. There was haemorrhages and infiltration of polymorphonuclear cells in the mucosal layer. In addition, hyperplasia and hypertrophy of goblet cells were also recorded. The hepatocytes of liver showed degeneration and disintegration with focal areas of coagulative necrosis. There was presence of intra-cytoplasmic eosinophilic inclusion bodies in the degenerated hepatocytes with a distinct halo. The cardiac muscle fibres showed degeneration and necrosis characterised by pyknosis and karryorehxis of the nuclei. Sometimes there was aggregation of mononuclear phagocytic cells. The lung parenchyma showed thickening of inter-alveolar septa with infiltration of mononuclear phagocytic cells. Sometimes there was inter and intra vascular haemorrhages. Syncytia formation characterised by fusion of the alveolar epithelial cells were also prominent in some cases. The spleen showed marked depletion of lymphocytes from the splenic corpuscle. At place there was proliferation of reticular cells. Sometimes there were splenic necrosis characterised by the presence of eosinophilic cellular debris. The renal parenchyma showed degeneration and necrosis of the tubular epithelium of proximal and distal convoluted tubules. The interstitial spaces were dilated along with atrophy of the glomerular tuft. Extravasation of RBCs could also be seen in interstitial tissue. Necrosis of the tubular epithelium was also prominent. In brain, there was proliferation of microglial cells and formation of glial nodule. Sometimes the brain showed perivascular cuffing characterised by aggregation of leukocytes in the perivascular spaces. The bursa of Fabricius showed focal areas of coagulative necrosis and depletion of lymphocyte from follicle.

During molecular detection, DEV specific PCR targeting the *UL 30* gene produced the amplification band exactly at 446 bp.

On phylogenetic analysis, it was observed that different nucleotide sequences of partial *UL30* gene formed three distinct clade designated as cluster 1, 2 and 3. The phylogenetic tree depicted that the sequence obtained in this study *viz.* ASM/DEV-01/2020 was present in cluster 1 and found to be closely related with the DEV isolates of Bangladesh and China, particularly strain VMH\_BAU\_DPV\_MAI5 (accession No. MT085742.1) of Bangladesh and Chinese strain VAC (accession no. EU082088.2).

## **Etiopathology of Mortality in Captive Wild Animals in and Around Guwahati**

*Mousumi Namasudra*

The present study was undertaken to enrich the knowledge regarding the cause of mortality in captive wild animals. A total of 80 captive wild animal carcasses belonging to the Assam State Zoo, were used in the study. The cause of death was ascertained on the basis of gross, histopathology and whenever warranted microbiological and parasitological analysis of samples were undertaken. The department of pathology had collected 55 specimens during 2009-2018 from the same zoo and remaining 25 specimens were collected from December 2018 to February 2020.

Pneumonia was responsible for the highest number of deaths. Pneumonia caused death of 14 (17.5%) captive wild animals. Mortality due to trauma was recorded in 10 (12.5%) cases. Traumatic injury due to (i) human-wild life conflict, (ii) inter or intra species fighting, (iii) cage injury and (iv) surgical interventions. Septicaemia caused 8 (10%) deaths in captive wild animals. Gastritis caused death in 7 (8.75%) animals. The cases of death due to nephritis or nephrosis were recorded in 6 (7.5%) animals. Nephritic lesion was a common finding in most animals as associated lesions. Enteritis was recorded in 5 (6.25%) animals of different species with the isolation of *E.coli* in few cases. Hepatitis was also recorded in 5 (6.25%) animals, they were two African rhino, two golden langur and one Asiatic black bear. Encephalitis caused death in 3 (3.75%) animals. They were Hoolock gibbon, Asiatic black bear and Royal Bengal tiger.

Other than this death due to drowning was recorded in a leopard cat. Capture myopathy caused death in Sambar deer and Spotted deer. Organophosphorus poisoning was recorded in one royal Bengal tiger. Cystitis caused death in one pigmy hog. Death due to electrocution was recorded in 2 elephants. In four pygmy hog polycystic kidney associated death was recorded. Death due to senility was recorded in an Assamese macaque and Rhino. Inanition associated with myocardial atrophy was recorded in a hoolock gibbon. One clouded leopard was died due to obesity. Thrombosis was observed in the heart of a Hoolock gibbon.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pathology**

**Major Adviser: Dr. C.V. Phangcho**

The different parasites recovered during post-mortem examination included- *Toxocara cati* and *Diphyllbothrium latum* from the small intestine of leopard cat, *Toxocara cati* from the small intestine of jungle cat, *Haemonchus* spp. from abomasums of swamp deer, *Amphistome* spp. from the intestine of rhino.

# **Pathomorphology and Molecular Diagnosis of Newcastle Disease Virus Infection in Poultry in and Around Guwahati**

*Taufique Ansari*

The present investigation was conducted to study the Pathomorphology and Molecular Diagnosis of Newcastle disease virus infection in Poultry in and around Guwahati.

In the present investigation 23 outbreaks were examined in 12 places in and around Guwahati where rate of morbidity was 42.65 per cent and mortality 64.17 per cent. During postmortem examination 12.69 per cent dead birds showed NDV positive gross lesions.

The rate of morbidity 48.19 per cent and mortality 67.87 per cent of nonvaccinated farms respectively is higher than the rate of morbidity 37.67 per cent and mortality 59.96 per cent of vaccinated farms. The rate of morbidity 45.56 per cent and mortality 67.38 per cent in broiler is higher than the rate of morbidity 39.68 per cent and mortality 60.40 per cent in layer. The Breed/Variety wise highest mortality was recorded in Cobb birds (48.49%) and lowest mortality in guinea fowl (0.15%). Season-wise, highest mortality rate was recorded in winter season (33.54%) and lowest during postmonsoon (15.36%).

Grossly, the affected proventriculus was thickened and with hemorrhages at the tips of the glands and all over the mucosa. The intestine and caecal tonsils showed focal narcotizing haemorrhagic ulcer. Liver was congested and necrotic. Lungs were congested and pneumonic. Spleen showed hemorrhages and splenomegaly. In few cases; concurrent infection was noticed in intestine with parasitic infection including coccidia (6.25%), ascaridia (18.75%) and reproductive disorder (12.5%). Histopathologically, proventriculus showed hemorrhages with sloughing of epithelium into the lumen. The intestine revealed hemorrhages and infiltration of mononuclear cells with necrosis and sloughing off villi. Caecal tonsils and spleen showed lymphoid depletion, hemorrhages and necrosis. The brain revealed mild gliosis, and neuronophagia with intracytoplasmic eosinophilic inclusion body in the HeLa cells

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pathology**

**Major Adviser: Dr. S. M. Tamuli**

cerebrum and necrosis of purkinje cells in cerebellum. The trachea showed congestion, hemorrhages and necrosis with infiltration of mononuclear cells.

The significant gross and histopathological lesions in the specific organ systems showed close relevance with the results of pathotyping of NDV virus isolates. The disease was confirmed by HI (63%) test and by RT-PCR (71.5%) from tissue samples. Pathotyping of samples on the basis of F gene by RFLP methods showed all the isolates were virulent i.e. 18 (100%). On the basis of MDT, 13 (73.22%) and 5 (27.77%) were found to be mesogenic and velogenic respectively. Sequencing and Phylogenetic analysis revealed that the sequences of representative samples belonged to genotype XIII in Class II of APMV-1 which was responsible for causing the disease outbreak in poultry of this region.

## **Role of Nanocurcumin on Experimentally Induced Alpha-Amanitin Toxicity in Rats**

*Khumtya Debbarma*

*Amanita phalloides* is responsible for more than 90% of mushroom-related fatalities, and no effective antidote is available. Alpha-amanitin ( $\alpha$ -AMA), the main toxin of *Amanita phalloides*, inhibits RNA polymerase II (RNAP II), causing hepatic and renal failure. The aim of the present study is to investigate the beneficial effects and nanocurcumin in the alpha-amanitin induced hepatotoxicity in rats. In the *in vivo* protocol, Group I served as negative control group (PBS @2 ml/200 gm body weight p.o on the day of administration of  $\alpha$ -AMA to the treatment groups for 4 weeks), Group II served as positive control group ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose), Group III served as Standard group ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + silymarin @100 mg/kg p.o. once in a week), Group IV ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + curcumin @800 mg/kg p.o once in a week), Group V ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @200 mg/kg p.o. once in a week), Group VI ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @400 mg/kg p.o. once in a week), Group VII ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @800 mg/kg p.o. once in a week) for four consecutive weeks. Blood and liver samples were collected for hematological, biochemical and histopathological analysis respectively. A histopathological examination was carried out after last treatment on 28<sup>th</sup> day. Hemoglobin levels were analyzed manually using Sahli's hemoglobinometer which was found to be decreased in alpha-amanitin administered group; transaminase levels, Creatinine, Total protein(TP), Urea, BUN and glucose were analyzed in serum. Nanocurcumin showed a beneficial effect by significantly improving the functional parameters particularly in alpha amanitin-induced hepatotoxicity and partially renal toxicity. In the histopathological evaluations, the toxicity that was generated with alpha-amanitin was significantly reduced by nanocurcumin, showing a possible hepatoprotective effect.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pharmacology and Toxicology**

**Major Adviser: Dr. Rohini Kumar Roy**

# **Toxic Potential of Acephate on Rainbow Rooster Chicken**

*Lakhyajyoti Saikia*

The present investigation was undertaken to study the acute and chronic toxicity of acephate on rainbow rooster chicken. A total of 45 numbers of rainbow rooster chickens were included in the experiment which were divided into 3 groups (Group A, B and C), each comprising 15 chickens. Group A birds served as acute toxicity group and were administered a single LD<sub>50</sub> dose of acephate i.e., 820 mg/kg body weight orally while Group B served as chronic toxicity group and were administered dose of 82 mg/kg body weight orally daily for a period of 90 days. Group C served as control. For acute toxicity study, blood was collected at 0, 3, 6, 12, 24 and 36 hours whereas blood was collected at weekly interval for chronic toxicity study. All the birds were monitored for any observable toxic symptoms throughout the experimental period and they were also weighed weekly to monitor body weight gain. Severity and extent of clinical signs varied accordingly to dosage administered to the birds. In case of acute toxicity group, within 3 hours of acephate administration birds exhibited clinical signs which included depression, anorexia, diarrhoea, excessive salivation, curved position and rigid stance with drooping of wings. Progressively the birds were unable to stand and sat on their hocks with curled toes followed by tremor, convulsions and recumbency before death. However the signs observed in Group B were less pronounced except the birds exhibited reduced feed intake, reduced body weight, slightly staggering gait, leg weakness, curled toes and diarrhoea were noticed in the latter part of the experiment. The haematological parameters (Haemoglobin, Total Erythrocyte Count, Total Leucocyte Count, Packed Cell Volume and Lymphocyte) were significantly decreased in both the treated groups as compared to the control. Significant increase in serum enzyme activities (Alanine Amino Transferase, Aspartate Amino Transferase, Total Cholesterol and Creatinine) was observed in both the treated groups. However the level of Serum Acetylcholinesterase and Serum Total Protein were found to be significantly reduced in treated groups as compared to the control. On postmortem, gross changes on liver, kidney and brain were recorded and mostly included necrosis, congestion and haemorrhage in liver, kidney and brain while edema was observed in the brain. In

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pharmacology and Toxicology**

**Major Adviser: Dr. D.C. Roy**

histopathological study, hepatic parenchyma shows degeneration of hepatocytes and lymphoidal aggregation in acute toxicity study while the liver in chronic toxicity group showed multiple areas of coagulative necrosis. In most of the cases there is extensive fibrosis with proliferation of biliary epithelial cells leading to formation of new bile canaliculi. The section of kidney showed extravasation of RBC with mild congestion, atrophy of glomerular tuft. In some places interstitial nephritis characterized by focal aggregation of mononuclear phagocytic cells could be noticed. Most of the renal tubules showed accumulation of hyaline cast. In chronic toxicity group, the brain parenchyma showed degeneration, necrosis of the nerve fiber, neuronophagia along with congestion. From the present study it was concluded that Acephate at both the dose rates produce toxicity to multiple systems of growing birds.

## **Elucidating Intracellular Signalling Mechanism in Nitric Oxide Mediated Effects on Goat Detrusor Muscle**

*Navya L.N*

In the current investigation, the role of nitric oxide on intracellular signalling in goat DSM was examined. Firstly, role of NO on intracellular calcium release mechanism was investigated in goat DSM. SNP-mediated inhibitory effect was reversed by L-NAME ( $10^{-5}$ M) as well as ODQ ( $10^{-5}$ M) on CCh-contracted goat DSM. SNP-mediated inhibitory effects were potentiated substantially by low calcium (0.63mM) PSS on CCh-contracted tissues. Replacing calcium (1.2mM) with strontium in PSS (Zero calcium) also potentiates SNP-mediated inhibitory effect on CCh-contracted tissues. In addition, SNP-mediated inhibitory effect was augmented in presence of L-type  $Ca^{2+}$  channels blocker, nifedipine ( $10^{-5}$ M). SNP-mediated inhibitory effect on CCh ( $10^{-5}$ M)-contracted goat DSM was reversed by prior incubation with fluoroaluminate ( $10^{-5}$ M) which suggest involvement of G-protein in the inhibitory effect of SNP. Similarly, phorbol-12-myristate ( $10^{-5}$ M) reverses SNP-mediated inhibitory effect on CCh-contracted goat DSM implicating a role of protein kinase in SNP-mediated inhibitory effect. Theophylline ( $10^{-5}$ M), a methyl xanthine, potentiates the inhibitory effect of SNP on CCh-contracted tissue. These results indicate that SNP causes decrease sensitivity to both extracellular  $Ca^{2+}$  as well as intracellular  $Ca^{2+}$  which play a role in augmenting inhibitory effect of SNP observed in low  $Ca^{2+}$  PSS and in presence of  $Ca^{2+}$  blockade in goat DSM. Secondly, role of NO on modulation of  $K_{ATP}$  channel on goat DSM was studied. Pinacidil ( $10^{-5}$ M and  $10^{-4}$ M) elicited dose dependent relaxant response on CCh- contracted goat detrusor. This was inhibited by SNP in a way similar to that of glibenclamide ( $10^{-5}$ M). 8-br-cGMP ( $10^{-5}$ M and  $10^{-4}$ M) elicited concentration-dependent relaxations of CCh-contracted tissues which were blocked by SNP ( $10^{-5}$ M). The results suggest that inhibitory effect of SNP on pinacidil-induced relaxation have direct interference with the  $K_{ATP}$  channel or regulatory protein in goat DSM. The result of present study suggest that SNP-mediated inhibitory effects on CCh-induced contraction are due to i) inhibition of both extracellular  $Ca^{2+}$  as well intracellular  $Ca^{2+}$  release mechanism and ii) inhibition of  $K_{ATP}$  channel in goat DSM.

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**Abstract of M.Sc. thesis**

**Department: Veterinary Pharmacology and Toxicology**

**Major Adviser: Dr. Dilip Kumar Deka**

# **Mosquito-Borne Flaviviruses in Livestock and Poultry Farms in Urban Settings of Guwahati: Mosquito Identification and Molecular Detection of Virus**

*Phunu Talukdar*

Arboviral diseases having zoonotic importance under the genus *Flavivirus* are many including Japanese encephalitis (JE) and West Nile Fever (WNV). The present investigation was envisaged to collect the baseline data on livestock and poultry farms, study the sero-prevalence of Flaviviruses in livestock and poultry, study the density pattern and determination of vector potential of certain mosquito species and mapping of Arboviral disease prevalent areas.

Baseline data *viz.*, respondent information, livestock (cattle/pig) and poultry (chicken) population, farming practices and health measures were recorded.

A total of 225 serum samples (75 from each species) collected from urban livestock (cattle and pigs) and poultry (chicken) farms of Guwahati were screened by using a competitive ELISA kit followed by HI test revealed 29.33% and 8.00% seropositivity for JEV in pig and poultry (chicken), respectively whereas 1.33% and 13.33% WNV seropositivity was recorded in cattle and poultry (chicken), respectively. Seropositivity of JEV in cattle and seropositivity of WNV in pig was recorded to be nil. There was no significant statistical difference in seropositivity of JEV and WNV with location, educational qualification of farmers, rearing system, type of floor and roof, frequency of disinfection and follow mosquito control measures in farms. Seropositivity of JEV and WNV was significantly associated ( $P < 0.05$ ) with in-contact animals/birds and presence of water source near farms. WNV seropositivity in cattle in relation to presence of water source nearby farm was found to be statistically non-significant. WNV seropositivity was significantly associated ( $P < 0.01$ ) with cattle farm hygiene.

A total of 2,893 mosquitoes were collected for 3 months (July'18-September'18) from selected farms, of which the most predominant species was *Culex quinquefasciatus* (28.79%) followed by *Cx. vishnui* group (17.49%). Density pattern of *Cx. quinquefasciatus*, *Cx. vishnui* group, *Cx. bitaeniorhynchus*, *Mansonia uniformis*,

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**Abstract of M.Sc. thesis**

**Department: Veterinary Public Health**

**Major Adviser: Dr. Razibuddin Ahmed Hazarika**

*Armigeres subalbatus*, *Ma. annulifera* and *Cx. gelidus* were categorized as dominant species while *Cx. malayi* and *Coquillettidia crassipes* as sub-dominant and satellite species, respectively.

Correlation of environmental variables and total mosquitoes revealed significant difference between total mosquitoes and daily minimum temperature, daily maximum temperature and daily relative humidity (1730 hrs).

A total of 135 pools of mosquito were screened by Real time one-step RT-PCR for detection of NS5 gene of *Flavivirus* of these 7 pools were found to be positive for *Flavivirus*. The pools mainly consisted of *Culex* and *Mansonia* species.

# **Sustainable Management of Dead Birds, Poultry Slaughterhouse and Hatchery Wastesthrough Composting**

*Ferdinee Dhar*

The present study entitled “sustainable management of dead birds, poultry slaughter house and hatchery wastes through composting” was undertaken to study the feasibility of composting as an alternative for poultry waste disposal. Before undertaking poultry waste composting trials, a survey was conducted using an interview schedule with open ended questions. The study showed that 100 per cent of the farmers discarded the dead poultry birds in dumping pits, 50 per cent sold their litter materials while some of them used it as fish feed and manure/soil amendment in crop cultivation. Among the hatcheries about 20 per cent of hatchery units sold their hatchery waste to feed producing companies, while 70 per cent of them discarded hatchery waste in dumping pits and 10 per cent incinerated them in incinerator. However, 100 per cent of the poultry meat sellers in the market place discarded their waste through Municipal Corporation.

The second part of the present study included bin composting of five treatment mixtures formulated as T0 (Poultry litter + paddy straw), T1 (Poultry litter + paddy straw + dead birds), T2 (Poultry litter + paddy straw + hatchery wastes), T3 (Poultry litter + paddy straw + poultry slaughter house wastes) and T4 (Poultry litter + paddy Straw + hatchery wastes + dead birds + poultry slaughter house wastes). Proximate analysis of different waste ingredients were analyzed for total carbon, total nitrogen, moisture and a C: N was adjusted to a desirable ratio of 20:1 and moisture level at 60 per cent. The wastes materials were sequentially layered following the internationally accepted standard method. Temperatures were measured and monitored daily at different points within the pile.

The completion of composting period took 53 days for T0, 71 days for T1, 72 days for T2, 59 days for T3 and 77 days for T4. The temperature profile of all treatment groups rises from the second day and reached the peak temperature by second week of composting (56°C in T0 followed by 67°C in T1, 64°C in T2, 60°C in T3, and 58°C in T4) and started declining gradually until composting process was complete.

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**Abstract of M.Sc. thesis**

**Department: Poultry Science**

**Major Adviser: Dr. (Mrs.) Reema Saikia**

The total ash content was increased at the end of secondary stage and ranged between  $60.12 \pm 3.49$  and  $70.91 \pm 3.31$  per cent whereas the total organic matter content and total organic carbon content were reduced at the end of secondary stage and ranged between  $29.09 \pm 1.30$  to  $39.99 \pm 1.73$  per cent and between  $16.24 \pm 0.94$  to  $19.75 \pm 1.38$  per cent respectively. There was significant reduction in total nitrogen content from primary to secondary stages in all treatments. Highest amount of nitrogen content at the end of secondary stage was observed in T4 ( $13.99 \pm 0.78$ ) group. At the end of composting process the C:N ratio of different treatment mixtures did not differ significantly and it ranged between 13.02 :1 and 18.37:1 which ensured compost stability.

The mean calcium, phosphorus, and potassium content of all treatment mixture was progressively increased during composting period which ranged between  $29.62 \pm 0.83$  to  $176.32 \pm 0.69$  g/kg,  $11.94 \pm 0.86$  to  $24.01 \pm 0.66$  g/kg and  $7.85 \pm 0.58$  to  $22.56 \pm 0.89$  g/kg respectively at the end of secondary stage.. Highest concentration of calcium content was recorded in T2 ( $176.32 \pm 0.69$  g/kg) group, highest phosphorus content was recorded in T1 ( $24.01 \pm 0.66$ ) group and highest potassium content was recorded in T3 ( $29.45 \pm 0.46$  g/kg) group.

The mean Salmonella count under different treatment groups during loading was recorded to be  $0.41 \pm 0.03$  log<sub>10</sub> cfu/g,  $0.72 \pm 0.05$  log<sub>10</sub> cfu/g,  $0.65 \pm 0.04$  log<sub>10</sub> cfu/g, ii  $0.78 \pm 0.04$  log<sub>10</sub> cfu/g and  $0.88 \pm 0.24$  log<sub>10</sub> cfu/g for T0, T1, T2, T3 and T4 groups, respectively. However, after the end of the secondary stage Salmonella count was not detected. The mean total coliform count under different treatment groups initially during loading was recorded to be  $5.45 \pm 0.65$  log<sub>10</sub> cfu/g,  $4.21 \pm 0.26$  log<sub>10</sub> cfu/g,  $3.23 \pm 0.41$  log<sub>10</sub> cfu/g,  $4.03 \pm 0.39$  log<sub>10</sub> cfu/g and  $6.36 \pm 0.52$  log<sub>10</sub> cfu/g for T0, T1, T2, T3 and T4 groups, respectively which remarkably reduced in the secondary stage to values lower than recommended international guidelines.

Thus, it is concluded that composting technology is an environmentally safe method of poultry waste disposal which is simpler process to be operated by the farmers with locally available equipments, and the finished compost can be used as a soil amendment and would provide efficient calcium, nitrogen, phosphorus and potassium for soil health.

## **Utilization of Chicken Whole Blood for Preparation of Chicken Nuggets**

*Konmoni Goyari*

The present study was undertaken to study the utilization of chicken whole blood for preparation of chicken nuggets and study the physico-chemical qualities, microbial and sensory properties of the developed product. The study was conducted in the Department of Poultry science, Assam Agricultural University, Khanapara, Guwahati-781022.

The entire experiment was carried out in two phases, in the first phase a total of five replicates of chicken nuggets comprising of four different formulations with different blood levels viz. T<sub>0</sub> (0 %), T<sub>1</sub> (11%), T<sub>2</sub> (14%) and T<sub>3</sub> (17%) were prepared with extender, binder, oil, spices, condiments and ice flakes. The prepared nuggets were sliced, packed in normal packaging (low density poly ethylene) and stored under refrigeration temperature (4°C). In the second phase the shelf life of the product was studied under normal refrigeration temperature (4°C) and quality characteristics were evaluated at 0, 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 12<sup>th</sup> and 15<sup>th</sup> days of storage period.

Different parameters such as iron estimation, physico-chemical qualities, proximate composition (moisture, crude protein and fat), organoleptic quality evaluation, microbial quality, shelf-life including cost of production were studied.

The iron content (mg/100mg) significantly (P<0.01) increased in proportion to the increasing level of blood incorporation in chicken nuggets. Highest iron content was found in T<sub>3</sub> (174.51±1.86) and lowest in T<sub>0</sub> (57.83±1.06) group. The blood incorporated nuggets showed a significant (P<0.01) difference between the control and treatment groups. However no significant (P>0.05) difference was observed between T<sub>2</sub> and T<sub>3</sub> groups.

The physico-chemical studies in chicken nuggets showed no significant difference (P>0.05) between the control and treated groups in emulsion stability. However incorporation of blood replacing lean meat resulted in higher emulsion stability (ml of oil/100g emulsion) numerically in the treated nuggets groups compared to control. The pH value of the chicken nuggets increased significantly (P<0.01) among groups with incorporation of blood as well as during refrigerated storage period from 0

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to 15<sup>th</sup> day. The water activity ( $a_w$ ) of the nuggets increased significantly ( $P<0.01$ ) with increase in days of storage. The water activity ( $a_w$ ) was found to be lowest in  $T_0$  and highest in  $T_3$  group. The TBA value (mg malondialdehyde/kg) showed significant ( $P<0.05$ ) differences between  $T_3$  and other groups ( $T_0$ ,  $T_1$  and  $T_2$ ) as well as with increase in storage of days. The tyrosine value (mg/100g) was found to increase with increase incorporation of blood. However, analysis of variance revealed significant ( $P<0.05$ ) difference in tyrosine value with increase storage of days.

Proximate composition studies of nuggets revealed that the moisture percent was seen to increase with corresponding increase in the level of blood.  $T_3$  ( $66.12\pm0.49$ ) group had highest moisture percent, followed by  $T_2$  ( $65.80\pm0.30$ ),  $T_1$  ( $65.74\pm0.60$ ) and  $T_0$  ( $65.66\pm0.47$ ) group. The moisture per cent showed no significant ( $P>0.05$ ) differences among the various treatment groups. The protein per cent in the products showed significant ( $P<0.01$ ) increase in the samples with incorporation of blood and the highest value was recorded in  $T_3$  ( $20.83\pm0.82$ ) group and lowest in  $T_0$  ( $18.61\pm0.50$ ) group. The fat per cent of chicken nuggets incorporated with whole blood showed significant ( $P<0.05$ ) difference between the control and blood incorporated groups. The fat per cent was recorded to be highest in  $T_0$  ( $5.38\pm0.24$ ) group which gradually decreased in  $T_1$  ( $4.99\pm0.00$ ),  $T_2$  ( $4.82\pm0.10$ ) and  $T_3$  ( $4.74\pm0.04$ ) group.

On overall acceptability in sensory evaluation of chicken nuggets, the highest score (7-point hedonic scale) was seen in  $T_0$  and  $T_1$  group followed by  $T_2$  and  $T_3$  group. Progressive reduction in overall acceptability of the products was found with incorporation of blood and with increase in storage of days. The overall acceptability scores differed significantly ( $P<0.01$ ) among treatment groups.

The total plate count (log cfu/g) recorded in the study were significantly ( $P<0.01$ ) higher in all nugget samples during all storage period at refrigerated temperature. The highest total plate count (log cfu/g) was recorded in  $T_3$  (3.41 to 5.77) followed by  $T_2$  (3.38 to 5.64),  $T_1$  (3.10 to 5.11),  $T_0$  (2.92 to 4.99) from 0 to 15 days but were within the permissible level. Yeast and mould (log cfu/g) were not detected throughout the storage period. Shelf-life of the blood added nuggets products were lower as compared to control.

The cost of production of chicken nuggets decreased with increased level of blood incorporation. The highest cost of production was found in  $T_0$  (Rs. 272.42) followed by  $T_1$  (Rs. 238.80),  $T_2$  (Rs. 229.58) and  $T_3$  (Rs. 220.40) per kg respectively.

Thus it can be concluded that whole blood can successfully be used for preparation of chicken nuggets for better iron and protein content in the nuggets.

# **Evaluation of Xenogenic Acellular Pericardium Matrix of Caprine and Porcine Origin for Abdominal Wall Reconstruction in Rabbit**

*Anjali Padhan*

The present study was carried out with the aim of evaluating the efficacy of xenogenic acellular caprine and porcine pericardium in surgical reconstruction experimentally created full thickness abdominal wall defect in rabbits (*Oryctolagus cuniculus*).

The experiment was conducted in eighteen (18) numbers of adult healthy rabbits of either sex maintained under ideal and same managerial condition. The animals were randomly divided into three groups, i.e. Group A, Group B and Group C consisting of six (6) animals in each. Full thickness abdominal wall defect of 2×2 sq. cm size was created on the lateral abdominal wall in all the animals and was repaired with acellular caprine pericardium, porcine pericardium and autologous tissue in group A, group B and group C respectively. Prior to surgical procedure, caprine and porcine pericardium were decellularised using sodium deoxycholate.

Caprine pericardium was decellularised with 2% sodium deoxycholate treatment for 36 hours and porcine pericardium was decellularised with 1.5% sodium deoxycholate for 48 hours under constant agitation in an orbital shaker at 180 rpm at 35°C without disturbing the microscopic architecture of the tissue.

Clinical parameters were checked on 0, 3rd, 5th, 7th and 10th post operative days. Post operative haemato-biochemical changes were recorded on 0, 10th, 20th and 30th days of operation. The wounds were reopened on 10th, 20th and 30th day for macroscopic and histopathological examination of the implanted matrix and surrounding host tissue.

Clinical parameters were significantly increased in all groups on 3rd post operative days and decreased subsequently. Moderate degree of swelling, exudation, pain and warmth was there in all the groups in all the groups on 3rd day of operation which were more pronounced in xenograft groups as compared to autograft group.

There was non-significant variation of haematological parameters within physiological limit in all the groups with slight variation among the groups. Serum ALP and serum total protein was increased significantly on day 10 in group A and group B

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and comparatively less significantly in group C. There was uniform and remarkable increase in random blood glucose in all the groups on day 10 of operation.

Mild to moderate visceral adhesion was recorded on 10th post-operative day in group A and group B which resolved automatically by the end of the experiment. On gross evaluation the host tissue proliferation was encouraging in all the groups however the in control group was fastest followed by group A and group B. Histopathological examination showed remarkable cellular infiltration in all the groups till last day of observation which was highest in group A. Angiogenesis and fibrogenesis were maximum and best visible from 10th day in group A.

Persistency of first lactation milk yield for Sahiwal cow along with the coefficient of variation was found as  $95.79 \pm 1.68$  kg and 6.09% respectively.

The least-squares means for presence of fat, solid not fat, protein, and density in the Sahiwal milk were  $4.42 \pm 0.02$  %,  $8.45 \pm 0.01$  %,  $3.23 \pm 0.01$  %, and  $29.34 \pm 0.04$ , respectively in our study.

Least squares analysis of variance technique revealed that season had a highly significant effect ( $P < 0.01$ ) on the fat, solid not fat and on the protein percentage but there was no significant effect of season on the density of milk. Least squares means and standard errors were calculated separately for the four seasons in such a way that for fat, the values were  $4.45 \pm 0.03$ %,  $4.28 \pm 0.02$ %,  $4.36 \pm 0.03$ %, and  $4.60 \pm 0.04$  in pre-monsoon season (S1), monsoon season (S2), post-monsoon season (S3) & winter season (S4), respectively. Means for SNF were  $8.48 \pm 0.02$ %,  $8.37 \pm 0.01$ %,  $8.39 \pm 0.02$ % and  $8.57 \pm 0.02$  in S1, S2, S3 & S4 seasons, respectively. Percent presence of protein were  $3.16 \pm 0.01$ %,  $3.21 \pm 0.01$ %,  $3.26 \pm 0.02$ % and  $3.27 \pm 0.02$  in S1, S2, S3 & S4 seasons, respectively. Again the values for density were  $29.43 \pm 0.07$ ,  $29.24 \pm 0.05$ ,  $29.28 \pm 0.08$  and  $29.42 \pm 0.09$  in S1, S2, S3 & S4 seasons, respectively. The period of milking had a highly significant effect ( $P < 0.01$ ) on the fat, solid not fat, protein percentage, and on the density of milk. The least-squares means of fat were  $4.11 \pm 0.02$ % in the morning period and  $4.73 \pm 0.02$  % in the evening period. The values were  $8.16 \pm 0.01$ % &  $8.75 \pm 0.01$ % for SNF;  $3.09 \pm 0.01$ % &  $3.36 \pm 0.01$ % for protein and  $28.66 \pm 0.05$  &  $30.02 \pm 0.05$  for density in the morning period and in the evening period, respectively.

The least-squares means for body growth in Sahiwal calves on the day of birth, 1st month, 2nd month, 3rd month, 4th month, 5th month, and 6th months were  $26.96 \pm 0.27$  kg,  $32.03 \pm 0.47$  kg,  $37.03 \pm 0.62$  kg,  $42.91 \pm 0.76$  kg,  $48.45 \pm 0.77$  kg,  $55.22 \pm 0.77$  kg and  $62.08 \pm 0.88$  kg, respectively.

Least squares analysis of variance technique revealed that sex had a significant effect ( $P < 0.05$ ) on the bodyweight of calves during the day of birth and at the 4<sup>th</sup> month of age, but there was no any effect of sex in the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup> and the 6<sup>th</sup> months of age. The body weights of male calves were found significantly higher than that of female calves. The least-squares means for male calves were  $27.54 \pm 0.39$  kg,  $32.71 \pm 0.68$  kg,  $38.30 \pm 0.89$  kg,  $44.43 \pm 1.10$  kg,  $50.27 \pm 1.10$  kg,  $56.53 \pm 1.11$  kg and  $63.16 \pm 1.27$  kg from birth to six months of age, respectively. On the other hand, least-squares means for female calves were  $26.38 \pm 0.37$  kg,  $31.35 \pm 0.66$  kg,  $35.77 \pm 0.85$  kg,  $41.39 \pm 1.06$  kg,

46.62 ± 1.06 kg, 53.91 ± 1.07 kg, 60.99 ± 1.22 kg from birth to six months of age, respectively. The male calves were found significantly higher than the female calves.

The information generated under the study will be helpful to understand the performance of Sahiwal cattle in the region and subsequently develop some policies for this unique germplasm.

## **Effects of Certain Anaesthetic Combinations in Goat**

*Gyandeep Choudhury*

. Fifteen clinical cases of goats (apparently healthy) of either sex and having body weight of 8-20 kg were divided into three groups consisting of five animals in each group. The goats in group I received (midazolam @ 0.4 mg/kg and ketamine @ 4 mg/kg body weight i.m); goats in group II received (tiletamine-zolazepam @ 3 mg/ kg body weight i.m) while goats in group III received (medetomidine @ 20 µg/kg and ketamine 5 mg/kg body weight i.m).

Induction time of 3.2±0.58, 3.8±0.32 and 5.12±0.15 minutes; duration of anaesthesia of 21.2±1.71, 25.4±2.14 and 110±5.14 minutes and recovery time of 44.80±2.35, 60±3.32 and 123.40±4.63 minutes were recorded in group I,II and III respectively. Cessation of palpebral and pupillary reflex alongwith downward rotation of the eyeball was observed in the animals of all the three groups. Muscle relaxation and analgesia was found to be moderate in group I, poor in group II and excellent in group III. The animals in all the three groups exhibited mild to moderate salivation. During recovery, the animals in group I exhibited tympany and shivering while animals in group III exhibited mild tympany with urination.

Significant (p<0.01) change in heart rate, respiration rate, rectal temperature, tidal volume, minute volume, MAP and SpO<sub>2</sub> were recorded in all the three groups. Significant (p<0.01) decrease was recorded in the haematological parameters,i.e, Hb, PCV and TEC. The biochemical parameters, i.e, GGT, blood glucose, blood creatinine and total protein also recorded significant ( p<0.05) change in the animals of all the three groups. Cortisol levels exhibited a significant (p<0.01) increase.

All the three combinations exhibited transient changes in the physiological, haematological, biochemical and stress hormone parameters and hence are suitable for clinical use in goats. The combinations, midazolam-ketamine and tiletamine-zolazepam are suitable for short surgical procedures like castration while the combination medetomidine-ketamine is more suited for surgical procedures of longer duration.

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**Major Adviser: Dr. Bhupen Sarma**

# **Comparative Study of Surgical Affections of Lakhimi and Cross-Bred Cattle of Assam with Their Therapeutic Management**

*Milton Engti*

The present investigation was conducted for comparative study of various surgical affections in Lakhimi and cross-bred cattle of Assam along with their therapeutic management. A total of 3137 cattle were surveyed during the period from (1<sup>st</sup> march 2019 to 30<sup>th</sup> November 2020), out of which 683 (21.77%) cattle were found to be affected with various surgical affections. During the survey Cross-bred cattle (21.81%) was found to be more affected with surgical affections as compared with Lakhimi cattle (20.88%). Maximum incidence of surgical affections was observed in summer season (64.12%) followed by winter (35.87%). Highest incidences of surgical affections were recorded in hoof affections (59%), which were followed by wounds (13.32%), bursitis (8.49%), fracture (3.80%), myiasis (3.36%), horn affections (3.07%), abscess (1.90%), umbilical hernia (1.75%), tail affections (1.46%), corneal opacity (1.02%), knuckling (0.87%), upward fixation of patella (0.58%), atresia ani (0.43%), corneal dermoid (0.43%), tumours (0.29%) and meningocoele (0.14%) respectively. Highest incidence of surgical affections was seen in the age group of 3-6 years (40.84%), followed by 6 and above years (30.30%), 1-3 years (19.91%) and 0-1 years (8.93%). Haematological investigations showed that the mean values of Hb, TEC, TLC and PCV of affected animals have decreased insignificantly as compared to healthy animals. The mean values of Neutrophil and Basophil percentages in affected animals were increased insignificantly as compared to healthy animals. The mean values of Lymphocyte and Monocyte percentage of the affected animals were decreased insignificantly as compared to the healthy animals. The mean values of Eosinophil percentage of the affected animals was increased significantly as compared to the mean values of the healthy animals. Biochemical tests revealed the mean values of serum Creatinine, Creatine Kinase and Phosphorus of the affected animals were increased insignificantly as compared to the mean value of the healthy animals. The mean value of serum Aspartate Aminotransferase (AST) in affected animals showed significant increase and Calcium in affected animals showed significant fall as compared to the mean values of the healthy animals.

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## **Dental Affections and Their Management in Dogs**

*Pinku Talukdar*

A total of 143 dental affections were recorded with incidence rate of 6.45% among the cases presented to Department of Veterinary Surgery and Radiology and Veterinary Clinical Complex, College of Veterinary Science, AAU, Guwahati-781022 over a period of one year w.e.f. 28<sup>th</sup> February 2020 to 1<sup>st</sup> March 2021. The highest incidence was recorded in males and in German spitz breed within an age group of 5 to 7 years. The common affection recorded was dental tartar with gingivitis and mostly 4<sup>th</sup> maxillary premolar teeth were involved. Dietary involvement showed disease affinity towards mixed homemade diet. Concurrent diseases occupied 33.56% involvement with dental affections moreover, majority of the dogs (90.21%) were deprived from oral health practices.

The common lesions for various dental affections were recorded in the form of inflamed gingiva, bleeding gum and light to heavy tartar deposition etc. The alkaline nature of salivary pH was found ideal for the diseases incidence with mean salivary pH of  $8.08 \pm 0.245$ . The periodontal score index revealed high score of stage III (41.66%) for periodontal diseases and calculus score revealed high score of II (48.95%) for dental tartar with the composition of 91.66% calcium on tartar analysis. Dental radiography provided good diagnostic tool for detecting the abnormalities of various forms of periodontal diseases and all the tooth associated structures were easily evaluated for presence of diseases. This study revealed no significant changes ( $P > 0.05$ ) in haematological and biochemical parameters. However, few parameters showed high level on 0 day indicating local or systemic dysfunction. Salivary enzymes like Creatine kinase, Serum glutamate oxaloacetate transaminase and Lactate dehydrogenase were proven to be good biomarkers for periodontal diseases as their levels were higher than normal range. Oral cavity harbored pathogens like *Staphylococcus* spp. as predominant genus which showed sensitivity for Amoxicillin drugs. Dental scaling along with polishing was effective in long term management of dental tartar and also acted as a preventive therapy in periodontal diseases. Specific antibiotics and metronidazole oral gel along with use of anti tartar sticks were some of the additional managerial practices which gave satisfactory results. Although, in advance stages of periodontal disease tooth extraction brought good outcome. Dental tumours appear mostly in benign forms which were effectively managed with surgical excision and electrocautery.

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# **Platelet Rich Plasma (PRP) with B-Tri Calcium Phosphate (B-TCP) and Demineralised Bone Matrix (DBM) in Healing of Bone Tissue in Rabbit**

*Suman Kalita*

The present study was carried out with the aim of assessing the efficacy of Platelet Rich Plasma +  $\beta$ - Tricalcium Phosphate and Demineralised Bone Matrix in bone reconstruction experimentally created full thickness radial osteotomy in New Zealand White rabbits (*Oryctolagus cuniculus*).

The experiment was conducted in eighteen (18) numbers of adult healthy rabbits of either sex maintained under ideal and same managerial condition. The animals were randomly divided into three groups, i.e., Group I, Group II and Group III consisting of six (6) animals in each. Full thickness radial bone osteotomy of 1 cm length was created on the mid-shaft of the radial bone in all the animals and the bone defect gap was filled with normal saline in Group I, Platelet Rich Plasma +  $\beta$ - Tricalcium Phosphate and Demineralised Bone Matrix in Group II, and Group III respectively. Prior to surgical procedure in the animals of Group II, the Platelet Rich Plasma (PRP) was prepared from the same rabbit by double centrifugation protocol, with lid closed and 1600 revolutions per minute (rpm) for 10 minutes, resulting in the separation of red blood cells, plasma with platelets and leucocytes. Plasma was centrifuged again at 2000 rpm for 10 minutes; as a result, Platelet Rich Plasma was separated.

Clinical parameters were recorded on 0, 3<sup>rd</sup>, 7<sup>th</sup> and 10<sup>th</sup> post-operative days. Post-operative haemato-biochemical changes were recorded on 0, 5<sup>th</sup>, 10<sup>th</sup>, 15<sup>th</sup> and 30<sup>th</sup> days of operation. The wounds were reopened on 20<sup>th</sup>, 40<sup>th</sup> and 60<sup>th</sup> day for histopathological examination of the implanted biomaterials and radiographical evaluation of defected bone.

Clinical parameters were significantly increased in all groups on 3<sup>rd</sup> post-operative days and decreased subsequently. Mild to moderate degree of swelling, exudation and warmth was there in all the groups; however, the degree of pain showed moderate to severe score on 3<sup>rd</sup> day of operation which were more pronounced in Group I as compared to Group II and III.

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There was non-significant variation of haematological parameters within physiological limit in all the groups. Serum ALP and Phosphorus in all the groups increased significantly till 30<sup>th</sup> day of observation. Serum creatine kinase level was significantly increased on 5<sup>th</sup> day followed by significant decrease till 30<sup>th</sup> day of observation in all the groups. The serum calcium level was significantly decreased from 0<sup>th</sup> day to 15<sup>th</sup> day and then subsequently significant increase on 30<sup>th</sup> day in all the groups.

Radiological examination revealed incomplete bridging of the proximal and distal ends of the radius in Group I and III but in Group II, the proximal and distal end of fracture fragments appears to be united towards the 60<sup>th</sup> post-operative days.

Histopathological examination showed fibrous connective tissue accumulation in Group I whereas osteoblastic activity and mineralization is quite prominent in Group II rather than Group III on 60<sup>th</sup> day. Angiogenesis and formation of osteoblasts were noticed on 40<sup>th</sup> day of observation particularly in Group II and III.