68 YEARS
THE GRADUATE SCHOOL
1958-2026

Sixty-fourth Convocation

Significant Post Graduate Students' Research

February 08-09, 2026

Abstracts

Chairperson

Dr. Rakesh Chandra Agrawal

Former Deputy Director General (Agricultural Education)
Indian Council of Agricultural Research, New Delhi

Convenor

Dr. Anil Dahuja

Coordinator, IQAC, ICAR-IARI

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Associate Dean (PG), ICAR-IARI

भाकृअनुप
ICAR

The Graduate School

ICAR-Indian Agricultural Research Institute

New Delhi - 110012

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Index

M.Sc./M.Tech.

Ph.D.

M.Sc./M.Tech. Theses Abstracts

Agricultural Economics

Mr. Harish B.

Name of the Student : Mr. Harish B.
Roll No. : 50106
Chairperson : Dr. Praveen K.V.

Dr. Praveen K.V.

Title of the Thesis

Fertilisers in India: trends and policy options

India's journey towards food self-sufficiency has been deeply shaped by fertiliser use, which underpinned rising crop yields and rural livelihoods for decades. However, the fertiliser economy now stands at a critical juncture, where past achievements are increasingly challenged by fiscal stress, environmental degradation, and equity concerns. Although domestic urea production has expanded to ensure near self-reliance, India remains heavily dependent on imports of phosphatic and potassic fertilisers, exposing the system to global shocks, as seen during the crises of 2008 and 2021-22 when subsidy outlays surged sharply. Fertiliser consumption has increased more than four-fold since the 1980s, but recent growth has slowed and remains nutritionally imbalanced, with nitrogen dominating and pushing the N:P:K ratio far from recommended levels. Spatial patterns show saturation in intensive-use states such as Punjab and Haryana, while eastern states including Bihar, Jharkhand, and Odisha are emerging as new growth centres, often replicating the same distortions. This study examines these dynamics using an integrated framework that combines long-term national and state-level data, district-level spatial analysis, econometric evaluation of two major reforms Direct Benefit Transfer (DBT) and Neem-Coated Urea (NCU) along with farmer and retailer surveys and an assessment of environmental equity through Virtual Nutrient Trade (VNT). The results indicate that DBT improved transparency and reduced diversion but had limited influence on fertiliser use intensity due to operational constraints. In contrast, NCU, developed by IARI, delivered consistent efficiency gains, reducing nitrogen use by nearly 9 kg per hectare annually while improving crop response. VNT analysis further shows that surplus-producing states bear a disproportionate environmental burden, raising concerns of inter-regional equity in food security. Overall, the findings suggest that fertiliser policy must move beyond subsidy management towards securing raw material access, promoting balanced nutrient use, scaling proven innovations like NCU, and embedding sustainability and equity into future strategies.

Agricultural Engineering

Ms. Sapna Soni

Name of the student : Ms. Sapna Soni
Roll No. : PG000165410101
Chairperson : Dr. Shiv Pratap Singh

Dr. Shiv Pratap Singh

Title of the Thesis

Development of fertilizer distribution mechanism and operating parameters' optimization of UAV-based fertilizer applicator

This study developed a spreading disc mechanism for UAV-based urea application and optimized its operational parameters under both laboratory and field conditions. The fertilizer distribution unit consisted of a rectangular hopper with a 39° wall slope to improve fertilizer flowability, integrated with interchangeable spreading discs containing 2–6 vanes and a flow control unit. Laboratory experiments were conducted using a factorial design, considering flight height (1, 2, and 3 m), vane number (2–6), and lateral distance. Open-field trials evaluated flight speed (2, 3, and 4 m/s), vane number, and lateral distance. Fertilizer deposition patterns were measured using a single-flight-line method, with rectangular trays placed across the swath to collect deposited granules. Distribution uniformity was assessed using the coefficient of variation (CV). Results showed consistently right-skewed deposition patterns across all treatments. Increasing the vane number from 2 to 6 significantly improved fertilizer distribution uniformity, reducing the CV from 55.80% to 38.21% in laboratory conditions and from 96.85% to 53.42% in field conditions. Uniformity declined with increasing flight height, with CV increasing from 36.04% at 1 m to 56.03% at 3 m, and with greater lateral distance, where CV increased from 21.08% at 2 m to 70.83% at 20 m. Optimal laboratory performance was achieved at a flight height of 2.0 m using a 6-vane spreading disc, which resulted in a CV of 30.37% and an effective lateral distance of 4 m. Under field conditions, the best performance occurred at a flight speed of 4 m/s with a 6-vane disc, yielding a CV of 33.05% and an effective lateral distance of 6 m. Overall, the optimized spreading disc design and flight parameters demonstrated strong potential for UAV-based fertilizer application, offering improved distribution uniformity and operational efficiency. The developed system can serve as an effective complement to ground-based equipment for precision fertilization in modern agriculture.

Agricultural Extension Education

Ms. Nushrat Jahan

Name of the student : Ms. Nushrat Jahan
Roll No. : 21988
Chairperson : Dr. R.N. Padaria

Dr. R.N. Padaria

Title of the Thesis

Assessment of risk communication and advisory services for climate change adaptation in Indo-Gangetic plains

Climate change poses profound challenges to agriculture, particularly in developing countries like India, where farmers are highly vulnerable to climatic variability and extreme weather events. The study was conducted in climatically fragile districts of the Indo-Gangetic Plains: Jhansi (drought-prone) in Uttar Pradesh and Darbhanga (flood-prone) in Bihar, to examine farmers' risk perception, social amplification and attenuation of risk, advisory services, and extension professionals' competencies in risk communication for climate change adaptation. Employing a cross-sectional and experimental (one-group before and after) research design, data were collected from 240 farmers and 100 extension professionals. The findings revealed that farmers' perception of floods and droughts was at a moderate to high level, with unpredictability and severe social, environmental, and psychological impacts emerging as key concerns. Ordinal logistic regression showed that prior experiences, communication ability, community participation, and institutional trust significantly amplified risk sharing, whereas gender and cultural compatibility showed attenuation of risks. Advisory services were found to be effective in promoting climate change adaptation (CCA) practices such as crop diversification, soil testing, agroforestry, and water conservation. Evaluation through Wilcoxon Signed Rank Test confirmed significant behavioural improvements among farmers who received advisories. Assessment of extension professionals highlighted moderate knowledge but critical skill gaps in networking, communication strategy, and audience segmentation. An e-learning module, designed using the ADDIE model, significantly enhanced professionals' knowledge and skills in risk communication, supporting blended capacity-building approaches. Further, a risk communication model was developed using the Stimulus-Organism-Response (SOR) framework and validated through PLS-SEM. The results underscored the central role of institutional awareness and negative emotions in shaping behavioural adaptation, while social participation and risk communication emerged as essential external drivers. The need for farmer-centric, emotionally-sensitive, and institutionally-credible communication strategies to strengthen climate resilience was emphasised.

Agricultural Physics

Mr. Aditya Kumar

Name of the student : Mr. Aditya Kumar
Roll No. : 21996
Chairperson : Dr. Monika Kundu

Dr. Monika Kundu

Title of the Thesis

Electric field based green remediation of dyes from irrigation water

The rapid growth in urbanisation, resource consumption, climate change and food requirement has led to water shortage. Industrial effluents containing dyes and other contaminants are further discharged into water bodies or released as such untreated, which further exacerbate the shortage of water to be used for irrigation purpose. Such wastewater if used for long time in irrigation, has detrimental impacts on both soil quality as well as crop health. However, there are highly efficient, less time consuming, environment-friendly and cost-effective technique available to remove dye from irrigation water. In this study, our main objective was to characterise and quantify dye in dye contaminated water, to design and integrate an electric field-based system and to evaluate its efficiency to remove dye from dye contaminated water. With the help of double beam U-V visible spectrophotometer, peak absorbance corresponding to characteristic wavelength was characterised and standard curve was prepared to quantify unknown concentration of dye present in dye contaminated water. An electric field-based system using graphite electrode was developed to remove dyes from irrigation water and efficiency of the developed electric field-based system was evaluated. From this study it was observed that highest removal efficiency was found for methyl orange was 99.22% for 0.5 ppm at operational time of 40 min at 20 volt. Similarly for removal of congo red from irrigation water, highest removal efficiency was found to be 98.4% for 0.5 ppm at operational time of 40 min at 20 volt. Energy consumption was found to increase with operational time, voltage and initial concentration. The electrochemical system developed in this study using graphite electrode was found to be efficient to remove dye from irrigation water. Efforts should be made to make this method applicable for removal of dye from irrigation water at field level.

Agricultural Statistics

Ms. Fasila K.P.

Name of the student : Ms. Fasila K.P.
Roll No. : 21990
Chairperson : Dr. Mrinmoy Ray

Dr. Mrinmoy Ray

Title of the Thesis

Bootstrap based prediction intervals for autoregressive tempered fractionally integrated moving average processes

Time series methodologies are used not only to model historical data but also to forecast future values of the underlying processes. These forecasts can be expressed as either point forecasts or interval forecasts. Prediction intervals are often preferred over point forecasts because they offer a comprehensive measure of uncertainty, support better risk management, facilitate strategic planning across a range of potential outcomes, and enable thorough evaluation of scenarios under different assumptions. Traditionally, the Box-Jenkins approach has been a dominant method for constructing prediction intervals in statistical models. However, this approach assumes that model residuals follow a normal distribution. When this assumption is violated, the coverage probability decreases, leading to unreliable forecasts and reducing the model's usefulness. The Autoregressive Tempered Fractionally Integrated Moving Average (ARTFIMA) model has emerged as an effective tool for capturing semi-long memory dynamics, which are often observed in agricultural commodity prices, climatological data, and similar time series. ARTFIMA models traditionally compute prediction intervals using the Box-Jenkins approach, although residuals from real-world data may not follow a normal distribution. To address this limitation, four bootstrap-based prediction interval methods have been proposed for the ARTFIMA model: Sieve Bootstrap (SB), Modified Sieve Bootstrap (MSB), Predictive Residual-Based Sieve Bootstrap (PSB), and Predictive Residual-Based Rescaled Sieve Bootstrap (PRSB). The performance of these methods was assessed through Monte Carlo simulations across three ARTFIMA processes, three error distributions (normal, t, and Laplace), two sample sizes, and three forecasting horizons. Evaluation was conducted using mean coverage, relative mean length, standard error of mean coverage, and standard error of mean length. The results indicate that PSB outperforms the other methods in constructing prediction intervals. Larger sample sizes and shorter forecasting horizons further improved prediction interval performance. An empirical application to weekly mustard price data further confirms that the PSB method outperforms the other bootstrap approaches.

Agronomy

Ms. Khushboo Devi

Name of the student : Ms. Khushboo Devi
Roll No. : 21999
Chairperson : Dr. Subhash Babu

Dr. Subhash Babu

Title of the Thesis

Effect of legumes integration and nitrogen management on productivity, profitability and environmental footprints of maize

A field experiment was carried out during the *Kharif* 2024 in three times replicated split plot design at ICAR-Indian Agricultural Research Institute, New Delhi. The study aimed to evaluate the effect of different legumes and nitrogen management on the yield, economics, environmental footprints, and soil health of maize. The soil of the experimental site was sandy loam in texture and alkaline in reaction, having 0.44% SOC, 150.07 kg/ha available nitrogen ($KMnO_4$-oxidizable), 12.43 kg/ha phosphorus (0.5M $NaHCO_3$), and 240.57 kg/ha potash (1N NH_4OAc). Four maize legume integrations (sole maize, maize + cowpea, maize + blackgram, and maize + *Sesbania*) were assigned in main plots, while three nitrogen levels (recommended dose of nitrogen; RDN: 150 kg/ha, 125% RDN, and 75% RDN) were allocated into subplots. Results indicated that maize integrated with *Sesbania* significantly enhanced growth attributes, including plant height, leaf area index, and dry matter accumulation, followed by maize + cowpea. Application of 125% RDN produced the highest growth parameters, though it was statistically comparable with RDN. Maize + *Sesbania* recorded the maximum grain (5.63 t/ha) and stover (9.83 t/ha) yields, while grain yield under RDN and 125% RDN remained statistically similar. The highest grain yield (5.84 t/ha) was observed with maize + *Sesbania* at 125% RDN, which was at par with maize + *Sesbania* under RDN. This treatment also resulted in the highest N, P, K, protein content, and nutrient uptake in maize grain. From an economic and energy perspective, maize + cowpea with RDN achieved 40.4% higher system productivity and 42.3% higher net returns than sole maize. It also produced higher energy output with lower specific energy input. Maize + cowpea with 75% RDN showed the highest energy use efficiency and energy productivity. This system also exhibited the lowest carbon footprints across energy, yield, and economic scales, along with the highest eco-efficiency. Soil health improvements were most pronounced under maize + *Sesbania*, particularly in physical, chemical, and biological properties, while N management mainly influenced biological indicators. Overall, maize + cowpea with optimized N management emerged as a sustainable and profitable option with minimal environmental footprints in semi-arid maize production systems.

Biochemistry

Ms. Krishna Priya Kannan

Name of the student : Ms. Krishna Priya Kannan
Roll No. : 22004
Chairperson : Dr. Sweta Kumari

Dr. Sweta Kumari

Title of the Thesis

Synergistic effects of light quality and growth regulators on carotenoid enhancement in mungbean sprouts

Non-transgenic carotenoid biofortification provides a sustainable strategy to mitigate vitamin A deficiency in plant-based diets; however, carotenoid accumulation is regulated by complex, multigene networks whose responses to interacting environmental cues remain difficult to predict. Sprouts represent a rapid and highly plastic system for nutritional enhancement. In this study, an integrated experimental and computational framework was developed to optimize carotenoid biosynthesis and associated nutritional traits in mungbean (*Vigna radiata*) sprouts under synergistic light–hormone treatments. A factorial design comprising twelve combinations of light quality (white, blue, red, and dark) and elicitors (water, methyl jasmonate, and methyl salicylate) was evaluated at the optimal 72-h germination stage. Total carotenoids varied nearly four-fold, ranging from 87.6 µg/g FW in dark controls to 347.9 µg/g FW under combined light–elicitor treatments. UPLC profiling revealed pathway-specific modulation, with β-carotene increasing up to 8.4-fold (164.3 µg/g FW) and lutein up to 6.2-fold (340.3 µg/g FW) relative to controls. Beyond carotenoids, light–hormone synergy significantly enhanced total phenolic content, antioxidant capacity (DPPH), protein accumulation, and carotenoid *in vitro* digestibility, while simultaneously reducing phytic acid levels, indicating concurrent improvement of nutritional quality and bioaccessibility. Expression analysis of eleven carotenoid biosynthetic genes demonstrated coordinated, treatment-specific transcriptional regulation rather than dominance of individual genes. Linear mixed models identified treatment effects as the primary determinants of carotenoid accumulation (conditional $R^2 > 0.85$), with incorporation of gene-expression data improving model performance by up to 31%. Structural equation modeling and weighted gene co-expression network analysis resolved distinct regulatory modules associated with β-carotene and lutein biosynthesis, featuring hub genes such as Z-ISO, ZDS, LCY-B, CHY-B, and ZEP. Multivariate integration of biochemical traits with FTIR spectral fingerprints further classified treatments into high-, mid-, and low-bioactive phenotypic clusters. Machine-learning models translated transcriptional and network features into predictive capability, with LASSO and Random Forest achieving high accuracy for β-carotene (R^2 = 0.92–0.98) and lutein (R^2 = 0.93–0.99). Collectively, this study establishes a reproducible, non-transgenic biofortification framework integrating environmental modulation, gene-network inference, and machine-learning prediction for rational enhancement of carotenoid-rich functional sprouts.

Bioinformatics

Mr. Shylin Joe S.

Name of the student : Mr. Shylin Joe S.
Roll No. : 22006
Chairperson : Dr. Sudhir Srivastava

Dr. Sudhir Srivastava

Title of the Thesis

Advanced statistical approach for metagenomics analysis addressing data heterogeneity and covariates

Metagenomics is the direct genetic analysis of genomes contained within an environmental sample. Data heterogeneity and covariates are two main challenges in the statistical analysis of metagenomics data. Statistical analysis of metagenomics data includes core microbiome identification and differential abundance analysis. The core microbiome is certain microbial taxa that are consistently present in a particular environment. Differential abundance analysis identifies taxa whose abundances vary significantly across conditions. There are several tools/packages available for core microbiome identification and differential abundance analysis, each has its own limitation. This study addresses these gaps by introducing an innovative approach for core microbiome identification and differential abundance analysis by developing a user-friendly web tool. In this study, *Arabidopsis thaliana* core root microbiome data have been used as a demo dataset. The developed approach entails multiple phases involving filtering, normalization, exploratory analysis, diversity analysis, core microbiome identification, testing the significance of the identified core, differential abundance analysis, adjusting effects of covariates, and visualization of results. To mitigate data heterogeneity, five filtering methods (abundance, occurrence, abundance and occurrence, membership, and hard cut-off filter) and eleven normalization methods (TMM, TMMwsp, RLE, GMPR, TSS, CSS, CLR, SRS, upperquartile, rrarefy, and invlogit) are provided. Core microbiome significance testing employs four statistical methods: F-test, Kruskal-Wallis, Levene's test, and Fligner-Killeen test. For differential abundance analysis, various statistical tests such as exact test, quasi-likelihood ratio test and quasi-likelihood F test have been provided, along with the options for covariate adjustment and multiple testing correction. Finally, a web tool for Core Microbiome identification and Differential abundance Analysis (CoreMDA) has been developed which is freely accessible at https://dabin-iasri.shinyapps.io/CoreMDA/.

Entomology

Mr. Suman Barman

Name of the student : Mr. Suman Barman
Roll No. : 22012
Chairperson : Dr. Shashank P.R.

Dr. Shashank P.R.

Title of the Thesis

Development of isothermal nucleic acid amplification assay for detection of melon fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae)

Fruit flies (Diptera: Tephritidae) comprise a highly diverse group, with nearly 200 economically important species. Among these, melon fly, *Zeugodacus cucurbitae* (Coquillett, 1899), is a destructive, polyphagous pest capable of inflicting up to 100% yield loss. Due to its impact and enforcement of international quarantine, rapid and accurate identification is essential for effective pest management and decision-making. Morphological diagnosis is challenging in immature stages, while molecular detection offers a precise alternative. In this context, eleven rapid and low-cost DNA extraction protocols were assessed for *Z. cucurbitae*. Four methods (Tween 20 + NaOH, PBS, TE buffer, and Chelex + Proteinase K) produced DNA of sufficient quality, confirmed through PCR amplification of COI gene. Furthermore, a loop-mediated isothermal amplification (LAMP) assay targeting COI gene was developed for on-site detection. The assay enabled detection of all life stages of *Z. cucurbitae* within 40 minutes at 60 °C, with high specificity validated against closely related non-target species, *Z. tau* Walker, 1849; *Bactrocera dorsalis* (Hendel, 1912); *B. divenderi* Maneesh, Hancock & Prabhakar, 2022; *B. zonata* (Saunders, 1842); and *B. correcta* (Bezzi, 1916). The assay displayed high sensitivity with detection limits of 1×10^{-12} ng/µl for genomic DNA and 1×10^{-16} ng/µl for plasmid DNA. Among tested template, ddH_2O proved most suitable for field use, enabling successful validation across laboratory, field, market and six geographical regions of India. Overall, simplified DNA extraction with melon fly-LAMP assay provides a rapid, low-cost, sensitive, and portable diagnostic platform for surveillance, quarantine and biosecurity interventions, thereby supporting sustainable agricultural production.

Environmental Sciences

Ms. Nisha Paul

Name of the student : Ms. Nisha Paul
Roll No. : 22016
Chairperson : Dr. Ashish Khandelwal

Dr. Ashish Khandelwal

Title of the Thesis

Synthesis and characterization of modified urea for enhancing nitrogen use efficiency of wheat under elevated carbon dioxide and temperature interaction

Wheat (*Triticum aestivum* L.) is a major global cereal sustaining nearly 40% of the world's population, and its productivity is highly dependent on nitrogen (N) fertilization. In India, wheat is grown on ~31.8 Mha with an annual production of ~113.2 Mt (2023–24). However, only 30–40% of applied urea-N is utilized by plants, while the remaining N is lost through leaching and volatilization, reducing nitrogen use efficiency (NUE) and increasing greenhouse gas emissions. Future climate change factors such as elevated CO_2 and temperature may intensify N losses and threaten wheat productivity. Therefore, development of climate-smart fertilizers with improved NUE is essential. In the present study, we developed four bio-based modified urea formulations: tannin-coated urea (TCU), lannea-coated urea (LCU), phenolic–polysaccharide–urea composite (PPUC), and phenolic–resin–urea composite (PRUC), using plant extracts and natural polymers. These formulations (35–45% N) were characterized by FTIR, DSC, and TGA, confirming successful coating/complexation and improved thermal stability over neem-coated urea (NCU). Nitrogen release studies indicated slower hydrolysis and nitrification in PRUC and LCU, reducing NH_4^+-N and NO_3^--N accumulation. Pot experiments under ambient, elevated CO_2, elevated temperature, and combined stress conditions showed that PRUC and PPUC enhanced soil enzyme activity, microbial biomass, chlorophyll content, and NDVI. Agronomically, PRUC-75 maintained yields comparable to or higher than NCU-100 with ~25% N saving and achieved highest NUE under combined stress (14.7 vs 7.0 g grain/g N). PRUC also improved grain hardness, gluten, and Zn enrichment without compromising flour recovery. Overall, PRUC at 75% recommended dose emerged as the most promising fertilizer for climate-resilient wheat production.

Fruit Science

Mr. Prabhanshu Mishra

Name of the student : Mr. Prabhanshu Mishra
Roll No. : 22029
Chairperson : Dr. Chavlesh Kumar

Dr. Chavlesh Kumar

Title of the Thesis

Morpho-biochemical and molecular diversity analyses of guava (*Psidium guajava* L.) germplasm

The present study investigated the extent of phenotypic, biochemical, and genetic diversity in guava. A total of 78 guava germplasm, comprising indigenous cultivars, exotic and USDA collections, and wild *Psidium* species, were evaluated under current study. Considerable variability was observed for quantitative traits: leaf blade length (5.57–17.17 cm), leaf width (2.07–7.90 cm), petiole length (0.17–0.77 cm), fruit length (2.77–9.48 cm), fruit width (2.68–8.84 cm), and fruit weight, reaching a maximum mean of 379.0 g. Qualitative traits such as branch attitude, bark and fruit peel colour, leaf shape and apex, and fruit surface also showed distinct variation, with wild species forming clearly differentiated morphological groups. Biochemical profiling of mature fruit pulp revealed wide diversity among genotypes. Total soluble solids ranged from 8.13 to 14.77 °Brix, titratable acidity varied markedly, resulting in TSS/acid ratios of 5.75–50.19, while ascorbic acid content ranged from 72.67 to 338.93 mg/100 g fresh pulp. Substantial variation was also recorded for phytochemical traits, including total phenols (117.93–449.60 mg GAE/100 g), flavonoids (54.99–242.77 mg QE/100 g), carotenoids (0.48–10.66 mg/100 g), and lycopene (mean 4.72 to 9.97 mg/100 g in pink-fleshed genotypes). Antioxidant activity assessed through DPPH and FRAP assays further confirmed significant genotype-dependent variation. Multivariate analyses highlighted the structure of diversity, with strong positive correlations between fruit weight and fruit width (r = 0.90***) and length (r = 0.84***), and between total phenols and flavonoids (r = 0.71***). PCA and cluster analyses distinctly separated wild accessions from cultivated types. Molecular diversity analysis of 78 guava genotypes using 44 polymorphic genome-wide gSSR markers detected 187 alleles (mean 4.25 alleles/locus) with a mean PIC of 0.52. Phylogenetic, STRUCTURE, and PCoA analyses resolved clear genetic groupings, while AMOVA indicated that most variation resided among individuals within populations (72%). Overall, the study demonstrates substantial morpho-biochemical and genetic diversity in guava germplasm, offering valuable resources for trait-targeted breeding to enhance fruit quality, nutritional value, and sustainability of the guava industry.

Genetics and Plant Breeding

Mr. Ananta Bag

Name of the student : Mr. Ananta Bag
Roll No. : 22035
Chairperson : Dr. Harikrishna

Dr. Harikrishna

Title of the Thesis

Genetic analysis and evaluation of MAGIC population-derived lines for heat tolerance in wheat (*Triticum aestivum* L.)

Wheat (*Triticum aestivum* L.), a globally vital cereal crop, is increasingly threatened by rising temperatures due to climate change, particularly during critical growth stages such as anthesis and grain filling. Developing heat-tolerant wheat varieties is essential to ensure stable productivity under such stress conditions. The present study evaluated 248 MAGIC population-derived lines, along with eight founder lines (HD 3086, HD 3043, HD 2985, HD 2932, HI 1544, HI 1563, VL 907, and GW 322) across three locations (IARI-Delhi, UAS-Dharwad, and ARI-Pune) under timely-sown irrigated (TSIR) and late-sown irrigated (LSIR) conditions. Significant genotypic variation was observed for traits such as DH, DM, CT, SPAD, NDVI, SL, SN, FLL, FLW, Fv/Fm UP, Fv/Fm LW, GPS, GWPS, TGW, BM, YLD, and HI. Correlation analysis highlighted positive associations of yield with biomass, TGW, GWPS and HI. MGIDI analysis identified 37 top-performing MAGIC lines under each condition (LSIR and TSIR), with HD 3043 showing stable adaptability. GGE biplot explained 66.44% of G × E variation, identifying MAGIC_31 and MAGIC_181 as environment-specific winners. Genotyping using the *Affemetrix 35K SNP array* yielded 11,574 high-quality SNPs, with population structure analysis revealing four subgroups and an average LD decay of 17.78 Mb. Genome-wide association study identified 293 significant MTAs (LOD > 3.5), including 30 pleiotropic loci and 43 SNPs significant after Bonferroni correction. These MTAs were mapped near candidate genes involved in growth regulation, stress tolerance, photosynthesis, and grain development (e.g., LRR-RLK, GST4, HSP70, and Osmotin-like proteins etc.). Moreover, the identified superior MAGIC lines represent promising candidates for future varietal release, while trait-associated genomic regions provide valuable targets for genomic selection and heat-resilient wheat breeding.

Microbiology

Mr. Arnab Banerjee

Name of the student : Mr. Arnab Banerjee
Roll No. : 22085
Chairperson : Mrs. Anju Arora

Mrs. Anju Arora

Title of the Thesis

Mapping lignin degradation by *Rhodotorula glutinis* Y1 and production of value-added compounds vanillin and ferulic acid

Lignin, a by-product from biorefining, pulp and paper industry is available in huge volume which can be potentially converted to high value aromatics for application in chemical and other industries after its depolymerisation. Biological method of lignin depolymerisation is a promising strategy for degradation and valorization. In this study, the yeast strain *Rhodotorula glutinis* Y1 was explored for its lignin degradation potential and production of vanillin and ferulic acid using alkaline lignin as substrate. *R. glutinis* Y1 could grow well in minimal medium with up to 0.5% alkaline lignin. The degradation level increased to about 50% when lignin was co-metabolised with 1% glucose. *R. glutinis* Y1 constitutively elaborated extracellular lignocellulolytic enzymes laccase (2.74 U/mL) and peroxidase (0.63 U/mL) in the presence of lignin and glucose. The lignolytic enzyme production by *R. glutinis* Y1 was further corroborated by dye decolorization (100 mg/mL). Detection of ferulic acid and vanillin in culture supernatants extracted with ethyl acetate and concentrated under vacuum, was done by thin layer chromatography. The HPLC analysis showed presence of 11.40 ppm vanillin and 30.47 ppm ferulic acid. Higher oxygenation status at 200 rpm showed faster rate since lignin degradation is highly oxidative process. Effect of C-source on lignin degradation was also studied which showed that lignin is co-metabolised at a faster rate in presence of easily metabolizable C-source. Similarly, assessment of complex organic nitrogen showed that peptone promoted growth and lignin degradation while soyabean extract showed the maximum accumulation of vanillin (316.02 ppm). Chemical modifications in the structure of degraded lignin were analyzed using FT-IR. The study revealed that *R. glutinis* Y1 was a promising lignin degrader and confirmed the production of value-added compounds ferulic acid and vanillin from lignin.

Molecular Biology and Biotechnology

Ms. Shreya Das

Name of the student : Ms. Shreya Das
Roll No. : 22038
Chairperson : Dr. Jasdeep Chatrath Padaria

Dr. Jasdeep Chatrath Padaria

Title of the Thesis

Deciphering the role of under-expressed gene in wheat for heat stress tolerance

Wheat (*Triticum aestivum* L.) is the second most cultivated crop after rice for human consumption with an annual production of 768.18 million metric tons in 2024-25 (www.fao.org). Heat stress is one of the major detrimental factors in wheat production leading to yield reduction up to 25-59%. The present study aimed at functional validation of the heat stress responsive gene Tahsp17.9 in wheat. Differential expression analysis of gene Tahsp17.9 in response to heat stress at grain filling stage in a panel of 19 contrasting wheat genotypes showed that the gene Tahsp17.9 was under-expressed in heat stress tolerant genotype Raj 3765 in comparison to heat stress sensitive genotype HD 2967. Tahsp17.9 was cloned into binary vector pCAMBIA1305.1, which was mobilized into *Agrobacterium tumefaciens* GV3101. *Agrobacterium* mediated in-planta transformation was carried out in wheat genotypes Raj 3765 and HD 2967. The 30-day old T1 seedlings were analyzed for presence of transgene by PCR using gene (Tahsp17.9) specific primers. The 27 and 38 seedlings of genotypes Raj 3765 and HD 2967, respectively gave the desirable amplicon of 486bp. For functional validation of the gene Tahsp17.9, 30 days old PCR positive seedlings of both the genotypes were exposed to heat stress @ 42ºC for 6 hours. The transgenic seedlings subjected to heat stress were observed to be withered, turning yellow and weak in comparison to non-transgenic seedlings. RT qPCR differential expression of the gene Tahsp17.9 in the transgenic lines of genotypes Raj 3765 and HD 2967 showed a higher fold change in comparison to the non-transgenic lines of the same genotypes. The relative water content of transgenic seedlings of genotypes Raj 3765 and HD 2967 sharply decreased by 30-33% compared to their non-transgenic (control) plants. The overexpression of the Tahsp17.9 gene reduced heat stress tolerance in wheat, making it a viable target for genome editing aimed at developing climate-resilient wheat.

Plant Genetic Resources

Mr. Nallavelli Akhil Sai

Name of the student : Mr. Nallavelli Akhil Sai
Roll No. : 22088
Chairperson : Mrs. Padmavati G. Gore

Mrs. Padmavati G. Gore

Title of the Thesis

Seed dormancy in genus *Vigna*: physiological and anatomical insights

Pulses constitute an affordable and vital source of dietary protein, and the genus *Vigna* comprises species of considerable agronomic, nutritional, and genetic importance. Seed dormancy is a key adaptive trait in *Vigna*, regulating germination timing, crop establishment, and the conservation and utilization of genetic resources. The present study investigated dormancy expression and responses to dormancy-breaking treatments across six *Vigna* species representing different stages of domestication; domesticated (*V. mungo*, *V. radiata*), semi-domesticated (*V. stipulacea*), and wild relatives (*V. sublobata*, *V. silvestris*, *V. setulosa*). Nineteen accessions were evaluated for germination behaviour, seed coat anatomical characteristics, and responses to pre-sowing treatments, including mechanical scarification, thermal treatment, and chemical scarification, in comparison with control. Seed coat microstructure was examined using scanning electron microscopy, while physiological and anatomical data were analysed using analysis of variance, Duncan's multiple range test, and correlation analysis. The findings revealed a clear domestication-related gradient in dormancy intensity. Domesticated species exhibited smoother testa surfaces, thinner cell walls, shorter macrosclereid layers, and negligible dormancy, achieving >90% germination without treatment. In contrast, wild species showed rough, thick-walled testa, elongated macrosclereids, and strong seed coat impermeability, resulting in <10% germination under control conditions; mechanical scarification, particularly nicking, was the most effective dormancy-breaking method. *V. stipulacea* displayed intermediate anatomical traits and dormancy responses. Correlation analysis indicated a negative association between macrosclereid length or seed hardness and germination, and a positive association between seed size traits and germination potential. Comprehensively, this study elucidates the structural functional basis of dormancy variation in *Vigna* and highlights the importance of tailored dormancy-breaking strategies to enhance germplasm utilization and crop improvement.

Plant Pathology

Ms. Dhanushree H.K.

Name of the student : Ms. Dhanushree H.K.
Roll No. : IARIBEN202320015
Chairperson : Dr. Sandeep Kumar G.M.

Dr. Sandeep Kumar G.M.

Title of the Thesis

Pathogen diversity and management of gummy stem blight in muskmelon (*Cucumis melo* L.)

Gummy stem blight (GSB), caused by *Stagonosporopsis* spp., poses a serious threat to muskmelon (*Cucumis melo* L.) cultivation worldwide. The present study investigated pathogen diversity, host range, and integrated management strategies for GSB in India. A total of 58 isolates collected from Bengaluru and Tumakuru (Karnataka) and Jalna (Maharashtra) were characterized using morphological traits, pathogenicity assays, microsatellite markers (Db01, Db05, Db06), and multilocus phylogeny (ITS, TUB, LSU). Of the 58 isolates, 46 were identified as *Stagonosporopsis citrulli* and 12 as *S. caricae*, while *S. cucurbitacearum* was not detected. This study provides the first systematic evidence of the coexistence of *S. citrulli* and *S. caricae* in muskmelon fields in India, with *S. citrulli* predominating. Virulence analysis revealed substantial pathogenic variability, with isolates ranging from highly virulent (IIHR-GSB33) to weakly virulent (IIHR-GSB57), based on median leaf lesion diameter. Host range studies using isolate IIHR-GSB27 demonstrated a broad cucurbit host spectrum. Watermelon, summer squash, round melon, and oriental pickling melon were highly susceptible, whereas bitter gourd, ridge gourd, pumpkin, and bottle gourd showed minimal susceptibility. Among biological control agents, *Bacillus subtilis* BS-2 and *Trichoderma asperellum* (IIHR-TV5) were identified as the most effective antagonists. *In vitro* and glasshouse evaluations identified several effective fungicides, including mancozeb, chlorothalonil, copper-based fungicides, and premix formulations such as tricyclazole + hexaconazole and fluopyram + tebuconazole, all of which were non-phytotoxic to muskmelon. Premix fungicides showed broad efficacy against multiple isolates. An integrated GSB management module combining seed treatment, soil enrichment with bioagents, sanitation practices, nutrient supplementation, stem protection, and need-based fungicide rotations was developed and validated. This holistic strategy enables effective and sustainable management of GSB in muskmelon while improving understanding of pathogen diversity and virulence patterns in India.

Plant Physiology

Ms. Navodhaya J.V.

Name of the student : Ms. Navodhaya J.V.
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Chairperson : Dr. Gurumurthy S.

Dr. Gurumurthy S.

Title of the Thesis

Summer high temperature stress-induced drought tolerance during reproductive development in chickpea (*Cicer arietinum* L.)

Chickpea, a predominantly winter-season crop, is highly susceptible to terminal drought stress during its reproductive stage, leading to significant yield losses. To address this challenge, we tested the hypothesis: Can summer chickpea seeds enhance drought tolerance when sown in the winter season? This study investigated the effects of seed harvest season summer (SS) vs. normal/winter season (NS) on morphological, physiological, biochemical, and yield responses of chickpea under water deficit stress (WDS) during the main growing season (winter). Seeds harvested in both seasons were used to evaluate genotype-specific performance under WDS across two consecutive seasons in the field. Results revealed that SS-derived plants exhibited significant improvement on the physiological traits, including higher relative water content, membrane stability index, and pollen viability under WDS conditions. Notably, yield increased by up to 32% in season 1 and 38% in season 2 for SS-derived plants compared to NS-derived plants under WDS. Biochemical analyses showed enhanced antioxidant defence in SS plants, with elevated activities of catalase (CAT) and peroxidase (POD), as well as increased chlorophyll and carotenoid contents indicative of greater protection against oxidative stress. Additionally, higher proline accumulation and improved photosystem II efficiency were recorded, reflecting superior stress adaptation mechanisms. Genotype-specific responses were prominent; for instance, IPC 06-11, ICE 15654-A and ICCV 191215 consistently demonstrated enhanced drought resilience and higher yields. These findings highlighted the potential of utilizing summer seeds as a low-cost, field-based strategy to improve drought tolerance and yield stability in chickpea. This research offers a novel approach to adapting chickpea cultivation to water-scarce environments during the main growing season.

Seed Science and Technology

Mr. Manja Naik E.

Name of the student : Mr. Manja Naik E.
Roll No. : 22082
Chairperson : Dr. Vishwanath R.Y.

Dr. Vishwanath R.Y.

Title of the Thesis

Developing respiration based rapid colorimetric viability testing kit

Seed quality is an important parameter which determines the field establishment and productivity. Traditional seed viability method like germination test, can take several weeks. The present study aimed to develop a rapid on-farm seed viability assessment kit. Oxidative stress in seeds leads to production of reactive oxygen species (ROS), resulting in mitochondrial damage, which reduces metabolic activities, including seed respiration as measured by CO_2 evolution. In this study, respiration in nine different crops was estimated, which showed the significant differences in the rate of CO_2 evolution, in which green gram having the highest CO_2 evolution (1878 ppm/seed) and the lowest in paddy (429 ppm/seed) and CO_2 evolution also showed positive relationship with viability in crops like paddy, maize, soybean and lentil. The CO_2 evolution in respiration was trapped in liquid acid base indicators –bromothymol blue, universal indicators, phenol red-which react with CO_2 forming a carbonic acid thus lowering the pH resulting in colour changes of the indicators. Among the three indicators screened, bromothymol blue proved best indicators, as it gives three distinct colours, which can distinguish the viable and non-viable seed. Testing process involves pre-soaking of seed for 2-4 h and single seed secured in seed holder and placed in incubation tube containing BTB solution for 2-8 h. A green/yellow colour indicates viable seed whereas blue (intial colour) was non-viable seed. Viability testing by this method assessed in crops like paddy, maize, wheat, lentil, soybean, green gram, broccoli, pumpkin and cucumber with a deviation of 0-20% from standard germination test. Estimated viability was also validated by measuring the optical density (OD) at 450 nm, there was a positive relationship between OD values and viability with R^2 range from 0.7-0.9. The present study led to the development of rapid on-farm SpeedySeed Viability Kit™.

Soil Science

Ms. Swati Singh

Name of the student : Ms. Swati Singh
Roll No. : 50109
Chairperson : Dr. T.J. Purakayastha

Dr. T.J. Purakayastha

Title of the Thesis

Impact of engineered biochar on stabilization of arsenic in soil

Arsenic (As) contamination in Eastern India poses severe environmental and public health risks, with over 6 million people are affected in West Bengal alone and extensive contamination documented across Assam. The As contamination in soils of these regions are severe due to irrigation of winter rice (*Oryza sativa* L.) with As contaminated water which caused biomagnification of this metalloid element in food chain. This study developed and evaluated engineered biochars from locally abundant feedstocks (rice straw, sugarcane bagasse, jute stalk) chemically treated with $FeCl_3$, goethite (FeOOH), and magnetite treatments to enhance As immobilization in contaminated Inceptisols from Assam and West Bengal. Biochars were comprehensively characterized for chemical, physical and spectral properties. Chemical modifications significantly enhanced the biochars' properties: $FeCl_3$ treatment achieved the highest iron loading (up to 731.26 g/kg) and markedly improved anion (up to 81.4 cmol (e^-)/kg) and cation exchange (58.6 cmol (p^+)/kg) capacities. The XRD, FTIR, and SEM analyses confirmed successful impregnation of iron oxide on chemically engineered biochar and modifications of their surface morphology. In both the soil types, $FeCl_3$-modified biochars demonstrated superior arsenic immobilization efficiency (up to 67.2% in Incpetisol, Assam, 58.8% in Inceptisol, West Bengal), with SBC-$FeCl_3$ showing the highest adsorption capacity (515 mg/kg in West Bengal) and bonding strength (7.91 L/mg). Freundlich isotherms (R^2 = 0.97–0.99) as compared to Langmuir isotherm indicating multilayer, heterogeneous adsorption mechanisms showed better fitting of As adsorption data. In a greenhouse experiement with rice as a test crop, the application of engineered biochars significantly reduced extractable As (up to 50% reduction), As content in rice straw (up to 63% reduction), and As uptake (up to 75% reduction) while improving soil organic carbon (up to 84% increase) and maintaining favourable pH conditions.

Ph.D. Theses Abstracts

Agricultural Chemicals

Mr. Partha Chandra Mondal

Name of the student : Mr. Partha Chandra Mondal
Roll No. : 11664
Chairperson : Dr V.S. Rana

Dr V.S. Rana

Title of the Thesis

Phytochemical analysis and pesticidal activity of *Mentha spicata* and *Cannabis sativa*

To address the problem of wheat aphids and root knot nematodes, *Mentha spicata* and *Cannabis sativa* were chemically investigated for their utilisation in the management of *Rhopalosiphum maidis, Sitobion avenae* and *Meloidogyne incognita*. The essential oils from *M. spicata* and *C. sativa* were isolated and their chemical composition was determined. Six pure compounds, *β*-sitosterol-3-*O*-*β*-D-glucoside, 3*β*,13*β*-dihydroxy-urs-11-en-28-oic acid, stigmasterol, 5,6-dihydroxy-7,8,4′-trimethoxyflavone, 5,6,4′-trihydroxy-7,8,3′-trimethoxyflavone, and 5,6,4′-trihydroxy-7,8-dimethoxyflavone were isolated from the methanolic extract of *M. spicata* and their structures were elucidated and identified. Six pure compounds namely, L-quebrachitol, sucrose, *rel*-(2*S*,3*S*,4*R*,16*E*)-2-[(2′*R*)-2′-hydroxy-nonadecanoylamino]-heneicosadec-16-ene-1,3,4-triol, *β*-sitosterol-3-*O*-*β*-D-glucoside, stigmasterol, and cannabispirone were also isolated from the methanolic extract of *C. sativa* and were identified. 3*β*,13*β*-dihydroxy-urs-11-en-28 oic acid and *rel*-(2*S*,3*S*,4*R*,16*E*)-2-[(2′*R*)-2′-hydroxy-nonadecanoylamino]-heneicosadec-16-ene-1,3,4-triol were reported for the first time from the genus *Mentha* and *C. sativa*. The essential oil and carvone from *M. spicata* and the methanolic extract of *C. sativa* were found to have promising nematicidal activity under *in vitro* and pot studies. The compounds isolated from the methanolic extract of *M. spicata* showed promising nematicidal activity (LC_{50} = 62.64-74.19 µg/mL) under *in vitro* study. The pot experiments showed the reduction of number of galls/plant of brinjal with better plant growth parameters at 3000 ppm of carvone and essential oil of *M. spicata* but less effective than velum prime. *M. spicata* oil (LC_{50} =2.1-2.9 mg/mL) and carvone (LC_{50}=0.9-1.9 mg/mL) also showed promising aphidicidal activity against aphids, bearing acetylcholinesterase inhibitory activity (IC_{50}=0.07-5.34 mg/mL), together with repellent activity (RD_{50} = 0.014-0.025 µl/cm^2) against both aphids. Nematicidal activity of *β*-sitosterol-3-*O*-*β*-D-glucoside, 5,6-dihydroxy-7,8,4′-trimethoxyflavone, 5,6,4′-trihydroxy-7,8,3′-trimethoxy flavone, and 5,6,4′-trihydroxy-7,8-dimethoxyflavone against *M. incognita* were also reported for the first time. Based on above studies, carvone and essential oil from *M. spicata* can be used to control *M. incognita* and wheat aphids, however, further studies under field conditions for their utilization in the management is suggested.

Agricultural Economics

Mr. Perka Shiva Kumar

Name of the student : Mr. Perka Shiva Kumar
Roll No. : 12205
Chairperson : Dr. Alka Singh

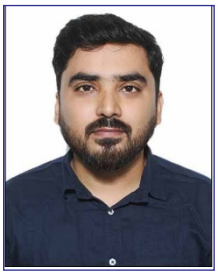
Dr. Alka Singh

Title of the Thesis

Assessing climate resilience and adoption of climate-smart agricultural technologies among smallholder farmers in Telangana

Climate change, driven largely by human activities, poses serious challenges to agriculture through rising temperatures, erratic rainfall, and increased vulnerability. Agriculture contributes about 19–29% of global greenhouse gas emissions and nearly 14% in India, mainly from livestock, fertilizer use, rice cultivation, and residue burning. Climate-Smart Agriculture (CSA), promoted by FAO, CGIAR, and ICAR, aims to enhance adaptation, mitigation, and climate resilience; however, adoption among smallholder farmers remains low (0–15%). In Telangana, intensified paddy cultivation, livestock expansion, and fertilizer use have increased emissions, while awareness and uptake of CSA practices are limited. Gender dimensions of CSA adoption are also insufficiently explored. This study addresses three objectives: (i) to examine climate resilience, adaptive capacity, and their determinants among smallholder farmers through a Systematic Literature Review (SLR); (ii) to analyze CSA adoption with a focus on gender differences; and (iii) to assess the impact of CSA adoption on climate resilience. A PRISMA-based SLR and meta-analysis were conducted to identify global adaptation strategies and gender effects. Primary data were collected from 440 adopters and non-adopters across four climate-vulnerable districts of Telangana. Analytical tools included the Extended Technology Acceptance Model, Mann–Whitney U test, thematic analysis, Climate Resilience Index, beta regression, and endogenous switching regression. The review highlighted conservation agriculture, crop diversification, agroforestry, integrated farming systems, and extension services as key adaptation strategies, while high vulnerability and low adaptive capacity emerged as major constraints. Although meta-analysis showed minimal overall gender effects, field-level evidence revealed distinct gendered adoption patterns. CSA adopters especially women demonstrated higher climate resilience, influenced by social networks, awareness, and access to credit. The study underscores the need for gender-inclusive, context-specific CSA policies and strengthened extension systems to enhance sustainable resilience among smallholder farmers.

Agricultural Engineering



Mr. Tushar Dhar

Name of the student : Mr. Tushar Dhar
Roll No. : 12207
Chairperson : Dr. Roaf Ahmad Parray

Dr. Roaf Ahmad Parray

Title of the Thesis

Machine vision-based site-specific spraying robot for protected cultivation

Tomato, a high-value greenhouse crop, is particularly susceptible to fungal diseases, mainly early blight, causing severe yield losses. Conventional disease diagnosis through visual scouting and laboratory analysis is tedious and unsuitable for real-time or large-scale crop management. Furthermore, blanket pesticide application leads to excessive chemical usage and increased operator exposure, posing serious health and environmental concerns. Hence, the present study was aimed to develop a machine vision–based site-specific spraying robot for precise detection and targeted management of early blight disease in tomato under protected cultivation. A lightweight object detection model, YOLOv10n, was trained on a validated dataset of 6,068 images comprising healthy and early blight infected tomato leaves. The causal pathogen, *Alternaria alternata*, was confirmed through morphological and molecular validation using internal transcribed spacer (ITS) sequence analysis. The trained model was integrated into a real-time machine vision–based site-specific spraying system. In addition, six convolutional neural network (CNN) models, MobileNetV2, DenseNet121, InceptionV3, VGG19, NASNetMobile, and a custom-built CNN, were trained for disease severity classification enabling future variable-rate pesticide application. Experimental investigations were conducted to optimize camera scanning speed, vehicle forward speed, nozzle size, operating pressure and nozzle spacing. Based on optimized parameters, a track-type robotic sprayer equipped with a linear camera scanning mechanism was developed. The robotic platform employed skid-type steering and integrated Jetson Nano, camera, Arduino controllers, solenoid valves, and selective nozzle actuation for targeted spraying. YOLOv10n model achieved precision of 0.947, recall of 0.953, and mAP values ranging from 0.935 to 0.985. Among CNN models, fine-tuned DenseNet121 achieved the highest disease severity classification accuracy of 99.61%. The developed robotic sprayer attained a detection actuation accuracy of 88.77% and resulted in pesticide saving of 78.30% compared to a knapsack sprayer. Overall, the developed system demonstrated strong potential for sustainable, precise, and safe disease management in greenhouse tomato production.

Agricultural Extension Education

Ms. Sweety Mukherjee

Name of the student : Ms. Sweety Mukherjee
Roll No. : 11976
Chairperson : Dr. R.N. Padaria

Dr. R.N. Padaria

Title of the Thesis

Effectiveness of *Kisan Sarathi*- a multimodal personalised extension and advisory system

Digital platforms are increasingly integrated into extension and advisory services (EAS) to deliver real-time, localised advisories. In this context, ICAR introduced *Kisan Sarathi*, a multimodal ICT-based platform linking farmers with extension services. With over 2.3 crore registered farmers across 3.1 lakh villages, implemented through 731 KVKs in 34 states and Union Territories and operating in 13 languages, *Kisan Sarathi* represents a major step towards grassroots agricultural empowerment. The study assessed farmers' awareness, preferences, and usage behaviour of digital EAS; analysed factors influencing adoption; evaluated extension professionals' digital competency; examined the effectiveness of *Kisan Sarathi;* and identified constraints while proposing strategies for improved adoption. Conducted in Haryana, Uttar Pradesh, and West Bengal, and collected data from 350 *Kisan Sarathi* users, 150 non-users, and 210 extension professionals. The disparities in awareness, with higher awareness in Haryana and lower levels in West Bengal, largely reflecting differences in digital infrastructure were noticed. Extension contact, social media use, and ICT ownership positively influenced awareness, while age and farming experience had negative correlations. Farmers preferred voice–text advisories delivered at least two weeks in advance, trusted research institutions as the primary source, and were willing to pay up to ₹10 for credible advisories. Perceived usefulness, perceived ease of use, self-efficacy, and system quality significantly shaped attitude, which influenced behavioural intention and actual usage. The Digital Competency Index categorised 45.2% of extension professionals as having medium competency, with higher weightage for ethics and responsibility, information management, and communication. Effectiveness analysis revealed that 41.1% of users perceived *Kisan Sarathi* as highly effective, while Difference-in-Differences analysis recorded a significant knowledge gain. Key constraints included network issues, language barriers, limited customisation, delayed responses, high workload, and weak feedback mechanisms. Policy implications emphasise region-specific awareness campaigns, grassroots digital literacy, strengthened KVK-led training, digital competency certification, and AI-driven personalised advisories.

Agricultural Physics

Mr. Aravind K.S.

Name of the student : Mr. Aravind K.S.
Roll No. : 11434
Chairperson : Dr. Ananta Vashisth

Dr. Ananta Vashisth

Title of the Thesis

Multistage wheat yield prediction using artificial intelligence and crop simulation models

Weather variability influences wheat growth and yield, resulting significant interannual production fluctuations. Reliable quantification of weather–yield relationships through prediction models is therefore essential. Field experiments were conducted during the *Rabi* seasons 2020–21 and 2021–22 at ICAR–Indian Agricultural Research Institute, New Delhi. Three widely cultivated wheat varieties (HD 3086, HD 2967, and PBW 723) were grown under timely, late, and very late sowing conditions to create contrasting weather environments across phenological stages. The DSSAT–CERES-Wheat model was calibrated and validated using observed phenological and yield data. Timely sown wheat had highest grain yield, followed by late and very late sowing. During validation, yield prediction accuracy ranged from 88–92% under timely sowing, 82–88% under late sowing, and 75–82% under very late sowing, reflecting the increasing impact of terminal heat stress with delayed sowing. Yield deviation remained within ±8–12%, ±10–15%, and ±15–22% for timely, late, and very late sowing, respectively. Among the tested cultivars, HD 3086 showed the lowest prediction error across sowing environments, indicating superior yield stability under heat stress.

District-level yield simulations showed deviations within ±10–20%, with improved agreement at flowering and grain-filling stages. Validation during *Rabi* 2022–23 demonstrated progressive improvement in prediction accuracy with crop advancement, with lowest deviation at grain filling (5–10%) and the highest at tillering (12–25%). Long-term district-level yield data from Punjab were analysed using weather variables from IMD, NASA-POWER, and combined datasets. Machine learning models, particularly support vector regression, random forest, and deep neural networks, performed better, having nRMSE values of 5–15% and improving accuracy by 20–40%. Forecast combination techniques further reduced prediction error by 35–65%, at flowering and grain-filling stages. Integrated modelling framework provides a reliable basis for operational district-level wheat yield prediction under variable climatic conditions.

Agricultural Statistics

Mr. Praveenkumar A.

Name of the student : Mr. Praveenkumar A.
Roll No. : 11996
Chairperson : Dr. Girish Kumar Jha

Dr. Girish Kumar Jha

Title of the Thesis

A text-based deep learning approach for forecasting agricultural prices

Accurate forecasting of agricultural futures prices is vital for risk management, evidence-based policymaking and stabilizing commodity markets. Yet, most conventional forecasting frameworks fail to account for sentiment embedded in financial news and struggle to effectively integrate both textual and numerical information. This thesis addresses these challenges by developing an advanced deep learning–based framework for soybean futures price prediction that incorporates Natural Language Processing (NLP), attention mechanisms, and non-parametric hybridization strategies. The study first introduces SENTI-AM-LSTM, a sentiment-enhanced attention-based forecasting model that combines soybean futures market data with sentiment information derived from 3,843 financial news headlines collected between January 2002 and December 2023. Sentiment scores were generated using VADER and TextBlob, and an attention mechanism was employed to prioritize influential sentiment signals and key market movements. The proposed model demonstrated markedly improved predictive accuracy compared with ARIMA, RNN, GRU, and traditional LSTM models. To further explore the role of textual information, embedding-based representations such as TF-IDF, Count Vectorizer, and Word2Vec were integrated with historical price features and modeled using RNN, GRU, and LSTM architectures. The analysis revealed that Word2Vec-based models capture contextual and semantic patterns more effectively, with Word2Vec_LSTM model achieving superior accuracy relative to other approaches. Beyond sentiment integration and embedding-based modeling, the research advances forecasting performance through a non-parametric hybrid strategy. The Two-Stage Non-Parametric Hybrid LSTM (TSNH-LSTM) combines the strengths of univariate and multivariate LSTM models using Nadaraya–Watson kernel method to generate adaptive forecast weights. This ensemble approach yields more accurate and stable predictions than individual deep learning models. Overall, the thesis presents a unified and comprehensive framework that integrates sentiment analysis, textual embeddings, deep learning architectures, and kernel-based hybridization for high-precision forecasting of soybean futures prices. The findings offer significant value to traders, policymakers, and agribusiness stakeholders by demonstrating how advanced AI-driven methodologies can enhance decision-making in agricultural commodity markets.

Agronomy

Ms. Twinkle Jena

Name of the student : Ms. Twinkle Jena
Roll No. : 12402
Chairperson : Dr. R.S. Bana

Dr. R.S. Bana

Title of the Thesis

Sulphur and micronutrient management effects on productivity and biofortification of maize-wheat cropping system

The maize–wheat cropping system is the third most predominant system in India, particularly across the Indo-Gangetic Plains. However, the exhaustive nature of both crops, imbalanced fertilizer use, and intensive cultivation practices have resulted in multiple issues, among which micronutrient deficiency has emerged as a major concern, threatening food quality, and nutritional security. Supplementation of sulphur (S) and micronutrients offers a viable strategy to enhance nutrient density and system sustainability. A two-year (2023–2025) multi-location field experiment was conducted to evaluate eight nutrient management treatments comprising different combinations of sulphur (S), zinc-embedded sulphur (Zn-ES), multimicronutrient-embedded sulphur (MM-ES), varying levels of recommended dose of fertilizers (RDF), FYM, microbial consortia, relative to control. The application of 100% RDF in combination with S, Zn-ES, and MM-ES significantly improved growth, physiological traits, and yield attributes of both maize and wheat. Yield enhancement of 5.9% in maize was observed with micronutrient supplementation over sole RDF, with higher gains in Karnal. In wheat, the corresponding improvement ranged from 22–28.5%. System productivity, gross returns, net returns, and benefit–cost ratio increased by 11.8–15.7%, 10.5–13.2%, 11.3–15.3%, and 2.6–7.6%, respectively. Comparable productivity and profitability were achieved with 75% RDF with S and micronutrients, indicating scope for fertilizer optimization. Soil enzymatic activity and micronutrient availability increased markedly with micronutrient supplementation. The micronutrients Fe, Mn, Zn, and Cu demonstrated enrichment with application of 50% RDF and higher doses of Zn-ES and MM-ES, exhibiting 46–87.7%, 23.8–26%, 15.9–50.5%, and 46.5–53.5%, respectively in maize, whereas, the corresponding improvement in wheat ranged from 28.5–37.8%. Targeted supplementation of sulphur and micronutrients improved nutrient uptake, remobilization efficiency, harvest index, and yield, thereby contributing to food and nutritional security in alignment with UN Sustainable Development Goal 2.

Biochemistry

Mr. Tamil Selvan S.

Name of the student : Mr. Tamil Selvan S.
Roll No. : 12016
Chairperson : Dr. Suresh Kumar

Dr. Suresh Kumar

Title of the Thesis

Biochemical, molecular and epigenetic basis of phytate accumulation in rice under varying phosphorus regime

Phosphorus (P) is an essential macronutrient that plays crucial roles in various cellular functions. P deficiency in the soil causes stunted growth of the plant with smaller leaves, fewer tillers, and a considerable decrease in yield. To decipher the functions of *Pup1* QTL and delineate the potential effects of P stress on plant growth and yield, physio-biochemical, molecular, and epigenetic analyses of rice genotype [Pusa-44 and a near-isogenic line-23 (NIL-23, harbouring *Pup1* QTL] were hydroponically grown under continuous P stress [deficiency (4 ppm) or extravagance (≥ 32 ppm)] till maturity. Better P-acquisition and utilisation efficiency of NIL-23 under P deficiency was endorsed by comparatively longer roots and improved root architecture with increased acid phosphatase activity and superior agronomic performance than that of Pusa-44. Transcriptome analysis indicated differential expression of genes for P transporters, carbohydrate, lipid metabolism, etc., in response to P deficiency. Moreover, the regulatory function of *Pup1* in reprogramming the expression of the genes involved in chromatin assembly, DNA methylation, cell wall organization, etc., was detected in the panicle of the tolerant genotype (NIL-23) on P deficiency. To understand the epigenetic (DNA methylation) regulation of gene expression in controlling P use efficiency, bisulfite sequencing was carried out under P deficiency stress, revealing that hypomethylation of genic regions in NIL-23 led to upregulation of key genes, including P transporters, P starvation response genes, which improve P scavenging, recycling, and stress adaptation. Excessive use of P in the medium did not improve plant growth/productivity, but phytate content in seeds increased significantly. Thus, our findings confirm a major regulatory function of *Pup1* QTL under P deficiency as well as the potential effects of excessive use of P on plant growth, productivity, and quality of the seed/produce. These findings would be useful in developing P-efficient cultivars for sustained production.

Computer Application

Mr. Lalit Birla

Name of the student : Mr. Lalit Birla
Roll No. : 11750
Chairperson : Dr. Anshu Bharadwaj

Dr. Anshu Bharadwaj

Title of the Thesis

Deep learning based above ground biomass (AGB) estimation and tree counting in mango orchards using satellite data

India is the world's leading mango producer, necessitating precise individual tree inventories and Above Ground Biomass (AGB) assessments for sustainable orchard management. Because traditional field methods are labor-intensive and difficult to scale across large regions, this study presents a non-destructive framework combining high-resolution multispectral satellite imagery with deep learning. Ground truth data, including tree height and DBH, were collected through methodical surveys to train and validate the models across diverse orchard structures. For tree detection, an enhanced object identification framework was developed using YOLOv8 integrated with a Bidirectional Feature Pyramid Network (BiFPN). This architecture improves multi-scale feature extraction, achieving an accuracy of 0.97, an F1-score of 0.91, and a mean average precision (mAP) of 0.94. These results significantly outperform standard YOLO configurations, highlighting the efficiency of bidirectional feature fusion in reducing detection errors and improving canopy representation. Concurrently, a Deep Neural Network (DNN) was developed for AGB estimation by merging satellite-derived vegetation indices with field biometric factors. The DNN demonstrated high predictive accuracy with R^2 of 0.9146 and a low Root Mean Square Error (RMSE) of 2.72. Comparative analysis confirmed the DNN's superiority over traditional machine learning models like Random Forest and XGBoost. This integrated approach offers a precise, scalable solution for precision horticulture, carbon stock assessment, and data-driven agricultural planning. By automating tree counting and biomass estimation, the framework supports the advancement of sustainable, technology-driven management practices in the global mango industry.

Entomology

Mr. Rakesh V.

Name of the student : Mr. Rakesh V.
Roll No. : 12034
Chairperson : Dr. Amalendu Ghosh

Dr. Amalendu Ghosh

Title of the Thesis

Spray-on application of nano-conjugated dsRNA to mitigate thrips-tospovirus threats in horticultural crops

Exogenous RNA interference offers a non-chemical, environmentally sustainable approach to insect pest management. Thrips is a major agricultural pest that causes severe yield losses through direct feeding and the transmission of tospoviruses. The study established a sustainable thrips-tospovirus management strategy through functional gene characterization, optimization of dsRNA production, spray-induced gene silencing (SIGS), and the development of a biopolymer-based dsRNA bioformulation (RiboThrips). Functional validation of key genes demonstrated stage-specific roles in thrips development, reproduction, and vector competence. The findings identified *E3-UBR7* as a critical vector factor supporting viral replication and movement in a stage-specific manner. Post-virus acquisition silencing of *E3-UBR7* in adults resulted in reduced (104-fold) groundnut bud necrosis virus (GBNV) titre and significantly suppressed virus transmission to healthy plants (15.66%). Silencing of *T. palmi V-ATPase-B* by oral delivery of dsRNA resulted in significant gene knockdown (5.40-fold), increased adult mortality (57.03%), and reduced reproductive fitness (67.73%). For scalable dsRNA production, six dsRNA isolation and purification protocols from *E. coli* HT115 (DE3) were evaluated. A modified TRIzol-absolute ethanol method was developed to produce dsRNA with higher yield and improved purity. Further, SIGS assay demonstrated that topical application of naked ds*V-ATPase-B* (3.0-5.0 µg/mL) significantly reduced thrips populations, providing protection for up to 10 days. To overcome the limitations related to rapid environmental degradation of naked dsRNA, a regenerative biopolymeric nanoparticle (BPNP)-conjugated dsRNA formulation, RiboThrips, was developed. RiboThrips enhanced dsRNA stability, nuclease resistance, pH-responsive sustained release, and shelf life beyond 12 months. Confocal microscopy confirmed efficient cellular uptake, systemic plant movement, and sustained dsRNA presence for over 28 days. Field and polyhouse trials demonstrated that RiboThrips provided protection up to 15 days under natural conditions, comparable to chemical pesticides, with high specificity and environmental safety. IP has been filed and transferred to the industry. Overall, the study validated thrips genes associated with fitness and virus transmission, optimized scalable, high-purity dsRNA production, and introduced a field-deployable dsRNA bioformulation for crop protection.

Environmental Sciences

Ms. Pooja L.R.

Name of the student : Ms. Pooja L.R.
Roll No. : 12043
Chairperson : Dr. Renu Singh

Dr. Renu Singh

Title of the Thesis

Synthesis, characterization, and utilization of nano zeolite urea ammonium nitrate fertilizer for increased nitrogen use efficiency in tomato (*Solanum lycopersicum*) and beet leaf (*Beta vulgaris var. bengalensis*)

Nanozeolite-based nitrogen (N) fertilizers have emerged as promising alternatives to conventional urea due to their high surface area, ion-exchange capacity, and controlled-release properties, which enhance nitrogen use efficiency (NUE) and reduce environmental losses. This study systematically evaluated the agronomic, physiological, biochemical, environmental, and safety impacts of unmodified nanozeolite urea fertilizer (NZUF) and surfactant-modified nanozeolite urea fertilizer (SNZUF) in beet leaf (*Beta vulgaris* var. *bengalensis*) and tomato (*Solanum lycopersicum*) over two consecutive years under controlled pot conditions. The research integrated nanozeolite synthesis and characterization (FTIR, XRD, SEM, TEM, TGA, and zeta potential) with toxicity assessment, leaching studies, soil enzymatic activities, and plant growth and yield analyses.

Both NZUF and SNZUF exhibited sustained nitrogen release over a 60-day period, significantly mitigating nitrogen losses. SNZUF at 100% recommended nitrogen dose (RDN) reduced ammonia volatilization by 20–24% in beet leaf and 41–44% in tomato, while NZUF reduced N_2O emissions by 38.5% and 48.7%, respectively. Enhanced activities of soil enzymes (urease, dehydrogenase, β-glucosidase) and plant nitrogen assimilation enzymes (NR, NiR, GS, and GDH) indicated improved microbial functioning and nitrogen metabolism. In beet leaf, nanozeolite treatments improved plant growth, photosynthetic efficiency, crude protein content, and yield (5–9%) without any toxicological effects. In tomato, NZUF at 120 kg N/ha consistently improved physiological performance, nitrogen uptake, microbial biomass nitrogen, fruit yield, and quality attributes, including ascorbic acid and lycopene content. Importantly, SNZUF applied at 75% RDN maintained yield and quality comparable to conventional urea. Overall, nanozeolite-based fertilizers demonstrate strong potential as climate-smart inputs for sustainable nitrogen management, improving productivity while minimizing environmental risks.

Floriculture and Landscaping

Mr. Veeresh

Name of the student : Mr. Veeresh
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Dr. Tejaswini Prakash

Title of the Thesis

Strategies for maximization of hybrid seed production: Comparative study in four F1 hybrids of marigold (*Tagetes erecta* L.)

Marigold is an important commercial flower crop of India and hybrids are in demand. However, the hybrid seeds are being imported due to the limited number of hybrids and availability of seeds. Present study was carried out for the establishment of quality hybrid seed production. Results revealed that the seed parent IIHRMYS-1, with age of 75 days, after transplanting exhibited significantly higher number of cuttings/plant (48.26), rooting percentage (97.27 %) and establishment percentage of rooted cutting (84.44 %). As seed parents exhibited delayed flowering with an extended duration ranging from 104.9 to 114.5 days, in contrast to the early-flowering pollen parents, which had a shorter flowering duration of 65.4 to 72.3 days. This discrepancy could be effectively addressed by staggered planting of pollen parents at multiple intervals, ensuring consistent pollen availability throughout the active flowering period of the seed parents. Pollen morphology, viability, and *in vitro* germination are crucial for enhancing seed set. The optimal germination was achieved using media containing 15% sucrose and 15% PEG and among the genotypes, the highest pollen germination rate was observed in IIHRMY 1-4 (54.09 %). Marigold male sterile lines need the assisted pollination to set seeds in hybrid seed production therefore, repeated pollination was attempted to study the impact on quality seed production in marigolds. Hybrid combination of Arka Abhi (IIHRMYS-1 × IIHRMY 2-1) with three times repeated pollination, exhibited the significantly highest number of seeds/flower (177.20), seed weight /flower (429.83 mg), and seed setting percentage of 71.59%. Seed production under polyhouse can be made efficient with the use of Indian honey bees as a pollinator. Results showed complementing bee pollination with hand pollination significantly increased seed set (75.09%). The present study highlighted the wider scope of potential for enhancing hybrid seed production in marigold in economically feasible way.

Fruit Science

Ms. Megha M.

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Roll No. : 12072
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Dr. C. Vasugi

Title of the Thesis

Morphological, biochemical characterization and identification of QTLs for fruit traits in guava (*Psidium guajava* L.)

Guava, a superfruit is rich in high nutrients and phytochemicals. Red pulp varieties possess more antioxidant than white. As there are only a few dual purpose cultivars, the present study was carried out involving 167 intervarietal progenies derived from the cross Purple local × Arka Poorna. Results revealed significant variations for leaf, shoot, fruit quality and phytochemical traits. The inheritance study for peel color exhibited a complimentary gene action with segregation ratio of 9:7 whereas, the pulp color, controlled by polygene segregated for 9:3:4. Highest PCV and GCV was exhibited for fruit weight (37.44 and 21.56 %), number of seeds 100^{-1} g fruit (42.69 and 25.58 %) and seed weight 100^{-1} g fruit (26.08 and 37.53 %). High heritability coupled with high genetic advance was recorded for peel, pulp and phytochemical traits. Cluster analysis resulted in four main groups with the cluster IV consisting of colored, progenies with higher fruit weight, outer pulp thickness and pulp per cent. Cluster II was dominated with high phytochemical traits. The principal component analysis (PCA) explained 75.8 % of total variance for all the traits studied. On the basis of evaluation six progenies *viz.,* PLAP8-17, PLAP8-20, PLAP8-28, PLAP9-13, PLAP9-25 and PLAP11-1 were identified. In order to identify the genetic loci associated with different traits, a high-density genetic linkage map was constructed using whole genome resequencing (WGRS). 60,797 high-quality SNPs were identified, of which 2177 were mapped onto 11 linkage groups. The map covered total length of 758.96 cM, with lengths ranging from 36.98 cM (LG10) to 125.15 cM (LG5) ensuring its utility for QTL mapping and molecular breeding. 72 major QTLs (LOD > 3) for peel and pulp color (7), fruit traits (47), biochemical traits and fruit firmness (18) were identified. The present study highlighted the potential for enhancing the nutritional value and exploitation in crop improvement.

Genetics and Plant Breeding

Ms. Adithya P. Balakrishnan

Name of the student : Ms. Adithya P. Balakrishnan
Roll No. : 11802
Chairperson : Dr. Anju Mahendru Singh

Dr. Anju Mahendru Singh

Title of the Thesis

Analysis of marker trait association for arabinoxylan content and influence of glutenin alleles on grain quality in wheat (*Triticum aestivum* L.)

India has achieved food security through substantial yield improvements in staple crops, including wheat. The concomitant improvement in nutritional and end product quality is in incipient stage in Inida. Simultaneously, changes in diet and lifestyle have led to increased health challenges among Indians e.g. ~15% adults today are suffering from diabetes compared to 3% in the year 2000. Therefore, improving the dietary fibre content which has a major effect in reducing the blood sugar as well as threat of cardiovascular diseases is highly relevant in this context. Arabinoxylan (AX) is the major dietary fibre in wheat and about 40-50% fibre is retained after milling in the whole wheat products such as *chapati*. Thus, enhancing the arabinoxylan (AX) content in wheat represents a durable strategy to bridge fibre intake gaps. Two hundred forty five diverse wheat genotypes grown across two environments were evaluated for total (TOT-AX) and water-extractable arabinoxylan (WE-AX) content in the whole wheat kernel flour. Wide genetic variation was observed for both TOT-AX (32.45–103.11 mg/g) and WE-AX (1.59–11.65 mg/g), thus identifying stable, high content donors for breeding. WE-AX showed high broad-sense heritability (84.42–87.04%) and negligible environmental influence while TOT-AX exhibited moderate heritability (51.50–55.56%) with significant environmental influence and genotype-by-environment interaction. Using this data, a NIRS-based prediction model, which is the first in the world, was developed to enable rapid phenotyping (R^2 = 0.883 for TOT-AX; 0.761 for WE-AX) and was successfully validated for its repeatability. About 100-120 samples per day can be estimated as compared to only about 20-25 samples per day with the conventional (wet chemistry) method. This study also focussed on identifying marker trait associations (MTAs) and candidate genes for AX content and biosynthesis using the Genome-Wise Association Study. A major MTA on chromosome 2B explaining about 49.20% of the phenotypic variance was identified for TOT-AX. Other smaller effect MTAs were identified on six other chromosomes *viz*.1A, 1B, 2D, 4D, 5B, and 7D. Two significant MTAs for WE-AX were detected on chromosomes 6B and 7A. Candidate genes controlling AX content and regulating its biosynthesis were also identified in this study. C 306 is an old Sharbati (GI tag) wheat variety known as the gold standard for chapati quality and possesses higher arabinoxylan and unique composition of glutenin alleles as compared to new varieties such as HD 2967. Analysis of seven haplotypes produced from backcrosses between C 306 and HD 2967 showed that the two alleles of C 306 *viz*. *Glu-B1e* and *Glu-D1*a improve extensibility and puffing while reducing *chapati* toughness. Thus, the above study offers valuable donors and alleles for breeders to utilize in their breeding programmed aimed at fibre and *chapati* quality enhancement in wheat.

Molecular Biology and Biotechnology

Mr. Ankur Poudel

Name of the student : Mr. Ankur Poudel
Roll No. : 11646
Chairperson : Dr. Pranab Kumar Mandal

Dr. Pranab Kumar Mandal

Title of the Thesis

Allele mining for negative regulators associated with nitrogen use efficiency in Indian rice germplasm

Nitrogen (N) is an important macronutrient for plant growth; however, its application often results in substantial environmental pollution. Rice notably exhibits the lowest Nitrogen Use Efficiency (NUE) among cereals, necessitating genetic improvements for environmental safety and cost-effective cultivation. Many negative regulators inhibit N uptake by the transporters. In the present study, an association panel of 96 diverse rice genotypes, comprising landraces, improved varieties, and EMS mutants were grown under hydroponics system with absolute control of optimum and suboptimum dosses of N. They were phenotyped for ^{15}N-responsive traits and also genotyped using 80K SNP array. Three important negative regulators for N uptake, namely *OsBT*, *OsNIGT1*, and *OsACTPK1* were subjected to allele mining among the genotypes under study. Root traits increased under N-stress, while yield attributes were higher under N-optimum conditions. Allelic comparison showed *OsBT* was more conserved than *OsACTPK1* and *OsNIGT1*. This was confirmed by variant analysis, nucleotide diversity and lowest number of haplotypes, indicating a key role in NUE under N-stress, plant development and survival. Candidate gene association under N-optimum conditions identified 17 moderate and minor MTAs for *OsBT* and *OsACTPK1*, with none for *OsNIGT1*. Under N-stress, 8 moderate and minor QTLs were detected only in the CDS of *OsBT* and *OsACTPK1*. GWAS showed significant variation, and distinct trait responses under different N-regimes indicated the need for separate breeding programs. Population structure analysis revealed two subpopulations with varying admixture. GWAS using MLM, FarmCPU, and BLINK identified 745 MTAs across N-optimum, N-stress, and SSI, with 36 common MTAs. Of these, 24 MTAs were novel. Candidate genes like *OsPRX59*, *OsPRX62*, *OsPSBS2*, *OsWAK14*, *OsWAK15*, *OsAMT3*, *OsNIN8*, and *OsHCT2*, were identified from MTAs, that confer overlapping abiotic and N-stress tolerance. These important genes can aid breeding rice varieties with improved NUE after their validation.

Plant Pathology

Mr. Samrat Paul

Name of the student : Mr. Samrat Paul
Roll No. : 12133
Chairperson : Dr. Parimal Sinha

Dr. Parimal Sinha

Title of the Thesis

Assessment of leaf curl infection risk in relation to host–vector interaction: aiming at the development of strategic management options

Chilli leaf curl disease, caused by Chilli leaf curl virus (ChiLCV) and transmitted by the whitefly *Bemisia tabaci*, is a major constraint to chilli production due to diagnostic confusion with symptomatically similar damage caused by mites and thrips. This study presents an integrated, field-deployable disease management framework that combines early detection, precise molecular diagnostics, and epidemiologically optimized intervention strategies. Non-invasive imaging approaches were developed for early and accurate detection, where thermal infrared imaging enabled pre-symptomatic ChiLCV detection under controlled conditions with 74.7% accuracy using zero-shot learning and automated SAM-based canopy segmentation, capturing host–pathogen interactions associated with altered stomatal conductance and transpiration. Although highly sensitive, microclimatic variability limits field deployment of thermal imaging, positioning it for seedling certification and protected production systems. For field surveillance, two complementary RGB-based systems were established. The lightweight SCA-MobiPlant classifier, integrating coordinated attention with MobileNetV3-Small, achieved 99.64% accuracy at 89 FPS using only 0.68 million parameters, reliably discriminating healthy, mite-affected, and virus-infected plants, while a semi-supervised annotation strategy reduced expert labelling effort by 30–50%. An advanced YOLOv9t-DyE + MobileSAM framework further enabled real-time detection, symptom discrimination, and pixel-level disease severity estimation, demonstrating robust field performance (POD 0.88, CSI 0.79) and a 12.15-fold reduction in assessment time. Both imaging systems were deployed as Android applications to support on-site diagnosis and disease incidence estimation. In parallel, a rapid point-of-care molecular diagnostic was developed using an RPA–CRISPR/Cas12a platform, overcoming PCR cross-reactivity and ELISA limitations and enabling specific ChiLCV detection from crude leaf extracts within one hour, including pre-symptomatic infections, with optimized lateral-flow interpretation supported by quantitative threshold modeling. Epidemiological modeling further identified immigration of viruliferous whiteflies as the primary epidemic driver, with host succulence governing transmission efficiency, and field validation revealed a critical intervention window at 3–4 weeks post-transplantation during which physical vector barriers maximized yield gains (≈ 3.7 t/ha). Together, this framework integrates imaging, molecular diagnostics, and epidemiological insights into a practical, chemical-free strategy for managing ChiLCV and other vector-borne plant diseases.

Plant Phsyiology

Mr. Animireddy China Malakondaiah

Name of the student : **Mr. Animireddy China Malakondaiah**

Roll No. : **12142**

Chairperson : **Dr. Ajay Arora**

Dr. Ajay Arora

Title of the Thesis

Physiological and gene expression analysis of contrasting stay-green and stem reserve mobilization containing wheat (*Triticum aestivum* L.) genotypes under combined heat and drought stress

Staygreen (SG) and stem reserve mobilization (SRM) are two important mutually exclusive traits contributing to grain filling under drought and heat stress in wheat. The present study was conducted in a genome wide association study (GWAS) panel consisting of 278 advanced breeding lines of wheat to find the markers linked with SG and SRM traits. Furthermore, to screen the superior genotypes through multi trait genotype ideotypes distance index (MGIDI), under combined heat and drought stress (HD). SG and SRM traits, *viz.* Normalized difference vegetation index (NDVI), Soil plant analysis development (SPAD), Leaf senescence rate (LSR), Canopy temperature (CT) and Stem reserve mobilization efficiency (SRE) were recorded. The trial was conducted in α-lattice design with 14 incomplete blocks per replicate, each block containing 20 genotypes and two replications under two conditions *viz.* control, HD. Analysis of variance and descriptive statistics showed a significant difference across the studied traits. The highest 52.56% of SRE reported under HD, while lowest 15.7% was recorded under control. Genotyping was carried out using the 35K Axiom R Wheat Breeder's Array, 14,625 SNPs were kept after filtering. Through GWAS, 36 significant Marker Trait Associations (MTAs) were identified that are located on 16 distinct chromosomes. Out of this, 22 MTAs and 14 MTAs were found under control and HD conditions respectively. We identified 6 contrasting wheat genotypes of six high/low SG and SRM containing wheat genotypes based on their performance during field experiment. Expression analysis of candidate genes like *serine/threonine-protein kinase 2* and *wall-associated receptor kinase* showed that they were involved in enhanced mobilization of carbon reserve to grain under HD condition. Genes like *protein phosphatase 2C*, *cytokinin dehydrogenase 11*, *protein Detoxification 40-like*, *F-box protein* and *pentatricopeptide repeat* were involved in the regulation of leaf senescence. Our study confirmed the association of mapped markers and its linked traits, which can be used in further marker-assisted selection (MAS) using efficient breeding tools.

Post Harvest Management

Mr. Sajeel Ahamad

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Roll No. : 12145
Chairperson : Dr. Ram Asrey

Dr. Ram Asrey

Title of the Thesis

Studies on the effects of green elicitors on quality retention and shelf-life extension of bell peppers during storage

Bell pepper (*Capsicum annuum* L.), a highly perishable vegetable crop, is particularly vulnerable to post-harvest quality deterioration during storage. This study investigated the effectiveness of various eco-friendly post-harvest treatments melatonin (MT), brassinosteroids (BRs), UV-C irradiation, and carnauba wax (CW) coating in maintaining the physicochemical quality, antioxidant potential, and extending the shelf life of bell peppers during cold storage. Treatments were evaluated individually and in combination, with a focus on physiological, biochemical, and structural parameters. Melatonin application at 120 µM effectively minimized physiological weight loss, reduced respiration rate, and delayed chlorophyll degradation, while enhancing firmness and overall sensory quality. The treatment also significantly elevated antioxidant levels, including total phenolics (TPC), flavonoids (TFC), and ascorbic acid (AsA), while suppressing malondialdehyde (MDA) accumulation, thus mitigating oxidative stress and cellular damage. Similarly, brassinosteroids at 10 µM improved firmness and biochemical composition by promoting antioxidant biosynthesis and enhancing antioxidant enzyme activities, while limiting lipid peroxidation. UV-C treatment (8 kJ/m²), a non-chemical approach with no residual effects, proved effective in maintaining structural integrity, reducing decay and weight loss, and enhancing the accumulation of antioxidants and bioactive compounds, including capsaicin, chlorophyll, phenolics, flavonoids, and ascorbic acid (AsA). FTIR and SEM analyses confirmed the preservation of cell wall structure, while UV-C treatment also delayed the activities of PG and PME, reduced MDA content, and resulted in higher retention of firmness and proline levels during storage. Synergistic benefits were observed when these treatments were applied in combination. MT + BRs, MT + UV-C and BRs + UV-C treatments significantly improved firmness retention, suppressed oxidative stress markers (MDA and reactive oxygen species), and delayed senescence extending the effective shelf life of bell peppers up to 25 days. More importantly, the integration of MT or BRs with carnauba wax (CW) at 1.5% concentration provided the most effective preservation outcomes. Specifically, MT-120 µM + CW 1.5% and BRs-10 µM + CW 1.5% treatments maintained superior post-harvest quality, minimized decay and oxidative stress, and extended shelf life up to 35 days under cold storage conditions.

Soil Science

Mr. Arkaprava Roy

Name of the student : Mr. Arkaprava Roy
Roll No. : 11604
Chairperson : Dr. K.M. Manjaiah

Dr. K.M. Manjaiah

Title of the Thesis

Solid-phase speciation and chemical equilibrium of arsenic in a polluted *Inceptisol* in the context of its uptake by rice as affected by silicon

Arsenic (As) contamination of paddy soils poses a serious public health risk in the Bengal Delta Plain, where rice grown under As-contaminated irrigation is a major dietary exposure pathway. Limited understanding of As solid-phase behaviour and strategies to restrict its transfer to rice grains has constrained mitigation efforts. This study investigated the solid-phase speciation, chemical equilibrium, adsorption–desorption dynamics of As in a polluted *Inceptisol*, and evaluated silicon (Si) amendments for reducing As uptake by rice. Sequential fractionation revealed that As was predominantly associated with amorphous Fe and Al oxides, accounting for 35.8% of total soil As. Pore-water geochemical modelling indicated dominance of $HAs(V)O_4^{2-}$ under simulated paddy conditions, with redox potential buffered by ferric complexes. Saturation indices suggested precipitation of Fe and Al oxyhydroxides, while formation of discrete As minerals was thermodynamically unlikely. Adsorption studies showed a high As sorption capacity (q_{max} up to 791 mg/kg), best described by the linear Langmuir model. Higher temperature increased q_{max} and adsorption affinity, whereas low-molecular-weight organic acids altered adsorption thermodynamics without markedly affecting affinity. Arsenic was largely irreversibly bound, with desorption enhanced at lower temperature and high (>1 mg/L) Si concentrations. Pot experiments with four rice cultivars demonstrated that Si amendments—sodium metasilicate, rice husk ash (RHA), and sugarcane bagasse ash—enhanced grain yield by 23.3–56.7% and reduced grain-As below the Codex limit (0.35 mg/kg). RHA at 207 kg Si/ha achieved the greatest reduction in grain (50.2%) and straw (34.8%) As. Badshabhog exhibited the lowest grain-As concentration and restricted husk-to-grain As translocation. The study highlights that combining low-As cultivars with by-product-based Si amendments offers an effective, practical strategy to mitigate As entry into the rice food chain in contaminated regions.

Vegetable Science

Ms. Anamika Chandel

Name of the student : Ms. Anamika Chandel
Roll No. : 11883
Chairperson : Dr. Shrawan Singh

Dr. Shrawan Singh

Title of the Thesis

Studies of '*Or*' gene associated developmental and hormonal changes in Indian cauliflower

Cauliflower (*Brassica oleracea* var. *botrytis* L., 2n=2x=18) is a nutrient-rich vegetable and an important source of dietary fiber, protein, glucosinolates and essential minerals. India is the second largest producer after China. It ranks as the 6th most important vegetable crop in the nation, with a production of 10.21 million MT from 0.523 million ha during 2024–25. Although white cauliflower is the most widely cultivated and consumed type, there is increasing interest in colourful cauliflower variants due to their enriched functional metabolites and superior health benefits. The *Or* gene is a natural mutant in cauliflower enables massive accumulation of β-carotene in edible curd, offering strong potential for food-based interventions against vitamin A deficiency. However, exploitation of *Or* gene in homozygous form is constrained due to its adverse effects on plant morphology, developmental transitions, and seed production. The present study evaluated *Or*-gene associated morphological, developmental and hormonal changes in homozygous (*OrOr*) and heterozygous (*Oror*) conditions using $F_{3:4}$ progenies [DC244 (*oror*)/$PKVA1_{HM}$ (*OrOr*)]. Homozygous orange lines ($CF_{Or\text{-}HM}$) produced intense orange curds, while heterozygotes (CFOr-HT) exhibited intermediate coloration. The *Or* gene followed a Mendelian segregation pattern in 1:2:1 ratio (intense orange: normal orange: white). Differences between *OrOr* and *Oror* were linked to variation in chromoplast number, shape, and size influencing β-carotene accumulation. Zygosity also significantly altered endogenous phytohormone profiles (GA, ABA, auxin, cytokinins). Exogenous GA_3 application (500 ppm in $CF_{Or\text{-}HM}$ and 250 ppm in CF_{WT} at vegetative + curd initiation stage) achieved parity in stalk length (69.33 vs 69.83 cm) and synchronized flowering (153 vs 153.5 days). Gene expression analysis revealed disruption of *BoGA20ox1* across all developmental stages in $CF_{Or\text{-}HM}$, *BoGA3ox1* at full curd stage, and *BoGA2ox1* at bolting stage. Overall, this study provides insights into chromoplast morphology, hormonal regulation and gene expression and provide model for flowering synchronization for efficient utilization of β-biofortified cauliflower.

Water Science and Technology

Mr. Arpula Sairam

Name of the student : Mr. Arpula Sairam
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Chairperson : Dr. Khajanchi Lal

Dr. Khajanchi Lal

Title of the Thesis

Drip fertigation in maize-wheat system under different nutrient management options

Improving resource use efficiency through advanced irrigation techniques and sustainable nutrient management by integrating low-cost organic manures including zero budget natural farming is accentuated to address the rising water scarcity, environmental degradation and escalating prices of chemical fertilizers. Impacts of surface drip (SDI) and subsurface drip (SSDI) with two levels of irrigation schedules (0.8 and 1.0 ET_c) and four nutrient management options (chemical fertilizers, CFNM; organic manures, OMNM; integration of chemical fertilizer and organic manures, INM; and natural farming, NFNM) were assessed on crop productivity, resource use efficiency, and monetary benefits of maize-wheat cropping system in a two year field study conducted at IARI during the 2022-24. Surface irrigation and soil application of recommended doses of NPK fertilizers (RDF) was taken as conventional control. Drip irrigation at 0.8 ET_c saved 50% of irrigation water and improved irrigation water productivity of maize-wheat system by 2.12-fold compared to conventional surface irrigation. INM led to a significant yield improvement of 11 and 21% in maize, 17 and 29% in wheat, and 14 and 24% in system maize equivalent yields, compared NFNM and OMNM treatments. The effects of irrigation schedules and irrigation methods on system crop water productivity were statistically non-significant. The balances of N (157 kg/ha) and P (76 kg/ha) were the highest in OMNM while the lowest (N, -299 kg/ha; P, -55 kg/ha) in NFNM. Net income from the maize-wheat system was in the order: CFNM (INR 103,815/ha) = INM (INR 97,424/ha) > NFNM (INR 75,946/ha) = OMNM (INR 66,385/ha). NFNM treatments saved INR 18,837 on fertilizer and reduced total cost of cultivation by 12% while maintaining a benefit-cost ratio (BCR) of 1.4 and producing 75-78% of the yields obtained with CFNM.


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