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ICAR-Indian Sugarcane Research Institute
Lucknow - 226 002

वार्षिक प्रतिवेदन
Annual Report

2025

भा.कृ.अनु.प. – भारतीय गन्ना अनुसंधान संस्थान
ICAR-Indian Sugarcane Research Institute

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From the Director's Desk

The Indian sugar industry continued its remarkable progress consolidating its position as one of the major contributors to the nation's agricultural economy. The sector registered significant achievements not only in sugar production but also in sugarcane productivity, diversification, value addition, and sustainability. The expanding ethanol programme, increased focus on renewable energy, and adoption of advanced technologies have further strengthened the industry's resilience and competitiveness. These developments have enhanced the economic security of sugar mills and farmers alike while contributing substantially to the nation's energy security, environmental sustainability, and foreign exchange savings.

The sustained growth of the sugar sector has been possible due to continuous improvements in sugarcane production technologies, enhanced varietal development programmes, and the increasing adoption of scientific crop management practices. However, the challenges posed by climate variability, declining natural resources, evolving pest and disease scenarios, and the need to meet the future demand for sugar, ethanol, and other value-added products necessitate a paradigm shift towards more precise, resource-efficient, and climate-resilient production systems.

Aligned with the national vision of *Viksit Bharat 2047*, the ICAR-Indian Sugarcane Research Institute has continued its efforts to develop innovative and sustainable technologies aimed at enhancing sugarcane productivity, profitability, and resource use efficiency. The Institute remains committed to delivering science-based solutions through multidisciplinary research, strategic partnerships, and effective technology dissemination.

In 2025, ICAR-ISRI advanced sugarcane breeding with new releases including CoLk 19204, registration of six varieties, and multi-location testing, while evaluating 23,000 seedlings and enhancing population improvement and DUS testing. Research in red rot proteomics and genome editing progressed, alongside the first online seed cane booking for >2,000 farmers. Seed production reached 10,150 quintals, with CoLk 14201 covering 1.22 lakh ha and new varieties widely distributed.

Optimized irrigation regimes and mulching based methods improved ratoon yield and water use efficiency, with rainfall meeting the majority of crop water needs. Enhanced nutrient management, silicon application, and timely ratoon initiation significantly boosted cane yield, CCS, and crop performance. Integrated weed management effectively controlled *Cyperus rotundus*, strengthened crop vigour, and further increased sugarcane productivity. Efforts towards standardization of drone-based crop protection technologies have gained momentum, facilitating timely and precise application of crop protection chemicals and other agro-chemicals while minimizing environmental impacts.

Research on integrated disease and pest management has yielded encouraging results, particularly for major diseases such as red rot and *pokkah boeng*, and important insect pests affecting sugarcane productivity. Advanced molecular approaches, including genome editing and marker-assisted breeding, are being increasingly integrated into varietal development programmes. Studies on climate-resilient production systems, stress physiology, and changing pest and disease dynamics are generating valuable insights for developing adaptive management strategies.

The Institute has also strengthened its research efforts in sugarcane mechanization through the development and refinement of farmer-friendly machinery and precision farming equipment. Innovations in planting, ratoon management, trash utilization, and controlled traffic farming are contributing to labour savings and improved operational efficiency. Collaborative initiatives with natural resource management institutions have further expanded the scope of mechanization research.

As the sole ICAR institute dedicated to research on sugar beet, ISRI continues to explore its potential as an alternate feedstock for sugar and bio-ethanol production. Multi-location trials conducted across tropical and subtropical regions have demonstrated encouraging results, opening new opportunities for crop diversification and enhanced feedstock availability for the biofuel sector.

The extension and outreach programmes of the Institute have played a pivotal role in transferring technologies to farmers, entrepreneurs, sugar industries, and other stakeholders. The Krishi Vigyan Kendras at Lucknow and Lakhimpur Kheri have continued to organize frontline demonstrations, on farm trials, capacity building programmes, and entrepreneurship development initiatives, thereby facilitating the widespread adoption of improved agricultural technologies.

The Institute has also continued its active participation in higher agricultural education through the IARI Mega University programme. Undergraduate, postgraduate, and doctoral programmes conducted at the IARI Lucknow Hub have contributed to the development of skilled human resources in agriculture and allied sciences.

During the year, ICAR-ISRI, Lucknow further strengthened its collaborations with national and international research institutions, state governments, industries, and developmental agencies. Partnerships with ICAR institutes, universities, sugar industries, government departments, and farmer organizations have facilitated impactful research, technology validation, and large scale dissemination of improved production and management practices.

The emerging opportunities and challenges in the sugar sector demand continuous innovation, stakeholder engagement, and strategic interventions. Guided by its mandate and commitment to excellence, the Institute shall continue to focus on developing profitable, sustainable, and climate-smart technologies for the holistic advancement of the Indian sugar industry.

This Annual Report presents a comprehensive account of the Institute's research achievements, extension activities, academic initiatives, technology commercialization efforts, and institutional developments during the year 2025. We gratefully acknowledge the guidance and support received from the Hon'ble Secretary, DARE and Director General, ICAR, the Deputy Director General (Crop Science), Assistant Director General (Commercial Crops), and all officials of ICAR, New Delhi. We also express our sincere appreciation to our collaborating institutions, industry partners, state governments, funding agencies, farmers, and stakeholders for their continued support and cooperation.

The contributions of all scientists, technical staff, administrative personnel, students, and members of the Annual Report Committee in compiling and bringing out this Annual Report are gratefully acknowledged and highly appreciated.

Director

Content

Executive Summary

Crop Production

- Different irrigation regimes and methods of irrigation significantly affected the growth of sugarcane ratoon crop as evident from the tiller count, NMC, average cane weight and cane length. The highest ratoon yield was harvested under the irrigation regime with IW: CPE ratio 1.0(101.71 t/ha) statistically similar to that recorded with IW: CPE ratio 0.8 (99.54 t/ha).
- Irrigation by skipping alternate trenches in ratoon crop caused significant reduction in the cane yield of ratoon crop (89.77 t/ha) as compared to flood irrigation or trench irrigation.
- The highest irrigation water productivity in ratoon cultivation was found under the irrigation regime having IW: CPE ratio 0.8 (73.87 L/kg) followed by IW: CPE ratio 0.6 (76.42 L/kg). Among irrigation methods the skip trench irrigation with mulching recorded the best water productivity (74.99 L/kg) followed by irrigating the trenches under mulching (75.12 L/kg).
- Water footprint of sugarcane third ratoon crop ranged between 104.92 and 127.39 L/kg. Partitioning among green, blue and grey components revealed that third ratoon gets more than 65% contribution from the rains and depends on irrigation only for 25 - 30% of its crop water needs.
- Application of silicate solubilizing bacteria @ 3 L/ha showed positive response on yield attributes and yield of plant and ratoon sugarcane either applied alone or in combination with different dosage and sources of silicon.
- Sugarcane yield (second year crop) was increased to the tune of 45.25, 56.34 and 60.52 percent with NF_1, NF_2 and RDF_1 over RDF_0 (average yield of both C_1& C_2 system 59.19 t ha^{-1}), respectively. Maximum sugarcane yield 95.01 t ha^{-1} recorded with RDF_1 was at par with NF_2 92.54 t ha^{-1} followed by NF_1 85.97 t ha^{-1}. Maximum vegetable pea yield was recorded with NF_2, followed by NF_1 and RDF_1.
- Sugarcane ratoon (first year crop) yield was increased to the tune of 61.56, 68.34 and 78.60 percent with NF_1, NF_2 and RDF_1 over RDF_0 (average yield of both C_1& C_2 system 44.94 t ha^{-1}), respectively. Maximum sugarcane yield 80.27 t ha^{-1} was recorded with RDF_1 was at par with NF_2 (75.65 t ha^{-1}) followed by NF_1 (72.61 t ha^{-1}). Maximum vegetable pea yield was recorded with NF2, followed by $NF_1$and RDF_1.
- Maximum sprouting, tiller production, number of millable canes, cane length, cane diameter, cane yield and commercial cane sugar was recorded in sugarcane ratoon initiated on 15th February (in 3rd ratoon) over other dates of initiation.
- Ratoon initiated on 15th February was significantly superior over ratoon initiated on 15th December of previous year in all the growth and yield parameters. Among the sub plot treatments all the treatments recorded significant superior over control on production of NMC, cane yield and CCS t/ha. Sugarcane yield was increased with February initiated ratoon by 27.28 percent over previous year January initiated ratoon in 3rd ratoon (57.61 t ha^{-1}).
- Under long-term strategies for managing *Cyperus rotundus* L. in sugarcane, the integrated weed management (IWM) approach combining stale seedbed preparation, pre-emergence sulfentrazone with mulching, and post-emergence application of halosulfuron + 2,4-D was found to be the most effective. This minimized weed competition, improved sugarcane growth, enhanced yield attributes, boosting crop vigour and leading to higher sugarcane yield.

Crop Improvement

- The proposal for identification and release of mid late maturing sugarcane variety CoLk 19204, for its cultivation in North West Zone was submitted to the Varietal Identification Committee of AICRP(S) during 2025. This variety recorded cane yield of 87.33 t/ha and CCS yield of 11.33 t/ha.
- Six sugarcane varieties, *viz*., CoLk 15201, CoLk 15207, CoLk 15466, CoLk 14201, CoLk 15206, and CoLk 16466 have been registered with the Protection of Plant Variety and Farmers' Right Authority, New Delhi, and their Registration Certificates were received in 2025. Four sugarcane varieties, *viz*., CoLk 16202, CoLk 16470, CoLk 09204 and CoLk 14204 were applied for registration in the category of 'Extant and Notified' under the PPVFRA, 2001 for their protection.
- Three early maturing sugarcane clones, *viz*., CoLk 25201, CoLk 25202, and CoLk 25203, and three mid late maturing clones, *viz*., CoLk 25204, CoLk 25205, and CoLk 25206 were accepted for multi-location testing in North West Zone

of India during the AICRP(S) Annual Group Meeting-2025 held at AAU, Jorhat, Assam.

- During the year 8 bi-parental sugarcane crosses were attempted at the National Distant Hybridization Facility, Agali. A total of 23322 seedlings derived from 31 bi-parental crosses and 45 GCs (from the crossing season 2023) were raised and transplanted in the field conditions for their evaluation.
- Under the ICAR-ISMA Collaborative Project for Identification of location-specific sugarcane genotypes, TRIAL-I is being conducted at 16 sugar mill farms of sub-tropical India, and entries of TRIAL-II are being multiplied at respective sugar mills for next year trial.
- A collection of 365 sugarcane genotypes consisting of *Saccharum officinarum*, *S. barberi*, *S. sinense*, ISH clones, Ikshu ISH clones, LG selections, commercial hybrids, 25 somaclonal variants, etc. is being maintained and the required material was supplied to various on going projects of the Institute. The collection includes 183 commercial hybrids, 51 ISH and Ikshu ISH lines, 71 LG clones and 30 species level genotypes.
- Under the population improvement program, the high sugar genotypes tested in the clonal stages recorded a mean value of >19% sucrose in juice in the month of January. Four sugarcane genotypes, *viz*., LG 16522, LG 16608, LG 16579, LG 16567 had >20-21% sucrose in juice in February 2025, with LG 16567 showing moderate resistance to the prevailing red rot pathotypes. The crosses involving LG 15533, LG 14564, LG 08422, LG 07590 exhibited good germination (>50%). The clones, CoLk 21203, CoLk 20203 (early maturing) and CoLk 20205 (mid late maturing) are being tested in the multi-location trials of AICRP (S).
- A total of 180 sugarcane clones including the identified, released and notified varieties from CVRC, varieties released from states and clones from Advanced Varietal Trials of AICRP(S) were maintained as reference collection for the sugarcane DUS Testing. DUS Testing Trial comprising of five sugarcane varieties, *viz*., CoLk 11203, CoLk 11206, CoLk 12207, CoLk 12209 and Co 12029 has been completed, and the certified DUS data of these five varieties along with the reference varieties for the two crop seasons has been submitted to the PPVFRA.
- The proteome of *C. falcatum* was analyzed through nano LC-MS/MS to investigate the abundance of proteins implicated in host penetration during red rot disease. Exclusive abundance of two actin cytoskeleton regulatory complex proteins (A1CD74, and Q4WG58) in infected cane tissue was recorded. Further, the average peptide counts of both the proteins (A1CD74, and Q4WG58) were relatively higher in CFS2 samples, compared to CFS1. The proteome analysis revealed exclusive abundance of two autophagy-related proteins (Q2GYD8, and Q871L5), suggesting their role in inducing pathogenicity during red rot disease.
- Under the ICAR Genome Editing Project, for lignin content modification, *COMT* (caffeic acid/5-hydroxyferulic acid *O*-methyltransferase) gene which is a crucial gene associated with lignin biosynthesis is being targeted. For this a single gRNA sequence from the consensus sequence present commonly in Exon-1 of all the homologues has been designed using PAM motif (NGG) of Cas9 endonuclease, and the construct development is in progress. For sucrose content modification, *ScRAV6* playing a key role in invertase-mediated control of sucrose accumulation is being targeted. Two gRNAs designed for *ScRAV6,* and single and dual guide RNA construct were developed. The transformation in variety CoLk 15207 is under progress.
- For the first time, online booking system of seed cane was started through ISRI website, wherein, >2000 farmers from Uttar Pradesh, Uttarakhand, Haryana, Punjab and Bihar booked their seed requirement in online mode. Each farmer was given 300 single buds of a variety as per their requisition.
- During the year 2024-25, approximately 10150 quintals of seed cane was produced. The variety CoLk 14201 is very much in demand and it has occupied about 1.22 lakh hectares area in Uttar Pradesh. More than 21 lakhs single buds of newly released sugarcane varieties (CoLk 16202 and CoLk 15466) were supplied to the various Cane Development Council through the allotment made by the Cane Commissioner, Govt. of Uttar Pradesh.
- During the autumn season 2024 and spring season of 2025, a total of 12.0 ha area was planted with newly released varieties for seed cane production, and a new variety CoS 18231 included in the seed production for 2024-25. In the crop season 2025-26, the 9740 q sugarcane seed of different varieties is expected to be produced.

- *In vitro* cultures of sugarcane varieties CoLk 14201 (Ikshu 9) and CoLk 15201 (Ikshu 8), CoLk 15207, CoLk 94184 were multiplied through enhanced axillary shoot proliferation using apical shoot explants, and ~ 15000 plantlets transferred to to field conditions, which will be put up in seed chain. Seed material derived from TC plants of sugarcane variety CoLk 14201 were planted in 01 ha area for seed multiplication.
- Under DBT Accredited Test Laboratory, 37965 TC samples were tested, out of which 3955 samples (90 samples of sugarcane, 3860 of banana and 85 of potato) were tested for mother stock virus indexing. 34013 samples (325 sugarcane, 33436 banana, 252 Black Pepper) were tested for genetic fidelity, which equals to quality certification of ~35 million tissue culture plantlets, for which test reports and certificate of quality were issued as per DBT Guidelines.

Crop Protection

- The survey was conducted in farmers' fields as well as different sugar mills of UP and Bihar during 2024- 25. Natural incidence of red rot was from trace incidence to 70% was recorded in variety Co 0238. However, Co 0118 showed red rot infection (1-5%) in Bihar and Uttar Pradesh. The Co 0238 is the major sugarcane variety found highly susceptible (20-40%) to *pokkah boeng* disease of sugarcane. Viral diseases like ScMV and ScBV are common in almost all sugarcane varieties. Incidence of Leaf Fleck disease was higher in CoLk 16202 (up to 50%).
- The incidence of top borer V brood (10-30%) was reported in command areas of Dhampur Sugar Mill, Dhampur, Dwarikeshpuram Sugar Mill, Afzalpur, Cooperative Sugar Mill, Snehroad, Uttam Sugar Mill Ltd., Barkatpur in Co 0238. Pyrilla was the dominant pest, ranging from trace levels to severe outbreaks (50-60 adults/ plant), and particularly in early planted and dense October-sown crops.
- An Artificial Intelligence (AI) based detection system was successfully developed using a large, expert annotated dataset of 18,785 images covering major diseases, insect pests, and physiological disorders. Among the evaluated deep learning models, ResNet-50 achieved the highest validation accuracy (97.12%), and optimized models were prepared for mobile and field deployment, strengthening real-time digital decision support.
- Comprehensive mapping of red rot pathogen (*Colletotrichum falcatum*) virulence across sub tropical India revealed CF13-like dominance, with red rot incidence ranging from 5–70%. Molecular and phenotypic analyses indicated early signs of variability but no major pathotype shift.
- Occurrence of a significant morpho molecular and pathogenic variability among *S. scitamineum* isolates were recorded in India.
- Major sugarcane viruses including Sugarcane streak mosaic virus (SCSMV), Sugarcane bacilliform virus (SCBV), and Sugarcane yellow leaf virus (ScYLV) were characterized by using specific PCR-based diagnostic primers.
- An experiment was conducted to detect and identify the mycotoxins in the juice of wilted and healthy sugarcane (control) variety Co-419 using HPLC. Mycotoxin *Deoxynivalenol* (DON), *Zearalenone* (ZON), *Fusaric acid* mycotoxins were present in the juice extracted from the wilt infected canes caused by *Fusarium sacchari.* No mycotoxin was detected in the healthy sugarcane plant juice.
- 84 and 13 genotypes of sugarcane were screened against red rot 2024-25 by artificial inoculation of two pathotypes CF 08 and CF13 of *Colletotrichum falcatum* at ISRI, Lucknow and ISRI RC Motipur respectively. Out of 84, 36 genotypes *viz.*,LG16567, LG15449, LG21006, LG21038, LG21097, LG21407, LG16548, LG15672, LG15538, LG16644, LG16428, LG21305, LG21226, LG21276, LG21039, LG16490, LG16684, LG16541, LG16593, LG21011, LG21351, LG21324, LG21180, LG21024, LG21329, LG21043, LG2, LG16560, LG15422, LG16674, LG16468, LG21234, LG21395, LG21327, LG21175 and LG21287 were rated as moderately resistance (MR) against both pathotypes CF08 & CF13 at ISRI, Lucknow. Out of 13 genotypes of sugarcane evaluated at ISRI, RC, Motipur, nine genotypes of sugarcane showed moderately resistance against both the pathotypes.
- Technology validation studies confirmed that Azoxystrobin + Difenoconazole-based sett treatment with soil drenching significantly reduced disease incidence (3.03%) and improved yield, while drone based fungicide application proved effective in minimizing secondary spread. Collectively, these initiatives integrate AI, molecular surveillance, and precision agriculture to enhance sustainable sugarcane production and disease management.
- Screening of 30 *Trichoderma* isolates was done against *F. sacchari* to identify the potent, promising and potential biocontrol strains of *Trichoderma*. Dual culture assay showed that 15

Trichoderma harzianum inhibited colony diameter of *F. sacchari* in the range of 12.57-78.56%.

- Total 115 isolates rhizospheric bacteria were isolated from sugarcane varieties Co0238 (28 isolates, CoLk 14201 (31 isolates, CoLK 16202 (19 isolates and CoJ 64 (37 isolates) on nutrient agar and King's B media. Out of 115 rhizobacteria, 8 isolates exhibited < 75.1- 100% inhibition of *Colletotrichum falcatum* CF13 and 2 isolates showed 75.1 - 100% inhibition of *Fusarium sacchari* under *in vitro* conditions.
- The developmental period of *Tetrastichus howardi* on stalk borer (*Chilo auricilius*) pupae remained largely stable (15.7–17.83 days) and was only marginally influenced by host size. In contrast, host pupal weight and length had a strong positive effect on reproductive performance: progeny production increased from ~41 to ~83 adults per pupa, and female emergence rose from ~38 to ~78 per pupa with increasing host size. A consistently female-biased sex ratio (>90%) was recorded across all pupal classes, with male emergence declining as host size increased.
- The integrated module (egg mass removal + parasitoid + chlorantraniliprole) was found most effective, registering the lowest brood-wise incidence (7.0-15.8%) and the highest yield (70.5 t/ha). Treatments combining chlorantraniliprole with *Trichogramma* also provided effective suppression top borer with and higher yield of sugarcane.

Biological Control Centre, Pravaranagar

- Application of *Heterorhabditis indica* + half dose of chlorpyrifos 20% EC + *Metarhizium anisopliae* efficiently reduced grub population (86.29%) and lowest clump mortality (14.51%) compared to *Heterorhabditis indica* (83%, 16.5%) chlorpyrifos 20% EC (61.42%, 25.41%) and *Metarhizium anisopliae* (75.5%, 20.21%) separately. *Heterorhabditis* spp. was found tolerant under different abiotic stresses, *viz.*, temperature, sand column, pH and compatible with insecticides.
- Field efficacy studies of Bacillus thuringiensis IISRBCCEB01 (Bt1), Bacillus thuringiensis IISRBCCEB02 (Bt2) against white grubs' infestation in sugarcane indicated that Bacillus thuringiensis IISRBCCEB02 showed lowest sugarcane clump mortality (53-58.87% reduction over control) than other bioagents and was on par with insecticides such as Acephate 50% + Imidacloprid 01.80% SP and Fipronil 40% + Imidacloprid 40%.
- Bacterial diversity profiling of COM0265 whole cane and billets at 0, 24, 48, and 72 h post-harvest using the metagenomics indicate the high relative abundance of *Enterobacter, Lactococcus, Weissella* than *Leuconostoc*, Lactobacillus, and *Pantoea* and these bacteria were predominantly associated with post-harvest sucrose deterioration in sugarcane. The change in alpha diversity metrices such as Faith PD and Shannon index after 24 h and chao1 richness after 48 h, indicated a strong shift in the bacterial community due to ecological shift and treatment effects.

Plant Physiology & Biochemistry

- The abiotic stresses (drought, salinity and waterlogging) reduced the plant height and cane weight of both the genotypes, A-27-12 and Col 64, however, A-27-12 (tolerant) had relatively less reduction in both the parameters. Similarly photosynthetic rate, stomatal conductance and chlorophyll stability index were also negatively impacted by abiotic stresses: highest reduction in these parameters was observed under drought.
- The activities of antioxidant enzymes *viz*., CAT, POX, APX and SOD were enhanced due to exposure of abiotic stresses: highest increase in activity of these enzymes were observed under drought in both the varieties.
- Partitioning of Si was minimum in root portion of sugarcane at both 90 and 180 DAP. However, S2D2M2 displayed maximum Si content in root in both control and stressed sugarcane (8.57 and 10.3 g kg-1) and minimum in SODOMO (4.10 and 4.67 g kg-1) at 90 DAP.
- HPAC pre-treatment led recovery of about 71.0% cellulose, 18.0% hemicelluloses, and 11.69 % lignin. Notably, 93.5% of the lignin was removed with the pre-treatment with minimum inhibitory compounds development. The optimal conditions for the hydrogen peroxide-acetic acid pre-treatment was 75°C, 2.5 h, and an equal volume mixture of hydrogen peroxide and acetic acid.
- Inhibitors produced during mild HPAC pre-treatment became problematic when pre-treatment temperature was increased to 200°C. Combining low severity HPAC pre-treatment and mechanical refining showed promise for improving ethanol production by integrated bioprocess.
- PGRs led to enhanced NMC ha-1 and cane yield (tha-1). Maximum germination % at 45 DAP was recorded with Ethrel @100 ppm. During the crop cycle, tiller numbers and biomass

accumulation till 270 DAP indicated that maximum improvement in germination and biomass dynamics occurred with Ethrel. Other biometric traits showed similar trends with maximum impact with sett soaking with Ethrel.

- Exogenous application of Ethrel & Gibberellic acid stimulated physiological growth, increased initial plant population and caused internodal elongation.
- The total 25 invertase genes were distributed on 16 different chromosomes representing three out of 10 chromosomes types/ class in sugarcane genome. In silico sequence comparison of these sequences revealed that they can be classified into 4 groups.
- Among significantly expressed gene, a total of 30 transcripts associated with carbohydrate metabolism, environmental adaptation and transcription factor genes were used and primer pairs were designed to validate those using different sets of RNA samples isolated from both the varieties.
- An Illumina based comparative differential transcriptomic analysis was performed using root samples of sugarcane variety: Col 64 subjected to waterlogging (R2) along with untreated control (R1).

Agricultural Engineering

- A tractor operated cane node planter was developed using CAD models for precise single node planting in deep furrows. Field evaluations determined that a round-shaped metering mechanism with an active pushing feature at a speed of 2.5 km/h achieved an 81.0% quality feed index and more than 83.0% germination rate.
- A patented tractor operated trash mulcher-cum-stubble shaver device was refined and field evaluated to reduce trash size and speed up decomposition in ratoon crops. Its performance was recorded excellent for ratoon initiation operations and trash management in sugarcane. The brittleness and trash colour were changed dramatically using ISRI trash decomposer.
- New implements, including a furrower-cum-packer and rotary weeder, were fabricated for CTF, which resulted in sugarcane yields nearly double those of conventionally managed fields. The performance of these newly developed tools was not causing the compaction in root zone of the crop. The sugarcane yields under fields of controlled farming were recorded two-fold increase compared to normal managed field.
- The upgraded sugarcane stripper-cum-detopper features a high-speed steel blade and a fork-type detrasher for efficient, single-pass operation. Performance testing showed average outputs of 90.1–115.5 kg/h, with physiological workloads remaining within acceptable limits.
- UAV based chemical spraying was optimized for height, speed and chemical of spray, offering an efficient alternative to manual knapsack spraying. It was successfully used for fungicide application to manage the spread of red rot, with afternoon sprays showing the highest efficacy. UAV based chemical application reduced water usage by 88–90% and labor costs by up to 86% compared to traditional methods. The institute has developed a comprehensive SOP for drone applications to ensure balanced spray efficacy, coverage, and drift control.
- E-powered tiller-cum-seeder was developed for the small land holding farmers, four-wheeled machine sows seeds at 3–5 cm depths for sugarcane companion in crops. It costs ₹ 32,000, achieving 0.1 ha/h field capacity for smallholders.
- Six tractor operated implements were manufactured for conducting field adaptability trials under various agro-climatic and soil conditions. Three tractor operated machines prototypes supplied to various institutes and farmers in Gujrat.
- An AI-assisted sugarcane bud cutting system was developed for precision sugarcane planting applications. A controlled imaging setup, AI-based node and bud detection model, and stepper motor driven cutting mechanism were designed and validated through bench-level trials, while integration of the alpha prototype is currently under progress.
- Prototype Feasibility Testing (PFT) at the ISRI farm demonstrated that the automatic potato-cum-sugarcane trench planter achieved an effective field capacity of 0.127 ha/h. Mechanization reduced planting costs by more than 74 % and labor requirements by 90%. PFT of drone-based herbicide spraying achieved a 90% reduction in water usage, requiring only 45–50 L/ha compared to 450–500 L/ha for manual methods. UAV systems operated 11 times faster than manual spraying, reducing labor costs by 85-87%.
- Modified sugarcane planters and ratoon management devices were demonstrated at

farmer's field of Hardoi and Lakhimpur Khiri on over 46.2 hectares across several districts, showing cost savings of 60–70%.

- An induction based jaggery making system was developed under AICRP on PHET for controlled and energy-efficient jaggery production. A 15-kW induction system with 50-liter operational capacity was finalized, and process temperature mapping identified 80–85°C for clarification and 118–125°C for concentration. CAD-based SS-304 vessel design and programmable temperature control architecture were also completed.
- Entrepreneurship and technology dissemination activities were promoted through the Agri-Business Incubation Center at ICAR–Indian Sugarcane Research Institute, Lucknow. During the reporting period, 03 entrepreneurs were incubated, 02 entrepreneurs graduated and initiated business operations, 05 awareness programmes were organized, and 02 value-added jaggery products along with 01 low-cost bagasse dryer technology were developed.
- Training, demonstration, and awareness programmes on jaggery production, value addition, sugarcane processing, and agri-entrepreneurship were organized for farmers, students, entrepreneurs, and officials. During the reporting period, 15 training and exposure programmes were conducted benefiting more than 450 participants, including farmers, farm women, students, and industry stakeholders from different states of India.

Agricultural Knowledge Management Unit (AKMU)

- Organic sugarcane production in Mandya district of Karnataka was profitable than conventional sugarcane cultivation. The farmers reap higher net returns due to premium prices for organic quality jaggery products, despite of low sugarcane yields. It has less cost of production, because low expenses on fertilizers and chemicals. The economic viability and net profitability of organic farms dependent on producer's ability to market jaggery products through super market, malls, FPOs or direct online marketing through electronic platforms at a premium. It needs awareness campaigns and consumers' support to the jaggery value added quality products
- The cost of sugarcane production in conventional method was higher (₹ 2,64,788/ ha) as compared to organic method (₹ 2,19,094/ha). The average productivity was 122.65 tons/ha and 98.58 tons/ha in conventional and organic method respectively. The net returns from organic sugarcane production was ₹ 1,99,871/ha as compared to ₹ 1,58,355/ha in conventional method. The farmers fetch 18-25% higher price from the organic jaggery making units and sugarcane juice venders. The sugar mills are not promoting organic sugarcane in its command area as the farmers adopted organic farming are not willing to supply it sugarcane to the sugar mill.
- The analysis of sugarcane intensiveness in area and productivity reveals that the high intensive sugarcane growing districts in UP had experience positive growth in area and productivity. However, the main sugarcane growing tropical states of Maharashtra and Karnataka have positive growth in area only. All the three leading sugarcane states including Tamil Nadu had observed decline trends in sugar productivity
- The sugarcane cost of cultivation in U.P. for crop year 2025-26 was estimated on the basis of primary data collected from 60 farmers from 6 districts (Three districts each from Western and Central Region) by using Participatory Rural Appraisal (PRA) techniques. The cost of cultivation for plant and ratoon crop was ₹ 3470 and ₹ 3180 per ton, respectively. The average cost of sugarcane cultivation was ₹ 3340 per ton. The average sugarcane productivity was 80.5 ton/ha and cost of production on Cost A_2+FL and Cost C_2 was ₹ 228308 and ₹ 268870 per ha respectively.
- The average sugarcane productivity in U.P. during 2025-26 declined due to wide spread red rot diseases in variety Co 0238 in western U.P. The area of variety Co 0238 in U.P. has also declined from 42.9 to 29.2 as compared to past year
- Field trial of 24 early and mid late sugarcane varieties recommended for Subtropical India conducted in two replications. Varieties undertaken in early group were CoLk 14201, CoLk 15466, CoLk 11203, CoS 17231, CoLk 9709, CoLk 16202, CoLk 15201, CoS 13235, Co 0118, CoLk 94184, CoLk 12207, Co 0238 while in mid-late group were CoS767, CoS 08279, CoLk 09204, CoLk 11206, CoLk 15207, Co 05011, CoPant 97222, CoLk 12209, CoLk 14204, CoLk 15206, CoLk 16030, CoPb 14185. The activities were performed to study sugarcane maturity based on HSV data of sugarcane crop images collected along with brix @ 10-15 days intervals and analyzed the data to get HSV and Hue frequency of images at above interval

ISRI Regional Centre, Motipur

- During the calendar year 2025, ICAR-ISRI Regional Centre, Motipur achieved significant progress in sugarcane varietal development and seed production for the North Central Zone (NCZ). Focused breeding efforts led to the advancement of six elite clones—three early and three mid-late—to Zonal Varietal Trials under AICRP (Sugarcane). These clones exhibited superior cane and CCS yield, improved sucrose content, and moderate resistance to red rot, strengthening the varietal pipeline for the region.
- The center successfully conducted all assigned AICRP trials with timely planting, proper ratoon management, and adherence to recommended agronomic practices. Monitoring visits appreciated the overall crop health and trial management.
- Under the Breeder Seed Production Programme implemented in collaboration with the Sugarcane Industries Department, Government of Bihar, more than 18,300 quintals of breeder seed were produced despite challenges posed by irregular rainfall and prolonged waterlogging.
- Outreach trials on advanced sugarcane clones under waterlogging conditions were conducted during 2025–26 at TSL, Bagaha; HSM, Harinagar and NSSM, Narkatiyaganj. CoLk 16468 and CoLk 15466 emerged as superior clones with high juice quality and recovery, while CoLk 20466 recorded higher brix (19.93%), purity (89.18%) and recovery (10.64%). CoLk 20468 also showed stable performance under flood-prone conditions of North Bihar.

Sugar beet Breeding Outpost, Mukteshwar

- A total of 149 germplasm accessions were maintained through systematic regeneration and cold storage preservation. Fresh seed production of 49 varieties/genotypes was completed with total seed yield exceeding 22 kg. Indigenous varieties LS 6 and IISR Comp 1 were multiplied for national supply. Multi location trials confirmed the broad adaptability of selected genotypes across eastern, northern, and semi-arid regions of India.
- Extensive screening of 48 sugar beet genotypes under field conditions identified valuable resistance sources against major pests and diseases. Genotypes SYT/06/10, L 33, and LKC 2000 exhibited strong resistance against *Spodoptera litura* and important root rot pathogens, providing critical genetic resources for future resistance breeding programmes.
- Under irrigated and drought conditions, indigenous genotypes displayed remarkable adaptability and stability. LKC 2006 recorded superior root weight and maintained high sucrose and purity under water-limiting environments, while LKC 95 demonstrated exceptional drought resilience with sustained sugar recovery traits.
- The programme successfully validated sugar beet–sugarcane intercropping systems across multiple factory command areas in Uttar Pradesh for enhanced land-use efficiency and farmer income. Yields up to 55-60 t/ha and sucrose levels up to 17% confirmed the feasibility of integrating sugar beet into existing sugarcane production systems, offering additional income opportunities to farmers and supplementary raw material for sugar industries during the crushing season.
- The All India Coordinated Research Project (AICRP) on Forage Crops focuses on the Initial Varietal Trial (IVT) in sugar beet. The programme aims to evaluate the performance, adaptability, and fodder potential of sugar beet genotypes across diverse agro-climatic regions of India. The trial includes 10 germplasm with two checks (LS 6 and IISR Comp 1) in Randomized Block Design (RBD) with three replications across multiple locations representing hill, north-western, north-eastern, central, and southern zones. The trials are expected to generate valuable data on growth, adaptability, and fodder yield of sugar beet genotypes. The data generated during Rabi 2025–26 will be compiled and evaluated next year for identification of promising and stable entries suitable for advancement and regional recommendation.

AICRP on Sugarcane

- Under crop improvement programmes, 450 parental clones were planted in the National Hybridization Garden, with 382 clones flowering (84.89% flowering intensity). ICAR–SBI, Coimbatore also supplied fluff to 22 participating centres.
- A climate-smart pre-breeding initiative supplied 44 crosses (26 red rot–resistant and 18 drought-tolerant) to collaborating centres. During 2024–25, two varieties were released nationally by the CVRC and nine more by SVRCs for state-level commercial cultivation.
- Multi-location trials showed that higher Recommended Dose of Fertilizer (RDF) significantly increased cane yield in the North

West and Peninsular Zones, while the East Coast Zone showed little response. Pre-monsoon moisture stress caused 5–35% yield loss, though good rainfall later supported compensatory growth.

- Liquid nano urea performed comparably to granular urea across several centres, with notable benefits at Kolhapur and in the acidic soils of Nayagarh. Use of microbial consortia improved yields and enabled up to 25% reduction in nitrogen fertilizer use at some locations.
- Weed management studies revealed severe yield losses (15–75%) under uncontrolled weed conditions, whereas pre- and post-emergence herbicides provided effective weed control and higher economic returns.
- The Plant Pathology programme involved 16 centres under eight projects, where 135 new red rot isolates were characterized, with indications of emerging pathotypes in the Peninsular Zone.
- Zonal varietal trials identified several resistant or moderately resistant entries against major sugarcane diseases such as red rot, smut, wilt, YLD, brown rust, and Pokkah boeng.
- Disease surveillance revealed region-specific vulnerabilities, especially red rot and wilt in subtropical India and foliar diseases in Kerala, while tissue culture–based management strategies for YLD remained effective across zones.
- The Entomology discipline conducted nine projects across 12 centres, where genotype screening identified entries showing tolerance/susceptibility reactions to major pests such as early shoot borer, internode borer, and mealy bugs. Pest surveys found most infestations manageable, except isolated severe top borer outbreaks, while emerging pests like *Phenococcus saccharifolii* and spiralling whitefly were also reported.
- Improved bio-agent mass multiplication techniques enhanced the production efficiency of agents like *Tetrastichus howardi* and *Telenomus dignus*. White grub management trials reduced grub incidence by up to 53%, and integrated pest-management approaches significantly improved cane yield and quality.
- Four sugarcane varieties—CoS 17231 (Bismil), CoH 17261 (CoH 179), Co 18022 (Karan-18), and CoPb 18213 (CoPb 100)—were released and notified by the CVRC in 2025 for the North West Zone; these early to mid-late maturing, high-yielding varieties showed good sucrose and CCS performance, resistance/moderate resistance to red rot and smut, lower susceptibility to major insect pests, tolerance to drought and salinity (in some varieties), and were recommended for irrigated conditions.
- Eight sugarcane varieties—Co 09004 (Amritha), Co 18003 (Aroh), CoP 18437 (Rajendra Ganna-3), Co 19017 (Karan-19), CoPb 19182 (CoPb 101), CoLk 19204 (Ikshu-18), CoS 19235 (Shekhar), and CoA 20322 (2014A 142)—were identified by AICRP(S) for release and notification across the East Coast, Peninsular, North Central & North Eastern, and North West Zones; these varieties are early to mid-late maturing, high-yielding with good sucrose and CCS content, and generally showed resistance/moderate resistance to red rot and smut along with lower susceptibility to major insect pests.

कार्यकारी सारांश

फसल उत्पादन

- विभिन्न सिंचाई व्यवस्थाओं और सिंचाई के तरीकों ने गन्ने की पेड़ी (रैटुन) फसल के विकास को गन्ने कि कल्ले (टिलर) की संख्या, मिल योग्य गन्ना एनएमसी (NMC), औसत गन्ने के वजन और गन्ने की लंबाई को महत्वपूर्ण रूप से प्रभावित किया। सबसे अधिक पेड़ी उपज, आईडब्ल्यू : सीपीई अनुपात 1.0 (101.71 टन/हेक्टेयर) वाली सिंचाई व्यवस्था के तहत प्राप्त की गई, जो आंकड़ो के हिसाब से आईडब्ल्यू : सीपीई अनुपात 0.8 (99.54 टन/हेक्टेयर) वाली सिंचाई व्यवस्था के बराबर थी।
- पेड़ी फसल में एक खाई (ट्रेंच) छोड़कर सिंचाई करने से, गन्ने की उपज में बाढ़ (फ्लड) सिंचाई या खाई (ट्रेंच) सिंचाई की तुलना में कमी (89.77 टन/हेक्टेयर) आई।
- पेड़ी फसल में उच्चतम सिंचाई जल उत्पादकता, आईडब्ल्यू : सीपीई 0.8 के अनुपात (73.87 लीटर/किग्रा) वाले सिंचाई व्यवस्था में पाई गई, उसके बाद आईडब्ल्यू : सीपीई 0.6 का (76.42 लीटर/किग्रा) दर्ज किया गया। सिंचाई के तरीकों में, मल्चिंग के साथ स्किप ट्रेंच सिंचाई में सबसे अच्छी पानी की उत्पादकता (74.99 लीटर/किग्रा) दर्ज की गई, उसके बाद मल्चिंग के तहत ट्रेंच की सिंचाई (75.12 लीटर/किग्रा) का स्थान रहा।
- गन्ने की तीसरी पेड़ी फसल का जल पदचिह्न (वाटर फुटप्रिंट) 104.92 और 127.39 लीटर/किग्रा के बीच रहा। हरे, नीले और भूरे घटकों के बीच विभाजन से पता चला कि तीसरी पेड़ी फसल को 65% से अधिक योगदान वर्षा से मिलता है और यह अपनी फसल की पानी की आवश्यकताओं के लिए केवल 25 - 30% ही सिंचाई पर निर्भर रहता है।
- सिलिकेट घोलने वाले बैक्टीरिया (*सिलिकेट सॉलुबिलाइजिंग बैक्टीरिया*) का 3 लीटर/हेक्टेयर की दर से प्रयोग करने पर बवाक और गन्ने की पेड़ी के उपज पर अच्छा प्रभाव देखा गया। चाहे इसे अकेले या सिलिकॉन की अलग-अलग डोज़ और सोर्स के साथ मिलाकर इस्तेमाल किया गया हो।
- बवाक गन्ने की उपज में आरडीएफ़$_0$ (दोनों सी$_1$ और सी$_2$ प्रणाली की औसत उपज 59.19 टन प्रति हेक्टेयर) की तुलना में एनएफ़$_1$, एनएफ़$_2$ और आरडीएफ़$_1$ के साथ क्रमशः 45.25, 56.34 और 60.52 प्रतिशत की वृद्धि हुई। आरडीएफ़$_1$ के साथ अधिकतम गन्ना उपज 95.01 टन प्रति हेक्टेयर दर्ज की गई, जो एनएफ़$_2$ (92.54 टन प्रति हेक्टेयर) के समकक्ष थी, इसके बाद एनएफ़$_1$ (85.97 टन प्रति हेक्टेयर) का स्थान रहा। मटर की अधिकतम सब्जी उपज एनएफ़$_2$ के साथ दर्ज की गई, उसके बाद एनएफ़$_1$ और आरडीएफ़$_1$ का स्थान रहा।
- गन्ने की पेड़ी की उपज में आरडीएफ़$_0$ (दोनों सी$_1$ और सी$_2$ प्रणाली की औसत उपज 44.94 टन प्रति हेक्टेयर) की तुलना में एनएफ़$_1$, एनएफ़$_2$ और आरडीएफ़$_1$ के साथ क्रमशः 61.56, 68.34 और 78.60 प्रतिशत की वृद्धि हुई। आरडीएफ़$_1$ के साथ अधिकतम गन्ना उपज 80.27 टन प्रति हेक्टेयर दर्ज की गई, जो एनएफ़$_2$ (75.65 टन प्रति हेक्टेयर) के समकक्ष थी, इसके बाद एनएफ़$_1$ (72.61 टन प्रति हेक्टेयर) का स्थान रहा। मटर की अधिकतम सब्जी उपज एनएफ़$_2$ के साथ दर्ज की गई, उसके बाद एनएफ़$_1$ और आरडीएफ़$_1$ का स्थान रहा।
- आंकड़ों से पता चला है कि तीसरी पेड़ी में 15 फरवरी को शुरू की गई गन्ने की पेड़ी फसल में अधिकतम अंकुरण, कल्ले (टिलर), मिल योग्य गन्नों की संख्या, गन्ने की लंबाई, गन्ने का व्यास, गन्ने की उपज और व्यावसायिक गन्ना चीनी (सीसीएस) दर्ज की गई। 15 फरवरी को शुरू की गई पेड़ी, पिछले वर्ष के 15 दिसंबर को शुरू की गई पेड़ी की तुलना में सभी विकास और उपज मानदंडों में काफी बेहतर थी। उप-खंड (सब-प्लॉट) उपचारों में, सभी उपचारों ने नियंत्रण (कंट्रोल) की तुलना में मिल योग्य गन्नों की संख्या (एनएमसी) के उत्पादन, गन्ने की उपज और व्यावसायिक गन्ना चीनी (सीसीएस) टन/हेक्टेयर पर महत्वपूर्ण रूप से श्रेष्ठ परिणाम दर्ज किए।
- 15 फरवरी को शुरू की गई पेड़ी, पिछले वर्ष के 15 दिसंबर को शुरू की गई पेड़ी की तुलना में सभी विकास और उपज मानदंडों में काफी बेहतर थी। उप-खंड (सब-प्लॉट) उपचारों में, सभी उपचारों ने नियंत्रण (कंट्रोल) की तुलना में मिल योग्य गन्नों की संख्या (एनएमसी) के उत्पादन, गन्ने की उपज और व्यावसायिक गन्ना चीनी (सीसीएस) टन/हेक्टेयर पर महत्वपूर्ण रूप से काफी बेहतर प्रदर्शन किया। तीसरी पेड़ी (57.61 टन प्रति हेक्टेयर) में पिछले वर्ष जनवरी में शुरू की गई पेड़ी की तुलना में फरवरी में शुरू की गई पेड़ी से गन्ने की उपज में 27.28 प्रतिशत की वृद्धि हुई।
- गन्ने में *साइपेरस रोटंडस एल.* (मोथा घास) के प्रबंधन के लिए दीर्घकालिक रणनीतियों के तहत, स्टेल सीडबेड की तैयारी, मल्चिंग के साथ अंकुरण-पूर्व *सल्फेन्ट्रोज़ोन*, और अंकुरण-पश्चात हैलोसल्फ्यूरॉन + 2,4-डी के अनुप्रयोग को मिलाने वाला एकीकृत खरपतवार प्रबंधन (*आईडब्ल्यूएम*) सबसे प्रभावी पाया गया। इससे खरपतवार की प्रतिस्पर्धा कम हुई, गन्ने के विकास में सुधार हुआ, उपज के गुणों में वृद्धि हुई, फसल की ताकत बढ़ी जिससे गन्ने की अधिक उपज प्राप्त हुई।

फसल सुधार

- उत्तर पश्चिम क्षेत्र में खेती के लिए मध्यम देर से पकने वाली गन्ने की किस्म कोलक 19204 की पहचान और रिलीज का प्रस्ताव वर्ष 2025 के दौरान अखिल भारतीय

समन्वित गन्ना अनुसंधान परियोजना की वैरिएटल आइडेंटिफिकेशन कमेटी को भेजा गया। इस किस्म ने 87.33 टन/हेक्टेयर गन्ने की उपज और 11.33 टन/हेक्टेयर व्यावसायिक गन्ना चीनी (सीसीएस) उपज दर्ज की।

- गन्ने की छह किस्मों, जैसे कि कोलख 15201, कोलख 15207, कोलख 15466, कोलख 14201, कोलख 15206, और कोलख16466 को पौधा किस्म और कृषक अधिकार संरक्षण प्राधिकरण (पीपीवीएफ़आरए), नई दिल्ली के पास पंजीकरण के लिए भेजा गया था, जिसका पंजीकरण प्रमाण पत्र 2025 में प्राप्त हुआ। गन्ने की चार किस्मों, कोलख 16202, कोलख16470, कोलख 09204 और कोलख 14204 को उनके संरक्षण के लिए पीपीवीएफ़आरए, 2001 के तहत 'विद्यमान और अधिसूचित' (इक्सटेंट एंड नोटिफाइड) श्रेणी में पंजीकरण के लिए आवेदन किया गया था।
- शीघ्र पकने वाले गन्ने के तीन क्लोन कोलख 25201, कोलख 25202 और कोलख 25203 और मध्यम देर से पकने वाले तीन क्लोन कोलख 25204, कोलख25205 और कोलख 25206 को असम कृषि विश्वविद्यालय, जोरहाट, असम में आयोजित अखिल भारतीय समन्वित गन्ना अनुसंधान परियोजना वार्षिक समूह बैठक-2025 के दौरान भारत के उत्तर पश्चिम क्षेत्र में बहु-स्थान परीक्षण के लिए स्वीकार किया गया।
- क्रॉसिंग सीज़न 2024 के दौरान कोयंबटूर के नेशनल हाइब्रिडाइज़ेशन गार्डन में कुल 36 बाई-पैरेंटल गन्ने के क्रॉस किए गए। इसके अलावा, अगली में नेशनल डिस्टेंट हाइब्रिडाइज़ेशन फैसिलिटी में 8 बाई-पैरेंटल गन्ने के क्रॉस करने की कोशिश की गई । 31 बाई-पैरेंटल क्रॉस और 45 जीसी$_{\text{एस}}$ (क्रॉसिंग सीज़न 2023) से मिले कुल 23322 पौधों को उगाया गया और उनके मूल्यांकन के लिए खेत में प्रत्यारोपित किया गया।
- स्थान-विशिष्ट गन्ना जीन प्ररूप की पहचान के लिए आईसीएआर –आईएसएमए सहयोगात्मक परियोजना के तहत, उप-ऊष्णकटिबंधीय भारत के 16 चीनी मिल प्रक्षेत्र में परीक्षण-1 आयोजित किया जा रहा है, और परीक्षण-2 की प्रविष्टियों को अगले वर्ष के परीक्षण के लिए संबंधित चीनी मिलों में बढ़ाया (मल्टीप्लाई किया) जा रहा है।
- 365 गन्ना जीन प्रारूप (जीनोटाइप) का एक संग्रह जिसमें *सैकरम ऑफिसिनेरम, एस. बार्बेरी, एस. साइनेन्स*, आईएसएच क्लोन, इक्षु आईएसएच क्लोन, एलजी चयन, वाणिज्यिक संकर (कमर्शियल हाइब्रिड), 25 सोमाक्लोनल वेरिएंट आदि का रखरखाव किया जा रहा है और संस्थान में चल रही विभिन्न परियोजनाओं को आवश्यक सामग्री की आपूर्ति की गई। संग्रह में 183 वाणिज्यिक संकर (कमर्शियल हाइब्रिड), 51 आईएसएच और इक्षु आईएसएच लाइनें, 71एलजी क्लोन और 30 प्रजाति स्तर के जीन प्ररूप (जीनोटाइप) शामिल हैं।
- जनसंख्या सुधार कार्यक्रम के तहत, क्लोनल चरणों में परीक्षित उच्च चीनी वाले जीन प्रारूप (जीनोटाइप) ने जनवरी के महीने के जूस में >19% सुक्रोज का औसत मान दर्ज किया। गन्ने के चार जीन प्रारूप (जीनोटाइप) एलजी 16522, एलजी 16608, एलजी 16579, एलजी16567 के फरवरी 2025 के जूस में >20-21% सुक्रोज था, जिसमें एलजी 16567 ने प्रचलित लाल सड़न (रेड रॉट) रोगजनकों के प्रति मध्यम प्रतिरोध दिखाया। एलजी 15533, एलजी14564, एलजी 08422, एलजी07590 से जुड़े क्रॉस ने अच्छा अंकुरण (>50%) प्रदर्शित किया। क्लोन कोलक 21203, कोलख20203 (जल्दी पकने वाले) और कोलख 20205 (मध्यम देर से पकने वाले) का अखिल भारतीय समन्वित गन्ना अनुसंधान परियोजना के बहु-स्थान परीक्षणों में परीक्षण किया जा रहा है।
- गन्ने के डीयूएस परीक्षण के लिए संदर्भ संग्रह के रूप में सीवीआरसी से पहचाने गए, जारी और अधिसूचित किस्मों, राज्यों से जारी किस्मों और अखिल भारतीय समन्वित गन्ना अनुसंधान परियोजना के उन्नत किस्म परीक्षणों के क्लोन सहित कुल 180 गन्ना क्लोन का रखरखाव किया गया। गन्ने की पांच किस्मों कोलख 11203, कोलख 11206, कोलख 12207, कोलख 12209 और को 12029 का डीयूएस परीक्षण पूरा हो चुका है, और दो फसल सीजन के लिए संदर्भ किस्मों के साथ इन पांच किस्मों के प्रमाणित डीयूएस आंकड़े पौधा किस्म और कृषक अधिकार संरक्षण प्राधिकरण (पीपीवीएफ़आरए), नई दिल्ली को दे दिया गया है।
- लाल सड़न रोग के संक्रमण के दौरान मेजबान में प्रवेश में शामिल प्रोटीन की प्रचुरता की जांच करने के लिए नैनो एलसी- एमएस/ एमएस के माध्यम से *सी. फाल्केटम* के प्रोटिओम का विश्लेषण किया गया। संक्रमित गन्ने के ऊतकों में दो एक्टिन साइटोस्केलेटन नियामक जटिल प्रोटीन (ए1सीडी74 और क्यू4डबल्यूजी58) की खास मात्रा रिकॉर्ड की गई। इसके अलावा, दोनों प्रोटीनों (ए1सीडी74 और क्यू4डबल्यूजी58) की औसत पेप्टाइड संख्या सीएफ़एस1 की तुलना में सीएफ़एस2 नमूनों में अपेक्षाकृत अधिक थी। प्रोटिओम विश्लेषण से दो ऑटोफैगी-संबंधित प्रोटीन (क्यू2जीवाईडी8, और क्यू87एल5) की खास मात्रा का पता चला, जिससे रेड रॉट बीमारी के दौरान पैथोजेनिसिटी पैदा करने में उनके योगदान का पता चलता है।
- भाकृअनुप जीनोम संपादन (जीनोम एडिटिंग) परियोजना के तहत, लिग्निन सामग्री संशोधन के लिए, सीओएमटी (कैफिक एसिड/5-हाइड्रॉक्सीफेरुलिक एसिड ओ-मिथाइलट्रांसफेरेज़) जीन को लक्षित किया जा रहा है, जो लिग्निन जैवसंश्लेषण से जुड़ा एक महत्वपूर्ण जीन है। इसके लिए सीएएस 9 एंडोन्यूक्लिअस के पीएएम मोटिफ (एनजीजी) का उपयोग करके सभी होमोलॉग्स के एक्सॉन-1 में सामान्य रूप से मौजूद कंसेंसस सीक्वेंस से एक एकल जीआरएनए (gRNA)

अनुक्रम डिजाइन किया गया है, और कंस्ट्रक्ट विकास प्रगति पर है। सुक्रोज सामग्री संशोधन के लिए, सुक्रोज संचय के इनवर्टेज-मध्यस्थता नियंत्रण में महत्वपूर्ण भूमिका निभाने वाले *एससीआरएवी6* (*ScRAV6*) को लक्षित किया जा रहा है। *एससीआरएवी6* (*ScRAV6*) के लिए दो जीआरएनए (gRNA) डिज़ाइन किए गए, और सिंगल और डुअल गाइड (RNA) कंस्ट्रक्ट विकसित किए गए। किस्म कोलक 15207 में स्थानांतरण (ट्रांसफॉर्मेश्न) की प्रक्रिया चल रही है।

- पहली बार, आईएसआरआई वेबसाइट के माध्यम से बीज गन्ने की ऑनलाइन बुकिंग प्रणाली शुरू की गई, जिसमें उत्तर प्रदेश, उत्तराखंड, हरियाणा, पंजाब और बिहार के >2000 किसानों ने ऑनलाइन मोड में अपनी बीज की आवश्यकता बुक की। प्रत्येक किसान को उनकी मांग के अनुसार एक किस्म की 300 एकल कलियाँ (सिंगल बड्स) दी गईं।
- वर्ष 2024-25 के दौरान लगभग 10150 क्विंटल बीज गन्ने का उत्पादन किया गया। किस्म कोलख 14201 की बहुत अधिक मांग है और इसने उत्तर प्रदेश में लगभग 1.22 लाख हेक्टेयर क्षेत्र को कवर किया है। उत्तर प्रदेश सरकार के गन्ना आयुक्त द्वारा किए गए आवंटन के माध्यम से विभिन्न गन्ना विकास परिषदों को गन्ने की नवीनतम किस्मों (कोलख 16202 और कोलख 15466) की 21 लाख से अधिक एकल कलियों की आपूर्ति की गई।
- शरद ऋतु सीजन 2024 और वसंत सीजन 2025 के दौरान, बीज गन्ना उत्पादन के लिए नई जारी किस्मों के साथ कुल 12.0 हेक्टेयर क्षेत्र लगाया गया था, और 2024-25 के लिए बीज उत्पादन में एक नई किस्म कोएस 18231 को शामिल किया गया। फसल सीजन 2025-26 में विभिन्न किस्मों के 9740 क्विंटल गन्ना बीज का उत्पादन होने की संभावना है।
- गन्ने की किस्मों कोलख 14201 (इक्षु 9), कोलख 15201 (इक्षु 8), कोलख 15207 कोलक और 94184 के *इन विट्रो* (In vitro) कल्चर को एपिकल शूट एक्सप्लांट का उपयोग करके संवर्धित एक्सिलरी शूट प्रोलिफरेशन के माध्यम से बहुगुणन किया गया, और लगभग 15000 पौधों को खेतों की स्थितियों में स्थानांतरित किया गया, जिन्हें बीज श्रृंखला में रखा जाएगा। गन्ने की किस्म कोलक 14201 के टीसी (टिशू कल्चर) पौधों से प्राप्त बीज सामग्री को बीज गुणन के लिए 01 हेक्टेयर क्षेत्र में लगाया गया।
- डीबीटी (DBT) मान्यता प्राप्त परीक्षण प्रयोगशाला (एक्रैडिटेड टेस्ट लैबोरेटरी) के तहत, 37965 टीसी नमूनों का परीक्षण किया गया, जिनमें से 3955 नमूनों (गन्ने के 90 नमूने, केले के 3860 और आलू के 85 नमूने) का मदर स्टॉक वायरस इंडेक्सिंग के लिए परीक्षण किया गया था। 34013 नमूनों (325 गन्ना, 33436 केला, 252 काली मिर्च) का आनुवंशिक निष्ठा (जेनेटिक फिडेलिटी) के लिए परीक्षण किया गया, जो ~35 मिलियन टिशू कल्चर पौधों के गुणवत्ता प्रमाणीकरण के बराबर है, जिसके लिए DBT दिशानिर्देशों के अनुसार परीक्षण रिपोर्ट और गुणवत्ता प्रमाणपत्र जारी किए गए।

फसल सुरक्षा

- वर्ष 2024-25 के दौरान उत्तर प्रदेश और बिहार के विभिन्न चीनी मिलों के साथ-साथ किसानों के खेतों में सर्वेक्षण किया गया। किस्म को 0238 में लाल सड़न रोग की प्राकृतिक घटना सूक्ष्म स्तर से लेकर 70% तक दर्ज की गई। हालांकि, को 0118किस्म ने बिहार और उत्तर प्रदेश में लाल सड़न संक्रमण (1-5%) दिखाया। को. 0238 प्रमुख गन्ना किस्म है जो गन्ने के *पोक्का बोइंग* (pokkah boeng) रोग के प्रति अत्यधिक संवेदनशील (20-40%) पाई गई। ScMV और ScBV जैसी वायरल बीमारियां लगभग सभी गन्ने की किस्मों में आम हैं। लीफ फ्लेक रोग की घटना कोलख 16202 में अधिक (50% तक) थी।
- धामपुर शुगर मिल, धामपुर; द्वारिकेशपुरम शुगर मिल, अफ़ज़लपुर; सहकारी शुगर मिल, स्नेहरोड; उत्तम शुगर मिल लिमिटेड, बरकतपुर के कमान क्षेत्रों में को 0238 में टॉप बोरर पंचवा ब्रूड (10-30%) का प्रकोप दर्ज किया गया था। पायरिला प्रमुख कीट था, जिसका सूक्ष्म स्तर से लेकर गंभीर प्रकोप (50-60 वयस्क/पौधा) तक देखा गया, और विशेषकर जल्दी बोई गई और अक्टूबर में बोई गई घनी फसलों में पाया गया।
- प्रमुख बीमारियों, कीटों और शारीरिक विकारों को चित्रित करने वाले 18,785 इमेज के एक बड़े, एक्सपर्ट-एनोटेटेड डेटासेट का इस्तेमाल करके एक आर्टिफिशियल इंटेलिजेंस (AI) आधारित पहचान प्रणाली सफलतापूर्वक विकसित की गई। मूल्यांकन किए गए डीप लर्निंग मॉडल में, ResNet-50 ने उच्चतम सत्यापन सटीकता (97.12%) हासिल की, और मोबाइल और फील्ड परिनियोजन (डिप्लॉयमेंट) के लिए अनुकूलित मॉडल (ऑप्टिमाइज़्ड मॉडल्स) तैयार किए गए, जिससे रियल-टाइम डिजिटल डिसीजन सपोर्ट मजबूत हुआ।
- उप-ऊष्णकटिबंधीय भारत में लाल सड़न रोगजनक (*कोलेटोट्राइकम फाल्कैटम*) की उग्रता के व्यापक मानचित्रण से CF13 जैसा असर दिखा, जिसमें लाल सड़न का असर 5-70% के बीच रही। आणविक और फेनोटाइपिक विश्लेषणों ने परिवर्तनशीलता के शुरुआती संकेतों का संकेत दिया लेकिन कोई बड़ा पैथोटाइप बदलाव नहीं देखा गया।
- भारत में *एस. स्किटामिनियम आइसोलेट्स* के बीच एक महत्वपूर्ण मॉर्फो -मॉलिक्यूलर और रोगजनक परिवर्तनशीलता की घटना दर्ज की गई।
- विशिष्ट पीसीआर-आधारित डायग्नोस्टिक प्राइमरों का उपयोग करके प्रमुख गन्ना वायरस जिसमें गन्ना स्ट्रीक मोज़ेक वायरस (SCSMV), गन्ना बैसिलीफॉर्म वायरस (SCBV), और गन्ना पीली पत्ती वायरस (ScYLV) की पहचान की गई।

- एचपीएलसी (HPLC) का उपयोग करके मुरझाए हुए और स्वस्थ गन्ने (कंट्रोल) की किस्म को -419 के रस में मायकोटॉक्सिन का पता लगाने और उनकी पहचान करने के लिए एक प्रयोग किया गया था। *फ्युसेरियम सैकेरी* (*Fusarium sacchari*) के कारण विल्ट (मुरझान) से संक्रमित गन्नों से निकाले गए रस में मायकोटॉक्सिन *डीऑक्सीनिवालेनॉल* (DON), *ज़ेरालेनोन* (ZON), *फ्यूसेरिक एसिड मायकोटॉक्सिन* मौजूद थे। स्वस्थ गन्ने के पौधे के रस में कोई मायकोटॉक्सिन नहीं पाया गया।
- आईएसआरआई, लखनऊ और आईएसआरआई, आरसी मोतीपुर में *कोलेटोट्राइकम फाल्कैटम* के दो पैथोटाइप सीएफ 08 और सीएफ 13 के कृत्रिम टीकाकरण द्वारा लाल सड़न 2024-25 के खिलाफ क्रमशः 84 और 13 जीन प्रारूपों की जांच की गई। 84 में से 36 जीन प्रारूप एलजी16567, एलजी15449, एलजी21006, एलजी21038, एलजी21097, एलजी21407, एलजी16548, एलजी15672, एलजी15538, एलजी16644, एलजी16428, एलजी21305, एलजी21226, एलजी21276, एलजी21039, एलजी16490, एलजी16684, एलजी16541, एलजी16593, एलजी21011, एलजी21351, एलजी21324, एलजी21180, एलजी21024, एलजी21329, एलजी21043, एलजी2, एलजी16560, एलजी15422, एलजी16674, एलजी16468, एलजी21234, एलजी21395, एलजी21327, एलजी21175 और एलजी21287 को आईएसआरआई, लखनऊ में दोनों पैथोटाइप सीएफ़ 08 और सीएफ़ 13 के खिलाफ मध्यम प्रतिरोधी (MR) के रूप में मूल्यांकित किया गया। आईएसआरआई, आरसी, मोतीपुर में मूल्यांकित गन्ने के 13 जीन प्रारूप में से नौ जीन प्रारूप ने दोनों पैथोटाइप के खिलाफ मध्यम प्रतिरोध दिखाया।
- प्रौद्योगिकी सत्यापन अध्ययनों ने पुष्टि किया है कि एज़ोक्सीस्ट्रोबिन + डाइफेनोकोनाज़ोल -बेस्ड सेट ट्रीटमेंट और मिट्टी को भिगोने से बीमारी का असर (3.03%) काफी कम हुआ और पैदावार बेहतर हुई, जबकि ड्रोन-बेस्ड कवकनाशी का अनुप्रयोग सेकेंडरी फैलाव को कम करने में असरदार साबित हुआ। सामूहिक रूप से, ये कोशिशें गन्ने के सतत उत्पादन और रोग प्रबंधन को बढ़ाने के लिए AI , आणविक निगरानी और सटीक कृषि को एकीकृत करती हैं।
- *एफ़. सैकेरी* के खिलाफ 30 *ट्राइकोडर्मा* आइसोलेट्स की स्क्रीनिंग की गई ताकि *ट्राइकोडर्मा* के असरदार, उम्मीद जगाने वाले और संभावित जैव-नियंत्रण उपभेदों (स्ट्रेन्स) की पहचान की जा सके। दोहरे संवर्धन परख से पता चला कि 15 *ट्राइकोडर्मा हार्ज़ियानम* ने *एफ़. सैकेरी* के कॉलोनी व्यास को 12.57-78.56% की रेंज में रोका।
- गन्ने की किस्मों को0238 (28 आइसोलेट्स), कोलख 14201 (31 आइसोलेट्स), कोलख 16202 (19 आइसोलेट्स) और कोजे 64 (37 आइसोलेट्स) से न्यूट्रिएंट और किंग्स बी मीडिया पर कुल 115 राइज़ोस्फेरिक बैक्टीरिया के आइसोलेट्स अलग किए गए। 115 राइज़ोबैक्टीरिया में से, 8 आइसोलेट्स ने *इन विट्रो* कंडीशन के तहत *कोलेटोट्रिचम फाल्केटम* सीएफ़ 13 का 75.1-100% अवरोध (इनहिबिशन) प्रदर्शित किया और 2 आइसोलेट्स ने *फ्युसेरियम सैकेरी* का 75.1-100% अवरोध (इनहिबिशन) दिखाया।
- स्टॉक बोरर (*चिलो ऑरीसिलियस*) *टेट्रास्टिचुशोवार्डी* प्यूपा पर *टेट्रास्टिचस हॉवर्ड* की विकास अवधि काफी हद तक स्थिर (15.7-17.83 दिन) रही और होस्ट के साइज़ से इस पर थोड़ा ही असर पड़ा। इसके विपरीत, मेजबान प्यूपा के वजन और लंबाई का प्रजनन प्रदर्शन (रिप्रोडक्टिव परफॉर्मेंस) पर बहुत अच्छा असर पड़ा| हर प्यूपा में प्रोजेनी प्रोडक्शन ~41 से बढ़कर ~83 एडल्ट हो गया, और होस्ट का साइज़ बढ़ने के साथ हर प्यूपा में फीमेल का निकलना ~38 से बढ़कर ~78 हो गया। सभी प्यूपा वर्गों में लगातार मादा-प्रधान लिंग अनुपात (>90%) दर्ज किया गया, जिसमें होस्ट का साइज़ बढ़ने के साथ नर कीट का निकलना कम हो गया।
- एकीकृत मॉड्यूल (अंडा समूह हटाना + परजीवी + क्लोरेंट्रानिलिप्रोल) सबसे प्रभावी पाया गया, जिसने सबसे कम ब्रूड-वार घटना (7.0-15.8%) और उच्चतम उपज (70.5 टन/हेक्टेयर) दर्ज की। क्लोरेंट्रानिलिप्रोल को *ट्राइकोगामा* के साथ मिलाने वाले उपचारों ने भी चोटी बेधक (टॉप बोरर) को असरदार तरीके से रोका गया और गन्ने की अधिक उपज प्राप्त हुई ।

जैविक नियंत्रण केंद्र, प्रवरानगर

- *हेटेरोरहाब्डिटिस इंडिका* (*Heterorhabditis indica*) + क्लोरपाइरीफॉस 20% EC की आधी मात्रा **+** *मेटारिज़ियम एनिसोप्लिया* (*Metarhizium anisopliae*) के संयुक्त प्रयोग से व्हाइट ग्रब (सफेद भृंग) की आबादी में 86.29% कमी तथा गन्ने के थानों (क्लंप) की न्यूनतम मृत्यु दर केवल 14.51% दर्ज की गई। यह परिणाम *हेटेरोरहाब्डिटिस इंडिका* (*Heterorhabditis indica*)) (83%, 16.5%), क्लोरपाइरीफॉस 20% □□ (61.42%, 25.41%) तथा *मेटारिज़ियम एनिसोप्लिया* (*Metarhizium anisopliae*) (75.5%, 20.21%) के अलग-अलग प्रयोग की तुलना में अधिक प्रभावी पायी गयी। इसके अतिरिक्त, *हेटेरोरहाब्डिटिस* प्रजातियाँ (***Heterorhabditis* spp**) विभिन्न अजैविक तनावों, जैसे तापमान, सैंड कालम, पीएच आदि के प्रति सहनशील पाया गया तथा कीटनाशकों के साथ भी इसकी अनुकूलता सिद्ध हुई।
- *बैसिलस थुरिंगिएन्सिस* (*Bacillus thuringiensis*) IISRBCCEB01 (Bt1) और *बैसिलस थुरिंगिएन्सिस* (*Bacillus thuringiensis*) IISRBCCEB02 (Bt2) की गन्ने में व्हाइट ग्रब नियंत्रण क्षमता का मूल्यांकन किया गया। परिणामों से पता चला कि Bt2 ने गन्ने के थानों की मृत्यु दर (नियंत्रण की तुलना में) 53–58.87% तक कम किया, जो अन्य जैविक एजेंटों से बेहतर था तथा एसिफेट 50% + इमिडाक्लोप्रिड (Imidacloprid) 1.80% SP और

फिप्रोनिल (Fipronil) 40% + इमिडाक्लोप्रिड (Imidacloprid) 40% जैसे रासायनिक कीटनाशकों के समान प्रभावी पाया गया।

- CoM0265 किस्म के संपूर्ण गन्ने और कटे हुए टुकड़ों (billets) में कटाई के बाद 0, 24, 48 और 72 घंटे पर मेटाजीनोमिक्स तकनीक द्वारा जीवाणु विविधता का अध्ययन किया गया। इसमें एंटेरोबैक्टर (Enterobacter), लैक्टोकोकस (Lactococcus) और वेइसेला (Weissella) जीवाणुओं की सापेक्ष प्रचुरता ल्यूकोनोस्टोक (Leuconostoc), लैक्टोबैसिलस (Lactobacillus) और पैंटोआ (Pantoea) की तुलना में अधिक पाई गई। ये जीवाणु कटाई के बाद गन्ने में सुक्रोज (चीनी) के क्षरण से प्रमुख रूप से जुड़े पाए गए। इसके अतिरिक्त, 24 घंटे के बाद फैथ पीडी (Faith PD) एवं शैनन इंडेक्स (Shannon Index) तथा 48 घंटे के बाद चाओ1 रिचनेस (Chao1 Richness) जैसे अल्फा-विविधता सूचकों में हुए परिवर्तन से संकेत मिला कि पारिस्थितिक बदलाव एवं उपचार प्रभावों के कारण जीवाणु समुदाय की संरचना में महत्वपूर्ण परिवर्तन हुआ।

पादप कार्यिकी और जैव रसायन

- अजैविक तनावों (सूखा, लवणता और जलभराव) ने दोनों जीनोटाइप, A-27-12 और Coj 64 की पौधे की लंबाई और गन्ने के वजन को कम कर दिया, हालांकि, A-27-12 (सहनशील) में दोनों मापदंडों में काफ़ी कमी आई। इसी तरह प्रकाश संश्लेषण दर, रंध्र चालकता (स्टोमैटल कंडक्टेंस) और क्लोरोफिल स्थिरता सूचकांक भी अजैविक तनावों से नकारात्मक रूप से प्रभावित हुए: इन मापदंडों में सबसे अधिक कमी सूखे में देखी गई।
- अजैविक तनावों के संपर्क में आने के कारण एंटीऑक्सीडेंट एंजाइमों जैसे कि CAT, POX, APX और SOD की गतिविधियां बढ़ गईं| इन एंजाइमों की गतिविधि में सबसे अधिक वृद्धि दोनों किस्मों में सूखे के दौरान देखी गई।
- 90 और 180 दिन रोपाई के बाद (DAP) दोनों अवस्थाओं पर गन्ने के जड़ वाले हिस्से में Si (सिलिकॉन) का विभाजन न्यूनतम था। हालांकि, S2D2M2 ने 90 दिन (DAP) पर नियंत्रण और तनावग्रस्त दोनों तरह के गन्ने की जड़ में अधिकतम Si सामग्री (8.57 और 10.3 ग्राम/किग्रा) और SODOMO में न्यूनतम (4.10 और 4.67 ग्राम/किग्रा) दिखा।
- गन्ने के ट्रेश से इथेनाल उत्पादन हेतु HPAC पूर्व-उपचार के कारण लगभग 71.0% सेल्युलोज, 18.0% हेमीसेल्युलोज और 11.69% लिग्निन की रिकवरी हुई। विशेष रूप से, न्यूनतम निरोधात्मक यौगिकों के विकास के साथ पूर्व-उपचार द्वारा 93.5% लिग्निन को हटा दिया गया था। हाइड्रोजन पेरोक्साइड-एसिटिक एसिड पूर्व-उपचार के लिए अनुकूलतम स्थितियां 75°C, 2.5 घंटे, और हाइड्रोजन पेरोक्साइड और एसिटिक एसिड का समान मात्रा का मिश्रण था।
- हल्के HPAC पूर्व-उपचार के दौरान उत्पादित अवरोधक तब समस्याग्रस्त हो गए जब पूर्व-उपचार तापमान को बढ़ाकर 200°C कर दिया गया। कम गंभीरता वाले HPAC पूर्व-उपचार और यांत्रिक शोधन (मेकेनिकल रिफाइनिंग) को मिलाने से एकीकृत जैवप्रक्रिया द्वारा इथेनॉल उत्पादन में सुधार की उम्मीद जगी है।
- पादप विकास नियामकों (PGRs)से उपचार के कारण मिल योग्य गन्नों की संख्या (एनएमसी) प्रति हेक्टेयर और गन्ने की उपज (टन/हेक्टेयर) में वृद्धि हुई। 45 दिन रोपाई के बाद (DAP) अधिकतम अंकुरण प्रतिशत एथ्रेल @100 पीपीएम के साथ रिकॉर्ड किया गया। फसल वृद्धि के दौरान, किल्ले (टिलर) की संख्या और 270 दिन रोपाई के बाद (DAP) बायोमास जमा होने से पता चला कि अंकुरण और बायोमास डायनामिक्स में सबसे ज़्यादा सुधार एथ्रेल के साथ हुआ। दूसरे बायोमेट्रिक लक्षणों ने भी ऐसे ही ट्रेंड दिखाए, जिनका सबसे ज़्यादा असर इथ्रेल के साथ सेट सोकिंग से हुआ।
- एथ्रेल और जिबरेलिक एसिड के बाहरी इस्तेमाल से दैहिकी विकास को बढ़ावा मिला, पौधों की शुरुआती संख्या बढ़ी और इंटरनोड की लंबाई में बढ़त दर्ज की गयी।
- कुल 25 इनवर्टेज जीन 16 अलग-अलग क्रोमोसोम पर फैले हुए थे, जो गन्ने के जीनोम में 10 क्रोमोसोम टाइप/क्लास में से तीन को दिखाते हैं। इन सीक्वेंस की इन-सिलिको सीक्वेंस तुलना से पता चला कि उन्हें 4 ग्रुप में बांटा जा सकता है।
- महत्वपूर्ण रूप से व्यक्त जीन के बीच, कार्बोहाइड्रेट चयापचय, पर्यावरणीय अनुकूलन और प्रतिलेखन कारक (ट्रांसक्रिप्शन फैक्टर) जीन से जुड़े कुल 30 ट्रांसक्रिप्ट का इस्तेमाल किया गया और दोनों तरह के जीन से अलग किए गए RNA सैंपल के अलग-अलग सेट का इस्तेमाल करके उन्हें वैलिडेट करने के लिए प्राइमर पेयर डिज़ाइन किए गए।

कृषि अभियांत्रिकी

- गहरी नालियों में सटीक सिंगल-नोड रोपण (प्लांटिंग) के लिए CAD मॉडल का उपयोग करके एक ट्रैक्टर चालित केन नोड प्लांटर विकसित किया गया। खेत मूल्यांकनों से पता चला कि 2.5 किमी/घंटा की गति से एक्टिव पुशिंग फीचर वाले एक गोल आकार के मीटरिंग तंत्र ने 81.0% गुणवत्ता फ़ीड सूचकांक और 83.0% से अधिक अंकुरण दर प्राप्त किया ।
- एक पेटेंटेड, ट्रैक्टर से चलने वाला ट्रैश मल्चर-कम-स्टबल शेवर डिवाइस को बेहतर बनाया गया और खेत में जांचा गया ताकि पेड़ी की फसलों में फसल अवशेष का साइज़ कम किया जा सके और अपघटन (डीकंपोजिशन) तेज़ी से हो सके। गन्ने में पेड़ी शुरू करने के संचालन और अवशेष (ट्रैश) प्रबंधन के लिए इसका प्रदर्शन उत्कृष्ट दर्ज किया गया। आईएसआरआई (ISRI) ट्रैश डीकंपोज़र का उपयोग करके अवशेषों के

टूटने की क्षमता (भंगुरता) और उसके रंग में काफी बदलाव आया।

- CTF के लिए एक फरोअर-कम-पैकर और रोटरी वीडर सहित नए उपकरण बनाए गए, जिसके परिणामस्वरूप गन्ने की उपज पारंपरिक रूप से मैनेज खेतों की तुलना में लगभग दोगुनी हो गई। इन नए विकसित उपकरणों के प्रचालन से फसल के जड़ क्षेत्र में संघनन (कॉम्पैक्शन) नहीं हो रहा था। नियंत्रित खेती के अनुपालन से गन्ने की उपज सामान्य रूप से मैनेज खेत की तुलना में दो गुना अधिक दर्ज की गई।
- अपग्रेडेड गन्ना स्ट्रिपर-कम- डिटॉपर में एक हाई-स्पीड स्टील ब्लेड और कुशल, सिंगल-पास ऑपरेशन के लिए एक फोर्क-टाइप डिट्रैशर का प्रयोग किया गया। प्रदर्शन परीक्षण ने 90.1–115.5 किग्रा/घंटा का औसत आउटपुट दिखा, जिसमें फिजियोलॉजिकल वर्कलोड स्वीकार्य सीमा के भीतर रहा।
- UAV (ड्रोन) आधारित रासायनिक छिड़काव को ऊंचाई, गति और छिड़काव के रसायन के अनुसार अनुकूलित किया गया, जो मैन्युअल नैपसैक छिड़काव का एक कुशल विकल्प प्रदान करता है। इसका उपयोग लाल सड़न के प्रसार को प्रबंधित करने के लिए फंगीसाइड एप्लिकेशन के लिए सफलतापूर्वक किया गया, जिसमें दोपहर के स्प्रे ने सबसे ज़्यादा असर दिखाया। । पारंपरिक तरीकों की तुलना में UAV आधारित रासायनिक अनुप्रयोग ने पानी के उपयोग को 88-90% और श्रम लागत को 86% तक कम कर दिया। संस्थान ने संतुलित स्प्रे प्रभावकारिता, कवरेज और बहाव (ड्रिफ्ट) नियंत्रण सुनिश्चित करने के लिए ड्रोन अनुप्रयोगों के लिए एक व्यापक एसओपी (SOP) विकसित किया है।
- छोटे जोत वाले किसानों के लिए ई-संचालित टिलर-कम-सीडर विकसित किया गया, चार पहियों वाली यह मशीन गन्ने की कंपेनियन फसलों के साथ 3-5 सेमी की गहराई पर बीज बोती है। इसकी कीमत ₹32,000 है, जिससे छोटे किसानों के लिए 0.1 हेक्टेयर/घंटा की क्षेत्र क्षमता मिलती है।
- विभिन्न कृषि-जलवायु और मिट्टी की स्थितियों के तहत कृषि अनुकूलनशीलता परीक्षण करने के लिए छह ट्रैक्टर चालित उपकरण निर्मित किए गए। गुजरात में अलग-अलग इंस्टिट्यूट और किसानों को तीन ट्रैक्टर से चलने वाली मशीनों के प्रोटोटाइप सप्लाई किए गए।
- गन्ने की सटीक बुआई के लिए एक AI-सहायता प्राप्त गन्ना बड कटिंग (आँख काटने वाली) प्रणाली विकसित की गई। एक नियंत्रित इमेजिंग सेटअप, AI-आधारित नोड और बड डिटेक्शन मॉडल, और स्टेपर मोटर चालित कटिंग तंत्र को डिज़ाइन किया गया जबकि अल्फा प्रोटोटाइप का एकीकरण वर्तमान में प्रगति पर है।
- आईएसआरआई प्रक्षेत्र पर प्रोटोटाइप व्यवहार्यता परीक्षण (PFT) ने प्रदर्शित किया कि स्वचालित आलू-सह-गन्ना ट्रेंच प्लांटर ने 0.127 हेक्टेयर/घंटा की प्रभावी क्षेत्र क्षमता प्राप्त की। यंत्रीकरण ने रोपण लागत को 74% से अधिक और श्रम आवश्यकताओं को 90% तक कम कर दिया। ड्रोन-आधारित शाकनाशी (हर्बिसाइड) छिड़काव के PFT ने पानी के उपयोग में 90% की कमी हासिल की, जिसके लिए मैन्युअल तरीकों के 450-500 लीटर/हेक्टेयर की तुलना में केवल 45-50 लीटर/हेक्टेयर की आवश्यकता थी। UAV प्रणालियों ने मैन्युअल छिड़काव की तुलना में 11 गुना तेजी से काम किया, जिससे श्रम लागत 85-87% कम हो गई।
- संशोधित गन्ना प्लांटर्स और पेड़ी प्रबंधन उपकरणों का प्रदर्शन हरदोई और लखीमपुर खीरी तथा अन्य कई जिलों के किसानों के खेतों में 46.2 हेक्टेयर से अधिक क्षेत्र पर किया गया, जिससे 60-70% की लागत बचत दिखाई दी।
- नियंत्रित और ऊर्जा-कुशल गुड़ उत्पादन के लिए एआईसीआरपी (पीएचईटी) के तहत एक इंडक्शन आधारित गुड़ बनाने की प्रणाली विकसित की गई। 50-लीटर परिचालन क्षमता वाले एक 15-किलोवाट इंडक्शन सिस्टम को अंतिम रूप दिया गया, और प्रक्रिया तापमान मानचित्रण ने क्लैरिफिकेशन के लिए 80-85°C और सांद्रता (गाढ़ा करने) के लिए 118-125°C की पहचान की। CAD-बेस्ड SS-304 वेसल डिज़ाइन और प्रोग्रामेबल टेम्परेचर कंट्रोल आर्किटेक्चर भी पूरा किया गया।
- आईसीएआर-भारतीय गन्ना अनुसंधान संस्थान, लखनऊ में एग्री-बिज़नेस इनक्यूबेशन सेंटर के माध्यम से उद्यमिता और प्रौद्योगिकी प्रसार गतिविधियों को बढ़ावा दिया गया। रिपोर्टिंग अवधि के दौरान, 03 उद्यमियों (एंटरप्रेन्योर्स) को इनक्यूबेट किया गया, 02 एंटरप्रेन्योर्स ने ग्रेजुएट होकर बिज़नेस ऑपरेशन शुरू किए, 05 जागरूकता कार्यक्रम आयोजित किए गए, और 02 मूल्य वर्धित गुड़ उत्पाद तथा 01 कम लागत वाली बगास ड्रायर तकनीक विकसित की गई।
- किसानों, छात्रों, उद्यमियों और अधिकारियों के लिए गुड़ उत्पादन, मूल्य संवर्धन, गन्ना प्रसंस्करण और कृषि-उद्यमिता पर प्रशिक्षण, प्रदर्शन और जागरूकता कार्यक्रम आयोजित किए गए। रिपोर्टिंग अवधि के दौरान, 15 प्रशिक्षण और एक्सपोज़र कार्यक्रम आयोजित किए गए, जिससे भारत के विभिन्न राज्यों के किसानों, महिला किसानों, छात्रों और उद्योग के हितधारकों सहित 450 से अधिक प्रतिभागियों को लाभ हुआ।

कृषि ज्ञान प्रबंधन इकाई

- कर्नाटक के मांड्या जिले में जैविक गन्ने का उत्पादन पारंपरिक गन्ने की खेती की तुलना में अधिक लाभदायक पाया गया। गन्ने की कम उपज के बावजूद,

जैविक गुणवत्ता वाले गुड़ उत्पादों की प्रीमियम कीमतों के कारण किसान उच्च शुद्ध लाभ कमाते हैं। इसमें उत्पादन की लागत कम होती है, क्योंकि उर्वरकों और रसायनों पर खर्च कम होता है। जैविक फार्मों की आर्थिक व्यवहार्यता और शुद्ध लाभप्रदता उत्पादक की सुपर मार्केट, मॉल,एफ़पीओ या इलेक्ट्रॉनिक प्लेटफॉर्म के माध्यम से सीधे ऑनलाइन मार्केटिंग द्वारा प्रीमियम पर गुड़ उत्पादों के विपणन की क्षमता पर निर्भर करती है।

- पारंपरिक तरीके से गन्ने की खेती की लागत, जैविक विधि (₹2,19,094/हेक्टेयर) की तुलना में अधिक (₹2,64,788/हेक्टेयर) थी। पारंपरिक और जैविक विधि में औसत उत्पादकता क्रमशः 122.65 टन/हेक्टेयर और 98.58 टन/हेक्टेयर थी। जैविक गन्ना उत्पादन से शुद्ध लाभ ₹1,99,871/हेक्टेयर था जबकि पारंपरिक विधि में यह ₹1,58,355/हेक्टेयर था। किसानों को जैविक गुड़ बनाने वाली इकाइयों और गन्ने के रस के विक्रेताओं से 18-25% अधिक कीमत मिलती है। चीनी मिलें अपने कमांड क्षेत्र में जैविक गन्ने को बढ़ावा नहीं दे रही हैं क्योंकि जैविक खेती अपनाने वाले किसान चीनी मिल को गन्ना आपूर्ति करने के इच्छुक नहीं हैं।

- गन्ने की क्षेत्रफल और उत्पादकता में सघनता के विश्लेषण से पता चलता है कि उत्तर प्रदेश में उच्च सघन गन्ना उगाने वाले जिलों ने क्षेत्रफल और उत्पादकता में सकारात्मक वृद्धि का अनुभव किया। हालांकि, महाराष्ट्र और कर्नाटक के मुख्य गन्ना उत्पादक उष्णकटिबंधीय राज्यों में केवल क्षेत्रफल में सकारात्मक वृद्धि हुई है। तमिलनाडु सहित तीनों प्रमुख गन्ना उत्पादक राज्यों में चीनी उत्पादकता में गिरावट का रुख देखा गया।

- फसल वर्ष 2025-26 के लिए उत्तर प्रदेश में गन्ने की खेती की लागत का अनुमान सहभागी ग्रामीण मूल्यांकन (PRA) तकनीकों का उपयोग करके 6 जिलों (पश्चिमी और मध्य क्षेत्र से तीन-तीन जिले) के 60 किसानों से एकत्र किए गए। प्राथमिक आंकड़ों के आधार पर पौधे और पेड़ी की फसल के लिए खेती की लागत क्रमशः ₹3470 और ₹3180 प्रति टन थी। गन्ने की खेती की औसत लागत ₹3340 प्रति टन थी। औसत गन्ना उत्पादकता 80.5 टन/हेक्टेयर थी और लागत A2+FL तथा लागत C2 पर उत्पादन लागत क्रमशः ₹228308 और ₹268870 प्रति हेक्टेयर प्राप्त की गई।

- पश्चिमी उत्तर प्रदेश में को. 0238 किस्म में व्यापक स्तर पर लाल सड़न रोग के कारण वर्ष 2025-26 के दौरान उत्तर प्रदेश में औसत गन्ना उत्पादकता में गिरावट आई। उत्तर प्रदेश में को 0238 किस्म का क्षेत्रफल भी पिछले वर्ष की तुलना में 42.9 से घटकर 29.2 हो गया।

- उपोष्णकटिबंधीय भारत के लिए अनुशंसित गन्ने की 24 अगेती (जल्दी) और मध्यम देर से पकने वाली किस्मों का क्षेत्र परीक्षण दो रेप्लिकेशंस में आयोजित किया गया। अगेती समूह में ली गई किस्में कोलख 14201, कोलख 15466, कोलख 11203, कोशा 17231, कोलख 9709, कोलख 16202, कोलख 15201, कोशा 13235, को 0118, कोलख 94184, कोलख 12207, को 0238 थीं, जबकि मध्यम-देर वाले समूह में कोशा767, कोशा 08279, कोलख 09204, कोलख 11206, कोलख 15207, को 05011, कोपंत 97222, कोलख 12209, कोलख14204, कोलख 15206, कोलख16030, कोपीबी 14185 शामिल थीं। गन्ने की फसल के HSV डेटा के आधार पर गन्ने की परिपक्वता का अध्ययन करने के लिए ब्रिक्स के साथ 10-15 दिनों के अंतराल पर आंकड़े दर्ज किए गए और उपरोक्त अंतराल पर छवियों की HSV और ह्यू (Hue) आवृत्ति प्राप्त करने के लिए डेटा का विश्लेषण किया गया।

आई.एस.आर.आई., क्षेत्रीय केंद्र, मोतीपुर

- कैलेंडर वर्ष 2025 के दौरान, आईसीएआर-आईएसआरआई क्षेत्रीय केंद्र, मोतीपुर ने उत्तर मध्य क्षेत्र के लिए गन्ना किस्म विकास और बीज उत्पादन में सार्थक प्रगति हासिल की। केंद्रित प्रजनन प्रयासों के कारण छह विशिष्ट क्लोन तीन शुरुआती और तीन मध्यम-देर वाले, एआईसीआरपी (गन्ना) के तहत जोनल वैरायटी ट्रायल्स में चिन्हित हुए। इन क्लोनों ने बेहतर गन्ना और सीसीएस (CCS) उपज, बेहतर सुक्रोज कंटेंट और लाल सड़न के प्रति मध्यम प्रतिरोध प्रदर्शित किया।

- बिहार सरकार के गन्ना उद्योग विभाग के साथ मिलकर चलाए गए ब्रीडर सीड प्रोडक्शन प्रोग्राम के तहत, अनियमित वर्षा और लंबे समय तक पानी भरे रहने की चुनौतियों के बावजूद 18,300 क्विंटल से ज़्यादा ब्रीडर सीड का उत्पादन किया गया।

- जलभराव की स्थिति में उन्नत गन्ना क्लोनों पर आउटरीच परीक्षण टीएसएल, बगहा; एचएसएम, हरिनगर और एनएसएसएम, नरकटियागंज में आयोजित किए गए थे। कोलख 16468 और कोलख 15466 उच्च रस गुणवत्ता और रिकवरी के साथ बेहतर क्लोन के रूप में चिन्हित किये गए जबकि कोलख 20466 ने उच्च ब्रिक्स (19.93%), शुद्धता (89.18%) और रिकवरी (10.64%) दर्ज की। कोलख 20468 ने उत्तरी बिहार की बाढ़ वाले हालात में भी स्थिर प्रदर्शन दिखाया।

शुगर बीट प्रजनन आउटपोस्ट, मुक्तेश्वर

- व्यवस्थित पुनर्जनन (रिजेनेरेशन) और कोल्ड स्टोरेज संरक्षण के माध्यम से कुल 149 जननद्रव्य (जर्मप्लाज्म) एक्सेसनों का रखरखाव किया गया। 49 किस्मों/जीन प्ररूप (जीनोटाइप) का ताजा बीज उत्पादन पूरा किया गया जिसका कुल बीज उत्पादन 22 किग्रा से अधिक रहा। राष्ट्रीय आपूर्ति के लिए देशी (इंडिजिनस) किस्मों LS 6 और IISR Comp 1 का गुणन किया गया। बहु-स्थान परीक्षणों ने भारत के पूर्वी, उत्तरी और अर्ध-शुष्क क्षेत्रों में चयनित जीनोटाइप की व्यापक अनुकूलनशीलता की पुष्टि की।

- खेत की स्थितियों में 48 चुकंदर जीन प्रारूप (जीनोटाइप) की व्यापक स्क्रीनिंग से प्रमुख कीटों और बीमारियों के खिलाफ मूल्यवान प्रतिरोध स्रोतों की पहचान हुई। जीन प्रारूप (जीनोटाइप) SYT/06/10, L 33, और LKC 2000 ने *स्पोडोप्टेरा लिटुरा* (*Spodoptera litura*) और महत्वपूर्ण जड़ सड़न रोगजनकों के खिलाफ मजबूत प्रतिरोध दिखाया, जिससे भविष्य के रेजिस्टेंस ब्रीडिंग प्रोग्राम के लिए ज़रूरी जेनेटिक रिसोर्स मिले।
- सिंचित और सूखे की स्थिति में, देशी (इंडिजिनस) जीन प्ररूप (जीनोटाइप) ने उल्लेखनीय अनुकूलनशीलता और स्थिरता दिखाई। LKC 2006 ने कम पानी वाले माहौल में भी जड़ों का वज़न बेहतर रखा और ज़्यादा सुक्रोज और शुद्धता बनाए रखी, जबकि LKC 95 ने लगातार शुगर रिकवरी के गुणों के सूखा प्रतिरोधिता दिखाई।
- भूमि-उपयोग दक्षता और किसान आय बढ़ाने के लिए उत्तर प्रदेश में कई फैक्ट्री कमांड क्षेत्रों में चुकंदर-गन्ना अंतरफसली (इंटरक्रॉपिंग) प्रणालियों को सफलतापूर्वक मान्य किया गया। 55-60 टन/हेक्टेयर तक की उपज और 17% तक के सुक्रोज स्तर ने मौजूदा गन्ना उत्पादन प्रणालियों में चुकंदर को एकीकृत करने की व्यवहार्यता की पुष्टि की, जो किसानों को अतिरिक्त आय के अवसर और पेराई सीजन के दौरान चीनी उद्योगों के लिए पूरक कच्चा माल प्रदान करती है।
- चारा फसलों पर अखिल भारतीय समन्वित अनुसंधान परियोजना (AICRP), चुकंदर में प्रारंभिक किस्म परीक्षण (IVT) पर केंद्रित है। इस कार्यक्रम का उद्देश्य भारत के विभिन्न कृषि-जलवायु क्षेत्रों में चुकंदर (शुगर बीट) जीनोटाइप के प्रदर्शन, अनुकूलनशीलता और चारे की क्षमता का मूल्यांकन करना है। इस परीक्षण में पहाड़ी, उत्तर-पश्चिमी, उत्तर-पूर्वी, केंद्रीय और दक्षिणी क्षेत्रों का प्रतिनिधित्व करने वाले कई स्थानों पर तीन पुनरावृत्ति (रेप्लीकेसन) के साथ रैंडमाइज्ड ब्लॉक डिजाइन (RBD) में दो चेक (LS 6 और IISR Comp 1) के साथ 10 जर्मप्लाज्म शामिल हैं। परीक्षणों से चुकंदर जीनोटाइप की वृद्धि, अनुकूलनशीलता और चारा उपज पर मूल्यवान डेटा मिलने की उम्मीद है। रबी 2025-26 के दौरान मिले डेटा को अगले साल इकट्ठा किया जाएगा और उसका मूल्यांकन किया जाएगा ताकि आगे बढ़ाने और क्षेत्रीय सिफारिश के लिए सही और स्थिर एंट्री की पहचान की जा सके।

अखिल भारतीय समन्वित अनुसंधान परियोजना (गन्ना)

- फसल सुधार कार्यक्रमों के तहत, राष्ट्रीय संकरण उद्यान (नेशनल हाइब्रिडाइजेशन गार्डन) में 450 पैतृक क्लोन लगाए गए थे, जिनमें से 382 क्लोन में फूल आए (84.89% फूल आने की तीव्रता)। भाकृअनुप – एसबीआई, कोयम्बटूर ने 22 भाग लेने वाले केंद्रों को फ्लफ (गन्ने का बीज) की भी आपूर्ति की।
- एक जलवायु-अनुकूल प्री-ब्रीडिंग पहल ने सहयोगी केंद्रों को 44 क्रॉस (26 लाल सड़न-प्रतिरोधी और 18 सूखा-सहनशील) की आपूर्ति की। 2024-25 के दौरान, सीवीआरसी द्वारा राष्ट्रीय स्तर पर दो किस्में रिलीज़ की गईं और राज्य स्तरीय व्यावसायिक खेती के लिए एसवीआरसी द्वारा नौ और किस्में रिलीज़ की गईं।
- बहु-स्थान परीक्षणों से पता चला कि उर्वरक की उच्च अनुशंसित खुराक (RDF) ने उत्तर पश्चिम और प्रायद्वीपीय (पेनीसुलर) क्षेत्रों में गन्ने की उपज में महत्वपूर्ण वृद्धि की, जबकि पूर्वी तटीय क्षेत्र में इसका असर कम दिखा। मानसून-पूर्व नमी के तनाव के कारण 5-35% उपज का नुकसान हुआ, हालांकि बाद में अच्छी बारिश से इसकी भरपाई हुई।
- तरल नैनो यूरिया ने कई केंद्रों पर दानेदार यूरिया के समान प्रदर्शन किया, कोल्हापुर में और नयागढ़ की अम्लीय मिट्टी में इसके इसके खास फायदे दिखे। माइक्रोबियल कंसोर्टिया के उपयोग से उपज बेहतर हुई और कुछ स्थानों पर नाइट्रोजन उर्वरक के उपयोग में 25% तक की कमी आई।
- खरपतवार प्रबंधन अध्ययनों से पता चला है कि अनियंत्रित खरपतवार की स्थिति में गंभीर उपज का नुकसान (15-75%) हुआ, जबकि अंकुरण-पूर्व और अंकुरण-पश्चात खरपतवारनाशकों (शाकनाशियों) ने प्रभावी खरपतवार नियंत्रण और उच्च आर्थिक लाभ प्रदान किया।
- पादप रोगविज्ञान (प्लांट पैथोलॉजी) कार्यक्रम में आठ परियोजनाओं के तहत 16 केंद्र शामिल थे, जहाँ पेनिनसुलर ज़ोन में उभरते पैथोटाइप्स के संकेतों के साथ 135 नए रेड रॉट आइसोलेट्स की पहचान की गई।
- जोनल किस्म परीक्षणों में गन्ने की प्रमुख बीमारियों जैसे लाल सड़न, कंडुआ (स्मट), उकठा (विल्ट), पीला पत्ता रोग (वाईएलडी), भूरा रतुआ (ब्राउन रस्ट), और पोक्का बोइंग के खिलाफ कई प्रतिरोधी या मध्यम प्रतिरोधी प्रविष्टियों की पहचान की गई।
- रोग निगरानी से क्षेत्र-विशिष्ट कमजोरियों का पता चला, विशेष रूप से उपोष्णकटिबंधीय भारत में लाल सड़न और उकठा और केरल में पत्तियों पर होने वाले रोग, जबकि YLD के लिए ऊतक संवर्धन (टिशू कल्चर)-आधारित प्रबंधन रणनीतियां सभी क्षेत्रों में प्रभावी रहीं।
- कीटविज्ञान (एंटोमोलॉजी) विषय ने 12 केंद्रों में नौ परियोजनाएं संचालित किए, जहां जीन प्ररूप (जीनोटाइप) स्क्रीनिंग ने अर्ली शूट बोरर, इंटरनोड बोरर और मीली बग जैसे प्रमुख कीटों के प्रति सहनशीलता/संवेदनशीलता प्रतिक्रिया दिखाने वाली प्रविष्टियों की पहचान की। कीट सर्वेक्षणों में पाया गया कि अधिकांश ग्रसन (इन्फेस्टेसन) प्रबंधनीय थे, सिवाय कुछ गंभीर टॉप बोरर के प्रकोप को छोड़कर, जबकि *फेनोकोकस सैकेरीफोलि* (*Phenococcus saccharifolii*) और सर्पिलिंग सफेद मक्खी (स्पाइरलिंग व्हाइटफ्लाई)

जैसे उभरते कीटों की भी रिपोर्ट मिली थी।

- बड़े पैमाने पर बेहतर जैव-एजेंट गुणन तकनीकों ने *टेट्रास्टिचुशॉवर्डी* और *टेलीनोमसडिग्नस* जैसे एजेंटों की उत्पादन दक्षता को बढ़ाया। व्हाइट ग्रब (सफेद लट) प्रबंधन परीक्षणों ने ग्रब की घटना को 53% तक कम कर दिया, और एकीकृत कीट-प्रबंधन तरीकों ने गन्ने की उपज और गुणवत्ता में काफी सुधार किया।
- गन्ने की चार किस्में—कोशा 17231 (बिस्मिल), कोएच 17261 (कोएच 179), को 18022 (करण-18), और कोपीबी 18213 (कोपीबी 100)—को उत्तर पश्चिम क्षेत्र के लिए सीवीआरसी 2025 द्वारा जारी और अधिसूचित किया गया, ये अगेती से मध्यम-देर से पकने वाली, उच्च उपज देने वाली किस्में थीं जिनमें अच्छा सुक्रोज और सीसीएस (CCS) का अच्छा परफ़ॉर्मेंस रहा, लाल सड़न और कंडुआ के प्रति प्रतिरोध/ मध्यम प्रतिरोध, प्रमुख कीटों के प्रति कम संवेदनशीलता, सूखे और लवणता (कुछ किस्मों में) के प्रति सहनशील थी, और सिंचित स्थितियों के लिए अनुशंसित की गईं।
- गन्ने की आठ किस्में—को 09004 (अमृता), को 18003 (आरोह), कोपी 18437 (राजेंद्र गन्ना-3), को 19017 (करण-19), कोपीबी 19182 (कोपीबी 101), कोलख 19204 (इक्षु-18), कोशा 19235 (शेखर), और कोए 20322 (2014A 142)—को पूर्वी तट, प्रायद्वीपीय, उत्तर केंद्रीय और उत्तर पूर्वी, और उत्तर पश्चिम क्षेत्रों में जारी करने और अधिसूचित करने के लिए एआईसीआरपी (गन्ना) द्वारा पहचाना गया ये किस्में अगेती से मध्यम-देर से पकने वाली, अच्छी सुक्रोज और सीसीएस (CCS) सामग्री के साथ उच्च उपज देने वाली हैं, और आमतौर पर प्रमुख कीटों के प्रति कम संवेदनशीलता के साथ लाल सड़न और स्मट के प्रति प्रतिरोधक/मध्यम प्रतिरोधक क्षमता दिखाती हैं।

About the Institute

The ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow was established in 1952 by the Indian Central Sugarcane Committee for conducting research on fundamental and applied aspects of sugarcane culture as well as to co-ordinate research work done on this crop in different states of the country. The Government of India took over the Institute from the Indian Central Sugarcane Committee on January 1, 1954, and thereafter, it was transferred to the Indian Council of Agricultural Research (ICAR), New Delhi on April 1, 1969. The Institute is located in Lucknow, the capital city of Uttar Pradesh and conveniently situated at about 12 km from CCS Airport, Amausi and about 5 km from Lucknow Railway Station. The climate of the area is sub-tropical semi-arid type. Monthly average maximum temperature during April to June ranges from 36ºC to 40ºC and minimum temperature during November to February ranges from 7ºC to 11.5ºC. The annual average rainfall is around 880 mm.

Vision

An efficient, globally competitive and vibrant sugarcane agriculture.

Mission

Enhancement of sugarcane production, productivity, profitability and sustainability to meet future sugar and energy requirement of India,

Mandate

(i) Basic, strategic and adaptive research on production and protection in sugarcane and breeding for sub-tropical region of the country.

(ii) Coordination and monitoring of applied research on national and regional issues to develop improved varieties and technologies.

(iii) Dissemination of technologies and capacity building.

Issues and strategies

To achieve the desired growth in area, productivity and recovery of sugarcane in different agro-ecological zones of the country and to extend appropriate information and technologies to the end users, following issues and strategies have been identified which need to be pursued at:

Issues

- Low levels of cane yield and sugar recovery
- Threats biotic and abiotic constraints
- High cost of cane cultivation
- Decline in factor productivity

Strategies

Increasing the level of cane yield and sugar recovery

a. Introgression of untapped genes in the parental gene pool

b. Enhancing selection efficiency through marker aided selection (MAS)

c. Improving sink strength and source efficiency

d. Enhancing productivity of ratoon cane

Reducing the cost of cane cultivation

a. Nutrient use efficiency through rhizospheric engineering and INM technology

b. Water use efficiency through micro- irrigation

c. Land use efficiency though companion cropping

d. Reducing cost of pesticide use in an eco-friendly manner through bio-intensive IPM and IDM

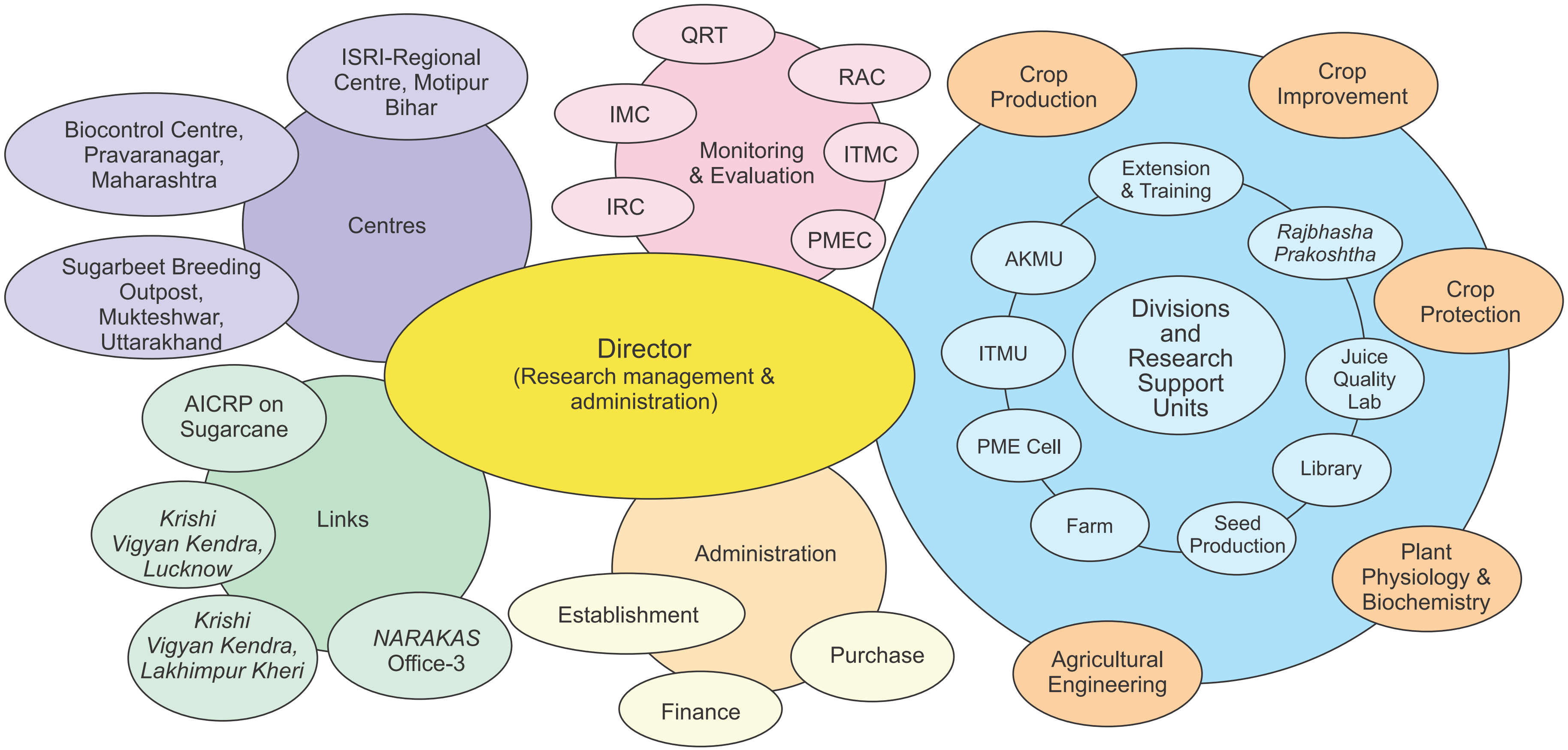
e. Mechanizing sugarcane farming

Arresting decline in factor productivity

a. Soil biological and nutritional dynamism

b. Carbon sequestering through cropping system.

ICAR-Indian Sugarcane Research Institute, Lucknow



Organizational Structure

Budget 2024-25

Particulars	Plan (Rs. in lakh)	
	Revised Estimate	Expenditure as on December 31, 2024
ICAR-Indian Sugarcane Research Institute, Lucknow	9733.43 including salary & pension	7001.08 including salary & pension
All India Coordinated Research Project on Sugarcane	1811.17 including salary & pension	1306.63 including salary & pension

Budget 2025-26

Particulars	Plan (Rs. in lakh)	
	Revised Estimate	Expenditure as on December 31, 2025
ICAR-Indian Sugarcane Research Institute, Lucknow	10964.19 including salary & pension	8052.89 including salary & pension
All India Coordinated Research Project on Sugarcane	1290.01 including salary & pension	991.70 including salary & pension

Staff Position

(As on 31/12/2025)

Category	Sanctioned	Filled	Vacant
RMP	**1**	**0**	**01**
Scientific			
Principal Scientist	07	06	01
Senior Scientist	14	06	08
Scientist	52	42	10
Total	**73**	**54**	**19**
Technical			
Category-I	77	50	27
Category-II	49	28	21
Category-III	03	02	01
Total	**129**	**80**	**49**
Administrative	**54**	**42**	**12**
Skilled Supporting Staff	**36**	**08**	**28**
Grand Total	**293**	**184**	**109**

CHAPTER 1

Genetic Improvement of sugarcane for higher cane and sugar productivity

Genetic improvement of sugar crops for superior varieties suitable for sub-tropical India

Identification of sugarcane variety CoLk 19204 (Mid-Late)

A proposal for the identification and release of the sugarcane variety CoLk 19204 (IKSHU-18) was submitted to the Varietal Identification Committee of AICRP(S) in 2025. This mid-late maturing variety, developed from the cross CoS 8436 × CoSe 92423, has demonstrated promising performance with a cane yield of 87.33 t/ha and a CCS yield of 11.33 t/ha. It recorded a sucrose content of 18.59% and a pol percentage of 13.80% at harvest, indicating good juice quality. Based on its agronomic and quality traits, CoLk 19204 has been recommended for cultivation in the North West Zone. The phenotypic characteristics (Fig1.1) of the variety are shown here as under.

Registration of sugarcane varieties

Six sugarcane varieties, *viz.*, CoLk 15201, CoLk 15207, CoLk 15466, CoLk 14201, CoLk 15206, and CoLk 16466 have been successfully registered with the Protection of Plant Variety and Farmers' Right Authority (PPVFRA, New Delhi, and their Registration Certificates were received in 2025. Four sugarcane varieties, *viz.*, CoLk 16202, CoLk 16470, CoLk 09204 and CoLk 14204 were applied for registration in the category of 'Extant and Notified' under the Protection of Plant Variety and Farmers' Right Act, 2001 for their protection. The duly filled applications of the aforesaid varieties have been submitted to the PPVFRA, New Delhi.

Table 1.1. Salient features of the accepted clones accepted for multi-location testing

Clone	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Red rot rating
CoLk 25201 (LG 20131)	LG 01118 × Co 92006	Early	98.64	13.11	18.93	MR
CoLk 25202 (LG 20255)	CoLk 13201 GC	Early	96.41	12.25	18.10	MR
CoLk 25203 (LG 16558)	CoLk 15205 × LG 07482	Early	95.65	12.28	18.27	MR
CoLk 25204 (LG 20259)	CoLk 13201 GC	Mid-late	101.96	15.00	20.92	MR
CoLk 25205 (LG 20101)	CoJ 88 GC	Mid-late	97.39	13.44	19.67	MR
CoLk 25206 (LG 20488)	CoLk 9202 GC	Mid-late	95.54	12.57	19.27	MR

Fig. 1.1 Phenotypic characteristics of the newly identified mid-late sugarcane variety CoLk 19204 (IKSHU-18)

Sugarcane clones for multi-location testing

Three early maturing sugarcane clones, *viz.*, CoLk 25201, CoLk 25202, and CoLk 25203, and three mid-late maturing clones, *viz.*, CoLk 25204, CoLk 25205, and CoLk 25206 have been accepted for multi-location testing in North West Zone of India during the AICRP(S) Annual Group Meeting-2025 held at AAU, Jorhat, Assam. The salient features of these clones are presented in Table 1.1.

Hybridization and seedling raising

A total of 36 bi-parental sugarcane crosses were made at the National Hybridization Garden, Coimbatore, during the 2024 crossing season, while an additional 8 crosses were attempted at the National Distant Hybridization Facility, Agali. Fluff of 59 genotypes was also requisitioned from the Sugarcane Breeding Institute, Coimbatore. Under the project titled "Pre-breeding for the development of climate-smart genetic stocks utilizing untapped genetic resources in the Saccharum complex," fluff of 18 trait-specific bi-parental crosses developed at ICAR-SBI Coimbatore, ICAR-SBI Regional Centre, Agali, and ICAR-SBI Regional Centre, Kannur during 2024 was received. All received fluff will be sown in glass/polyhouses for seedling raising. Additionally, 23,322 seedlings derived from 31 bi-parental crosses and 45 general crosses (from the 2023 crossing season) were successfully raised and transplanted under field conditions for further evaluation.

Selection in Seedling (C_0) Population

Based on high Brix (HR Brix) values and other important growth parameters, a total of 580 clones were selected from the seedling (C_0) population. These selected clones have subsequently been advanced to the next stage and planted as C_0 clones along with standard check varieties for further evaluation and performance assessment.

Evaluation of Clonal Generations

A total of 111 sugarcane clones were selected from the C1 population and advanced to the C2 generation for further evaluation. From the C2 population, 37 promising clones were identified and promoted to the C3 generation, where they were also screened for

Table 1.2. Performance of elite sugarcane genotypes under Station Trial (2024-25)

Clone	Cane yield (t/ha)	CCS yield (t/ha) 10 M	CCS yield (t/ha) 12 M	Sucrose % 10 months	Sucrose % 12 months
LG 15482	77.91	10.07	11.07	18.47	20.44
LG 16558	95.65	12.28	13.27	18.27	19.71
LG 20459	73.09	8.85	10.50	17.37	20.59
LG 20304	85.26	10.19	10.77	17.10	18.49
LG 20488	95.54	11.15	12.57	16.74	19.27
LG 20561	79.71	9.76	9.44	17.57	17.06
LG 20255	96.41	12.25	14.24	18.10	20.98
LG 20259	101.96	11.95	15.00	16.88	20.92
LG 20101	97.39	11.91	13.44	17.50	19.67
LG 20131	98.64	13.11	14.21	18.93	20.44
CMS 206	89.48	9.96	12.83	16.07	20.41
CMS 207	94.97	9.08	12.93	14.05	19.68
Standards					
CoS 767	75.65	8.52	9.18	16.17	17.61
CoPant 97222	84.53	9.97	12.14	16.85	20.31
Co 05011	75.43	8.79	10.53	16.66	19.87
CoJ 64	71.01	8.64	8.77	17.49	17.92
Co 0238	82.95	10.33	11.21	17.88	19.67
CoLk 14201	83.50	10.59	11.68	18.13	19.96
CD at 0.05	**10.33**	**1.63**	**1.88**	1.52	**1.88**
CV %	**7.15**	**9.42**	**9.51**	5.29	**5.75**

resistance to red rot disease. Among these, the most promising clones were evaluated in replicated trials to assess their yield and quality performance. Based on yield, quality parameters, and red rot resistance, ten superior clones—LG 16465, LG 21226, LG 21235, LG 21301, LG 21324, LG 21329, LG 21368, LG 21403, LG 21407, and LG 21490—were selected and included in the Station Trial (2025–26) for further evaluation.

Station Trial (2024-25)

Twelve elite sugarcane clones as LG 15482, LG 16558, LG 20101, LG 20131, LG 20255, LG 20259, LG 20304, LG 20459, LG 20488, LG 20561, CMS 206, and CMS 207—along with six standard varieties, Co 0238, CoJ 64, CoLk 14201, CoS 767, CoPant 97222, and CoLk 15207, were evaluated in the Station Trial (2024–25) for their growth, yield, and quality parameters. The performance of these clones is presented in Table 1.2.

Evaluation of Early Sugarcane Clones for North West Zone

Initial Varietal Trial (Early)

A trial comprising ten sugarcane genotypes *viz.*,Co 21012, Co 21013, Co 21014, CoPb 21181, CoPb 21182, CoLk 21201, CoLk 21202, CoLk 21203, CoPb 21211, and CoH 21261—along with three standard varieties, CoJ 64, Co 0238, and Co 05009, was conducted to evaluate their performance for various yield and quality parameters.

Among the genotypes, CoLk 21201 recorded the highest cane yield (96.25 t/ha), followed closely by CoPb 21182 (96.19 t/ha) and CoH 21261 (95.20 t/ha). A similar trend was observed for CCS yield, where CoLk 21201 ranked first (12.48 t/ha), followed by CoLk 21203 (12.16 t/ha) and CoPb 21182 (11.39 t/ha).

The highest sucrose content at harvest was recorded in CoLk 21203 (18.66%), followed by CoLk 21201 (18.63%). Among the standard varieties, Co 0238 performed best, registering the highest cane yield (89.01 t/ha) and CCS yield (10.60 t/ha).

Advanced Varietal Trial-I Plant (Early)

Five sugarcane clones, *viz.,* CoLk 20016, CoLk 20202, CoLk 20203, CoPb 20211 and CoH 20261 along with three standards, CoJ 64, Co 0238 and Co 05009 were evaluated for yield and quality parameters.

Among the test genotypes, CoLk 20202 recorded the highest cane yield (90.16 t/ha) as well as CCS yield (11.35 t/ha). The genotype, CoLk 20202 showed the highest sucrose percentage at harvest (18.06%), followed by CoLk 20203 (17.87%).

Among the standards, Co 0238 was the best check for cane yield (86.00 t/ha) and CCS yield (10.79 t/ha).

Advanced Varietal Trial-II Plant (Early)

Four sugarcane clones, *viz.,* CoLk 19201, CoLk 19202, CoPb 19212, and CoS 19231, along with three standard varieties, *viz.,* CoJ 64, Co 0238, and Co 05009 were evaluated for yield and quality characters.

The genotype, CoLk 19202 recorded the highest cane yield (96.67 t/ha) and CCS yield (11.60 t/ha) among the test entries, followed by CoPb 19212 and CoLk 19201. Among the test entries, CoS 19231 recorded the highest sucrose content at harvest (17.68%), followed by CoLk 19202 (17.23%) and CoLk 19201 (14.79 %). Among the standard varieties, Co 0238 was the best for cane yield (84.19 t/ha) and CCS yield (9.99 t/ha).

Advanced Varietal Trial- Ratoon (Early)

Four sugarcane genotypes, *viz.,* CoLk 19201, CoLk 19202, CoPb 19212 and CoS 19231 along with three standards, CoJ 64, Co 0238 and Co 05009 were evaluated for their ratooning ability. The genotype, CoLk 19202 recorded the highest cane yield (89.14 t/ha) and CCS yield (11.47 t/ha). Among the standard varieties, Co 0238 was found the best for cane yield (83.67 t/ha) and CCS yield (10.35 t/ha).

Seed Multiplication (Early)

The seeds of eight sugarcane genotypes viz., CoPb 22181, CoLk 22201, CoLk 22202, CoLk 22203, CoPb 22211, Co 22020, CoH 22261, and CoH 22262 have been multiplied to ensure an adequate quantity of planting material for the next year's trial. This multiplication will facilitate the evaluation of these genotypes under replicated trial conditions, allowing assessment of their performance for yield, quality and disease resistance in the subsequent testing cycle.

Evaluation of Mid-late Sugarcane Clones for North West Zone

Initial Varietal Trial (Mid-late)

Ten sugarcane clones CoPb 21183, CoPb 21184, CoLk 21204, CoLk 21205, CoLk 21206, CoS 21231, CoS 21232, CoS 21233, CoH 21262 and CoH 21263 along with three standard varieties, CoS 767, CoPant 97222 and Co 05011, were evaluated for their performance in terms of cane yield, CCS yield and sucrose content.

Among the test genotypes, CoS 21232 recorded the highest cane yield (117.91 t/ha), followed by CoH 21263 (111.88 t/ha) and CoLk 21204 (110.20 t/ha). The highest CCS yield was observed in CoLk 21204 (13.80 t/ha), followed by CoS 21232 (13.19 t/ha) and CoLk 21206 (12.76 t/ha). In terms of sucrose content at harvest, CoH 21262 ranked highest (18.69%), followed by CoLk 21205 (18.49%) and CoLk 21204 (18.11%). Among the standard varieties, CoPant 97222 performed best for CCS yield (12.10 t/ha), followed by Co 05011 and CoS 767.

Advanced Varietal Trial I - Plant (Mid-late)

Seven sugarcane clones, *viz.*, Co 20017, CoPb 20181, CoLk 20204, CoLk 20205, CoPb 20212, CoS 20231 and CoS 20232 along with three standards, CoS 767, CoPant 97222 and Co 05011 were evaluated for yield and quality parameters.

The genotype CoLk 20204 recorded the highest cane yield (102.80 t/ha), followed by CoPb 20212 (99.17 t/ha) and CoS 20231 (93.82 t/ha). Similarly, CoLk 20205 exhibited the highest sucrose content at harvest (19.37%), followed by CoLk 20204 (18.51%) and CoS 20231 (17.80%). Among the standard varieties, CoPant 97222 was found the best for cane yield (88.95 t/ha) and CCS yield (11.01 t/ha).

Advanced Varietal Trial II - Plant (Mid-late)

Seven sugarcane genotypes, *viz.*, Co 19017, Co 19182, CoLk 19204, CoPb 19213, CoPb 19214, CoS 19232 and CoS 19235 along with three standards, CoS 767, CoPant 97222 and Co 05011 were evaluated for yield and quality parameters.

The genotype, CoLk 19204 recorded the highest cane yield (102.33 t/ha) followed by CoS 19235 (94.73 t/ha). Whereas, CoLk 19204 exhibited the highest sucrose at harvest (18.27%) followed by Co 19017 (18.20%) and CoS 19232 (17.69%). Among the standard varieties, Co 05011 was found the best for cane yield (87.01 t/ha) and CCS yield (10.38 t/ha).

Advanced Varietal Trial - Ratoon (Mid-late)

Seven sugarcane genotypes, *viz.*, Co 19017, Co 19182, CoLk 19204, CoPb 19213, CoPb 19214, CoS 19232 and CoS 19235 along with three standards, CoS 767, CoPant 97222 and Co 05011 were evaluated for their ratooning ability. The genotype, Co 19204 recorded the highest cane yield (85.85 t/ha) and CCS yield (11.42 t/ha).

Among the standard varieties, CoS 767 was found the best for cane yield (65.41 t/ha) and CoPant 97222 for CCS yield (7.94 t/ha).

Seed multiplication (Mid-late)

The seeds of eight sugarcane genotypes—CoPb 22181, CoLk 22201, CoLk 22202, CoLk 22203, CoPb 22211, Co 22020, CoH 22261, and CoH 22262—have been multiplied to ensure sufficient planting material for the next year's IVT (Initial Variety Trial). This multiplication will facilitate the evaluation of these genotypes under replicated trial conditions for their assessment for yield, quality, and adaptability.

Identification of Location-Specific Sugarcane Genotypes

(ICAR-ISMA Collaborative Project)

ICAR-ISRI, Lucknow has joined as a collaborative partner in the ICAR-ISMA Collaborative Project, which has been approved with a total funding of Rs 100.0 lakh for five years (2023–24 to 2027–28). The primary objective of the project is to identify location-specific sugarcane genotypes. During the current year (2024–25), TRIAL-I is being conducted at 16 sugar mill farms across sub-tropical India, while the entries for TRIAL-II are being multiplied at the respective sugar mills in preparation for next year's trial.

TRIAL-I

Entries: Co 16029, Co 17018, Co 20016, Co 20017, Co 20019, Co 21012, Co 14012, CoLk 14201 and CoLk 15207.

Standards: Co 0238, Co 0118 and one Local Standard.

TRIAL-II (Multiplication)

Entries: Co 14034, Co 16029, , Co 17015, Co 19017, Co 20016, Co 20017, Co 20019, Co 21012, Co 21014, Co 22020, Co 22021, Co 22023, CoLk 19201, CoLk 19202, CoLk 19204, CoLk 20202, CoLk 20204.

Standards: Co 0238, Co 0118 and CoLk 14201

Germplasm maintenance and pre-breeding for improved genetic stocks

Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions

A collection of 365 sugarcane genotypes consisting of *Saccharum officinarum*, *S. barberi*, *S. sinense*, ISH clones, IkshuISH clones, LG selections, commercial hybrids, 25 soma-clonal variants, etc. was maintained and the required material was supplied to various on-going projects of the Institute. The collection includes 183 commercial hybrids, 51 ISH and IkshuISH lines, 71 LG clones and 30 species level genotypes. A '*Varietal Cafeteria*' comprising of 20 early and mid-late maturing varieties was planted in October 2024 to provide an opportunity for farmer to select varieties of their choice. DUS descriptor-based characterization is being carried out for the LG clones in the collection.

Population improvement and development of sugarcane genetic stocks for high sugar accumulation potential for sub-tropical India

The project aims for population improvement for high sugar accumulation potential in the sub-tropical sugarcane genotypes and to develop high sugar sugarcane genetic stocks. The high sugar genotypes tested in the clonal stages had a mean value of >19% sucrose in juice in the month of January 2025. Four sugarcane genotypes, viz., LG 16522, LG 16608, LG

16579, LG 16567 had >20-21% sucrose in juice in February 2025, with LG 16567 showing moderate resistance to the prevailing red rot pathotypes. Two clones from second clonal stage, viz., LG 22404 and LG 22521 exhibited 20-21% sucrose in juice in February 2025. Overall, these values are an increase of 5-10% over the standard check Co 0238 for mean sucrose % in juice, and 4-8% over Co 0238 for CCS%. These clones needs to be further validated in the next crop seasons. Genotyping studies were initiated for molecular studies in the high sugar genotypes identified in the previous selection cycles.

The fluff sown in the mist chamber in November 2025 showed satisfactory germination in the different crosses. The crosses involving LG 15533, LG 14564, LG 08422, LG 07590 exhibited good germination (>50%). The fluff from closes involving the species/improved accessions gave very few seedlings (less than 10 from approximately 4-5 g fluff). Hand Refractometer Brix readings recorded in the seedlings transplanted to field in 2024 had ~10% of the seedlings with a mean HR Brix values more than 20 (^{o}Bx) in January 2025. A total of 202 clones from the seedling population were advanced to the first clonal stage (C-1). The seedlings from crosses involving LG 14564 and CoLk 15202 exhibited a higher proportion of stools with high HR Brix values. The clones, CoLk 21203, CoLk 20203 (early maturing) and CoLk 20205 (mid-late maturing) are being tested in the multi-location trials of AICRP (Sugarcane).

DUS Testing in Sugarcane (Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority)

Maintenance of reference collection of sugarcane varieties

A total of 180 sugarcane clones were maintained as reference collection for the sugarcane DUS Testing during the crop season 2024-25. This reference collection includes all the identified, released and notified varieties from CVRC, varieties released from states and clones from Advanced Varietal Trials of AICRP(S) available with different research organization working on sugarcane. Observations on various morphological traits used for DUS testing were recorded on the sugarcane clones maintained in the reference collection as per the DUS Testing guidelines.

DUS Testing Trial

DUS Testing Trial comprising of five sugarcane varieties, *viz.*, CoLk 11203, CoLk 11206, CoLk 12207, CoLk 12209 and Co 12029 has been completed during 2023-24. The certified DUS data of these five varieties along with the reference varieties for the two crop seasons has been submitted to the Authority.

The DUS Testing Trial (2024-25/First year) comprising of 04 newly released sugarcane varieties, CoLk 15201, CoLk 15207, CoLk 15466 and Co 16030 along with reference varieties has been planted at main DUS testing centre, Lucknow. The observations on DUS characters will be recorded as per the DUS testing procedure in sugarcane.

Biotechnological interventions for accelerated genetic gains

Investigating the differentially expressed sugarcane proteins in red rot susceptible and tolerant sugarcane cultivars during *C. falcatum* infection

The proteome of *C. falcatum* was analyzed through nanoLC-MS/MS to investigate the abundance of proteins implicated in host penetration during red rot disease (Fig. 1.2). Actin cytoskeleton-regulatory complex proteins are diverse group of fungal proteins, implicated in supporting the actin cytoskeleton of fungi, and polarized hyphal growth during host penetration. Through study of *C. falcatum* proteome, we found exclusive abundance of two actin cytoskeleton-regulatory complex proteins (A1CD74, and Q4WG58) in CFS1 and CFS2 samples. Further, the average peptide counts of both the proteins (A1CD74, and Q4WG58) were relatively higher in CFS2 samples, compared to CFS1. In filamentous fungi, the process of autophagy plays a vital role in boosting the accumulation of pressure of appressoria (infection structure of fungi) which is required to invade the host cell wall. In *C. falcatum* cultured with sugarcane stalks (CFS1 and CFS2), the proteome analysis revealed exclusive abundance of two autophagy-related proteins (Q2GYD8, and Q871L5), suggesting their role in inducing pathogenicity during red rot disease. Histone methylation is customarily known to regulate chromatin structure in higher organisms. In some filamentous fungi, histone-lysine N-methyltransferase proteins revealed their participation in enhancing the hyphal growth, and production of fungal spores. The proteome analysis also revealed the exclusive abundance of two histone-lysine N-methyltransferase proteins (Q4WTT2, and Q8X0S9) in *C. falcatum* samples cultured with sugarcane stalks (CFS1 and CFS2).

Transcriptomics based identification of host and pathogen genes involved in red rot disease of sugarcane and their validation

To substantiate the protein abundance, we evaluated the real time expression of genes corresponding to both the actin cytoskeleton-regulatory complex

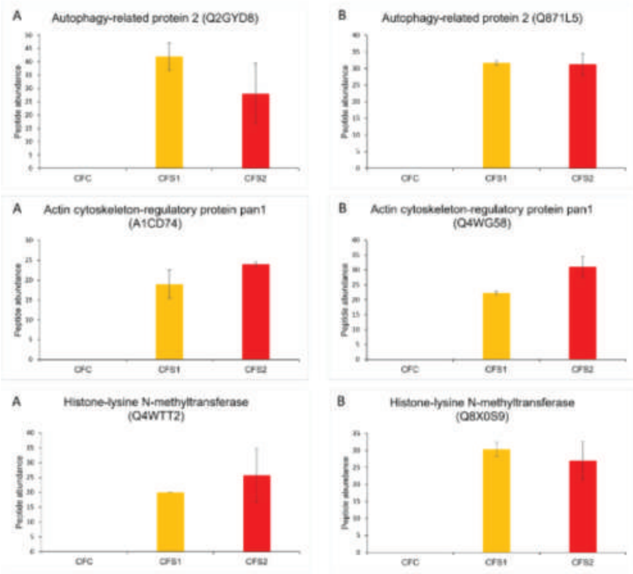


Fig. 1.2. Protein abundance of actin cytoskeleton-regulatory proteins, autophagy-related proteins, and histone-lysine N-methyltransferase proteins in CFC, CFS1, and CFS2 samples. X-axis represents the treatments, along with control, while Y-axis represents the peptide abundance. Error Bars denote the standard error, calculated from the standard deviation of biological triplicates. CFC= Control *C. falcatum* without sugarcane stalk tissues at full strength PDB; CFS1= *C. falcatum* with fine-cut sugarcane stalk tissues at ¼ strength PDB; CFS2= *C. falcatum* with fine-cut sugarcane stalk tissues at ½ strength PDB.

proteins (A1CD74, and Q4WG58). The results indicated significant enhancement in the expression of both the genes in *C. falcatum* samples cultured with sugarcane stalks (CFS1, CFS2, and CFS3), compared to control (CFC). However, the gene corresponding to Q4WG58 protein, displayed reduced expression in CFS3 samples, compared to CFS1, and CFS2 counterparts. Real-time expression analysis of both of the autophagy-related genes (belonging to uniprot IDs- Q2GYD8, and Q871L5), also corroborated the results of proteomics (Fig. 1.3). Both the genes by demonstrated a significant upsurge in the expression in *C. falcatum* cultured with sugarcane stalk (CFS1, CFS2, and CFS3), compared to control (CFC). In case of histone-lysine N-methyltransferase genes also, corresponding to Q4WTT2 protein, the expression was considerably higher in *C. falcatum* samples cultured with sugarcane stalks (CFS1, CFS2, and CFS3), compared to control (CFC). However, expression of histone-lysine N-methyltransferase gene, corresponding to Q8X0S9 protein, was not induced in CFS1, and CFS3 samples of *C. falcatum*, compared to CFS2 counterpart.

Enhancing climate resilience and ensuring food security with genome editing tools (ICAR EFC Project)

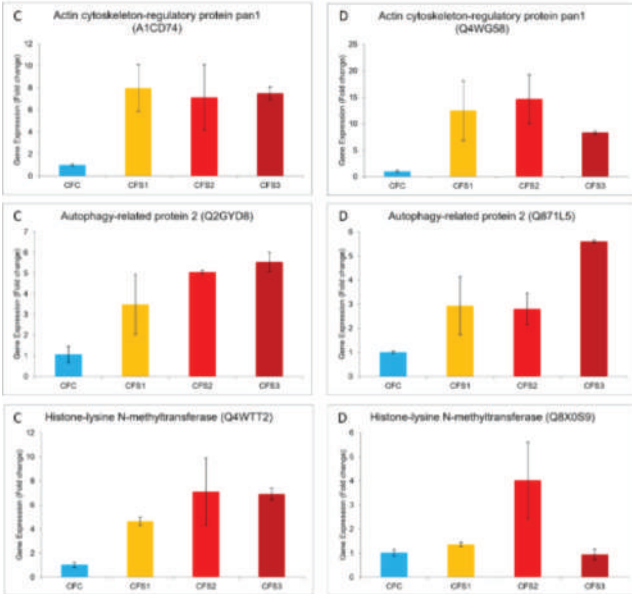


Fig. 1.3. Gene expression of actin cytoskeleton-regulatory proteins, autophagy-related proteins, and histone-lysine N-methyltransferase proteins in CFC, CFS1, CFS2, and CFS3 samples. X-axis represents the treatments, along with control, while Y-axis represents the fold change in gene expression. Error Bars denote the standard error, calculated from the standard deviation of biological triplicates. CFC= Control *C. falcatum* without sugarcane stalk tissues at full strength PDB; CFS1= *C. falcatum* with fine-cut sugarcane stalk tissues at ¼ strength PDB; CFS2= *C. falcatum* with fine-cut sugarcane stalk tissues at ½ strength PDB; CFS3= *C. falcatum* with fine-cut sugarcane stalk tissues at full strength PDB.

Component: Reducing the lignin content by knocking-down *COMT* gene in sugarcane though CRISPR-CAS approach

COMT (caffeic acid/5-hydroxyferulic acid *O*-methyltransferase) is a crucial gene associated with lignin biosynthesis. COMT enzyme catalyses the methylation step and converts the aldehyde and alcohol precursors of 'S' lignin into 5-hydroxy-coniferaldehyde and 5-hydroxyconiferyl alcohol to finally yield sinapaldehyde and sinapyl alcohol, respectively. CRISPR-CAS approach shall be used to knock-down the expression of *COMT* gene to reduce the lignin content in sugarcane. We have searched the sugarcane genome database (https://sugarcane-genome.cirad.fr/) to get the information about the number of *COMT* gene homologues and their respective sequences including exons and introns. In the search we found 7 homologues of COMT gene, each having two exons named as Exon-1 and Exon-2 in our study. Further, we have designed discrete primers for each homologue to get the respective gene sequences of homologues in our sugarcane. We have also designed a single gRNA sequence from the consensus sequence present commonly in

Exon-1 of all the homologues. The gRNA sequence has been designed using PAM motif (NGG) of Cas9 endonuclease.

Component: Sugar content modification

Sucrose content modification: In our previous study (Plant Gene 2022), a gene *RAV6* playing a key role in invertase-mediated control of sucrose accumulation was identified to be over-expressed in late sugar accumulation genotypes. *RAV*6, when searched in the sugarcane reference genome (*S.* hybrid R570), three chromosomal locations-Chromosome 1, 3, and 7 were found to contain 17 copies of the *RAV6* gene, including allelic variants across these loci. *RAV6* locus harbouring the target sequence was amplified in a mid-late variety, CoLk 15207, and the presence of gRNA target sequences was confirmed through sequencing. For the knock-out study, two guide RNA (gRNA) sites were identified to target conserved regions across all 17 copies of the gene. gRNA was cloned in to a multiplexing vector pRGEB32. Two selected clones were analysed for correct orientation and sequence integrity. Further, one confirmed clone was used for transformation in *Agrobacterium* strain EHA105 is being used for transformation in a late sugar accumulation variety CoLk 15207.

Quality seed production and clean seed program

Seed production in agricultural crops (ICAR Seed Project)

During the year 2024-25, approximately 10150 quintals of seed cane was produced. The variety CoLk 14201 is very much in demand and all the seed produced during the season was supplied through the *Ganna Vikas Parishad* and to individual farmers of almost all cane growing districts of Uttar Pradesh. This variety is gaining popularity among sugarcane farmers as well as sugar mills. After inclusion in the seed chain in 2021-22, horizontal spread of this variety is very fast. During 2024-25, it has occupied about 1.22 lakh hectares area in Uttar Pradesh. More than 21 lakhs single buds of newly released sugarcane varieties (CoLk 16202 and CoLk 15466) were supplied to the various Cane Development Council through the allotment made by the Cane Commissioner, Govt. of Uttar Pradesh.

For the first time, on-line booking system of seed cane was started through ISRI website during 2024-25. More than 2000 farmers (1003 in Autumn and 1009 in Spring season) from Uttar Pradesh, Uttarakhand, Haryana, Punjab and Bihar booked their seed requirement in online mode. Each farmer was given 300 single buds of a variety as per their requisition. During the autumn season 2024 and spring season of 2025, a total of 12.0 ha area was planted with newly released varieties for seed cane production, and a new variety CoS 18231 included in the seed production for 2024-25. Under Seed Cane Awareness, seed of newly released varieties CoLk 16202, CoLk 15466 and CoLk 14201 were distributed to farmers and several sugar industries of Uttar Pradesh, and Bihar. Field Visits of the farmers and other stakeholders to popularize recently released and notified varieties were also organized at the Institute.

Production of disease-free and genetically pure seed cane through micropropagation

A total of 110 nos. of fresh *in vitro* cultures of sugarcane varieties, CoLk 14201 (Ikshu-10; early: 27 stocks), CoLk 15201 (Ikshu 11; early: 08 stocks), CoLk 15466 (Ikshu 13; early: 20 stocks), CoLk 15207 (Ikshu 12; 20 stocks) and CoLk 16202 (20 stocks) were established under *in vitro* conditions. These established mother cultures were virus indexed. Most of these cultures are in 3rd-4th cycle of multiplication.

Virus-indexed mother stock cultures were supplied to TC Units of Balrampur Chini Mills Limited, Haidergarh (CoLk 94184), UP Cooperative Sugar Mills, Azamgarh Unit (CoLk 14201), and Nasirpur Farms, Patiala (CoLk 16202). Fresh virus-indexed mother cultures of sugarcane varieties, CoLk 14201, CoLk 15201, CoLk 15466, CoLk 15207, and CoLk 16202 were established under *in vitro* conditions.

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Table 1.3: Seed cane availability for the crop season (2025-26)

S. No.	Variety	Approx. quantity (q)	S. No.	Variety	Approx. quantity (q)
1	CoLk 16202	4510.0	9	CoLk 15201	130.0
2	CoLk 14201	1830.0	10	CoLk 9709	120.0
3	CoLk 11203	950.0	11	CoLk 12207	120.0
4	CoLk 15207	500.0	12	CoLk 09204	100.0
5	CoLk 15466	480.0	13	CoLk 16466	100.0
6	CoLk 16470	350.0	14	CoLk 94184	100.0
7	CoLk 14204	150.0	15	CoLk 12209	100.0
8	CoLk 15206	150.0	16	CoLk 11206	50.0
Total quantity 9740.0 quintal					

Accredited Test Laboratory under National Certification System for Tissue Culture-raised Plants (DBT, New Delhi)

An Accredited Test Laboratory (ATL) for genetic fidelity and virus indexing of tissue culture raised plants is under operation at ISRI, Lucknow, with the financial support from the Department of Biotechnology (DBT), New Delhi, under NCS-TCP (2021-2026). The aim of ATL is to support the tissue culture production units for testing of mother stock and TC plants so as to ensure genetically uniform and virus-free planting materials to the farmers. During the year 2025, a total of 37965 (as against 30042 samples in 2024) were tested, out of which 3955 samples comprising of 90 samples of sugarcane, 3860 of banana and 85 of potato from DBT recognized tissue culture production facilities were tested for mother stock virus indexing. Of the total samples, 34013 samples comprising of 33436 samples of banana, 325 of sugarcane, and 252 of Black Pepper were tested for genetic fidelity testing, which equals to quality certification of ~35 million tissue culture plantlets, for which test reports and certificate of quality were issued as per DBT Guidelines. The testing included virus indexing of sugarcane for *Sugarcane mosaic virus* (SCMV), *Sugarcane yellow leaf virus* (SCYLV), *Sugarcane bacilliform virus* (SCBV), and phytoplasma, and banana samples for *Banana bract mosaic virus* (BBrMv), *Cucumber mosaic virus* (CMV), *Banana bunchy top virus* (BBTV), and *Banana streak virus* (BSV)].

Revenue Generation

During FY 2024-25, a total of Rs 47.35 lakh revenue was generated through sale of sugarcane planting material (Seed cane). The sugarcane seed was supplied to different *Ganna Vikas Parishad* located in various sugarcane growing districts of Uttar Pradesh and sugarcane seed material of different varieties were made available to the farmers.

Thus, A total of 9,740 q of seed cane was made available during the period. The distribution was dominated by CoLk 16202 (4510 q), followed by CoLk 14201 (1830 q) and CoLk 11203 (950 q), reflecting ongoing varietal diversification.

CHAPTER 2

Natural Resource Management

Enhancing Productivity, Sustainability and Resilience in Sugarcane

Long-term strategies for the management of *Cyperus rotundus* L. in Sugarcane

Infestation of *Cyperus rotundus* (purple nutsedge) has emerged as a serious constraint in sugarcane cultivation causing substantial yield and economic losses, particularly during the early crop growth stages due to intense competition for nutrients, moisture and space. Its rapid growth, early emergence and increasing resistance to herbicides limit the effectiveness of individual control measures, necessitating a well-planned integrated weed management approach. In this context, to enhance the comprehensive insights, a project entitled "Long-term Strategies for the Management of *C. rotundus* in Sugarcane" was initiated during 2023–24 to develop sustainable and efficient control strategies by exploiting its biological weaknesses such as shade intolerance, with systematic field evaluation of integrated approaches planned during 2024–25. The project consisted following experiments as detailed below:

a) Herbicide Synergy on population and dry weight of *C. rotundus* and other weeds in sugarcane

The experiment tested various new herbicide molecules, either alone or in combination as tank-mixed formulations, to assess their efficacy. These treatments were replicated three times using a Randomized Block Design (RBD). The objective was to evaluate the effectiveness of these herbicides on weed control, particularly *C. rotundus*, in a sugarcane crop. The data (Table 2.1) revealed that weed dry matter of *Cyperus rotundus* and tubers was significantly influenced by treatments at both 60 and 90 DAP, whereas dry weight of other weeds remained non-significant. Post-emergence application of halosulfuron alone or in combination with 2,4-D recorded the lowest dry weight of *C. rotundus* and tubers, particularly at 90 DAP, indicating its higher efficacy against sedges. Integrated and ready-mix pre-emergence treatments maintained moderate suppression of *C. rotundus*. The control plot consistently recorded higher weed and tuber dry weight, reflecting unchecked weed growth.

Dry weight of individual weed species such as *Echinochloa colona, Parthenium hysterophorus, Dactyloctenium aegyptium and Paspalum spp.* did not differ significantly among treatments at both stages. However, most herbicidal treatments considerably reduced weed dry weight compared to the control, with several treatments recording minimal values (close to 1.0 g m^{-2}). Ready-mix and integrated herbicide treatments provided broader-spectrum control across weed species. Post-emergence sulfonylurea herbicides, particularly halosulfuron-based treatments, were more effective against *Cyperus rotundus* and tuber formation, while integrated and ready-mix PE/PPI treatments ensured broader weed suppression

Effect on Sugarcane growth, yield attributes and sugarcane yield

The treatment involving sulfentrazone followed by sulfentrazone + clomazone (PPI & PE) recorded the highest germination (54.26%), maximum tiller population at 150 DAP (117.64 $\times 10^3$ ha^{-1}), shoot count at 180 DAP (125.14 $\times 10^3$ ha^{-1}) and NMC at 280 DAP (103.75 $\times 10^3$ ha^{-1}), indicating superior crop establishment and stand maintenance (Table 2.2). Ready-mix treatments such as clomazone + metribuzine, clomazone + sulfentrazone and 2,4-D + metribuzine + pyrazosulfuron also maintained relatively higher tiller density and NMC (88.05–95.70 $\times 10^3$ ha^{-1}) compared to single post-emergence treatments. The control plot recorded the lowest germination (36.57%) and NMC (63.05 $\times 10^3$ ha^{-1}). The highest cane yield was obtained with sulfentrazone followed by sulfentrazone + clomazone (98.61 t/ha). This treatment also produced the longest canes (188.0 cm), while higher cane girth (25.43 mm) and maximum single-cane weight (1.00 kg) were recorded under ethoxysulfuron + 2,4-D and clomazone + metribuzine, respectively.

b). Integrated approaches for management of *Cyperus rotundus* for higher sugarcane system productivity in sub-tropics

A field experiment comprising 10 treatments *viz.* deep summer ploughing + either green manuring in situ (*Sesbania* sp) or post-emergence application of glyphosate twice and both the treatments were supplemented with stale seed bed preparation using herbicide. Further these treatments were superimposed with pre-emergence application of sulfentrazone @ 0.75 kg/ha followed by mulching with previous crop residues and post- emergence application of halosulfuron @ 0.07 kg/ha + 2,4-D @

Table 2.1. Effect of herbicide combinations on population and dry weight of *Cyperus rotundus* and other weeds in sugarcane

	Treatment	*Cyperus rotundus* (g/m^2)		*Other weeds* (g/m^2)		*Dry weight of tuber* (g/m^2)	
		60 DAP	90 DAP	60 DAP	90 DAP	60 DAP	90 DAP
T1	Sulfentrazone @ 0.75-1.0 kg/ha PE+Ametryn @ 1.0 kg/ha PE	9.099	10.744	1.000	1.000	6.656	6.203
T2	Sulfentrazone @ 0.75-1.0 kg/ha PE+2,4-D @ 1.5 kg/ha PO	8.500	8.950	5.717	1.000	8.907	6.420
T3	Halosulfuron @ 0.09 kg/ha PO	6.502	1.000	4.871	3.929	6.452	1.000
T4	Flaxasulfuron @ 0.375 kg/ha PO	8.375	6.781	3.313	1.000	8.065	6.564
T5	Ethoxysulfuron @ 0.06 kg/ha PO	7.970	8.358	4.156	2.661	7.224	7.559
T6	Halosulfuron @ 0.0675 kg/ha + 2,4-D @ 1.0 kg /ha PO	6.090	1.000	4.797	3.304	8.213	1.000
T7	Flaxasulfuron @ 0.375 kg/ha+2,4-D @ 1.0 kg/ha PO	6.932	10.218	4.275	2.036	7.966	7.971
T8	Ethoxysulfuron @ 0.06 kg/ha + 2,4-D @ 1.0 kg/ha PO	7.084	7.487	6.491	2.148	7.707	5.718
T9	Sulfentrazone @ fb Sulfentrazone 28% WP + Clomazone 30% (ready mix) 360 fb 700 + 750 PPI & PE	8.520	9.036	6.694	1.000	6.958	6.008
T10	Clomazone 22.5% + Metribuzine 21% WP (ready mix) 56.3 + 525 PE	9.660	10.647	6.848	2.170	7.222	6.857
T11	Clomazone 30% + Sulfentrazone 28% WP (ready mix) 700 + 750 PE	7.241	7.068	5.047	4.158	6.778	4.881
T12	Mesotrione 2.27% + Atrazine 22.7% SC 875 PO	10.303	9.775	8.051	3.211	8.220	6.618
T13	Halosulfuron methyl + Metribuzine (ready mix) 54+247.5 PO	8.066	6.745	1.000	2.598	9.672	6.193
T14	2-4 D sodium salt + Metribuzine + Pyrazosulfuronethyal (ready mix) 1320+1050+30 PO	7.677	6.999	6.537	1.962	8.254	6.715
T15	Control	10.095	9.571	7.854	2.981	8.058	6.717
LSD (p=0.05)		2.159	2.641	NS	NS	1.609	1.744

*Data is subjected to square root transformation using √X+1.

1.5 kg/ha. Pre-emergence application of atrazine @ 2.0 kg/ha + post-emergence application of 2,4-D @ 1.0 kg/ha as PO at 60 DAP followed by one interculture operation at 90 DAP as standard check and farmer's practice (Control) were included. The experiment was laid out in RBD with three replications.

The weed density in sugarcane was significantly influenced by different weed management treatments, with a clear and consistent trend of reduction as the intensity of integrated practices increased. *Motha* (*Cyperus spp*.) density was relatively high under treatments involving only deep summer ploughing combined with green manuring or glyphosate application (T1 and T2) at mustard harvest as well as at 60 and 90 DAP.

Introduction of the stale seedbed technique prior to sugarcane planting (T3 and T4) effectively reduced *motha* population by eliminating the initial flush of emerging weeds (Table 2.3). A further decline in *motha* density was observed with the addition of pre-emergence application of sulfentrazone along with crop residue mulching (T5 and T6), indicating suppression of tuber sprouting and early establishment. The lowest *motha* density throughout the crop growth period was recorded under treatments receiving both pre- and post-emergence herbicides, particularly halosulfuron + 2,4-D (T7 and T8), which proved superior to the ISRI recommended practice (T9) and farmers' practice (T_{10}).

Table 2.2. Cane growth and its attributes as influenced by treatments in Sugarcane

	Treatment	Germination %	Tillers count (000/ha)		Shoot count (000/ha)	NMC count (000/ha)	Yield (t/ha)
		45 DAP	150 DAP	180 DAP	240 DAP	280 DAP	
T1	Sulfentrazone @ 0.75-1.0 kg/ha PE+Ametryn @ 1.0 kg/ha PE	40.740	77.360	111.387	104.860	77.087	75.140
T2	Sulfentrazone @ 0.75-1.0 kg/ha PE+2,4-D @ 1.5 kg/ha PO	40.463	77.083	109.997	104.583	76.250	72.083
T3	Halosulfuron @ 0.09 kg/ha PO	41.573	89.443	115.280	106.663	84.307	81.803
T4	Flaxasulfuron @ 0.375 kg/ha PO	40.373	76.113	111.387	100.693	71.667	71.807
T5	Ethoxysulfuron @ 0.06 kg/ha PO	40.370	74.723	106.110	98.057	71.387	69.583
T6	Halosulfuron @ 0.0675 kg/ha + 2,4-D @ 1.0 kg /ha PO	38.980	74.443	106.803	97.360	70.140	68.057
T7	Flaxasulfuron @ 0.375 kg/ha+2,4-D @ 1.0 kg/ha PO	37.777	72.363	104.443	95.277	69.997	66.663
T8	Ethoxysulfuron @ 0.06 kg/ha + 2,4-D @ 1.0 kg/ha PO	36.667	70.833	100.693	94.303	63.333	60.973
T9	Sulfentrazone @ fb Sulfentrazone 28% WP + Clomazone 30% (ready mix) 360 fb 700 + 750 PPI & PE	54.257	117.637	125.140	120.610	103.750	98.613
T10	Clomazone 22.5% + Metribuzine 21% WP (ready mix) 56.3 + 525 PE	45.183	102.497	125.693	118.610	88.053	85.833
T11	Clomazone 30% + Sulfentrazone 28% WP (ready mix) 700 + 750 PE	44.077	92.223	123.053	110.417	86.390	84.307
T12	Mesotrione 2.27% + Atrazine 22.7% SC 875 PO	42.503	90.277	115.833	109.583	85.973	83.750
T13	Halosulfuron methyl + Metribuzine (ready mix) 54+247.5 PO	41.113	87.080	113.333	105.140	81.663	77.913
T14	2-4 D sodium salt + Metribuzine + Pyrazosulfuronethyal (ready mix) 1320+1050+30 PO	46.020	111.943	118.193	120.057	95.697	92.223
T15	Control	36.573	68.890	95.697	85.693	63.053	47.917
SE(m)		1.954	4.279	6.015	5.517	5.310	3.570
C.D.		5.690	12.461	17.515	16.065	15.462	10.396

Similar response was observed for other weed species, including grasses and broad-leaved weeds. Cultural practices alone (T1 and T2) recorded comparatively higher densities of associated weeds, while the stale seedbed technique (T3 and T4) significantly reduced their population at 60 and 90 DAP. The integration of sulfentrazone as pre-emergence herbicide with mulching (T5 and T6) further minimized weed emergence by restricting light penetration and weed seed germination. The most effective control of mixed weed flora was achieved under integrated treatments T7 and T8, which registered the lowest density of other weeds due to broader spectrum control offered by sequential herbicide application. Although the recommended practice (T9) effectively reduced weed density compared to farmers' practice (T10), it was less effective than the integrated weed management treatments.

Overall, the results indicated that integrated weed management strategies combining cultural, mechanical and chemical methods are most effective in reducing *motha* and other weed densities in sugarcane.

Species-wise weed dry matter as influenced by weed management

Higher dry matter of *motha* was recorded under treatments involving only cultural practices (T1 and T2) and farmers' practice (T10) at mustard harvest as well as at 60 and 90 DAP, indicating poor suppression of perennial sedges (Table 2.3). Inclusion of the stale seedbed technique (T3 and T4) resulted in a noticeable reduction in *motha* dry matter due to depletion of early-emerging propagules. Further reduction was observed with the application of sulfentrazone along with mulching (T5 and T6). The lowest *motha* dry matter at 60 and 90 DAP was recorded under integrated treatments involving sequential application of pre- and post-emergence herbicides, particularly T7 and T8, demonstrating their effectiveness in restricting growth and biomass accumulation of *motha*. Dry matter accumulation of total weeds followed a similar trend. Treatments T1 and T2 recorded higher total weed dry matter at both stages, while farmers' practice (T10) also showed comparatively higher weed biomass. The introduction of stale seedbed, pre-emergence herbicide and mulching significantly reduced total weed dry matter under T3 to T6. The minimum total weed dry matter at 60 and 90 DAP was observed under T7 and T8, which were comparable or superior to the ISRI recommended practice (T9).

Among individual weed species, grasses and broad-leaved weeds such as *Parthenium*, crowfoot grass and *Paspalum* contributed substantially to weed biomass under conventional practices. Their dry matter accumulation was progressively reduced with integrated weed management practices, with the lowest values recorded under T7 and T8. Overall, the results clearly indicate that integrated weed management involving stale seedbed, mulching, and sequential application of pre- and post-emergence herbicides was most effective in minimizing species-wise weed dry matter accumulation in sugarcane.

Growth, yield and quality of sugarcane as influenced by weed management strategies

Sugarcane growth was significantly influenced by weed management treatments (Table 2.4). Germination at 45 DAP increased from 35.1% under farmers' practice (T10) to >45% under integrated treatments, with the highest in T7 (45.9%) and T8 (45.0%). Tiller population was markedly higher under improved weed control, peaking in T8 (100.6 thousand ha^{-1} at 150 DAP) compared to T10 (52.5 thousand ha^{-1}). Similar trends were observed for shoot population and number of millable canes (NMC), with T8 recording the highest NMC (81.1 thousand ha^{-1}), followed by T7 (75.8 thousand ha^{-1}). Yield attributes also improved, as cane length (198.3 cm), girth (27.42 mm), and single cane weight (1.133 kg) were highest under T8, followed by T7. Consequently, cane yield was maximized in T8 (104.7 t ha^{-1}) and T7 (101.4 t ha^{-1}), significantly outperforming ISRI recommended practice (71.4 t ha^{-1}) and farmers' practice (50.0 t ha^{-1}). Overall, integrated weed management involving stale seedbed, pre-emergence sulfentrazone with mulching, and post-emergence application of halosulfuron +

Table 2.3. Weed dry weight (g/m^2) as influenced by treatments in Sugarcane

Treatment	*Cyperus rotundus* (g/m^2)			*Other Weeds* (g/m^2)	
	At mustard harvest	60 DAP	90 DAP	60 DAP	90 DAP
T1:Deep summer ploughing (May-June) +Green manuring (July-August) + oilseed (September-February) fb Sugarcane planting	11.460	9.438	7.010	4.840	10.436
T2: Deep summer ploughing (May-June) fb Glyphosate application twice (July-August) + oilseed crops fb Sugarcane planting)	9.243	8.189	6.644	4.704	10.384
T3: T1 + Stale Seed bed (March) before planting of Sugarcane	9.053	7.972	6.495	3.227	9.909
T4: T2 + Stale Seed bed (March) before planting of Sugarcane	8.838	7.543	6.232	3.162	9.758
T5: T3 + pre-emergence application of sulfentrazone @ 0.75 kg/ha fb mulching with previous crop residues	7.813	7.036	6.015	2.606	8.413
T6: T4 + pre emergence application of sulfentrazone @ 0.75 kg/ha fb mulching with previous crop residues	7.587	6.223	5.946	2.401	8.101
T7: T5 + post emergence application of halosulfuron @ 0.70 kg/ha + 2,4-D @ 1.5 kg/ha (PO)	7.530	5.601	5.621	1.000	5.864
T8: T6 + post emergence application of halosulfuron @ 0.70 kg/ha + 2,4-D @ 1.5 kg/ha (PO)	7.218	4.843	5.345	1.000	5.250
T9: Atrazine 20 kg PE + 2,4-D 1.0 kg/ha at 60 DAP fb intercul-ture at 90 DAP (ISRI Recommended practice)	7.798	7.638	5.141	1.000	2.696
T10: Control (Farmers practices) ie early rice fb mustard-Sug-arcane	11.944	9.496	4.587	1.545	4.016
SE(m)	1.176	1.126	0.381	0.990	1.030
LSD (p=0.05)	NS	NS	1.139	NS	3.084

Table 2.4. Cane attributes and cane yield as influenced by treatments in Sugarcane

Treatment	Germination %	Tillers count (000/ha)		Shoot count (000/ha)	NMC count (000/ha)	Yield (t/ha)
	45 DAP	150 DAP	180 DAP	240 DAP	280 DAP	
T1: Deep summer ploughing (May-June) +Green manuring (July-August) + oilseed (September-February) fb Sugarcane planting	36.267	64.480	87.630	89.517	58.520	65.850
T2: Deep summer ploughing (May-June) fb Glyphosate application twice (July-August) + oilseed crops fb Sugarcane planting)	36.400	64.813	89.443	86.147	60.703	68.777
T3: T1 + Stale Seed bed (March) before planting of Sugarcane	37.467	67.113	93.590	87.593	60.850	75.297
T4: T2 + Stale Seed bed (March) before planting of Sugarcane	41.197	72.667	90.110	94.297	70.703	87.370
T5: T3 + pre-emergence application of sulfentrazone @ 0.75 kg/ha fb mulching with previous crop residues	42.163	74.703	92.740	96.187	71.370	90.480
T6: T4 + pre-emergence application of sulfentrazone @ 0.75 kg/ha fb mulching with previous crop residues	45.303	75.297	93.003	99.963	75.223	95.780
T7: T5 + post emergence application of halosulfuron @ 0.70 kg/ha + 2,4-D @ 1.5 kg/ha (PO)	45.900	83.553	97.590	100.777	75.780	101.443
T8: T6 + post emergence application of halosulfuron @ 0.70 kg/ha + 2,4-D @ 1.5 kg/ha (PO)	45.037	100.630	105.890	106.337	81.147	104.703
T9: Atrazine 20 kg PE + 2,4-D 1.0 kg/ha at 60 DAP fb interculture at 90 DAP (ISRI Recommended practice)	40.807	64.183	87.257	86.667	64.593	71.443
T10: Control (Farmers practices) ie early rice fb mustard-Sugarcane	35.110	52.483	64.037	66.520	54.963	50.037
SE(m)	4.062	1.645	3.480	3.625	2.387	2.761
LSD (p=0.05)	NS	4.924	10.419	10.855	7.148	8.267

2,4-D proved most effective in improving sugarcane growth, yield attributes, cane yield and quality by minimizing weed competition and enhancing crop vigour.

Improved agronomic interventions for enhancing productivity of sugarcane ratoon crop

Tiller and shoot populations varied with ratoon initiation time (Table 2.5). The highest tiller count was observed in February-initiated ratoon (187,767 ha^{-1}), followed by March and April, while the lowest was recorded in May (149,574 ha^{-1}) at 150–180 DARI, though differences were not statistically significant. Shoot population was also highest in February (156,433 ha^{-1}), which was at par with March but significantly higher than April and May; the lowest was recorded in May (115,885 ha^{-1}).

Among fertilizer treatments, STCR-based NPK application without IPNS produced the highest tiller count at 150 DARI (182,963 ha^{-1}). However, at later stages, STCR with IPNS recorded slightly higher shoot population (152,798 ha^{-1}), followed by STCR without IPNS (143,789 ha^{-1}).

Effect of date of ratoon initiation on single cane parameters and sugarcane yield

The longest canes (240.77 cm) were recorded in February-initiated ratoon, which was significantly superior to April and May, and at par with March. Cane thickness was also highest in February (24.38 mm), significantly exceeding March (21.59 mm), April (21.08 mm), and May (19.10 mm), with the thinnest canes observed in May. Similarly, maximum cane weight (0.951 kg/cane) was recorded in February initiated crop, significantly higher than all other treatments.

The NMC was highest in February (120,823), while the lowest was recorded in May initiated crop, consequently, the highest cane yield was obtained from February initiation (93.79 t/ha), followed by March (89.08 t/ha), April (72.02 t/ha), and May (67.81 t/ha). February ratoon yielded 5.02%, 23.21%, and 27.70% more than March, April, and May,

Table 2.5. Influence of initiation time and fertilizer treatment on shoot population

Date of planting	Shoot population (ha)		
	150 DARI*	180 DARI	Shoot Count
February	187764.10	157969.8	156433.5
March	180850.50	156049.4	145624.1
April	179039.8	142606.3	136076.8
May	149574.1	136954.7	115884.8
SE(m)	13206.5	5158.5	3652.8
CD(p=0.05)	NS	NS	12886.3
Fertilizer treatment			
Recommended NPK	162757.2	141975.3	136749.0
NPK through using STCR Without IPNS	182963.0	150411.50	143786.0
NPK through using STCR with IPNS	177201.6	152798.4	134979.4
SE(m)	6021.5	3675	3525.9
CD (p=0.05)	NS	NS	NS

* Days after ratoon initiation

respectively, and was significantly superior to April and May (Table 2.6).

The soil test crop response (STCR)-based fertilization without IPNS recorded slightly higher cane length (226 cm) and NMC (115,694), whereas STCR with IPNS showed marginally higher cane thickness (21.76 mm) and cane weight (0.833 kg/cane), though differences were non-significant. The highest yield (81.60 t/ha) was observed under STCR without IPNS, followed by STCR with IPNS (80.69 t/ha) and recommended NPK (79.87 t/ha), with no significant differences among treatments.

The highest number of tillers was recorded in the February ratoon initiated crop under treatment T4 (Atrazine 2000g/ha (Pre) fb Ametryn 1500g/ha + 2,4-D 725g/ha (Post) (Table 2.7).

The NMC count, a key yield-attributing trait, was highest in the T4 treatment (Atrazine 2000g/ha (Pre) fb Ametryn 1500g/ha + 2,4-D 725g/ha (Post)) across all herbicidal applications. This treatment recorded NMC values of 115,000, 123,703, 120,740, and 99,259 for February, March, April, and May ratoon initiation, respectively, compared to control values of 93,888, 99,814, 88,888, and 71,296 for the same periods (Fig. 2.1).

Effect of weed control and ratoon initiation date on ratoon crop yield

Yield, being the outcome of yield-attributing traits and overall crop growth, was significantly influenced by ratoon initiation month and herbicidal treatments (Table 2.8). Across all initiation periods, February

Table 2.6. Effect of date of ratoon initiation on single cane parameters and cane yield

Ratoon initiation time	Length (cm)	Girth (mm)	Weight (kg)	NMC (ha)	Yield (t/ha)
February	240.77	24.38	0.951	120823.0	93.79
March	233.66	21.59	0.893	114952.0	89.08
April	224.88	21.08	0.741	105349.8	72.02
May	191.44	19.10	0.653	88724.3	67.81
SE(m)	3.31	0.55	0.036	2763.3	2.97
CD(p=0.05)	11.67	1.94	0.126	9748.4	10.5
Fertilizer treatment					
Recommended NPK	217.58	21.16	0.803	101769.5	79.87
NPK through using STCR Without IPNS	226.00	21.70	0.794	112592.6	81.60
NPK through using STCR with IPNS	224.50	21.76	0.833	108024.7	80.69
SE(m)	5.33	0.45	0.032	158.6	4.36
CD(p=0.05)	NS	NS	NS	NS	NS

Table 2.7. Weed control and ratoon initiation month effects on NMC count

Sr no.	Treatment	NMC (ha)			
		February	March	April	May
1	T1 Control	93,888.900	99,814.810	88,888.880	71,296.300
2	T2 Flumioxazin 50 100g/ha (Pre) fb trash mulching	104,259.300	120,925.900	103,148.100	82,222.230
3	T3 Flumioxazin 100 g/ha fb 2,4-D 725 g/ha + Halosulfuron 67.5 g/ha(Post)*	106,481.500	114,444.400	102,592.600	85,555.550
4	T4 Atrazine 2000g/ha(Pre) fb Ametryn 1500 g/ha + 2,4-D 725 g/ha (Post)*	115,000.000	123,703.700	120,740.700	99,259.250
5	T5 Ametryn 1500 g/ha (Pre) fb SL 160 60 g/ha(Post)*	105,370.400	118,703.700	111,851.900	85,555.550
6	T6 Trash mulching alone@ 10 t/ha	102,407.400	116,851.900	113,333.300	91,111.120
7	T7 Metribuzine 750 g/ha(Pre) fb Trash mulching	102,963.000	113,888.900	107,037.000	91,481.480
8	T8 Trash mulching(10 t/ha) fb 2,4-D 725 g/ha + Ametryn 1500 g/ha(Post)*	106,666.700	117,963.000	100,370.400	85,925.930
9	T9 Trash mulching fb 2,4-D 725 g/ha + halosulfuron 67.5 g/ha(Post)*	105,555.600	121,481.500	109,074.100	79,074.070
10	T10 Hand weeding (At 30, 60 and 90 Days After Ratoon Initiation)	114,074.100	124,259.300	118,518.500	97,037.040
	SE(m)	6,595.193	99,814. 810	88,888.880	6,814.503
	CD(p=0.05)	N/A	N/A	N/A	N/A

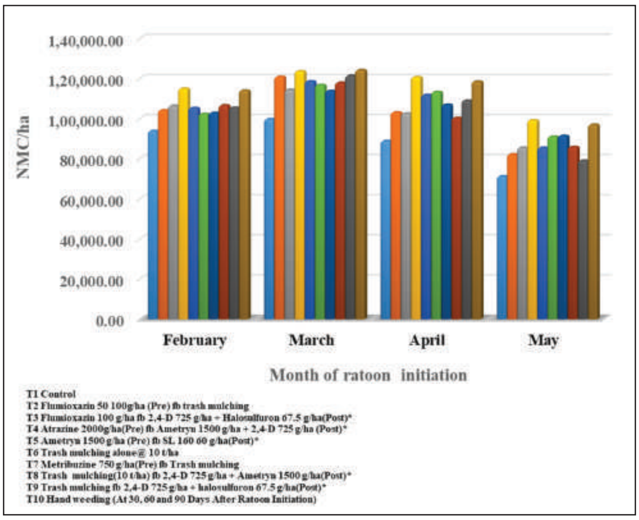


Fig. 2.1. Effect of weed control measures and month of ratoon initiation on NMC of ratoon crops

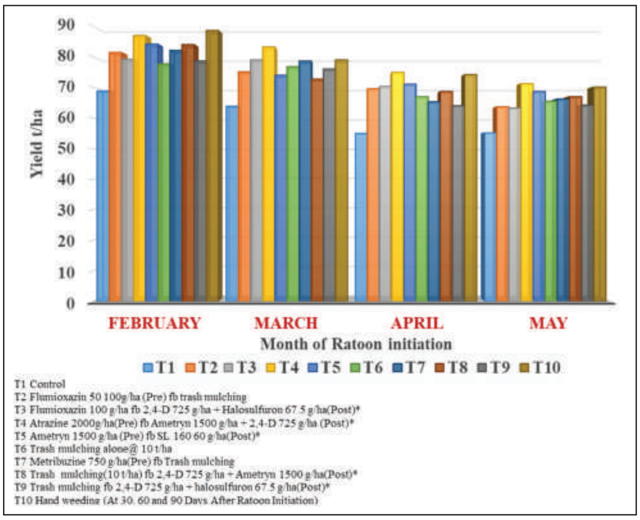


Fig. 2.2. Effect of weed control measures and month of ratoon initiation on yield of ratoon crops

produced the highest yield. The T4 treatment (Atrazine 2000 g/ha (Pre) fb Ametryn 1500 g/ha + 2,4-D 725 g/ha (Post)) recorded the maximum cane yield of 87.0, 83.3, 75.0, and 71.3 t/ha in February, March, April, and May initiated ratoons, respectively. It was significantly superior to control, T6, and T9; while in March it outperformed control, T5, and T8; in April it was higher than T6, T7, and T9; and in May it exceeded control, T2, and T3.

Considering all the variable it was concluded that February and march month is most suitable month for planting as well as ratoon initiation and secondly T4 Atrazine 2000g/ha (Pre) *fb* Ametryn 1500 g/ha + 2,4-D 725 g/ha (Post)*) was most effective in controlling the weed growth (Fig.2.2).

Enhancing water productivity of sugarcane production system by regulating irrigation regimes and field moisture management

A field experiment was initiated in February 2021 to study the effects of IW/CPE-based irrigation regimes and field moisture management practices on sugarcane growth, yield, water productivity, and water footprint. During 2025–26, the performance of the third ratoon of the crop established in 2022 was evaluated. The ratoon was initiated on 10.02.2025 and harvested on 15.12.2025. The experiment was conducted in 7 × 6 m plots with paired-row planting (150:30 cm). Trenches formed between rows were used for post-monsoon irrigation treatments. A uniform irrigation was applied at 30 and 45 DARI, followed by scheduling as per treatments.

The study included three irrigation regimes based on IW/CPE ratios (1.0, 0.8, 0.6) with 75 mm irrigation depth, and six moisture management practices: flood irrigation without mulch (M1), flood irrigation with mulch (M2), trench irrigation without mulch (M3), trench irrigation with mulch (M4), alternate trench irrigation without mulch (M5), and alternate trench irrigation with mulch (M6). Irrigation water was measured using a water meter. Treatments were arranged in a strip plot design with three replications, with irrigation regimes as main plots and moisture management practices as sub-plots. The recorded data (Table 2.9, 2.10, 2.11, 2.12) indicated that:

- Irrigation regimes and methods significantly influenced sugarcane ratoon growth and yield traits; highest yield was recorded under IW:CPE 1.0 (101.71 t/ha), closely followed by IW:CPE 0.8 (99.54 t/ha)
- Skipping alternate trenches significantly reduced yield (89.77 t/ha), while irrigation at IW:CPE 0.8 showed the highest water productivity, with

Table 2.8. Effect of Weed control measures and month of ratoon initiation on yield of ratoon crops

S. No.	Treatment	Sugarcane yield (t/ha)			
		February	March	April	May
1	T1 Control	68.89	63.88	55.00	55.18
2	T2 Flumioxazin 50 100g/ha (Pre) fb trash mulching	81.48	75.18	69.63	63.70
3	T3 Flumioxazin 100 g/ha fb 2,4-D 725 g/ha + Halosulfuron 67.5 g/ha (Post)*	79.26	79.07	70.37	63.33
4	T4 Atrazine 2000g/ha (Pre) fb Ametryn 1500 g/ha + 2,4-D 725 g/ha (Post)*	87.03	83.33	75.00	71.30
5	T5 Ametryn 1500 g/ha (Pre) fb SL 160 60 g/ha (Post)*	84.25	74.07	71.11	68.70
6	T6 Trash mulching alone@ 10 t/ha	77.77	76.85	67.03	65.55
7	T7 Metribuzine 750 g/ha (Pre) fb Trash mulching	82.22	78.70	65.37	66.29
8	T8 Trash mulching (10 t/ha) fb 2,4-D 725 g/ha + Ametryn 1500 g/ha (Post)*	84.07	72.78	68.70	67.04
9	T9 Trash mulching fb 2,4-D 725 g/ha + halosulfuron 67.5 g/ha (Post)*	78.70	76.11	64.07	64.26
10	T10 Hand weeding (At 30, 60 and 90 Days After Ratoon Initiation)	88.70	79.07	74.26	70.18
	CD(p=0.05)	8.17	8.35	6.77	7.82
	SE(m)	2.72	2.79	2.26	2.61

Table 2.9. Effect of irrigation regime and water application methods on sugarcane third ratoon growth

Treatment	Initial tiller count ('000/ha)	Tiller count 140 DARI ('000/ha)	NMC ('000/ha)	Average cane length (cm)
Irrigation regime (IW:CPE ratio)				
1.0	119.74	107.77	100.58	277.22
0.8	116.14	108.18	100.07	276.00
0.6	111.74	97.93	89.77	272.83
CD (P=0.05)	NS	07.11	6.05	NS
Irrigation method				
Flooding	112.25	111.49	103.29	280.88
Flooding with mulch	115.90	101.78	95.75	274.55
Trench irrigation	118.62	108.55	101.01	278.55
Trench irrigation with mulch	117.41	106.56	94.90	275.33
Skip trench irrigation	108.20	102.29	95.17	274.44
Skip trench with mulch	103.10	97.10	90.72	268.33
CD (P=0.05)	NS	11.52	7.70	11.37

Table 2.10. Effect of irrigation regime and water application methods on sugarcane third ratoon yield and quality

Treatment	Average cane weight (kg)	Average cane girth (cm)	Cane yield (t/ha)	Sucrose (%)
Irrigation regime (IW:CPE ratio)				
1.0	1.233	2.342	101.71	16.38
0.8	1.239	2.304	99.54	15.76
0.6	1.223	2.300	83.77	15.82
CD (P=0.05)	NS	NS	11.44	NS
Irrigation method				
Flooding	1.172	2.220	95.61	16.14
Flooding with mulch	1.207	2.357	98.78	16.06
Trench irrigation	1.191	2.274	96.20	15.89
Trench irrigation with mulch	1.304	2.318	97.89	16.19
Skip trench irrigation	1.229	2.329	91.99	16.15
Skip trench with mulch	1.287	2.393	89.59	15.49
CD (P=0.05)	0.092	NS	7.32	NS

Table 2.11. Effect of irrigation regime and water application methods on quantity of water used and water productivity of sugarcane third ratoon

Treatment	Irrigation water (mm)	Rain (mm)	Total water (mm)	Total Water productivity (m^3/ton)	Irrigation water productivity (m^3/ton)	Irr. Water productivity (Rs/m^3)
Irrigation regime (IW:CPE ratio)						
1.0	925.8	951	1876.8	184.52	91.02	42.84
0.8	735.4	951	1686.4	169.41	73.87	52.78
0.6	640.2	951	1591.2	189.94	76.42	51.03
CD (P=0.05)	-	-	-	-	-	-
Irrigation method						
Flooding	878.22	951	1829.22	191.32	91.85	42.45
Flooding with mulch	862.35	951	1813.35	183.57	87.29	44.67
Trench irrigation	751.28	951	1702.28	176.95	78.08	49.94
Trench irrigation with mulch	735.42	951	1686.42	172.27	75.12	51.91
Skip trench irrigation	703.68	951	1654.68	179.87	76.48	50.98
Skip trench with mulch	671.95	951	1622.95	181.15	74.99	52.00
CD (P=0.05)	-	-	-	-	-	-

mulched trench-based systems performing best among methods.

- Water footprint ranged from 104.92 to 127.39 L/kg, with >65% contribution from rainfall, indicating that irrigation met only about 25–30% of crop water requirement.Third ratoon (Second cycle)

Effect of silicon nutrition on growth, yield, juice quality and soil health of sugarcane under subtropical conditions

A field experiment was conducted to evaluate the integrated effect of silicon sources and silicate solubilizing bacteria (SSB) on growth, yield, juice quality, and soil properties. The experiment comprised ten treatments: T_1 – control (without SSB), T_2 – control with SSB, T_3 – silicon @ 300 kg/ha through bagasse ash without SSB, T_4 – silicon @ 300 kg/ha through bagasse ash with SSB, T_5 – silicon @ 400 kg/ha through bagasse ash without SSB, T_6 – silicon @ 400 kg/ha through bagasse ash with SSB, T_7 – silicon @ 300 kg/ha through diatomaceous earth without SSB, T_8 – silicon @ 300 kg/ha through diatomaceous earth with SSB, T_9 – silicon @ 400 kg/ha through diatomaceous earth without SSB, and T_{10} – silicon @ 400 kg/ha through diatomaceous earth with SSB.

The crop was planted at a spacing of 75 cm using the mid-late maturing sugarcane variety CoLk 09204 in

Table 2.12. Water footprint of sugarcane third ratoon as influenced by irrigation regime and water application method

Treatment	Green water footprint (m^3/ton)	Blue water footprint (m^3/ton)	Grey water footprint (m^3/ton)	Total water footprint (m^3/ton)
Irrigation regime (IW:CPE ratio)				
1.0	58.39	26.87	19.66	104.92
0.8	59.66	27.45	20.09	107.21
0.6	70.89	32.62	32.62	127.39
CD (P=0.05)	-	-	-	-
Irrigation method				
Flooding	62.11	28.584	20.91	111.62
Flooding with mulch	60.12	27.66	20.24	108.03
Trench irrigation	61.73	28.40	20.79	110.93
Trench irrigation with mulch	60.67	27.91	20.43	109.02
Skip trench irrigation	64.56	29.70	21.74	116.01
Skip trench with mulch	66.29	30.50	22.32	119.12
CD (P=0.05)	-	-		-

a randomized block design with three replications. Observations on tillering, number of millable canes (NMC), cane length, and cane yield revealed significant differences among treatments. Application of SSB @ 3 L/ha resulted in a positive response in yield attributes and overall cane yield, both when applied alone and in combination with different silicon sources and levels (Table 2.13). A similar beneficial effect of SSB was also observed in the ratoon crop (Table 2.14).

Assessment and standardization of natural farming techniques for sugarcane production system

An experiment entitled "Assessment and Standardization of Natural Farming Techniques for Sugarcane Production System" was conducted during winter 2022 and 2023 with the objectives to: (i) develop and standardize cow-based fermented liquid formulations for natural farming; (ii) develop feasible technologies to improve soil environment and enhance profitability and sustainability of sugarcane; and (iii) assess the effect of natural farming techniques on soil health and biotic stress in sugarcane-based systems.

The experiment comprised eight treatments, including four nutrient management practices: absolute control (RDF_0: 0 kg NPK), recommended dose of fertilizers (RDF_1), natural farming (NF_1), and organic farming (NF_2: NF_1) supplemented with biofertilizers and organic manures). These were evaluated under two intercropping systems: S_1 (sugarcane + vegetable pea; ratoon + berseem) and S_2 [sugarcane + (vegetable pea–navdhanya–dhaincha); ratoon + (berseem–navdhanya–dhaincha)].

Table 2.13. Number of tillers, NMC, cane length and cane yield as influenced by silicate solubilising bacteria and different sources and dosage of silicon (2nd year plant crop)

Treatment	Tiller no. (000/ha)	NMC (000/ha)	Cane length (cm)	Yield (t/ha)
Control (No SSB)	100.89	92.47	241.98	88.62
Control with SSB	104.02	95.12	244.84	92.28
Silicon @ 300 kg/ha through bagasse ash without SSB	110.28	100.91	253.09	98.40
Silicon @ 300 kg/ha through bagasse ash with SSB	112.21	102.94	255.75	100.95
Silicon @ 400 kg/ha through bagasse ash without SSB	113.55	104.15	260.15	102.57
Silicon @ 400 kg/ha through bagasse ash with SSB	116.64	106.28	262.60	104.89
Silicon @ 300 kg/ha through diatomaceous earth without SSB	110.37	101.15	254.15	98.96
Silicon @ 300 kg/ha through diatomaceous earth with SSB	113.03	103.12	257.18	101.25
Silicon @ 400 kg/ha through diatomaceous earth without SSB	114.36	104.35	260.56	102.90
Silicon @ 400 kg/ha through diatomaceous earth with SSB	116.95	106.53	264.13	105.22
SEm ±	6.13	5.07	8.13	5.81
CD (P=0.05)	2.05	1.69	2.72	1.94

Table 2.14. Number of tillers, NMC, cane length and cane yield as influenced by silicate solubilizing bacteria and different sources and dosage of silicon (1st year ratoon crop)

Treatment	Tiller no. (000/ha)	NMC (000/ha)	Cane length (cm)	Yield (t/ha)
Control (No SSB)	161.28	94.57	232.08	75.21
Control with SSB	164.37	97.74	235.23	78.07
Silicon @ 300 kg/ha through bagasse ash without SSB	174.25	103.62	242.96	83.40
Silicon @ 300 kg/ha through bagasse ash with SSB	179.71	105.61	245.65	85.75
Silicon @ 400 kg/ha through bagasse ash without SSB	182.37	106.84	248.92	86.99
Silicon @ 400 kg/ha through bagasse ash with SSB	185.04	108.95	251.78	88.96
Silicon @ 300 kg/ha through diatomaceous earth without SSB	174.45	103.65	243.59	83.52
Silicon @ 300 kg/ha through diatomaceous earth with SSB	180.26	105.76	246.11	86.03
Silicon @ 400 kg/ha through diatomaceous earth without SSB	183.06	106.95	250.37	87.14
Silicon @ 400 kg/ha through diatomaceous earth with SSB	185.24	109.02	252.13	89.17
SEm ±	9.48	5.30	7.60	5.28
CD (P=0.05)	3.17	1.77	2.54	1.76

Natural farming treatments included the use of cow-based formulations such as Beejamrutha, Drava Jeevamrutha and Ghan Jeevamrutha, along with botanical extracts like Neemastra and Brahmastra. Organic farming treatments involved natural farming practices supplemented with biofertilizers and organic manures.

The data (Table 2.15) indicated that all treatments under both cropping systems (S_1 and S_2), namely RDF_1, NF_2 and NF_1, recorded significantly higher growth parameters, yield attributes, cane yield and commercial cane sugar (CCS) compared to RDF_0. Among the treatments, RDF_1 produced the maximum tillers, number of millable canes, cane length, cane diameter, cane yield and CCS, followed by NF_2 and NF_1 under both systems. The highest sugarcane yield (95.01 t ha^{-1}) was recorded with RDF_1 (93.74 t ha^{-1} in S_1 and 96.28 t ha^{-1} in S_2), which was statistically at par with NF_2 (92.89 t ha^{-1}; 91.81 and 93.26 t ha^{-1} in S_1 and S_2, respectively), followed by NF_1 (82.08 t ha^{-1}). All these treatments were significantly superior to RDF_0 (59.19 t ha^{-1}). A similar trend was observed in the ratoon crop (Table 2.16.). Vegetable pea yield was highest under NF_2, followed by NF_1 and RDF_1 in both cropping systems.

Similarly, data presented in Table 2.16 (ratoon crop) showed that RDF_1, NF_2 and NF_1 under both S_1 and S_2 systems significantly outperformed RDF_0 in terms of growth, yield attributes, cane yield and CCS. The maximum sugarcane yield (80.23 t ha^{-1}) was recorded with RDF_1 (79.11 and 81.42 t ha^{-1} in S_1 and S_2, respectively), which was at par with NF_2 (75.65 t ha^{-1}), followed by NF_1 (72.74 t ha^{-1}), and all were significantly superior to RDF_0 (44.94 t ha^{-1}). The trend of vegetable pea yield remained similar, with NF_2 recording the highest yield, followed by NF_1 and RDF_1 under both cropping systems.

Table 2.15. Effect of nutrient management and intercropping system on sugarcane

Treatment	Germination %	Tillers production at 120 DAP 000' ha^{-1}	NMC 000' ha^{-1}	Height of plant (CM)	Dai (MM)	Sugarcane yield	CCS (t/ha)
RDF_0S_1	34.47	119.08	71.10	252.93	24.80	58.30	7.35
RDF_0S_2	34.93	119.96	72.73	254.17	24.93	60.08	8.09
RDF_1S_1	36.67	155.85	93.84	285.23	26.37	93.74	11.54
RDF_1S_2	36.63	158.25	95.99	289.07	26.57	96.28	10.96
NF_1S_1	37.60	140.77	88.71	270.40	25.53	85.31	10.83
NF_1S_2	37.40	141.98	90.14	273.33	25.70	86.64	10.29
NF_2S_1	37.67	148.54	93.39	279.80	26.30	91.81	11.08
NF_2S_2	37.27	149.90	93.79	282.63	26.40	93.26	11.54
C.D. (0.05%)	1.33	6.82	8.62	9.41	0.68	6.39	1.82

Table 2.16. Effect of nutrient management and intercropping system on sugarcane ratoon

Treatment	Tillers production at 120 DAP 000' ha^{-1}	NMC (000/ha)	Plant height (CM)	Dai (MM)	Sugarcane yield (t/ha)	CCS t
RDF S	128.70	74.33	247.23	24.23	44.26	6.23
RDF^{0}S^1	129.96	76.33	249.27	24.60	45.62	6.12
RDF^{0}S^2	171.09	102.69	276.44	26.10	79.11	10.87
RDF^{1}S^1	173.25	105.39	278.60	26.40	81.42	11.43
NF S^1 ^{2}	155.77	98.96	259.70	24.03	71.82	10.13
NF^{1}S^1	156.98	100.72	262.57	24.83	73.39	10.42
NF^{1}S^2	163.55	102.40	268.60	25.13	75.02	10.56
NF^{2}S^1	165.15	102.63	271.13	25.37	76.28	10.88
CD^2 ^{2}	**9.15**	**5.18**	**6.31**	**0.61**	**7.38**	**1.38**

Sugarcane yield (second year crop) increased to the tune of 45.25, 56.34 and 60.52 percent with NF_1, NF_2 and RDF_1 over RDF_0 (average yield of both S_1& S_2 system 59.19 t ha^{-1}), respectively. Maximum sugarcane yield 95.01 t ha^{-1} was recorded with RDF_1 was at par with NF_2 92.54 t ha^{-1} followed by NF_1 85.97 t ha^{-1}. Maximum vegetable pea yield was recorded with NF2, followed by $NF_1$and RDF_1.

Sugarcane ratoon (first year crop) yield increased to the tune of 61.56, 68.34 and 78.60 percent with NF_1, NF_2 and RDF_1 over RDF_0 (average yield of both S_1& S_2 system 44.94 t ha^{-1}), respectively. Maximum sugarcane yield 80.27 t ha^{-1} was recorded with RDF_1 was at par with NF_2 75.65 t ha^{-1} followed by NF_1 72.61 t ha^{-1}. Maximum vegetable pea yield was recorded with NF2, followed by $NF_1$and RDF_1.

Assessing nutritional management approach for enhanced cane and sugar productivity of multiple ratoons initiated under variable dates

A field experiment was carried out with the objective to 'develop feasible technology to improve the sugarcane ratoon productivity, profitability and sustainability in multiple ratooning system, with the application of sugarcane bagasse ash (SBA), sulphitation press mud cake, brown manuring and potassium silicate. The experiment consisted of 10 treatments in main plot (Nutritional management) five treatments *viz.* N_1: Recommended practices of ratoon management, N_2: N_1 +300 kg Si/ha through sugarcane bagasse ash (SBA), N_3: N_2 +500 kg SPMC (sulphitation press mud cake), N_4: N_3 + foliar spray of 2.5% potassium silicate at 0, 30 and 60 Days of ratoon initiation and N_5: N_5 + brown manuring of *Sesbania* at ratooning, and in sub plot two treatment as dates of sugarcane ratoon initiation *viz.* D_1: 15 December & D_2: 15 February. The experiment was initiated with 3rdratoon initiation on December 2023 and February 2024.

The data (Table 2.17) revealed that, maximum sprout, tillers production, production of number of millable canes, cane length, cane diameter, cane yield and commercial cane sugar was recorded in sugarcane ratoon initiated on 15th February in 3rdratoon. Ratoon initiated on 15th February was significant superior over

Table 2.17. Effect of date of sugarcane ratoon initiation and nutritional management approach on tiller production, NMC, height of plant, cane diameter, cane yield and CCS (3rdratoon)

Treatment	Sprout %	Tillers (June) '000 ha^{-1}	NMC '000 ha^{-1}	Cane length (cm)	Cane diameter (cm)	Cane yield t ha^{-1}	CCS t ha^{-1}
Dates of sugarcane ratoon initiation							
15 Dec. (D_1)	79.61	154.66	80.32	210.49	2.23	57.61	6.68
15 Feb. (D_2)	86.42	197.69	93.21	228.65	2.32	73.67	9.28
CD (P=0.05)	2.70	10.27	10.01	5.80	0.041	7.46	0.68
Nutritional management approach							
N_1	80.61	166.45	82.77	210.59	2.24	60.75	7.48
N_2	81.47	171.72	84.45	216.73	2.26	63.23	7.58
N_3	83.21	176.50	87.03	221.12	2.27	65.37	7.78
N_4	84.37	180.55	88.46	223.57	2.29	68.30	8.36
N_5	85.42	185.65	91.14	225.83	2.31	70.56	8.73
CD (P=0.05)	3.09	4.87	3.73	9.16	NS	1.32	NS

ratoon initiated on 15th December of previous year in all the growth and yield parameters. Among the sub plot treatments all the treatments recorded significant superior over control on production of NMC, cane yield and CCS t/ha in 3rdratoon of sugarcane.

Ratoon initiated on 15th February was significant superior over ratoon initiated on 15th December of previous year in all the growth and yield parameters. Among the sub plot treatments all the treatments recorded significant superior over control on production of NMC, cane yield and CCS t/ha. Sugarcane yield was increased with February initiated ratoon tune of 27.28 percent over previous year January initiated ratoon in 3rdratoon (57.61 t ha^{-1}).

CHAPTER 3

Management of Insect Pests & Diseases

Characterization, diversity and genomics of sugarcane and sugar beet pathogens and their management

Survey and surveillance of insect pests and diseases of sugarcane in subtropical India

During the 2024–25 period, systematic surveys and surveillance visits were conducted across major sugarcane growing areas and sugar mill command regions to assess the incidence of key diseases and insect pests, document varietal performance under field conditions, and engage with farmers on prevailing crop health issues. Field observations revealed the continued prevalence of red rot in several commercial varieties. The disease was noted in varieties such as Co 0238, Co 0118, CoS 8279, as well as in certain unidentified varieties in farmers' fields. In the Riga command area (Sitamarhi), a red rot incidence of approximately 10% was recorded in Co 0238, indicating active disease pressure in the region.

Wilt symptoms were observed in Co 98014, with mild wilt also noted in Co 0118 in localized pockets. Smut infection was recorded in CoP 9301 and Co 0238 suggesting persistent inoculums sources in the region. Moderate to severe incidences of *Pokkah Boeng* were observed across several varieties, including CoP 9301, Co 0118, CoS 8279, and CoLk 14201, indicating the presence of conducive environmental conditions for disease development. Viral disease complexes were widely prevalent, particularly in Co 0238, CoLk 14201, CoPk 5191, Co 0118, and Co 98014. Symptoms such as Leaf Fleck, Ring spot, Mosaic, and Yellow Leaf Disease (YLD) were commonly observed, reflecting sustained viral pressure in the surveyed areas. Additionally, top rot symptoms were recorded in select fields.

During field inspections, phytotoxicity symptoms were observed in Co 0238 and Rajendra Ganna-1, likely due to excessive or improper application of chemical mixtures. Interactions with farmers revealed partial adoption of sett treatment practices and limited implementation of healthy seed nursery programs, factors that may contribute to the persistence and spread of diseases. Representative samples and field images of red rot, wilt, smut, *Pokkah Boeng*, Leaf Scald, viral diseases (including Leaf Fleck, Ringspot, Mosaic, and YLD), and insect damage were collected and brought to the laboratory for further documentation and controlled analysis

Overall, the survey findings highlight that red rot continues to be a major constraint in sugarcane production, with concurrent incidences of *Pokkah Boeng*, wilt, smut, viral diseases, and insect pests affecting key commercial varieties. Strengthening disease surveillance, improving seed health management, diversifying varieties, and promoting integrated pest and disease management practices are essential steps toward sustaining productivity in the region.

Surveys conducted by ICAR-ISRI, Lucknow during 2024-25 in the command areas of DCM Ajbapur, Balrampur Chini Mills (Kumbhi) and Bajaj Hindustan

Infection of Red rot in grand growth phase

Pokkah boeing symptoms

Phytotoxicity symptoms

Initial phase of ring spot

Severe leaf fleck symptom

Late infection of ring spot

Fig. 3.1. Natural occurrence of diseases of sugarcane in the farmer's field

Top borer damaged shoot and egg masses

Pyrilla and egg masses

Sugarcane black beetle infestation

Fig. 3.2. Natural occurrence of insect pest of sugarcane in the farmer's field

Sugar (Gola) revealed variable pest incidence across major sugarcane varieties. The incidence of top borer V brood (10-30%) was reported in command areas of Dhampur Sugar Mill, Dhampur, Dwarikeshpuram Sugar Mill, Afzalpur, Cooperative Sugar Mill, Snehroad, Uttam Sugar Mill Ltd., Barkatpur in Co 0238. Pyrilla was the dominant pest, ranging from trace levels to severe outbreaks (50-60 adults/plant), and particularly in early planted and dense October-sown crops. Although *Epiricania* parasitism was recorded, it was inadequate to suppress pyrilla under hot and dry conditions, with higher incidence observed in trash-mulched fields. Top borer infestation ranged from 1-15%, occasionally reaching 40% in localized pockets, while insecticide-treated fields showed negligible pest pressure. White grub infestation was sporadic in the range of 30% to 70% in the ratoon and plant crop of COM0265 in Maharashtra. The infestations of woolly aphids, pyrilla, internodes, and early shoot borer were reported in the range of 20–50%, and minor infestations of top borer, root borer, and termite damage in the range of 10-15% were also reported in the surveyed sugarcane fields.

Fig. 3.3. Field visit of sugarcane and discussion with Riga Sugar Co. Ltd. (Unit of Nirani Sugars Ltd.), Dhanuka Gram, Riga, Sitamarhi, Bihar

Artificial Intelligence based detection of disease and insect pests of sugarcane

The project successfully developed and validated an artificial intelligence–based system for accurate detection of diseases and insect pests of sugarcane with strong translational potential. A comprehensive, expert-annotated image dataset comprising 22,916 RGB images across six major categories such as Insect Damage (5,310), Pest Damage (418), Diseases (12,721), Physiological Disorders (718), Insect Life Cycle (2,679), and Healthy Canes and Leaves (760) was created, representing one of the most extensive standardized datasets for sugarcane crop protection (Fig. 3.4). Comprehensive evaluation of seven state-of-the-art CNN architectures identified ResNet-50 as the best-performing and most accurate model, achieving 97.12% validation accuracy, while YOLO11n-cls showed superior stability and EfficientNet-B0 delivered consistent performance. Advanced ensemble fusion strategies further enhanced classification robustness, with attention-weighted fusion achieving 96.39% accuracy and high ROC-AUC values (>0.99). Importantly, the models were optimized and exported in PyTorch, TorchScript, and ONNX formats, ensuring deployment readiness for mobile, edge, and field-level applications, thereby strengthening digital decision support for sugarcane crop protection.

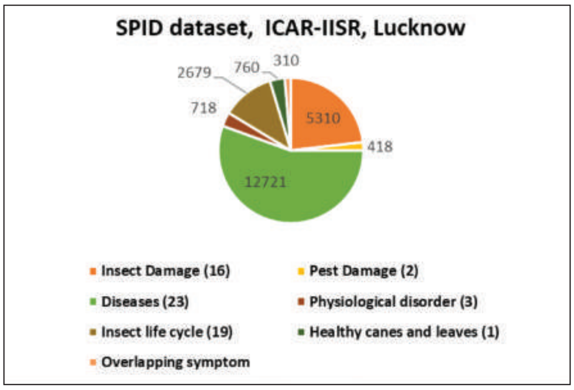


Fig. 3.4. Category-wise distribution of annotated images in the spid dataset for sugarcane pest and disease detection (ICAR–ISRI, Lucknow)

Unveiling the sugarcane virome to enhance productivity in sub-tropical India

Significant progress was made in the project on sugarcane virome characterization, which aimed to explore the diversity of viruses infecting sugarcane in subtropical India using next-generation sequencing (NGS). A total of twelve symptomatic sugarcane genotypes were selected and sampled for virome analysis. High-quality nucleic acids were successfully extracted from these samples, with concentrations ranging from 37.2 to 718.7 ng/µl and purity values (260/280 ratio ~1.82–2.14), confirming their suitability for sequencing. The samples were then subjected to NGS, generating between 78.9 and 133.3 million reads per sample. The high-quality metrics (Q20: ~94.6–96.9% and Q30: ~89.6–92.7%) indicated reliable, high-depth sequencing data. Bioinformatic analysis of the sequencing data revealed the presence of major sugarcane viruses, including Sugarcane streak mosaic virus (SCSMV), Sugarcane bacilliform virus (SCBV), and Sugarcane yellow leaf virus (ScYLV). Sequence identities of these viruses ranged from 81–98% when compared to reported isolates. To enable rapid detection of these viruses, specific PCR-based diagnostic primers were standardized for ScYLV, SCSMV, and SCBV. These diagnostics will enhance virus detection, improve disease surveillance, and contribute to the development of clean seed programs, all of which are crucial for sustainable sugarcane cultivation.

Mapping the virulence pattern and identifying virulence hot spots of sugarcane red rot pathogen in sub-tropical region

The project successfully mapped the virulence pattern and identified virulence hotspots of the sugarcane red rot pathogen *Colletotrichum falcatum* in subtropical India, generating valuable epidemiological and evolutionary insights. Systematic surveillance and screening of 65 field isolates from Uttar Pradesh and Bihar revealed red rot incidence ranging from 5–70%, underscoring significant spatial variability in pathogen aggressiveness. Phenotypic screening against standard pathotypes CF08 and CF13 on 20 differential varieties revealed a dominant presence of CF13-like isolates across most regions, confirming their status as the primary threat. However, notable site-specific deviations were observed, such as avirulent isolates on the typically susceptible Co 975 and moderately virulent isolates on CoJ 64, indicating emerging variability within the pathogen population. Multilocus sequence analysis (including ITS, ACT, and CaM markers) corroborated the phenotypic findings and detected incipient divergent genotypes, suggesting the early onset of pathotype shifts (Fig. 3.5.). These findings provide a robust scientific foundation for targeted surveillance, resistance breeding, and region-specific red rot management strategies, essential for mitigating the impact of red rot on sugarcane production.

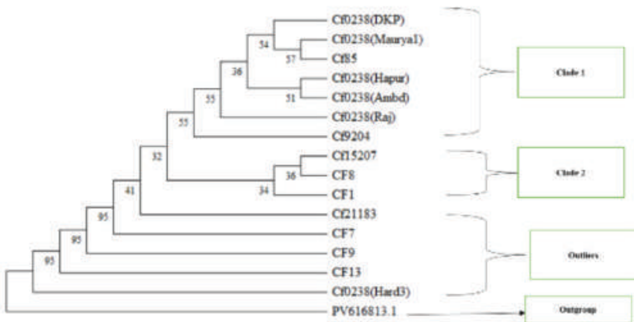


Fig. 3.5. Phylogenetic analysis of *C. falcatum* isolates using ITS region gene sequences

Characterization of *Sporisorium scitamineum* causing sugarcane smut disease

Sugarcane smut pathogen, *Sporisorium scitamineum*, is a major biotic stressor in global sugarcane cultivation. This biotrophic fungal pathogen is known for a drastic reduction in quality and yield in susceptible sugarcane varieties. In this study, forty five isolates were collected from six major sugarcane growing states of India. Typical symptoms of infected sugarcane plants with smut were observed during course of survey and in experimental field studies. The characteristic symptoms of whip smut, i.e., the emergence of a prominent black or greyish whip like structure from the central growing point (shoot apex) of the plant, were observed (Fig. 3.6). The isolates of *S. scitamineum* were found to have considerable variation in their colony morphology and radial growth when cultured on Yeast extract Peptone Sucrose Agar media (YePSA). The colony diameter measured on the 4th, 8th, and 12th day after inoculation (DAI) showed significant differences in growth patterns among the isolates. The mean colony diameter ranged at the 12th DAI from 0.73 cm (Kappu-3) to 3.9 cm

(Isolates 7 and 9). Fast-growing isolates such as P8 (3.3 cm), 7 (3.9 cm), 9 (3.9 cm), 1 (2.93) and K2 (2.72 cm) showed rapid mycelial growth, with maximum average growth rates of 0.254 cm/day (P8), 0.231 cm/day (K2), 0.223 cm/day (Cu-2) and 0.229 cm/day (Isolate 7). More than 30 varieties/ entries/ germplasms were found to be moderately to severely affected by this disease. These sugarcane varieties are cultivated in large acreage in subtropical and tropical regions, highlighting the widespread distribution and adaptive potential of this fungus. The mycelial and sporidial pure cultures were established and detailed morphological examination, teliospore germination assays, molecular identification and pathogenicity testing were performed. Significant variability was observed among the isolates with respect to teliospore morphology and germination behaviour. Molecular identification through ITS region-specific primers resulted in consistent amplification of the expected amplicon size in all forty five isolates, while selected isolates were further validated using bE gene-specific primers, confirming their identity as *S. scitamineum*. Pathogenicity tests conducted on a susceptible sugarcane variety, CoLk 11203, revealed differences in incubation period and disease expression among the isolates. Apart from observing the phenotypic symptoms and characteristic whips in artificially inoculated setts, a PCR-based method was standardised to detect the pathogen in asymptomatic plants.

Genomic DNA was successfully extracted from all 45 isolates of smut using mycelial mat and mass multiplied sporidia grown under aseptic conditions**.** Using a Nanodrop spectrophotometer, the quality and concentration of extracted DNA were assessed, and also via agarose gel electrophoresis, with all samples, which showed DNA of good quality & concentration, suitable for downstream applications. The three sets

Fig 3.6.a,b Characteristic whip-like structure developed at early stage of plant development restricting its growth**, c:** Initial emergence of smut whip and subsequent drying**; d, e:** Typical fully grown whip-like structure**; f, g:** Emergence of multiple tillers with multiple whips

of primers *viz.,* ITS1 & ITS4 targeting the internal transcribed spacer region, bE4 & bE8 targeting the bE mating type locus, and SL1 & SR4 targeting the smut linkage (SL) region were used for PCR amplification. Amplification by ITS1 and ITS4 yielded about 550 bp, distinct and consistent amplicons in all isolates (Fig. 3.7).

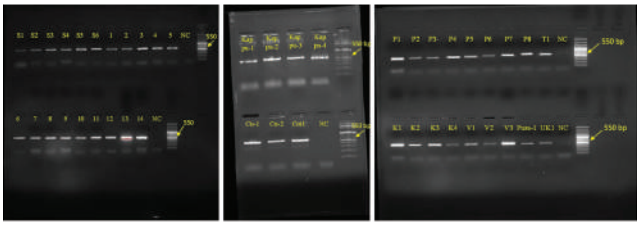


Fig 3.7. Agarose gel electrophoresis showing PCR amplification of *S. scitamineum* DNA using ITS1 and ITS4 primers (NC-Negative Control)

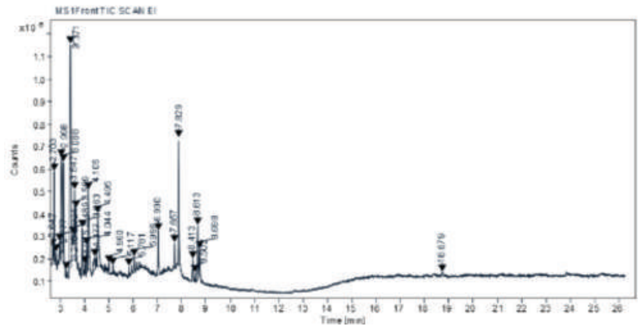


Fig. 3.8. GCMS analysis of mycotoxins from wilt sugarcane plant juice

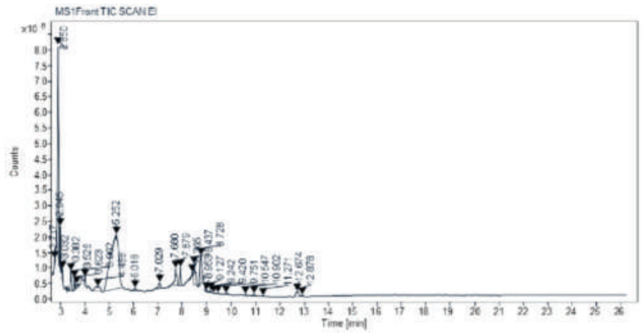


Fig. 3.9. GCMS analysis of mycotoxins from healthy sugarcane plant juice

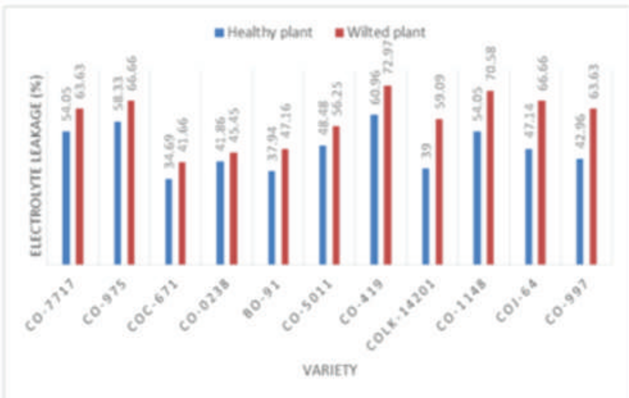


Fig. 3.10. Electrolytes losses in healthy and wilted sugarcane plants

Isolation, identification and pathogenicity of wilt pathogen in sugarcane

An experiment was conducted to detect and identify the mycotoxins in the juice of wilted (*Fusarium sacchari*) and healthy sugarcane (control) variety Co-419 using HPLC. The results showed that *Deoxynivalenol* (DON), *Zearalenone* (ZON), *Fusaric acid* mycotoxins were present in the juice extracted from the wilt infected canes and it is reported that these mycotoxins are produced by the *Fusarium* spp. Furthermore, *Aflatoxin B1, Aflatoxin B2, Aflatoxin G1, Aflatoxin G2, Ochratoxin A, Glycyrrhetinic acid, Viridicatol and Pseurotin A* were also detected in the wilted sugarcane juice, though these are not produced by the *Fusarium* spp. (Fig. 3.8 & Fig. 3.9). There was no mycotoxin detected in the healthy sugarcane plant juice. A study was conducted to find out the electrolytes losses in the sugarcane wilted and healthy leaf tissues in 11 varieties *viz.*,Co-7717, Co-975, CoC-671, Co-0238, BO-91, Co-5011, Co-419, CoLk-14201, Co-1148, CoJ-64, and Co-997. The results showed that the wilted leaf tissues lose more electrolytes in all the varieties than healthy plants. Screening of 30 *Trichoderma* isolates was done against *F. sacchari* to identify the potent, promising and potential biocontrol strains of *Trichoderma*. Dual culture assay showed that 15 *Trichoderma harzianum* inhibited colony diameter of *F. sacchari* in the range of 12.57-78.56% (Fig. 3.10).

Evaluation/screening of sugarcane germplasm against red rot and smut

84 and 13 genotypes of sugarcane were screened against red rot 2024-25 by artificial inoculation of two pathotypes CF 08 and CF13 of *Colletotrichum falcatum* at ISRI, Lucknow and ISRI RC Motipur respectively. Out of 84, 36 genotypes *viz.*,LG16567, LG15449, LG21006, LG21038, LG21097, LG21407, LG16548, LG15672, LG15538, LG16644, LG16428, LG21305, LG21226, LG21276, LG21039, LG16490, LG16684, LG16541, LG16593, LG21011, LG21351, LG21324, LG21180, LG21024, LG21329, LG21043, LG2, LG16560, LG15422, LG16674, LG16468, LG21234, LG21395, LG21327, LG21175 and LG21287 were rated as moderately resistance (MR) against both pathotypes CF08 & CF13 to cause red rot. Two LG21235, LG15460 showed resistant against pathotype CF13 and moderately resistant against CF 08 of *C. falcatum*. Out of eighty four genotypes tested for smut reaction, 76 genotypes were rated as resistant (R) to smut diseases. Out of 84 genotypes of sugarcane 34 and 43 were rated as resistance (R) to wilt and YLD respectively. Out of 13 genotypes of sugarcane evaluated at ISRI RC, Motipur, nine genotypes *i.e.* 2017-18-16, CoSe 95422, 2017-18-27, CoLk 94184, Co 19301, 2016-17-13, 2016-17-99, 2016-126, 2022-23-82 showed moderately resistance against both the pathotype (Table 3.2).

Table 3.1. Pathogenic reaction of sugarcane genotypes against red rot, wilt smut and YLD diseases of sugarcane under field conditions at ISRI, Lucknow

Pathogenic Reaction	No. of Germplasm / clones of sugarcane				
	Red rot		Wilt	Smut	YLD
	CF08	CF13			
Resistant (R)	0	2	12	76	58
Moderately resistant (MR)	66	43	49	8	20
Moderately susceptible (MS)	11	11	3	0	4
Susceptible (S)	3	12	7	0	1
Highly Susceptible (HS)	2	8	0	0	0

Table 3.2. Pathogenic reaction of sugarcane genotypes against red rot, wilt smut and YLD diseases of sugarcane under field conditions at ISRI RC, Motipur

Pathogenic Reaction	No. of Germplasm / clones of sugarcane				
	Red rot		Wilt	Smut	YLD
	CF08	CF13			
Resistant (R)	0	2	12	76	58
Moderately resistant (MR)	66	43	49	8	20
Moderately susceptible (MS)	11	11	3	0	4
Susceptible (S)	3	12	7	0	1
Highly Susceptible (HS)	2	8	0	0	0

Integrated insect pests and disease management for subtropical sugarcane

To manage the major sugarcane diseases, particularly red rot, and the insect pest, top borer, integrated management strategies were implemented in two sugar mill command areas in Uttar Pradesh: (i) Hargaon and (ii) Loni. Large plot trials were established in approximately 1.0 ha areas at each of the sugar mills, both of which are endemic to red rot, using the popular variety Co 0238. The results from these trials were promising. The treated plots exhibited a red rot incidence of just 5-10%, whereas the neighbouring untreated fields had significantly higher incidence rates of 50-60%. Additionally, observations on disease and pest occurrences revealed a high viral load, including Sugarcane streak mosaic virus (ScSMV), Leaf Fleck, and Yellow Leaf Disease (YLD) across all cultivated varieties. The integrated management treatment demonstrated a potential yield gain of 5-9 t/ha, highlighting the effectiveness of the ICAR-ISRI technologies in improving disease and pest management, and in boosting sugarcane productivity in the region.

Management of *pokkah boeng* disease of sugarcane

The minimum disease severity (4.44%) was observed with foliar spraying of copper oxychloride at a concentration of 0.2%, followed closely by Carbendazim at 0.1%, which recorded a disease severity of 4.64%. *Trichoderma* culture applied through sett treatment also showed promising results, with a severity of 11.24%. In contrast, the maximum disease severity (44.92%) was recorded in treatments where *Trichoderma* culture was applied foliar (T3). No significant effect was observed with the soil application of *Trichoderma* culture, which resulted in a disease severity of 35.34%, indicating limited efficacy for managing *pokkah boeng* disease.

Development and commercialization of bio control agent-based bio formulation for sustainable management of diseases of sugarcane crop

A screening of 26 *Trichoderma* isolates was conducted against *Fusarium sacchari* to identify the most potent, promising, and potential biocontrol strains. The liquid culture filtrate assay revealed that 15 *T. harzianum* isolates inhibited the colony diameter of *F. sacchari* by 10.85–77.56%. During the 2024 autumn season, the susceptible sugarcane varieties Co-419 and Co-7717 were treated with the most potent *T. harzianum* (concentration 2 x 10^6/ml) for 10 hours, followed by planting in pots containing a compost-soil mix (1:5). After 48 hours, the pots were inoculated with *F. sacchari* (1.5 x 10^6/ml) to evaluate the biocontrol efficacy.

In total, 115 rhizospheric bacterial isolates were obtained from four sugarcane varieties: Co0238 (28 isolates), CoLk 14201 (31 isolates), CoLK 16202 (19 isolates), and CoJ 64 (37 isolates), using nutrient agar and King's B media. Among these, 70 isolates exhibited antagonistic activity against *Colletotrichum falcatum* CF13 under *in vitro* conditions. Thirty four isolates showed 25.1–50.0% inhibition, 28 isolates displayed 50.1–75.0% inhibition, and 8 isolates exhibited >75.1–100% inhibition (Fig. 3.11 & Fig. 3.13). For *Fusarium sacchari*, five isolates demonstrated 1–25% inhibition, 32 isolates inhibited fungal growth by 25.1–50.0%, and 11 isolates showed 50.1–75.0% inhibition. Only two isolates exhibited >75.1–100% inhibition under *in vitro* conditions (Fig. 3.12).

Additionally, eight bacterial endophytes were isolated from the sugarcane variety CoLk 16202, specifically from the bud, leaf, and root—known hotspots for beneficial endophytic colonization. Five endophytes were isolated from the bud, three from the leaf, and one from the root. These eight endophytic bacterial isolates were assessed for their antagonistic potential against *Sporisorium scitamineum* using the dual culture assay. The inhibitory efficacy was classified into three categories based on percent inhibition: High (>30%), Moderate (15–30%), and Low (<15%). Among the eight isolates, 6Fe showed the highest inhibition (37.54%), followed by 7Ge (32.58%), both falling under the high efficiency category. Two isolates, 1Ae (27.83%) and 4De (26.89%), demonstrated moderate antagonistic activity.

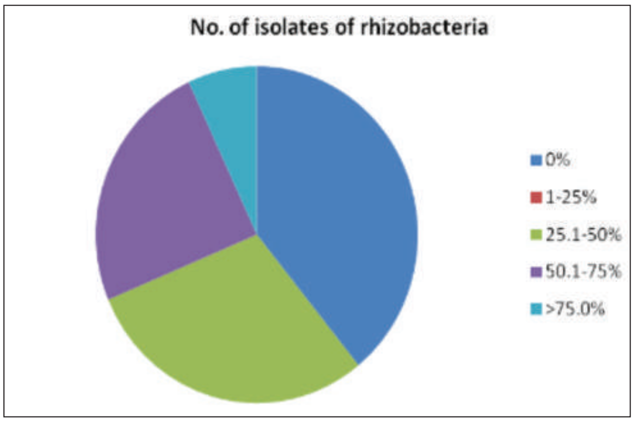


Fig. 3.11. Rhizobacteria isolates showing antagonistic activity against *Colletotrichum falcatum* CF13 under *in vitro* condition

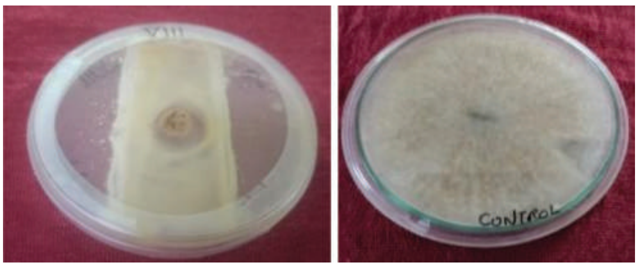


Fig. 3.12. Growth inhibition of *Colletotrichum falcatum* CF13 by Rhizobacteria under *in vitro* condition

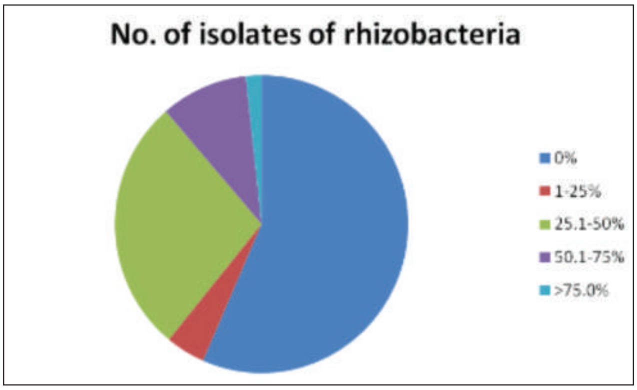


Fig. 3.13. Rhizo-bacteria isolates showing antagonistic activity against *Fusarium sacchari* under *in vitro* condition

Evaluation of sugarbeet germplasms/ varieties against fungal diseases suitable for Indian climate

A total of 50 sugar beet germplasm lines were screened during the 2024–25 season under natural field conditions for major diseases including Cercospora leaf spot (*Cercospora betae*), Alternaria leaf spot (*Alternaria alternata*), Phoma leaf spot (*Phoma betae*), Fusarium yellows, and viral disease complex. Foliar disease incidence was relatively low during the season, while root rot was more prominent. Among foliar diseases, Alternaria and Cercospora leaf spots were the most commonly observed but appeared at later growth stages. Disease evaluation identified HILMA, LS 6, IISR COMP 1, and UK FODDER as resistant to major foliar diseases, indicating their potential use in breeding programs for developing disease-resistant sugar beet varieties suitable for Indian conditions (Fig. 3.14).

Pure cultures of sugar beet-associated fungi were obtained and used for DNA isolation from mycelial mats using the CTAB method. PCR amplification with ITS1/ITS4 primers yielded consistent 550 bp amplicons from all isolates, which were sequenced by Sanger technology for species identification and deposited in NCBI. Additional multilocus characterization using Tef1α MLST primers produced ~690 bp amplicons that were also Sanger sequenced to refine phylogenetic resolution. The ITS-based analysis identified major pathogens including *Fusarium oxysporum*, *F. equiseti*, *Phomabetae*, *Alternaria alternata* and related *Alternaria* spp., and *Athelia rolfsii*,

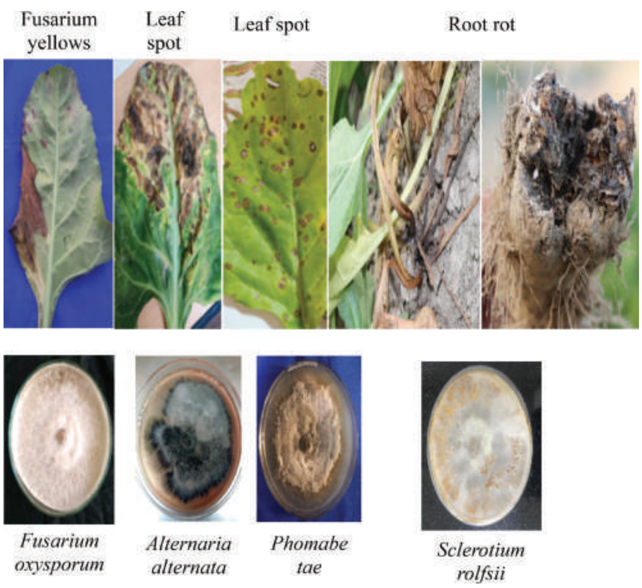


Fig. 3.14. Major foliar and root diseases & pathogens of sugar beet

with representative sequences assigned accession numbers such as PP976465–PP976469 and PP767293. Phylogenetic trees confirmed the close relationship of the sugar beet isolates of *Alternaria alternata*, *Neocamarosporium betae*, *Fusarium oxysporum* and *Athelia rolfsii* with reference accessions from diverse hosts, validating the molecular identification.

ICAR EFC Project: Enhancing climate resilience and ensuring food security with genome editing tools

Genome editing of sugarcane for resistance to sugarcane yellow leaf virus was initiated using the CRISPR-Cas9 system by targeting the susceptibility complex formed by poleroviral eIF4E and eIF4G, focusing on the susceptible variety CoLk 14201, in which the genes occur as eIF4E-1 and eIF4E-2 isoforms in the R570 reference genome. The genomic organization of these factors was resolved, revealing eIF4E-1 copies on chromosomes 2A, 2B, 2C, 2D, 2F, 2G and 2H, and eIF4E-2 on chromosomes 1A, 1B and 1D, with orthologs in CoLk 14201 validated by isoform-

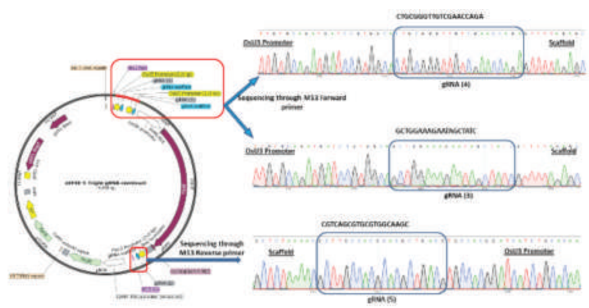


Fig. 3.15. Triple gRNA construct for targeting *eIF4E-1* gene

specific primers, Sanger-sequenced amplicons and multiple sequence alignment to identify conserved regions. Conserved functional domains of eIF4E-1 (6T), particularly regions involved in cap-binding and host protein interactions, were exploited to design three guide RNAs with BbsI overhangs, which were cloned to develop single, dual and triple gRNA constructs in Cas9-based vectors (including pRGEB32, pOsU3-gRNA-POsUQ.cas9 and puc1300) for multiplex knockout of eIF4E-1 and eIF4E-2 (Fig. 3.15). These gRNA cassettes were introduced into *Agrobacterium tumefaciens* strain EHA105 for plant transformation, while in parallel the eIF4G gene on chromosome 3 was targeted via dual-gRNA (gRNA1+2) and single-gRNA (gRNA3 and gRNA5) constructs in pRGEB32. callus was transformed with EHA105 Agrobacterium strain harbouring binary vector for the expression of Cas9 nuclease and eIF4E-1 targeting gRNA(s) cassette. Transformed calli are at selection and regeneration stage.

Deployment of settling nurseries with mechanized priming of sugarcane setts

Substantial progress was achieved under the UPCAR-funded project aimed at promoting mechanized sett priming and nursery based sugarcane production through a KVK network approach in Uttar Pradesh. A comprehensive benchmark survey across six districts assessed prevailing farmer practices, disease incidence, and awareness gaps related to seed treatment and nursery management. Infrastructure strengthening was undertaken through establishment of shade net nursery units and installation of Sett Treatment Devices (STD) and seed cutting machines at ICAR–ISRI Lucknow, KVK Lakhimpur, and MGKVK Gorakhpur. Capacity building remained a major focus, with over 1,000 farmers trained under VKSA across 25 villages, along with targeted hands-on training for SSI entrepreneurs and KVK personnel (Fig. 3.16). Mechanized priming demonstrated significant improvements in plant growth parameters, including enhanced height, girth, and leaf dimensions ($p < 0.001$). Varietal trials identified Co 0238 and Co 7717 as superior performers, while germination improvements were also observed in vegetative propagated crops such as ginger. The technology reduced chemical wastage by up to 80% and standardized protocols for managing red rot, wilt, and smut diseases of sugarcane.

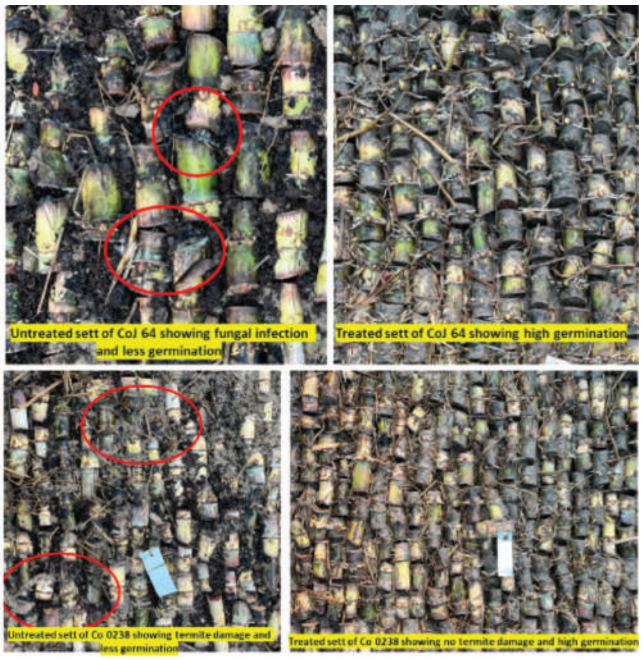


Fig. 3.16. Effect of mechanized priming of sugarcane varieties Co 0238 and Co 7717 on germination of setts

Management of Yellow leaf through meristem culture

Tissue culture derived plants of two sugarcane varieties, CoLk 14201 and CoLk 16202, produced at the Tissue Culture Laboratory of ICAR-Indian Sugarcane Research Institute (ICAR-ISRI), Lucknow, were successfully established and maintained under field conditions during the 2024–25. Approximately 4,000 plantlets of CoLk 14201 and 500 of CoLk 16202, raised through meristem culture, were meticulously monitored and found to be free from yellow leaf disease (YLD). The severity of YLD was evaluated across all tissue culture-raised materials using a standardized 0–5 rating scale, and no visible symptoms were observed in any of the plants. Further, 15 plants were indexed for the presence of the YLD-associated pathogen using RT-PCR and no positive amplification was found in all tested samples.

Smart delivery of agro-inputs using Sett Treatment Device for biotic and abiotic stress management in sugarcane and other vegetatively propagated crops

A red rot management trial was conducted using a Sett Treatment Device (STD) on sugarcane cultivar Co0238 with four treatments: T1 – mechanized sett treatment with Thiophanate Methyl + *Paenibacillus alvei* and soil drenching; T2 – Thiophanate Methyl (Hexastop 70% WP) sett treatment with soil drenching and foliar spray; T3 – combination of T1 + foliar spray; T4 – untreated control.

Among the treatments, T2 (Thiophanate Methyl sett treatment with soil drenching and foliar spray) showed the best performance, recording the highest number of healthy plants at both 60 DAP (26.67) and 90 DAP (49.66). T1 and T3 also improved plant health compared to the control, while untreated plots (T4) had the lowest number of healthy plants (20.25 at 60 DAP; 45 at 90 DAP).

Efficient delivery of fungicides and agro-inputs to manage fungal diseases of sugarcane

Field experiments were conducted at ICAR-ISRI, Lucknow, during 2024–25 to evaluate improved methods of fungicide delivery for managing red rot in sugarcane variety Co 0238. The study aimed to assess the impact of mechanized sett treatment and soil drenching on disease incidence, germination, and yield. Six treatments were evaluated, including sett treatment with Thiophanate methyl (70WP), sett treatment with Azoxystrobin 18.2% + Difenoconazole 11.4% SC, combinations of these treatments with soil drenching at 45 and 90 days after planting (DAP), an infected sett control, and a healthy control. The highest germination percentage (41.54%) was recorded in the treatment involving sett treatment with Azoxystrobin + Difenoconazole (T3), with no primary disease incidence observed during early growth. In contrast, the untreated infected control (T5) recorded the maximum red rot incidence of 51.52% from June onwards. The minimum disease incidence (3.03%) was observed in treatments involving soil drenching (T2 and T4) as well as in the healthy control during September 2024. Secondary inoculum development was observed after 120 days of planting across treatments, indicating the importance of sustained disease management. Yield data further supported the superiority of combination treatments. The lowest average plot yield (32.03 kg per 6 × 3.6 m² plot) was recorded in the infected control. The highest yield (60.33 kg) was obtained in T4 (sett treatment + soil drenching with Azoxystrobin + Difenoconazole), followed by T3 (57.15 kg). Treatments involving Thiophanate methyl recorded comparatively lower yields. The study clearly demonstrated that mechanized sett treatment at planting followed by soil drenching at 90 DAP significantly reduced disease incidence and improved yield (Fig. 3.17). The combination of Azoxystrobin and Difenoconazole proved more effective than Thiophanate methyl in managing red rot under field conditions.

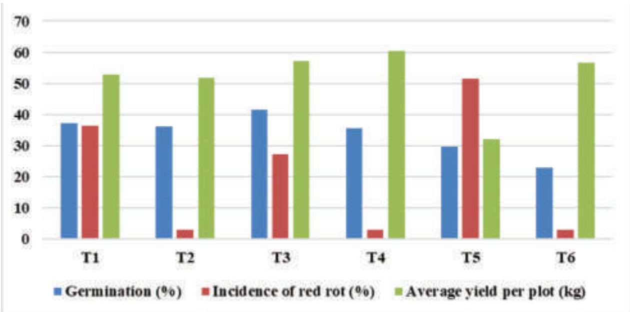


Fig. 3.17. Effect of different treatments on germination, red rot incidence and yield of sugarcane

Standardizing drone-based delivery of fungicides to manage fungal diseases of sugarcane

An experiment was conducted to standardize drone-based fungicide application for managing secondary spread of red rot in sugarcane variety Co 0238. The study evaluated the efficacy of Thiophanate Methyl (70WP) at 1.3 g/L (0.1%) applied using drone technology. Drone spraying was carried out at a flying height of 2 meters and a speed of 4 m/s under wind conditions below 8 km/h. The performance of drone application was compared with conventional high-volume spraying methods. Disease progression was assessed through leaf bioassays, challenge inoculation, and histopathological studies. Lesion

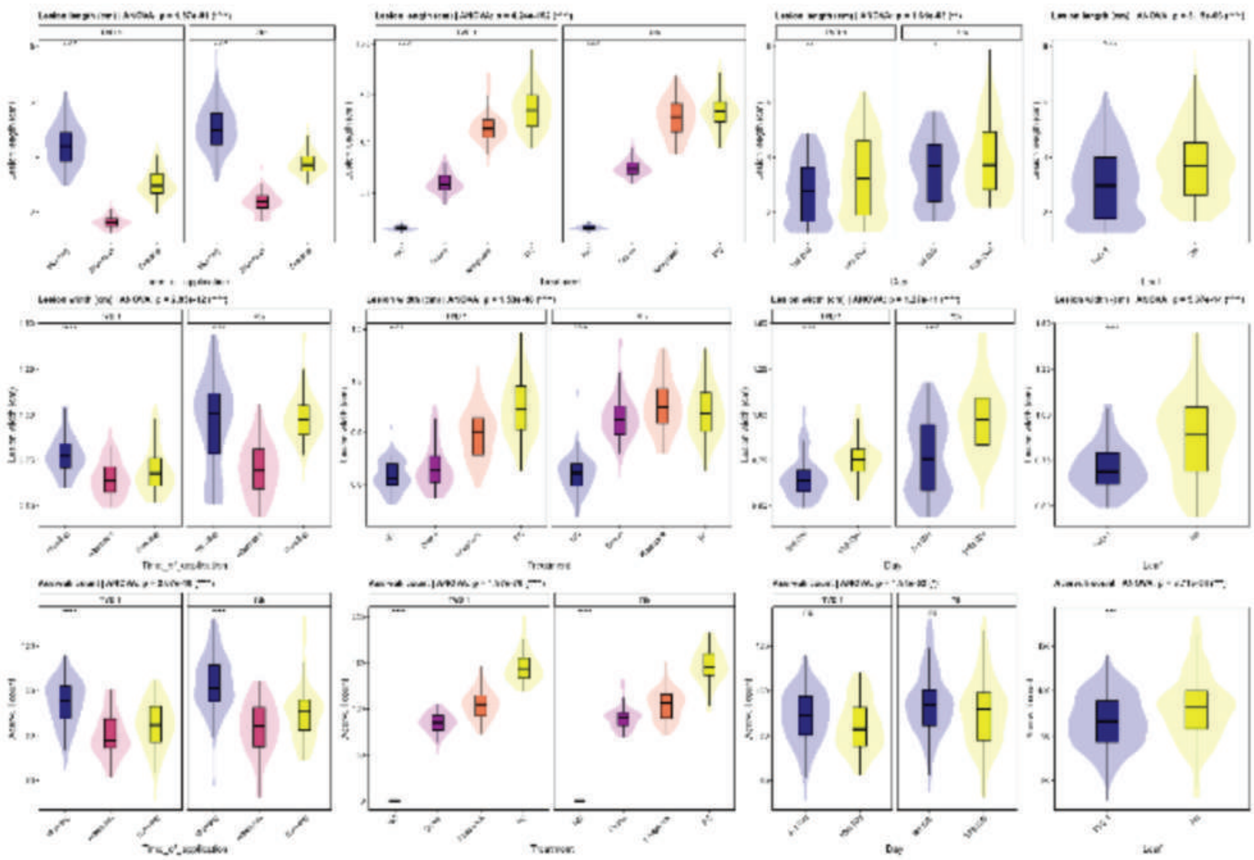


Fig. 3.18. Leaf bioassay and histopathological responses of sugarcane leaves following drone-applied thiophanate-methyl against *C. falcatum* pathotype CF13 at 3rd and 10th day after application

length and width were recorded at 72 hours after inoculation on Top Visible Dewlap (TVD-1) leaf and the seventh leaf. The results indicated that afternoon drone spraying was the most effective application timing. It produced the smallest lesion dimensions (1.4 cm × 0.49 cm on TVD-1 leaf and 2.10 cm × 0.65 cm on the seventh leaf at 72 hours), minimal acervuli formation, and the least pathogen spread across nodes. These findings confirmed superior fungicidal efficacy when applied through drone during afternoon hours. The study highlights the potential of drone-based fungicide delivery as a precision agriculture tool for sugar factory command areas. It ensures uniform coverage, reduces labor dependency, and enhances disease control efficiency, particularly during periods of secondary infection spread.

Efficient delivery of fungicides and other agro inputs to manage major fungal diseases in sugarcane

The experiment conducted using the variety Co 0238, comprised of six treatments *viz.*,T1 : Sett treatment in STD with Thiophanate methyl (70WP)- 1.3g/lit, T2 : Sett treatment in STD + Soil Drenching with Thiophanate methyl (70WP)- 1.3g/lit by 45&90 days, T3: Sett treatment in STD with Azoxystrobin 18.2% and Difenoconazole11.4% W/W SC 1.0 ml / lit., T4: Sett treatment in STD + Soil Drenching with Azoxystrobin 18.2% & Difenoconazole11.4%, T5: Infected Setts/ Setts + Grain inoculum, T6: Healthy control. The highest germination was recorded in (41.54%) in treatment T3 with no primary disease incidence. Minimum disease incidence (3.03%) was noticed in T2 i.e. Sett treatment in STD + Soil drenching with Thiophanate methyl (70WP)- 1.3g/lit by 45&90 days folwed by T3: (Sett treatment in STD with Azoxystrobin 18.2% and Difenoconazole11.4% W/W SC 1.0 ml /lit. The lowest average plot (6×3.6 m^2) yield recorded was 32.03 kg in T5 and maximum 60.33 kg was in T4 followed by T3 (57.15 kg) (Fig. 3.22). It can be concluded that the mechanized sett treatment at the time of planting and soil drenching at 90 days of planting have significant effect on disease incidence and yield of sugarcane.

Standardizing drone-based delivery of fungicides to manage fungal diseases in the sugar factory areas

A study was conducted to evaluate the efficacy of drone-based fungicide application for managing the secondary spread of red rot in sugarcane (variety Co 0238) using Thiophanate Methyl (70WP) at 1.3g/L (0.1%) with suitable wetting agents, applied at a flying height of 2m and speed of 4 m/s under wind conditions below 8.0 km/h, with conventional high-volume sprays for comparison; leaf bioassays, challenge inoculation, and histopathological studies revealed that afternoon drone sprays were the most effective, as it resulted in the smallest lesion length (1.4 cm) and width (0.49 cm) on Top Visible Dewlap 1 leaf and 2.10 and 0.65 on 7th leaf at 72 hours, the least pathogen spread across nodes, and minimal acervuli formation, confirming the superior efficacy of afternoon application

Management of Yellow leaf through meristem culture (Lucknow Centre)

Tissue culture-derived plants of two sugarcane varieties, CoLk 14201 and CoLk 16202, produced at the Tissue Culture Laboratory of ICAR-Indian Sugarcane Research Institute (ICAR-ISRI), Lucknow, were successfully established and maintained under field conditions during the 2024–25 season. Approximately 4,000 plantlets of CoLk 14201 and 500 of CoLk 16202, raised through meristem culture, were meticulously monitored and found to be free from yellow leaf disease (YLD). The severity of YLD was evaluated across all tissue culture-raised materials using a standardized 0–5 rating scale, and no visible symptoms were observed in any of the plants. Further, all plants were indexed for the presence of the YLD-associated pathogen, and results confirmed the absence of infection in all tested samples.

Development of inoculation techniques for *pokkah boeng* disease (*Fusarium verticilloides*) of sugarcane

The experiment was conducted on 17 April 2025 following recommended agronomic practices to ensure optimum crop growth and uniform plant health. Eight treatments were imposed for development of inoculation techniques for *pokkah boeng* disease as per the AICRP (S) technical programme (T_1 – Sett treatment (30 minutes at the time of planting, T_2 – Soil inoculation at planting, T_3 – Foliar application (27 June 2025), T_4 – Sterilized toothpick inoculation (03 September 2025), T_5 – Cotton swab method (03 September 2025), T_6 – Spindle inoculation (27 June 2025), T_7 – Stem inoculation (03 September 2025), and T_8 – Control. Disease development was monitored periodically after inoculation. Pokkah boeng symptoms were first observed in T_9 (foliar application, Figure 1) on 12 July 2025, followed by T_6 (spindle inoculation) on 17 July 2025. No disease symptoms were observed in T_1 (sett treatment) and T_2 (soil inoculation) up to 02 August 2025. Further, no disease development has been recorded so far in T_4 (toothpick inoculation), T_5 (cotton swab method), and T_7 (stem inoculation) treatments. The results indicate that foliar spraying (T_3) and spindle inoculation (T_6)

are effective methods for inducing pokkah boeng disease symptoms under field conditions. Symptom development occurred within 15 days of inoculation, demonstrating their suitability for pathogenicity testing. Other inoculation methods did not produce symptoms within the observation period (Fig. 3.19). .

Fig. 3.19. Twisting and curling symptoms of *Pokkah boeng* symptoms by foliar inoculation

Characterization, identification and management of insect pests of sugarcane

Responses of host weight of stalk borer, *Chilo auricilius* pupa on biological attributes of *Tetrastichus howardi*

On stalk borer pupa, developmental period varied from 17.33 to 17.83 days and not influenced by different weighed pupae. The production of progeny per pupa was recorded lowest as 41.17 and increased with increases of weight of pupa (< 0.050 to >0.091g). The maximum (82.83 progeny/pupa) was obtained from pupa of weight >0.091g.

The number of female also increased per pupa (37.67 to 77.50) as increased weight of pupa. The female based sex ratio (>90%) was observed in all ranges of weighed pupa. The parasitoid sex ratio left a major impact upon its population dynamics. Female biased ratio in fed condition is very relevant to their use as biological control agents, and can assist in improving mass rearing programme (Fig. 3.20). The smaller host pupae gave rise to small number of parasitoids

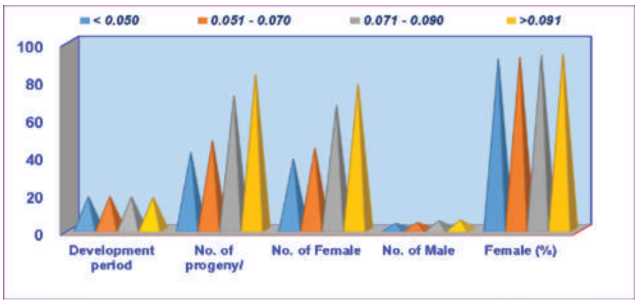


Fig. 3.20. Responses of host weight of stalk borer, *Chilo auricilius* pupa on biological attributes of *Tetrastichus howardi*

whereas larger ones supported development of more parasitoids.

A significant difference was observed in the developmental period, which varied from 15.7 to 16.2 days, and this variation was influenced by the length of the pupa. The development of parasitoids depends on the resources available, different hours of exposure, host size, weight and host quality.

The number of progeny and female emergence/ pupa increased with increase of length. There was also significant difference of percentages female emergence. The male emergence (%) decreased with increase of length of as well as sex ratio also increased with increase of length. Larger host size contributed to maximization of progeny. The mean number of exit hole increase with length and number of adults emerged.

Maintenance of natural population of insect-pests of sugarcane

The incidence of first brood was significantly high (20.8-33.7%) in CoLk 11203, CoLk 8102,Co 7717 and Co 1148 with least susceptible varieties were CoLk 13204, CoLk 94184, CoLk 11206, CoLk 16201, CoLk 16202, CoLk 14201, CoLk 16203, CoS 767, CoS 8436, Co 0238, CoC 671, BO 91, CoJ 64 and Khakai. The second brood infestation was lower than first brood, its ranges 0.6 to 6.5% in eighteen varieties. The third brood's infestation is critical in sugarcane ecosystem. During 2024, infestation of third brood was reduced (0.1-2.6%) due to high temperature during moth emergence of top borer. Due to high temperature severe mortality of larvae/pupae was observed. The incidence of fourth brood ranged from 6.9 to 15.8% in different varieties .In general, attack of fourth brood has serious consequence on a sugarcane crop because the plant is not in a position to compensate through tillering (by this time, tillering is over and cane formation has gained the momentum) as most of the energies are diverted for the stalk elongation (Fig. 3.21).

The incidence of stalk borer in standing cane (August) varied from 3.6 to 10.2% in eighteen varieties. The activity of stalk borer generally increases during the monsoon months with more rainfall but during August and September less rainfall observed. During the fag end of monsoon period, stalk borer larvae infest the water shoots and due to the infestation, a curious symptoms, due to high sheath mining activity of the initial instars, appears on the leaf. Larvae of stalk borer pass the summer month (April-June) rather in hardship, and its population dwindles during this period. The internode borer incidence was increased than stalk borer in different varieties. It's incidence ranged from 6.3 to 17.6% in CoLK 13204, CoLk 8102,

Fig. 3.21. Stalk borer, *Chilo auricilius* Dudgeon and Internode borer, *Chilo sacchariphagus indicus* (Kapur)

CoLk 94184, CoLk 11203, CoLk 11206, CoLk 16201, CoLk 16202, CoLk 14201, CoLk 16203, CoS 767, CoS 8436, Co 7717, Co 1148, Co 0238, CoC 671, BO 91, CoJ 64 and Khakai

The incidence of mealy bug, *Saccharicoccus sacchari* was observed in standing cane in the month of June and August.The mean incidence in eighteen varieties ranged from 12.7 to 29.5% during June. However, incidence was increased with maximum in Co1148 (70.1%) followed by CoLk 13204, CoLk 8102, CoLk 11203, CoLk 11204, CoLk 16203, Co 0238 (63.9-66.4%) and rest of varieties it varied 48.8-62.4% in the month of August. The main source of carry-over of *S.sacchari* is through seed cane and ants. The mealy bug depends on symbiotic ants for defence and transportation, and in turn provides the ants with honey- dew that exudes from the body. When the leaf sheaths covering the colonies are disturbed, the ants in neighboured immediately give protection and carry the bugs to adjacent nodes or stalks.Mealy bugs are capable of infesting any sugarcane genotypes.

Advancing sugarcane borer's rearing and insecticidal impacts on pest and their bioagents

Evaluation of insecticides against the egg parasitoid *Trichogramma chilonis* indicated that Chlorantraniliprole 18.5% W/W (88.5-91.0%) was the safest insecticide with parasitoid emergence comparable to the control (88.5-90.0%). Imidacloprid 17.8% SL also showed low toxicity with high emergence (84.0-87.0%). Thiamethoxam 25% WG caused moderate suppression (75.5-84.0%), whereas Fipronil 5% SC (67.5-78.0%), Chlorpyrifos 20% EC (65.5-75.0%) and Profenofos + Cypermethrin (68.5-75.0%) significantly reduced parasitoid emergence. Residual toxicity was lowest in Chlorantraniliprole (16.73-22.37%) and highest in Profenofos + Cypermethrin (41.20-61.75%). Overall, Chlorantraniliprole and Imidacloprid were found comparatively safer for *T. chilonis* under laboratory conditions.

Behavioural studies on parasitoid *Tetrastichus* sp. & black bug

Exploratory olfactometer studies revealed differential behavioural responses of insects to plant essential oils. Fresh plant materials were subjected to hydro-distillation using a Clevenger apparatus for extraction of essential oils, and the obtained oils were collected, dried over anhydrous sodium sulphate, and stored at 4 °C until further use. The behavioural responses of insects to the extracted oils were evaluated under laboratory conditions using a Y-tube olfactometer. Attractance of *Tetrastichus* spp. was assessed by releasing adults individually into the olfactometer and recording their orientation towards the odor source. Repellency of the oils against sugarcane black bug was determined by observing the insect choice between treated and control arms of the Y-tube. In the case of the parasitoid *Tetrastichus* sp., lemon oil showed significant attraction (χ^2 = 4.54; $p < 0.05$) and bael oil also elicited strong attraction (χ^2 = 5.00; $p < 0.05$) (Fig. 3.22). In contrast, bottle brush oil (χ^2 = 5.55; $p < 0.05$) and Christmas tree oil (χ^2 = 4.00; $p < 0.05$) exhibited significant repellency to the sugarcane black bug (Fig. 3.23). GC-MS analysis indicated that lemon oil was dominated by limonene (22.14%) and linalool (17.76%), bottle brush oil by eucalyptol (37.04%) and α-pinene (19.30%), bael oil by 1,2-cyclohexanediol derivative (21.65%) and (-)-carvone (14.58%), whereas Christmas tree oil contained higher proportions of citral (37.40%) and neral (29.33%). These findings suggest that specific plant-derived volatiles may influence

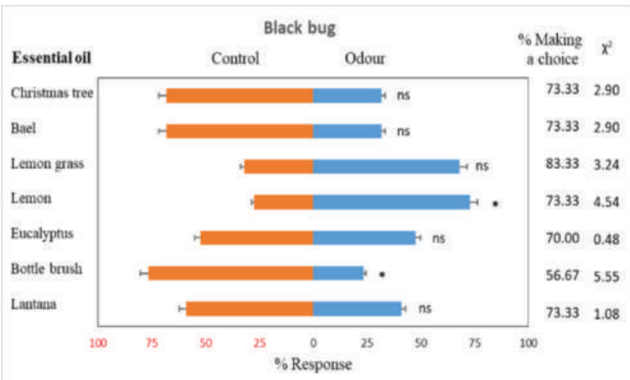


Fig. 3.22. Behavioural bioassay of Black bug using Y-tube olfactometer against different essential oils

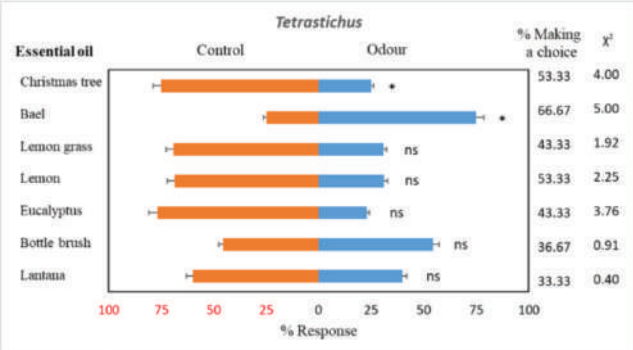


Fig. 3.23. Behavioural bioassay of *Tetrastichus* using Y-tube olfactometer against different essential oils

parasitoid attraction and pest repellency, indicating their potential application in semiochemical-based pest management strategies.

AICRP on Sugarcane

Evaluation of zonal varieties/genotypes for their reaction against major insect-pests in the area

Five sugarcane genotypes, viz., Co 20016, CoLk 20202, CoLk 20203, CoPb 20211 and CoH 20261 along with three standard checks (CoJ 64, Co 0238 and Co 05009) were evaluated against major insect-pests under AVT Early-I Plant trial. All entries recorded least susceptibility against top borer, stalk borer and internode borer, whereas high susceptibility (HS) was observed for mealy bug across genotypes. In AVT Early (II Plant), four sugarcane genotypes—CoLk 19201, CoLk 19202, CoPb 19212 and CoS 19231—along with three standard checks (CoJ 64, Co 0238 and Co 05009) were evaluated, and all entries exhibited a less susceptible (LS) reaction to stalk borer (SB) and internode borer (INB); however, for top borer (TB) and mealy bug (MB), highly susceptible (HS) reactions were observed in all genotypes except Co 0238, which showed a moderately susceptible (MS) reaction to TB, and CoLk 19201 and Co 0238, which recorded MS reactions to MB.

Seven sugarcane genotypes viz., Co 20017, CoPb 20181, CoLK 20204, CoLK 20205, CoPb 20212, CoS 20231 and CoS 20232 with three standard checks viz., CoS 767, CoPant 97222, Co 05011 were evaluated against ESB, INB, SB, TB, RB and MB in AVT Mid late I Plant. All genotypes showed LS reaction for top borer, stalk borer and internode borer at Lucknow. For mealy bug reaction was HS at Lucknow. A total of seven sugarcane genotypes, viz., Co 19017, CoPb 19182, CoLk 19204, CoPb 19213, CoPb 19214, CoS 19232 and CoS 19235, along with three standard checks (CoS 767, Co 05011, CoPant 97222), were evaluated against major insect pests, including early shoot borer (ESB), top borer (TB), stalk borer (SB), internode borer (INB), mealybug (MB) and root borer (RB) under AVT Mid-late II Plant. At Lucknow, all genotypes showed an MS reaction to TB, LS reaction to SB and INB, while a HS reaction was recorded against mealy bug.

Monitoring of insect-pests and bio-agents in sugarcane agro-ecosystem

Sugarcane top borer incidence was highest in the 1st brood (25%), indicating greater vulnerability during early crop stages, while later broods showed markedly lower infestation. Stalk borer incidence remained moderate (7.5%) and internode borer pressure was minimal (2.6%). Mealy bug infestation increased with crop age, rising from 16.3% in June to 26.9% in August, highlighting early top borer and late-season mealy bug as critical windows for timely IPM interventions.

Standardization of simple and cost-effective techniques for mass multiplication of sugarcane bio-agents

ICAR-ISRI, Lucknow demonstrated that **adult nutrition significantly enhanced progeny output and sex ratio (>92%)** in *Tetrastichus howardi*, improving mass-rearing efficiency. Assessment of yield losses caused by borer pests of sugarcane under changing climate scenario

Integrated modules (chemical + biological/cultural) consistently minimized borer incidence and maximized cane yield and juice quality. IPM reduced yield losses by **18–27%**, improved brix, pol, and purity, and significantly lowered internode, stalk, and top borer damage. Correlation analyses confirmed a **strong negative association between borer incidence and yield**, emphasizing the economic relevance of IPM.

Integrated approach to manage top borer in northwest zone

The untreated check recorded the highest top borer incidence across broods (12.5-38.5%) and the lowest cane yield (54.0 t/ha), indicating severe yield loss. The integrated module (egg mass removal + parasitoid + chlorantraniliprole) was most effective, registering the lowest brood-wise incidence (7.0-15.8%) and the highest yield (70.5 t/ha). Treatments combining chlorantraniliprole with *Trichogramma* also provided effective suppression and higher yields, whereas sole biological or chemical treatments were only moderately effective.

Management of sucking pests (mealy bug/ white fly/ wooly aphid/ aphid/ pyrilla/ scale insects) in sugarcane

The untreated control showed the highest mealybug infestation (18–78%) and lowest yield (54.9 t/ha). The integrated module (seed treatment + *Metarhizium anisopliae* + pyriproxyfen + diafenthiuron) recorded the lowest infestation (8-22%), highest yield (71.9 t/ha), and superior juice quality. Overall, bio-intensive integration proved most effective and sustainable for mealybug management.

Biological Control Centre, Pravaranagar, Maharashtra

Utilization of entomopathogenic nematodes against white grubs infesting sugarcane

Evaluation of field-efficacy of *Heterorhabditis indica* against white grubs in sugarcane: The field experiment was conducted on natural white grub infested suru-planted sugarcane plot in randomized bloc design with seven treatments and three replications (area: 25 m^2, cv: CoM 0265).There are two methods of *H. indica* application as a liquid formulation (5 × 10^7 IJs / ha and imposition of *H. indica*-killed Galleria cadaver @2 Galleria per clump along with *M. anisopliae* and *B. bassiana* (1 × 10^8 CFU/g) (1 kg each), chlorpyrifos 20%EC, EPN+META, EPN+half dose of chlorpyrifos.

The highest reduction in white grub population and less clump mortality (16.58- 19.32%) was observed in EPN+half dose of chlorpyrifos, followed by *H-indica* as liquid drenching and implantation of Galleria cadaver) as compared to *M. anisopliae* and *B. bassiana* and chlorpyrifos 20%EC. Imposition of EPN and fungal entomopathogens was observed to suppress the white grub population (>75%) and less clump mortality (<22%) over the untreated control. However, Furthermore, combining the *H. indica* with a half dose of insecticide recorded significantly less white grub population (86.29%) and the lowest clump mortality (14.51%) after 30 DAA. (Figure 3.24 & 3.25)

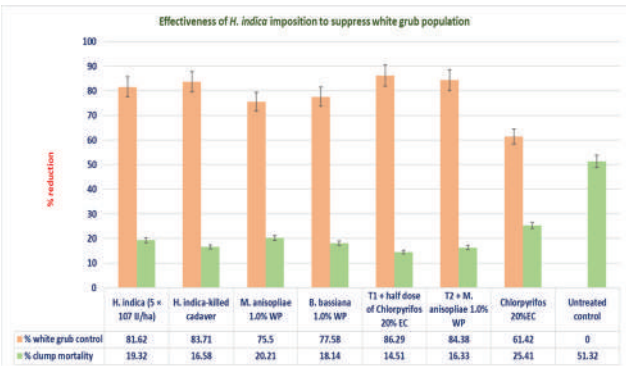


Fig. 3.24. Effectiveness of *H. indica imposition* in suppression of whit grub population at the field level in sugarcane

Fig. 3.25: Susceptibility of white grubs to *H. indica* in sugar cane field, (A) *H. indica* imposition in sugarcane fields (B). *H. indica* killed white grubs in fields

a. **Ecological characterization of native *H. indica* strains:** Six native strains of *H. indica* (H1, H2, H3, H4, H5 and H6) were characterized for ecological fitness by studying their longevity under different abiotic stresses such as temperature (5-40°C), pH range (4 to 10), Oxygen levels and soil depth (5 to 15 cm). Under the sand column assay, all *Heterorhabditis* strains kill Galleria in 24 to 192 hours in 5 cm, 10 cm and 15 cm sand columns. All six *Heterorhabditis* strains are tolerant to insecticides except Thiamethoxam and Clothianidin (15-20% nematode mortality). A temperature range of (20-30°C) was found amenable to these strains; however, H1, H2 and H3 were found to survive in (5-10°C), and H4, H5 and H6 were found live in (35-39°C). All *Heterorhabditis* strains were found to be tolerant in the pH range (5 to 9), while maximum mortality (60%) was seen at pH 4.

b. **Isolation, characterization and pathogenicity of EPN strains from white grub-affected fields:** On average, 30 soil samples collected from white grub-affected sugarcane fields in Rahuri tehsil of Ahilyanagar (MS) were baited with last larval instars of *Corcyra cephalonica*. Three maroon-coloured dead larvae were noticed in 4 soil samples after 12 days of baiting, washed and put on a white trap for EPN recovery. Presence of conspicuous morphological features and PCR amplification of *ITS* (PX788687), *D2-D3 expansin* (PX796479) and *CO-I* (PX780828) revealed an EPN species that belongs to the *Heterorhabditis* group. Infection of this EPN strain at a rate of 500 to 4000 IJs/grub kills the 2nd and 3rd grub instar white grub in 5 to 15 days (Fig.3.26).

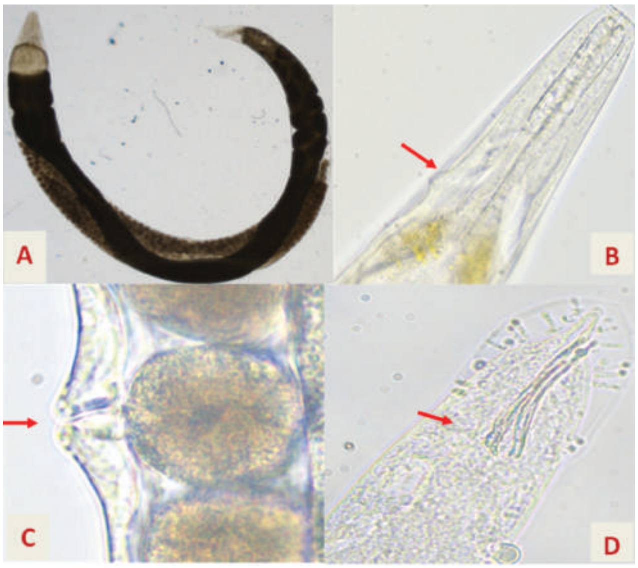


Figure 3.26. Distinct morphological features of *Heterorhabditis* sp. (A). large sized C shaped hermaphrodite (B) Position of excretory pore (arrow) (C). Protruded vulva in females (D) Bursal papillae at the tail tip in males

c. **Isolation, and characterization of entomopathogenic fungi, *Beauveria brongniartii*, from dead white grub:**

Entomopathogenic fungi were isolated from dead white grubs mummified by white filamentous fungi which was collected from the grubs rearing units using potato dextrose agar (PDA) and Sabouraud Dextrose Agar (SDAY). The microscopic examination revealed that the mycelium is white and becomes yellow-pinkish on maturity. Conidia are ellipsoidal to oval with clusters of spores. The partial sequencing of ITS and beta-tubulin markers, revealed that our isolate belongs to *Beauveria brongniartii, which was* designated as ISRIBCCBB01 and ITS sequence submitted in the NCBI GenBank database with an accession number as PX930903**.** Furthermore, inoculation of this strain to *Galleria mellonella* kills the larvae in 7to 8 days (Fig. 3.27).

Bio-prospecting of entomopathogenic bacteria for management of white grubs infesting sugarcane

We conducted *invitro* bio efficacy studies of *Bacillus thuringiensis* IISRBCCEB01, *Bacillus thuringiensis* IISRBCCEB02, Beauveria, Metarhizium, Insecticides recommended for white grub' control, such as Acephate 50% + Imidacloprid 01.80% SP, Fipronil 40% + Imidaclopríd 40% WG, Thiamethoxam 00.90% + fipronil 00.20% w/w GR, and entomopathogenic nematodes against first-instar grubs. Field collected adult beetles (100 N0.) were reared for first instar grubs in plastic trays containing a 2:2 sterilized mixture of soil and vermicompost, which were inoculated

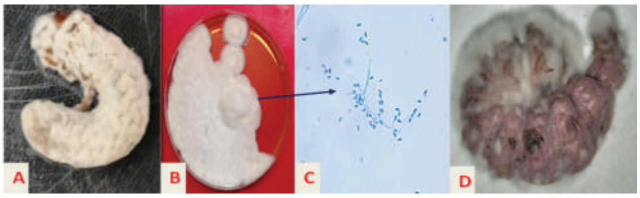


Fig. 3.27. Entomopathogenic fungi, *Beauveria brongniartii* (A) Growth of *Beauveria brongniartii* on white grub (B) Whitish-pinkish growth on SDAY media (C) Ellipsoidal to oval spores and (D) Mycelium growth on *G. mellonella*

subsequently with bioagents and insecticides. The plastic trays were maintained under room conditions of 28 ± 2°C temperature and 70 ± 5% relative humidity for 90 days. Fresh neem leaves were used as feed for the adult beetles. The observations on grub mortality due to infection by different bioagents and insecticides were carefully recorded at 30 days interval for 90 days. The percentage mortality of the grubs was calculated using Abbott's formula. Among the twenty-one treatments, *Bacillus thuringiensis* IISRBCCEB02 (2 × 10^{12} spore/gm) showed the highest mortality compared to other bioagents and insecticides. EPN, Beauveria, Metarhizium, and insecticides exhibited 36-56% and 58-85% mortality, whereas a combination of different bioagents showed 32-55% mortality 60 days after inoculation

Field bio efficacy trials were carried out in a white grub-infested sugarcane field (Variety, COM0265) at BCC, Pravaranagar during 2025-26. The field trial was laid out in a Randomized Block Design with 21 treatments and each treatment had four replications. The crop was sown in December 2024 and harvested in December 2025. All treatments were applied by drenching the root zone of each clump; the first application was done in June and the second application was done 30 days after the first application. All agronomic practices with the recommended dose of fertilizers were followed until crop harvest to maintain good plant health, as per the package of practices of sugarcane crop. Clump damage caused by white grubs was calculated by recording the total number of damaged clumps and the total number of clumps per treatment.

$$\text{Clump damage (\%)} = \frac{\text{Number of damaged clumps}}{\text{Total number of clumps}} \times 100$$

The clump damage due to white grubs' infestation was lowest (3.56%) in thiamethoxam 00.90% + fipronil 00.20% w/w GR (135+30 g.a.i./ha) treated plots which was statistically superior over rest of the treatments and followed by Bt2 (2×1010), fipronil 40% + imidacloprid 40% WG (200 + 200 g.a.i/ha) and Meta+Bea treated plots which recorded 6.51%, 6.68% and 6.84% clump damage, respectively.

Diversity profiling and management strategies of bacteria associated with post-harvest sucrose bio deterioration in sugarcane

The manually harvested whole cane and mechanically harvested billets were collected during the May 2024 sugarcane harvest season stored at open field conditions and cane samples drawn at 0, 24, 48, and 72 h post-harvest to estimate bacterial diversity through metagenomic analysis. DNA was extracted from juice samples and amplicon-based sequencing was performed to identify bacteria using the V4 region of the 16S rRNA gene (16S V4). This yielded 6260609 paired-end reads for the 16S V4 region. A total of 203 bacterial OUT was observed in both whole and billet canes. Permutational multivariate analysis of variance (PERMANOVA) showed that overall, bacterial compositions significantly differed between storage durations of 0, 24, 48, and 72 h and methods of harvesting (P = 0.01). The high relative abundance of *Enterobacter, Lactococcus, and Weissella* compared to *Leuconostoc, Lactobacillus, and Pantoea* was observed over the storage duration and harvesting methods. The change in alpha diversity, such as Faith PD and Shannon index after 24 h and chao1 richness after 48 h, indicate that a strong shift in the bacterial community due to bacterial competition for carbon sources, ecological shifts, and treatment effects (Fig. 3.28). Bacterial diversity using Metagenomic analysis showed that *Enterobacter, Lactococcus, and Weissella* are the predominant genera involved in post-harvest sucrose deterioration in sugarcane.

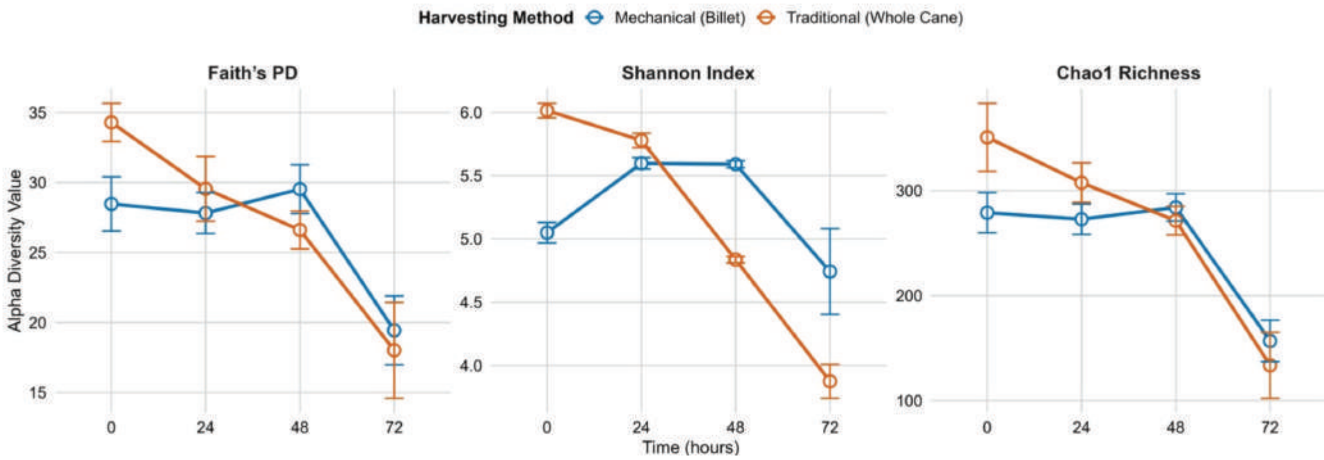


Fig. 3.28. Alpha diversity metrics of bacterial communities in whole cane and billets on different storage days post-harvest

Survey and surveillance of insect pests and diseases of sugarcane in the tropical area (Maharashtra)

Surveys and surveillance were conducted to assess the seasonal prevalence of diseases and pests in sugarcane across the command areas of sugar mills in the Ahmednagar, Nashik, Jalgaon, Nanded, and Sangli districts of Maharashtra.

Incidence of Diseases: The major disease incidences observed included brown spot, rust, and *pokkah boeng*, with prevalence rates ranging from 60% to 80%, 25% to 60%, and 30% to 50%, respectively, in the surveyed fields. Yellow leaf disease (YLD) was monitored at rates of 20% to 30% in the ratoon crop of CoM0265 and the plant crop of Co86032, while a minor incidence of sugarcane leaf scorch (10% to 15%) was also reported in both varieties. Smut incidence was observed at 5% to 10% in both the ratoon and plant crops of CoM0265 and VSI 8005. However, a severe incidence was reported on CoVSI03102 and VSI8005 in the Nanded district. Additionally, a minor incidence of wilt was reported in MS 10001 and CoM0265.

a. **Identification and pathogenicity of *Fusarium* species associated with *pokkah boeng* of sugarcane in Maharashtra:** In this study, a total of eleven *Fusarium* sp. isolates associated with *pokkah boeng* disease were collected from sugarcane cultivars VSI08005, CoVSI03102, and Jowar in the Nanded and Ahilyanagar districts. Additionally, three Fusarium sp. isolates linked to wilt disease were obtained from MS 10001 and CoM0265 in the Ahilyanagar district. These isolates were then isolated, purified, and maintained at IISR-BCC, Pravaranagar (Fig. 3.29). The pathogenicity test revealed that all isolates induced disease symptoms in the CoM 0265 cultivar, with a disease severity index ranging from 9.99 to 13.33 in leaf axil inoculated plants (Table 3.3). Observations of colony color, growth pattern, and pigmentation were recorded, with growth rates varying from 1.57 to 3.01 mm per day. Symptoms noted during the pathogenicity test included chlorosis and necrosis of leaves, punctured lesions, twisted leaves, reduced total leaf area, death of the plant top, and stalk rot.

b. **Isolation and identification of *Cercospora* sp associated with brown spot disease of sugarcane:** In this study, isolation technique for *Cercospora* sp. associated with brown spot of sugarcane was standardized. The isolation of fungus using spores collected from infected sugarcane leaves on water agar has resulted in the successful isolation of the sugarcane brown spot pathogen. On PDA, colonies were dark brown to greenish-black, with raised surface and folds, reaching 7.5 mm diameter after 14 days (Fig. 3.30a). The mycelium was light brown and septate, with green pigment aggregates (Fig. 3.30b). Conidia were hyaline, solitary, obclavate, straight to curved, with subacute apex and truncated base, measuring 122.99 µm length, 2.51 µm basal width, 0.84 µm upper tip width, and 1.3 µm hila (Fig. 3.31c). Conidiophores were pale to dark brown, erect, subcylindrical, geniculate, and rarely branched, measuring 107.43 × 3.41µm. Conidiogenous cells were integrated, terminal or intercalary (Fig.3.30d). These morphological characteristics confirmed its identification as *Cercospora* sp. BLASTn search of ITS, 18S rRNA, beta-tubulin, and actin genes partial sequences showed 96–99% and 88–90% similarity with *Cercospora* spp. The phylogenetic tree, derived from the ITS region, â-tubulin, and actin genes sequences, supported the known phylogenetic relationships within *Cercospora*. The Cercospora IISRBCCBP01 isolate was distinctly separated from other described species of Cercospora, forming a well-supported lineage that was distinct from all other species (Fig. 3.31).

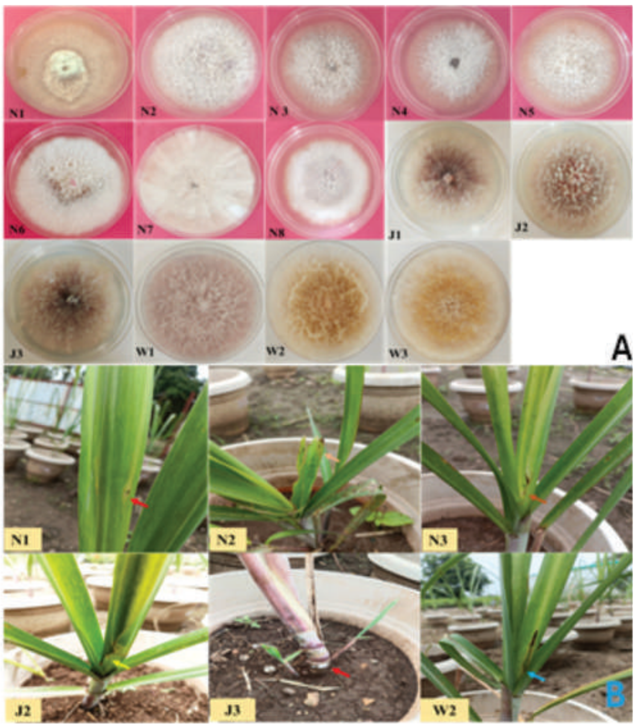


Fig. 3.29. Plate photographs of axenic cultures of *Fusarium* sp. associated with pokkah boeng isolated from different locations and cultivars

Table 3.3. The details of *Fusarium* sp. isolates with growth rate

Sr. No	Isolate	Variety	Location	Growth Rate (mm)
1	N1	VSI 3102	Beldara	2.32
2	N 2	VSI 3102	Beldara	2.43
3	N 3	VSI 8005	Shekapur Kandhar	2.06
4	N 4	VSI 8005	Shekapur Kandhar	2.06
5	N 5	MS 10001	Bolsa Umri	2.19
6	N 6	MS 10001	Bolsa Umri	2.02
7	N 7	VSI 8005	Shekapur Kandhar	2.34
8	N 8	VSI 3102	Beldara	2.17
9	J 1	Local var	Pravaranagar	2.02
10	J 2	Local var	Pravaranagar	2.99
11	J 3	Local var	Pravaranagar	2.61
12	W 1	CoM 265	Pravaranagar	2.40
13	W 2	CoM 265	Pravaranagar	3.08
14	W 3	CoM 265	Pravaranagar	2.91

The species closely related to the lineage containing *Cercospora* IISRBCCBP01 were *C. nicotianae*, *C. kikuchi*, and *C. armoraciae*, which formed polyphyletic and monophyletic sister lineages, respectively, to the isolates of Cercospora IISRBCCBP01. Based on these analyses, *Cercospora* IISRBCCBP01 was clustered in an independent branch, separate from any known species, and was thus proposed as *Cercospora longipes*. The sequences were deposited in GenBank (ITS, PQ056713; 18S rRNA, PQ056724; tub2, PX233329;

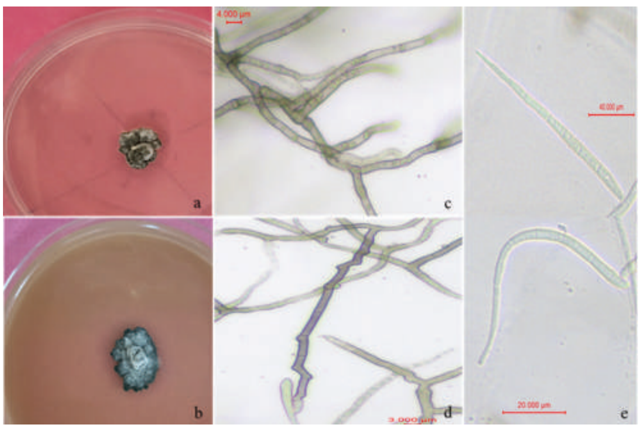


Fig. 3.30. Pure culture of *C. longipes* along with mycelium, conidiophore and conidia. a- radial growth on PDA, b- radial growth on 25%F+20%V8 agar, c-mycelium, d- dark brown septate conidiophores arising from mycelium with conidiogenous cell, e- Straight to curved, 3-10 septate conidia

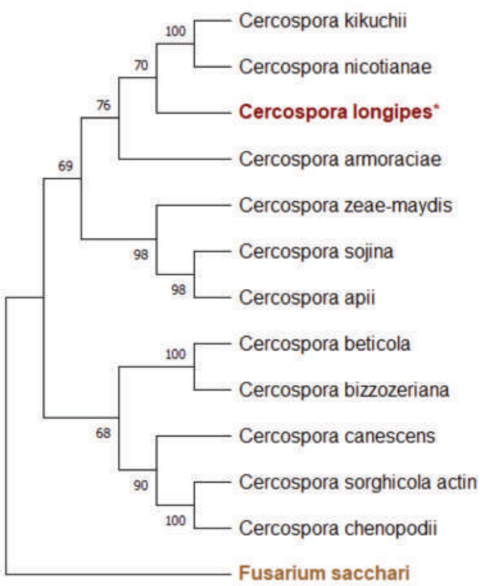


Fig. 3.31. A Maximum parsimony tree based on the concatenated alignment of sequence data of ITS, β-tubulin and actin gene showing phylogenetic relatedness of sequenced *Cercospora longipes* (shown in bold brown colour with *) with other *Cercospora* species obtained from NCBI. *Fusarium sacchari* was designated as outgroup

act, PX207089) and culture in National Agriculturally Important Microbial Culture Collection (NAIMCC), Mau Nath Bhanjan, Uttar Pradesh, India, under accession number TF3681 for preservation. This is the first report on isolation technique, pathogenicity protocol, molecular characterization, and sporulation techniques of *C. longipes* IISRBCCBP01.

b. **Methodology for production of *Cercospora longipes* inoculum for large scale screening of sugarcane genotypes:** In our previous study, we reported that the mycelium bit (5 mm) inoculation method yielded $3.5x10^6$ and $0.25x10^6$ spores/ml in 25% sugarcane fresh leaf extract agar and PDA media, respectively, from a whole plate harvest in 10 ml of sterile water. However, plate inoculation by spreading 100 µl of spore inoculum ($2x10^6$ spores/ml) in 25% FLE and PDA resulted in spore production of approximately $6.21x10^6$ and $6.26x10^6$ spores/ml, which is 1600 times more than the mycelium bit inoculation method. We also examined the effect of different media concentrations, such as 25%, 50%, and 100% of FLE agar and PDA media, as well as spore age on spore production and disease incidence. The PDA at 100% concentration produced the highest spore count, whereas 25% FLE media yielded the highest spores at 50% concentration

Disease incidence was significantly highest in spores produced from 100% concentration of PDA and 25% FLE. Spores aged 9, 12, and 14 days produced significantly more spores compared to those aged 3 and 6 days. However, no significant differences were observed in the spore production capacity of 9, 12, and 14-day-old spores from PDA. The 14-day-old spores from 25% FLE media produced significantly more spores compared to 3, 6, 9, and 12-day-old spores. Disease incidence was significantly higher in 12 and 14-day-old spores than in 3, 6, and 9-day-old spores (Fig. 3.32a-d). This method has direct applications in screening a large number of sugarcane genotypes for brown spot resistance under field conditions. To the best of our knowledge, this is the first report on methods for producing inoculum of *Cercospora longipes* for large-scale screening of sugarcane genotypes for brown spot resistance.

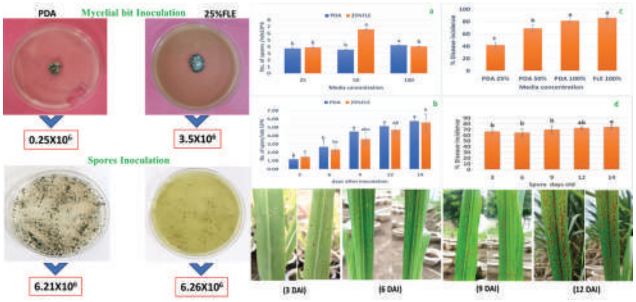


Fig.3.32. Effect of different media concentration on spore count (a), and disease incidence (c) PDA and 25%FLE on spore count (b), spore age on disease incidence (d), Pathogenicity test- incidence of brown spot at different days after inoculation (e)

c. **Isolation, identification and molecular characterization of mycoparasitic fungi of brown rust of sugarcane**

The natural incidence of mycoparasitic fungi *Sphaerellopsis* sp was observed on rust pustules in the range of 50-80% per leaves in CoM0265, Co86032. Mycoparasitic *Cladosporium* sp. IISRBCCMF01, IISRBCCMF02, IISRBCCMF03, IISRBCCMF04, IISRBCCMF05 isolates, isolated from parasitized rust uredospores were characterized morphologically and molecularly by partial sequencing of actin, translation elongation factor one alpha, beta tubulin an ITS region (Fig. 3.33). BLASTn search of the ITS, beta-tubulin, tef and act amplification sequences of the *Cladosporium* sp. isolates in the NCBI database revealed that these sequences exhibited 96–99% similarity, with those of the genus *Cladosporium* sp. The phylogenetic tree, derived from the ITS, β-tubulin, tef and actin genes sequences places all the five isolates within the genus *Cladosporium* forming a strongly supported monophyletic clade. This clade shows high bootstrap support 100% indicating that the isolates are genetically very similar to each other and clearly belongs to *Cladosporium* sp. The IISRBCCMF isolates cluster closest to *Cladosporium ribis* and *C.*

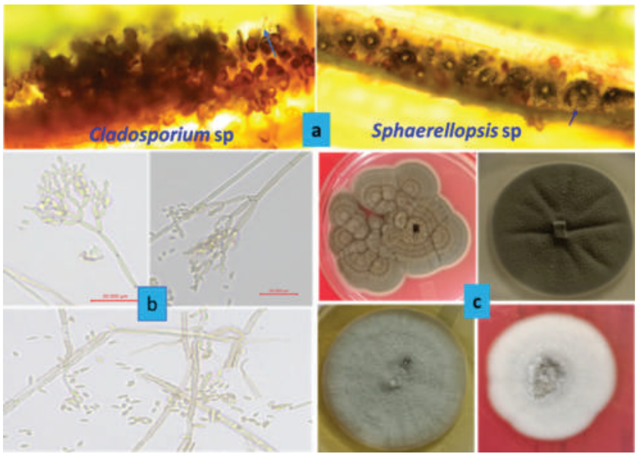


Fig. 3.33. Mycoparasitic fungi incidence on brown rust of sugarcane reported during survey and surveillance. a- parasitized pustules of rust; b- morphometry, c: axenic culture of mycoparasitic fungi

vicinum, but they form a distinct subclade rather than grouping directly within any single described species. Several deeper nodes separating the study isolates from closely related species show moderate to low bootstrap support (39–70%), suggesting limited resolution at the species level (Fig. 3.34). Mycoparasitic *Cladosporium* sp. IISRBCCMF01, IISRBCCMF02, IISRBCCMF03, IISRBCCMF04 culture was deposited in the National Agriculturally Important Microbial Culture Collection (NAIMCC), Mau Nath Bhanjan, Uttar Pradesh, India, under accession number NAIMCC-F-04704, NAIMCC-F-04706, NAIMCC-F-04705, NAIMCC-F-04703 respectively, for preservation. To our knowledge, this is the first report on the isolation, identification, and molecular characterization of mycoparasitic *Cladosporium* from

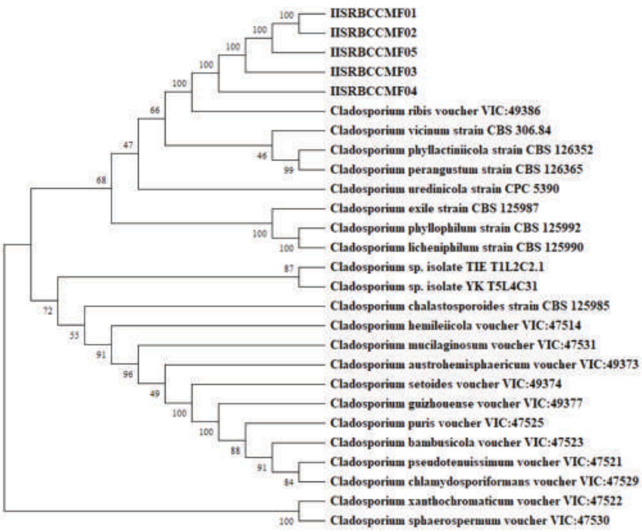


Fig. 3.34. Maximum parsimony tree based on the concatenated alignment of sequence data of three loci, ITS, tef 1á and actin gene showing phylogenetic relatedness of *Cladosporium* sp (IISRBCCMF01, 2, 3, 4, 5) with other mycoparasitic Cladosporium sp obtained from NCBI

the brown rust pathogen *Puccinia melanocephala* in sugarcane.

d. **Infestation of insect pests:** White grub infestation was sporadic in the range of 30% to 80%; however, the ratoon crop was severely damaged during the monsoon dry spell in July in the surveyed area. The infestations of woolly aphids, pyrilla, internodes, and early shoot borer were reported in the range of 20% to 50%, and minor infestations of top borer, root borer, and termite damage of 10-15% were also reported in the surveyed sugarcane fields. The infestation of the whitefly *Aleurolobus barodensis* was 50-90% in the sugarcane-growing area of North Maharashtra from June to October; however, an increasing level of infestation of the whitefly *Neomaskellia andropogonis* was also reported in Ahmednagar, the sugar mills command area.

e. **Parasites and Predators reported:** The predator of sugarcane pyrilla, *Epiricania melanoleuca*, was observed in the range of 2-3 cocoons per clump during July – January. Pyrilla egg masses were also parasitized by the parasitoid *Tetrastichus pyrilli*. The woolly aphid predator *Micromus igoratus* and cetrid fly larvae were observed in the range of 5-6 per leaf wherever a high density of nymphs was present. The infestation of nymphal and pupal parasitoids was observed in *Aleurolobus barodensis*, and Coccinellidae predator incidence was also observed in the white fly *Neomaskellia andropogonis*. Coccinellidae predators were observed on the eggs and nymph stages of the whitefly *Neomaskellia andropogonis*.

f. **Isolation, Identification, and *molecular characterization* of entomopathogenic and saprophytic fungi from different parasitization patterns in sugarcane white fly *Aleurolobus barodensis***

We observed the fungal growth on nymphal and pupal stages of white fly *Aleurolobus barodensis* which are difficult to differentiate, whether it is saprophytic or entomopathogenic fungi (EPF). A total twenty-eight isolates of fungi were isolated from different parasitisation pattern in nymphs and pupae to identify the entomopathogenic fungi (EPF) (Fig. 3.35). Based on partial sequencing of ITS, Translation elongation factor alpha 1, and beta-tubulin, saprophytic fungi were identified as *Penicillium* sp., *Epicoccum* sp., and *Alternaria* sp., and *Fusarium* sp. and *Cladosporium* sp. were identified as entomopathogenic fungi. In vitro bioassay studies showed that the entomopathogenic fungi Cladosporium sp cause 60-80% mortality, whereas Alternaria sp. and *Fusarium* sp cause 30-40% mortality in the nymphal instars and pupal stages of *Aleurolobus* barodensis.

Externally funded Projects

RKVY Funded Project: Establishment of Biological Control Laboratory for mass production of bio-agents against insect-pest and diseases and dissemination of technology for enhanced cane and sugar productivity of Maharashtra

Under the RKVY scheme, the Government of India of Maharashtra approved and sanctioned the project of Rs. 501.82 Lakh during the 23rd State Level Sanctioning Committee (SLSC) meeting under the chairmanship of the Chief Secretary of the Government. of the Maharashtra IISR-Biological Control Centre, Pravaranagar. The RKVY unit sanctioned 1.28 Cr as 100% funding as per the norm of the Government of India and direct ICAR-Indian Institute of Sugarcane Research, Lucknow to raised remaining funds of Rs. 376.82 Lakh as self-funding to execute the project. Of this total funding, 80 Lakhs were sanctioned for the construction of the biocontrol laboratory and 48.81 Lakhs for the purchase of instruments. Meanwhile we requested Government of Maharashtra to provide total funding for completion of project at this juncture RKVY cell communicated to submit the revised detailed project report for total funding of Rs. 501.82 Lakh. Now we have submitted a revised project of Rs. 598.93 Lakh for complete execution of project at BCC, Pravaranagar.

Networking Project: Improving water use efficiency and economizing water use in sugarcane cultivation in India

The evaluation of irrigation practices in sugarcane plant crops season 2024-25 revealed substantial differences in irrigation water use, water use efficiency (WUE), and water productivity (WP). The data (Tables 3.4) demonstrated that drip irrigation (T6) consistently required the least irrigation water (1642.22 mm), resulting in water savings of 12–45%

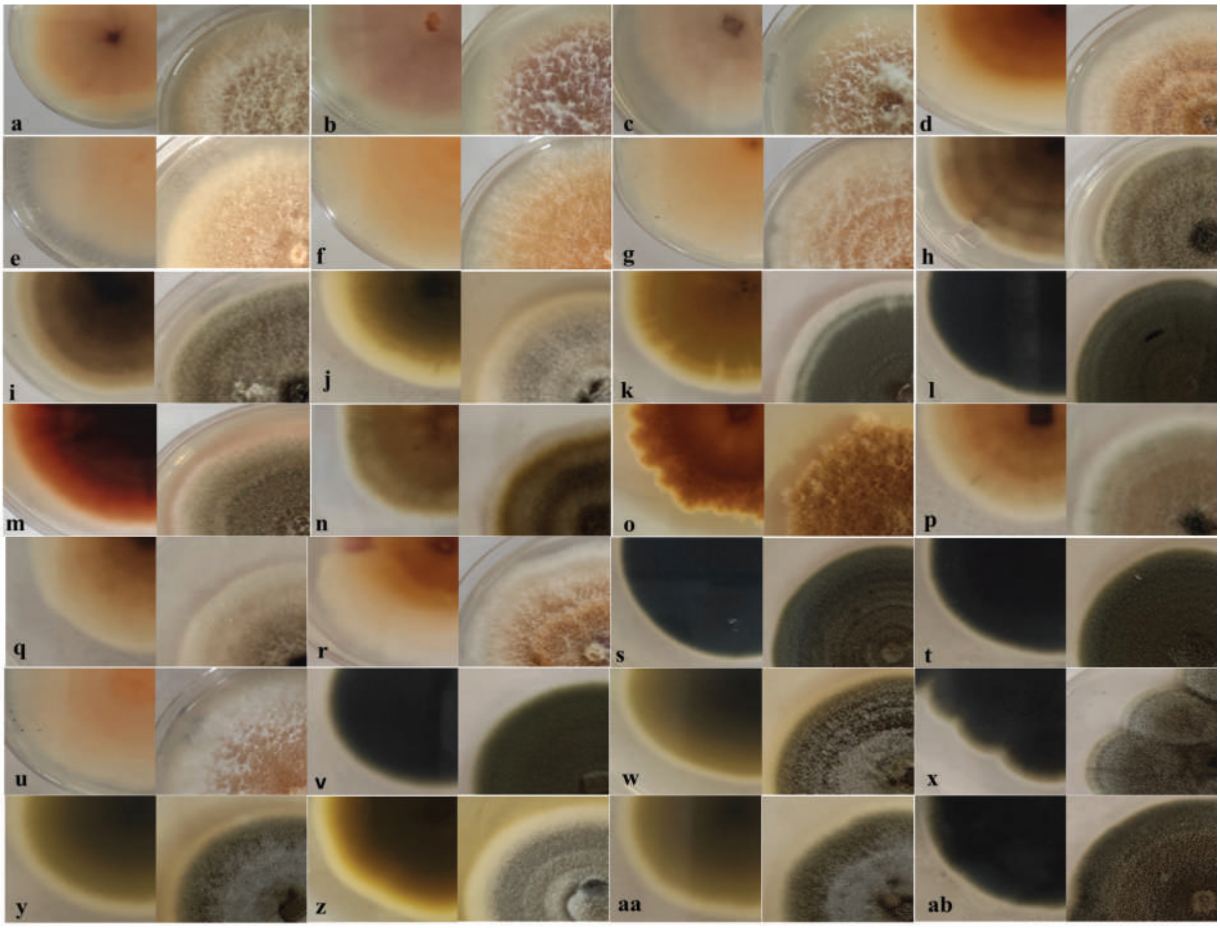


Fig. 3.35. Culture plates photographs of fungi isolated from different parasitization pattern in white fly *Aleurolobus barodensis; a- Fusarium sp., b- Fusarium sp., c- Fusarium sp., d- Fusarium sp., e- Fusarium sp., f- Fusarium sp., g- Fusarium sp., h- Alternaria sp., i- Alternaria sp., j- Cladosporium sp., k- Cladosporium sp., l- Penicillium sp., m-Epicoccum sp., n-Cladosporium sp., o- Fusarium sp., p- Alternaria sp., q- Cladosporium sp., r- Fusarium sp., s- Cladosporium sp., t- Cladosporium sp., u- Fusarium sp., v- Cladosporium sp., w- Cladosporium sp., x- Cladosporium sp., y- Cladosporium sp., z- Cladosporium sp., aa- Cladosporium sp., ab- Cladosporium sp.*

Table 3.4. Effect of water saving technology on cane yield and water productivity 2024-25

Treatments	Yield (t/ha)	IWA (mm)	RR (mm)	TW (mm)	TWP (kg/ ha /mm)	IWP (kg/ ha /mm)
T1: Irrigation at critical stages (Farmers' practice)	172.38	1860.54	682.11	2542.65	67.79	92.65
T2: Trash Mulching in sugarcane	167.78	1803.67	682.11	2485.78	67.50	93.02
T3: Skip furrow irrigation in sugarcane	144.89	1799.29	682.11	2481.40	58.39	80.53
T4: Trench method of sugarcane planting	129.19	1954.56	682.11	2636.67	49.00	66.10
T5: Flat planting of sugarcane with recommended irrigation scheduling for the region	149.61	1867.87	682.11	2549.98	58.67	80.10
T6: Drip irrigation in sugarcane as per scheduling for the region	179.70	1642.22	682.11	2324.33	77.31	109.42
T7: Prominent cropping system of the region with recommended irrigation scheduling (Maize-Soybean-Wheat)	34.35	1657.82	682.11	2339.93	14.68	20.72

IWA-Irrigation water applied, RR- rainfall received, TW- total water, TWP- total water productivity, IWP-irrigation water productivity

compared to farmer's practice (T1: 1860.54 mm). Among surface irrigation methods, trash mulching, with recommended irrigation scheduling (T2: 1803.67 mm) and trench (T4: 1954.56 mm) and skip-furrow (T3: 1799.29 mm) methods achieved moderate savings, while flat planting methods (T5: 1867 mm) consumed similar or slightly higher amounts than farmers' practice. By contrast, the prominent cropping system (Maize–Soybean–Wheat; T7) consistently demanded the highest irrigation input (T7: 1657.82 mm), underscoring its greater consumptive use.

IWA-Irrigation water applied, RR- rainfall received, TW- total water, TWP- total water productivity, IWP-irrigation water productivity.

CHAPTER 4

Research in Plant Physiology & Biochemistry

Physiological and Biochemical approaches for increasing cane yield, enhancing sucrose recovery and improving climate resilience in sugarcane

Physiological and molecular bases of multiple abiotic stress tolerance in sugarcane

Abiotic stresses, including drought, salinity, and waterlogging, negatively affected plant height and cane weight in both sugarcane genotypes, A-27-12 and CoJ 64. However, A-27-12 (tolerant genotype) exhibited relatively less reduction in these parameters. Similarly, photosynthetic rate, stomatal conductance, and chlorophyll stability index were all impacted by stress, with the most significant reductions observed under drought conditions.

Sucrose metabolizing enzymes (SPS, SS, and SAI) showed decreased activity under all stress conditions, with drought causing the highest reduction compared to salinity and waterlogging. These changes were consistent with transcriptomic analysis, which revealed down regulation of SPS, SS, and SAI genes.

Conversely, antioxidant enzymes (CAT, POX, APX, and SOD) exhibited enhanced activity in response to abiotic stresses, particularly drought, which led to the highest increases in enzyme activity. Gene expression analysis confirmed the upregulation of CAT, POX, APX, and SOD genes under drought stress.

Pathway analysis revealed that A-27-12 upregulated 90 genes across 16 pathways in response to drought, compared to only 20 genes in CoJ 64. This suggests that A-27-12's tolerance is largely due to the broader genetic response to drought stress.

Evaluation of silica application in relation to moisture stress, disease and pest tolerance and productivity in sugarcane

In order to study the impact of silicon application on biochemical traits and spatiotemporal distribution of silicon under moisture stress, a pot culture experiment was conducted using sugarcane variety CoLk 11206. Sucrose metabolism enzyme including soluble acid invertase (SAI) and sucrose phosphate synthase were assayed. It was observed that SAI specific activity decreased in drought stressed sugarcane plants (0.962 U mg^{-1} protein) over non-treated plants (1.312 U mg^{-1} protein) raised in similar condition. However, in control raised sugarcane stalks SAI activity were slightly increased (0.985 U mg-1 protein) with silicic acid (S2D2M2) over respective stress counterparts (0.962 U mg^{-1} protein). Moreover, control grown non-treated sugarcane plants (1.312 U mg^{-1} protein) (S0D0M0), exhibited slightly higher SAI activity (1.372) over stress counterparts. In case of SPS activity non-significant difference between non-treated sugarcane (S0D0M0) raised in control (109.23 U mg^{-1} protein) and stressed conditions (110.72 U mg^{-1} protein) was observed. Leaf silicon content in stressed sugarcane plants at 90 DAP significantly differed as compared to non-stressed plant. The maximum silicon content recorded in S2D2M2 in stressed sugarcane (16.45 g kg^{-1}), and minimum in S0D0M0 (8.23 g kg^{-1}).

However, at 180 and 210 DAP Si content of leaf was reduced in both control and stressed crops.Silicon content in leaf sheath was initially (90 DAP) less as compared to leaf portion of the cane, with the advancement of crop growth (180 and 210 DAP) it was increased in both control and stressed sugarcane.

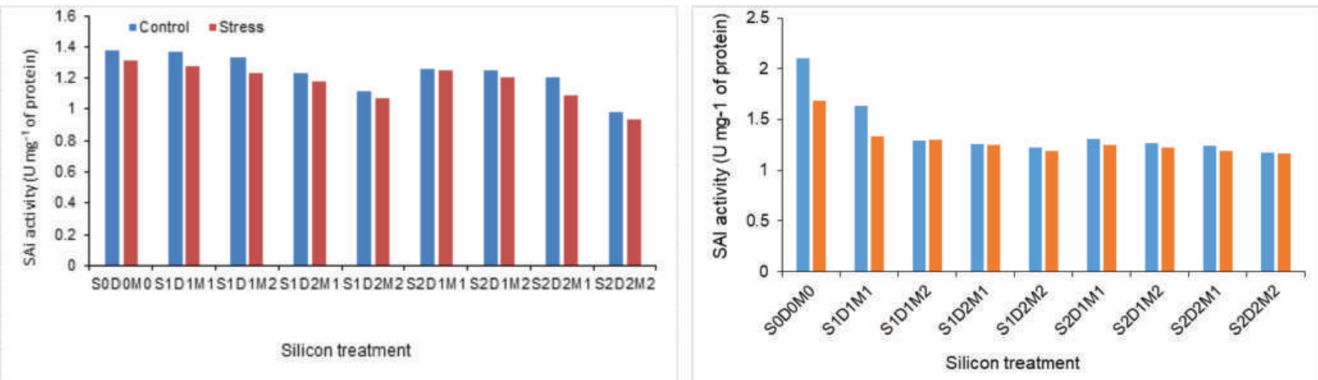


Fig. 4.1. SAI activity in stalk tissue in 10 month and 12 month crop

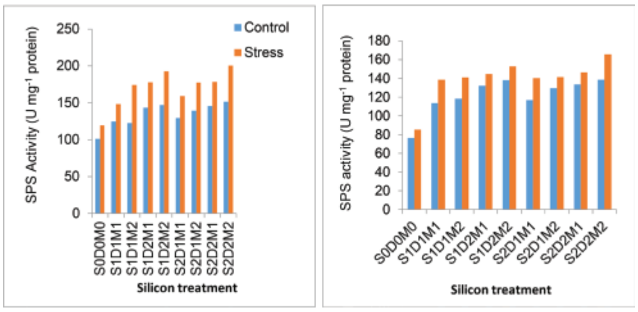


Fig. 4.2. SPS activity in stalk tissue in 10 month and 12 month crop

The maximum silicon content at 180 DAP recorded in S2D2M2 in both control (14.62 g kg^{-1}) and stressed sugarcane (15.51 g kg^{-1}), while least in S0D0M0 (7.10 and 7.35). However, differences between control and stressed sugarcane at 180 DAP was increased among their counterparts. Silicon content in stalk portion of sugarcane significantly differed in S0D0M0 grown in control (5.17 g kg^{-1}) and stressed condition (6.54 g kg^{-1}) at 90 DAP. However, S2D2M2 displayed maximum Si content in stalk in both control and stressed sugarcane (10.15, 11.82 g kg^{-1}). Moreover, Si content in stalk were increased with crop growth advancement. Partitioning of Si was minimum in root portion of sugarcane at both 90 and 180 DAP. However, S2D2M2 displayed maximum Si content in root in both control and stressed sugarcane (8.57 and 10.3 g kg^{-1}) and minimum in S0D0M0 (4.10 and 4.67 g kg^{-1}) at 90 DAP.

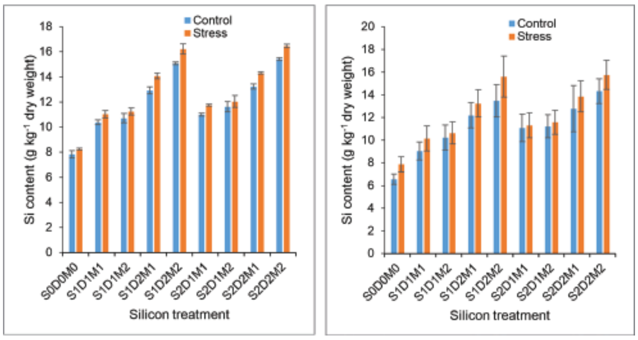


Fig. 4.3. Silicon content of sugarcane leaf at 90 and 180 DAP

Process development for enhancing ethanol recovery from sugarcane trash and B- heavy molasses

HPAC pre-treatment led recovery of about 71.0% cellulose, 18.0% hemicelluloses, and 11.69% lignin. Notably, 93.5% of the lignin was removed with the pre-treatment with minimum inhibitory compounds development. The optimal conditions for the hydrogen peroxide–acetic acid pre-treatment was 75°C, 2.5 h, and an equal volume mixture of hydrogen peroxide and acetic acid. Compared to other pre-treatment process *vis a vis* liquid hot water (LHW) pre-treatment under the same conditions, the HPAC pre-treatment was more effective at increasing enzymatic digestibility. Low severity HPAC pre-treatment effectively increased sugar yields and ethanol production from unwashed pre-treated SCT. HPAC pre-treatment improved ethanol yield to 93.8%, but the synergistic effect of two stage pre-treatment method decreased as pre-treatment severity increased. Inhibitors produced during mild HPAC pre-treatment became problematic when pre-treatment temperature was increased to 200°C. Combining low severity HPAC pre-treatment and mechanical refining showed promise for improving ethanol production by integrated bioprocess.

Assessment of scope for invigoration of biomass dynamics during sugarcane growth cycle through plant growth regulators

Five experiments were conducted to assess the impacts of PGRs in sugarcane plant crop, ratoon I and II crops. The field experiments on ratoon crop was initiated March 2024 with spray of two doses of NAA (@50 and @100 ppm) on ratoon stubbles along with water, Ethrel and absolute control using CoLk 94184. While in the first experiment, impact of PGRs on biomass dynamics were assessed in Oct 2024; the second experiment dealt with usage of PGRs in Field No. D44 in spring season, Feb 2024. Further, in experiment III, biomass dynamics were assessed for sugarcane Ist ratoon crop initiated in autumn 2024 and in experiment IV, biomass dynamics were assessed for sugarcane IInd ratoon crop. Experiment V has been planted to continue to study of PGRs in October 2024. Exogenous application of Ethrel, NAA @ 50 and 100 ppm & Gibberellic acid (GA3) stimulated physiological growth, increased initial plant population and caused internodal elongation. Significant improvements were recorded in biometric traits responsible for yield attributes. PGRs led to enhanced NMC ha^{-1} and cane yield (tha^{-1}). Maximum germination % at 45 DAP was recorded with Ethrel @100 ppm. During the crop cycle, tiller numbers and biomass accumulation till 270 DAP indicated that maximum improvement in germination and biomass dynamics occurred with Ethrel. Other biometric traits showed similar trends with maximum impact with sett soaking with Ethrel. Number of plants ha^{-1}, per cane weight and cane weight (tha^{-1}) indicated maximum effect of Ethrel. At 330 DAP, the hormonal interventions led to maximum cane yield of 155.15 tha^{-1}. There was maximum increase in biomass accumulation with phasic application of Ethrel and foliar spray of GA3. Field demonstrations of PGR Technology were conducted with plant crops of sugarcane varieties CoLk 16202, CoLk 15201, CoLk 14201, CoLk 15466, and CoLk 15206. The application of Ethrel externally on cane prompted physiological

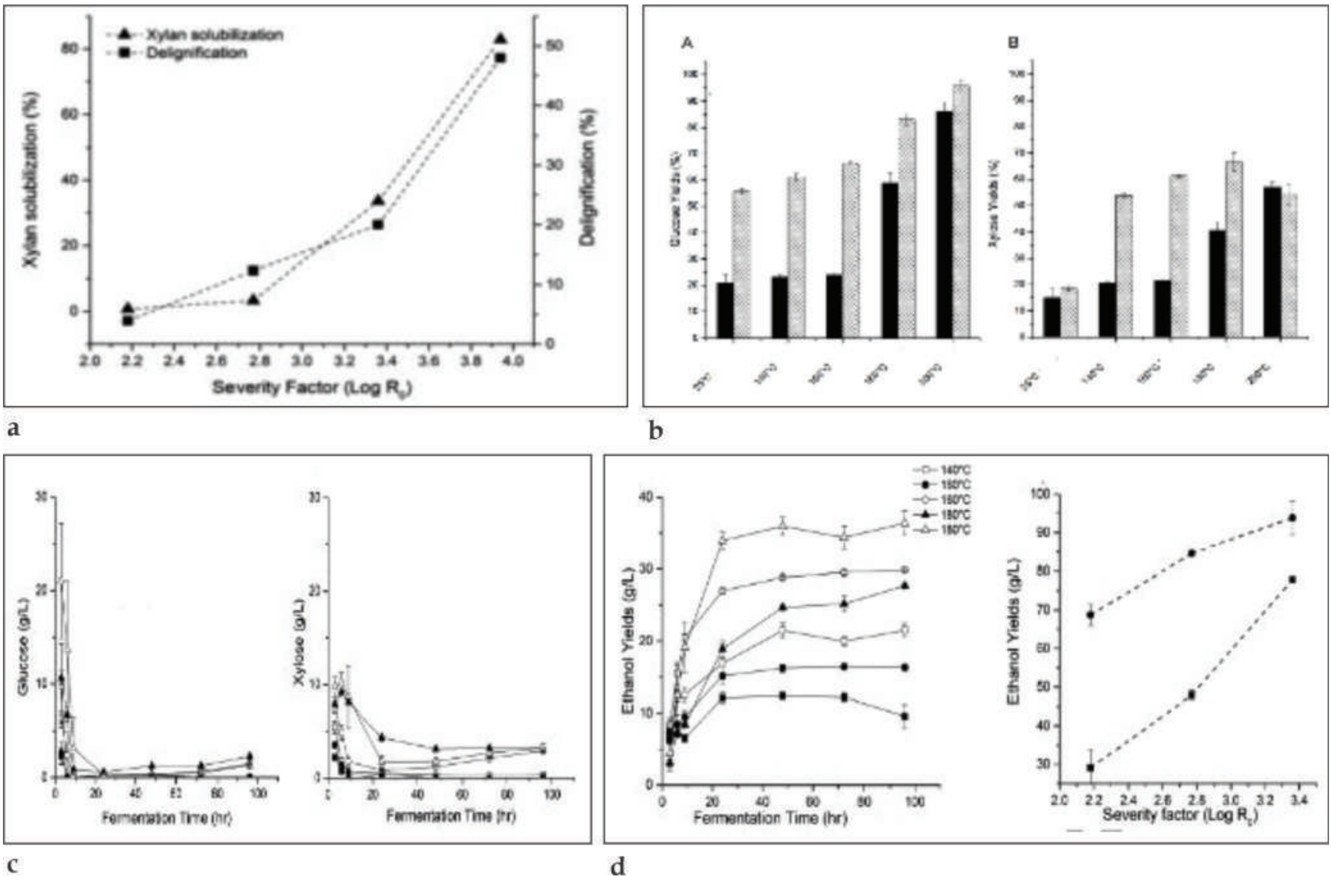


Fig. 4.4. Process development for enhancing ethanol recovery from sugarcane trash and B- heavy molasses. a. Xylan solubilisation and bagasse delignification extend after four severity HPAC pre-treatments. Xylan solubilisation and SCT delignification were calculated by subtracting residual Xylan/lignin content of pre-treated SCT based on dry mass of SCT from initial Xylan/lignin content. b. Overall sugar recovery yields (A: glucose; B: xylose) from two stage pre-treatment and 72 h enzymatic hydrolysis. HPAC: LHW pre-treatment. 25 °C samples performed same process except the reactions were at room temperature for 10 min instead of in high temperature c. Sugar concentration (A: glucose; B: xylose) profiles of pre-treated SCT samples during 96 hour simultaneously saccharification and fermentation. d. Ethanol profile and final ethanol yield of two stage pre-treated samples during simultaneously saccharification and fermentation. Final ethanol yields are displayed with ordered pre-treatment severity

growth, boosted initial plant population and induced internodal elongation. At 45 days after planting (DAP), the highest germination percentage. Cane length, girth, internodal numbers, internodal weight, number of roots, root length, number of root hairs and cane weight showed maximum impact with Ethrel. Tiller numbers and biometric traits showed similar trends with maximum impact with sett soaking with Ethrel till 270 DAP. PGR Technology was also demonstrated with ratoon crop (Ist) of sugarcane varieties Exogenous application of Ethrel & Gibberellic acid stimulated physiological growth, increased initial plant population and caused internodal elongation. Significant improvements were recorded in biometric traits responsible for yield attributes.

Sugarcane IInd ratoon crop was initiated on 12 Feb 2024 with spray of Ethrel (@100 ppm) on ratoon stubbles along with absolute control using CoLk 94184 and CoLk 14201. During the ratoon crop cycle, tiller numbers and biomass accumulation till 210 DAP indicated that maximum improvement in sett sprouting with Ethrel spray on CoLk 94184 as compared to CoLk 14201 and their control respectively. Maximum sprouting % was recorded with Ethrel against their control at 20, 30 and 45 DAP. Biomass partitioning into leaves decreased from about 75% at sprouting emergence to 20-25% at the end of the tillering phase. Cane stalk was about 9-12% of the total biomass at 75 DAP and peaked to about 60-80% at GGP of the crop cycle. Ethrel spray @100 ppm partitioned more biomass into the stalks in both varieties. The trend was especially clear after partitioning to stem had peaked during the grand growth stage at 210 DAP while stalk to total biomass ratios were close for CoLk 94184 and CoLk 14201, ranging from 56.0 to 52.1%. The biomass accumulation pattern remained same till 180 DAP. Tiller numbers ha-1 were 1,65,226, 1,45,106, with CoLk 94184 and CoLk 14201 at 180 DAP. Other biometric traits showed similar trends with maximum impact with sett soaking with Ethrel spray in CoLk 94184 followed by CoLk 14201 till 240 DAP. Number of plants ha-1, per cane weight and cane weight (tha^{-1}) indicated maximum effect of Ethrel spray on CoLk 94184, followed by CoLk 14201 with 1, 65,683, 1, 08,532 plant numbers ha^{-1} against 72,376 and 65,241 plant numbers ha^{-1} in their control respectively. The experiment continues in the field for further data collection until the harvest stage.

Biochemical and molecular characterization of soluble invertases of sugarcane

Varietal evaluation of PGR treatment

For the second year, six recently released varieties (CoLK 16202, CoLK 14201, CoLK 15466, CoLK 15206, CoLK 15201 and CoLK 94184) were selected for studying the effect of PGR treatment of germination, growth and production of sugarcane. These will be investigated for invertase activity in different tissues at both, biochemical and molecular levels. The results suggested that 40 ppm ethrel treatment enhanced germination in all the varieties, however, the effect was quite variable among selected varieties. On 28th day after planting, the most prominent in germination was recorded in ethrel treated setts as compared to control (upto 6.0 folds). CoLK 14201 exhibited 3.6 fold, CoLK 94184 (1.7 fold), CoLK 15206 (2.1 fold), CoLK 15466 (1.8 fold), CoLK 16202 (1.4 fold) enhancement in germination.

On 60th day after planting, the most prominent effect of ethrel treatment was found in CoLK 15201, which showed minimum germination in control and ethrel treatment enhanced the germination (upto 3.3 folds). CoLK 14201 exhibited 1.7 fold, CoLK 94184 (1.6 fold), CoLK 15206 (1.6 fold), CoLK 15466 (1.7 fold), CoLK 16202 (1.3 fold) enhancement in germination.

During initial growth phase the data was recorded for different parameters. It was observed that the number

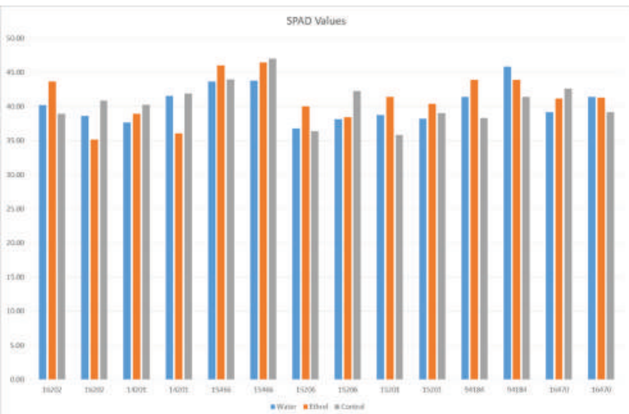


Fig. 4.5. Total chlorophyll content

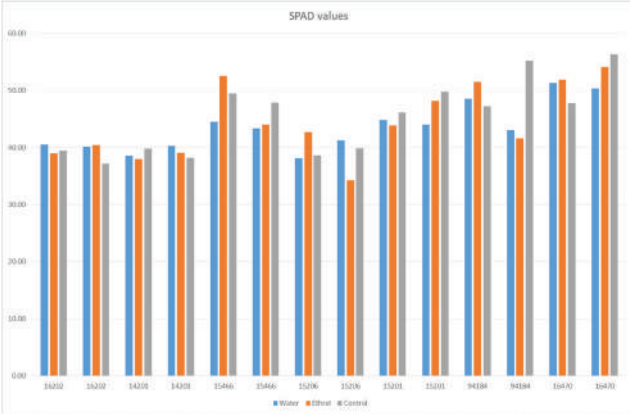


Fig. 4.6. Total chlorophyll content

of stalk in the clum was positively affected by ethrel treatment in all the varieties. Mean leaf area, leaf number was found to be maximum in ethrel treated samples. Ethrel treatment increased average stalk length in all the varieties over control. However the increment was maximum for CoLK 15206 (1.82 fold) and minimum for CoLK 16202 (1.07 fold) over control.

In silico analysis of invertase inhibitor genes of sugarcane

Total 25 invertase inhibitor genes were found in sugarcane genome. These were mainly distributed in three classes of chromosomes i.e. Chr 3, Chr 7 and Chr 10.

Table 4.1. Distribution of invertase inhibitor genes in sugarcane genome

SI. No.	Chromosome no.	Inhibitor
1.	3A	2
2.	3B	2
3.	3C	1
4.	3D	2
5.	3E	2
6.	3F	1
7.	7A	2
8.	7B	2
9.	7C	1
10.	7D	2
11.	7E	1
12.	10A	1
13.	10B	1
14.	10C	2
15.	10D	1
16.	7-10A	2
TOTAL		**25**

Table 4.2. ***In silico*** **sequence comparison**

	Chromosome	Start	End	Length	Name
1	10A	7740177	7743566	3390	PME/Invertase inhibitor like protein
2	10B	8162238	8162832	595	PME/Invertase inhibitor like protein
3	10C	3845996	3846858	863	PME/Invertase inhibitor like protein
4	10C	3852723	3853518	796	PME/Invertase inhibitor like protein
5	10D	6104712	6105451	740	PME/Invertase inhibitor like protein
6	3A	690978	692393	1416	Putative invertase inhibitor
7	3A	65184399	65185140	742	Invertase inhibitor
8	3B	1814866	1816422	1557	Putative invertase inhibitor
9	3B	66358284	66359023	740	Invertase inhibitor
10	3C	2631921	2633317	1397	Putative invertase inhibitor
11	3D	2149447	2150844	1398	Putative invertase inhibitor
12	3D	66301625	66302363	739	Invertase inhibitor 2
13	3E	531091	532478	1388	Putative invertase inhibitor
14	3E	64671824	64672562	739	Invertase inhibitor
15	3F	431389	432745	1357	Putative invertase inhibitor
16	7A	33944552	33945519	968	Invertase inhibitor 2
17	7A	54550860	54551565	706	Invertase inhibitor 1
18	7B	31227714	31228626	913	Invertase inhibitor 2
19	7B	53161254	53161785	532	Invertase inhibitor 1
20	7C	49770939	49771470	532	Invertase inhibitor 1
21	7D	30257810	30258790	981	Invertase inhibitor 2
22	7D	51497824	51498355	532	Invertase inhibitor 1
23	7E	41128969	41130130	1162	Invertase inhibitor 1
24	7_10A	5207939	5208533	595	PME/Invertase inhibitor like protein
25	7_10A	79517518	79518049	532	Invertase inhibitor 1

1. PME/Invertase inhibitor like protein
2. Putative invertase inhibitor
3. Invertase inhibitor 1
4. Invertase inhibitor 2

The total 25 invertase genes were distributed on 16 different chromosomes representing three out of 10 chromosomes types/ class in sugarcane genome (Table 4.1). *In silico* sequence comparison of these sequences revealed that they can be classified into 4 groups (Table 4.2).

The inhibitor genes with similar/ homologous sequences are found on a specific class of chromosomes. These are also comparable in the length/ size.

Effect of various modulators on invertase

The study explored the impact of various chemical effectors on acidic invertase enzyme activities in sugarcane variety CoLk 14201. For neutral invertase, activators like $BaCl_2$, $C_3H_7NO_2S{\cdot}HCl$, $LaCl_3$, and $C_5H_{11}NO_2S$ increased activity, with $C_3H_7NO_2S{\cdot}HCl$ showing the most significant activation at 108.3%. In contrast, inhibitors such as $Bi(NO_3)_3$, $Pb(NO_3)_2$, and $LaCl_2$ significantly reduced activity, with $Pb(NO_3)_2$ causing the highest inhibition at 88%. This reduction in activity is crucial for managing sucrose levels,

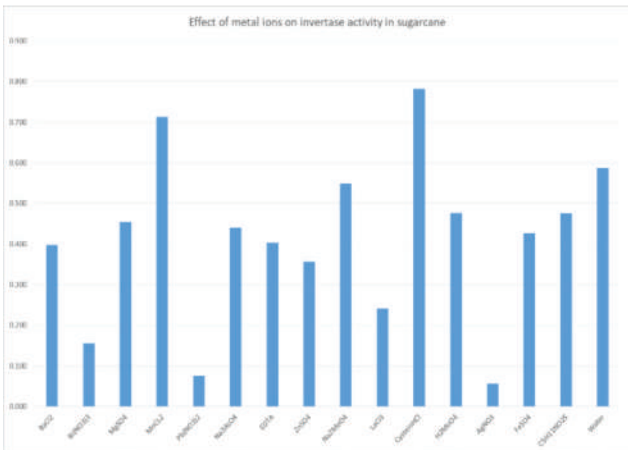


Fig 4.7. Effect of metal ions on invertase activity in Sugarcane

as neutral invertase is directly involved in sucrose breakdown (Rahman et al., 2004). The inhibitory effects observed in the study, such as those by $ZnSO_4$ on acidic invertase, align with earlier findings where Zn^{2+} was shown to reduce invertase activity in sugarcane. $AgNO_3$, $Pb(NO_3)_2$ and $Bi(NO_3)_3$ were found to inhibit invertase activity. $MnCl_2$ and Cystein-HCl activated the invertase activity.

Screening and identification of sugarcane lines tolerant to water-logging and their physio bio-chemical investigation

Transcriptome analysis using leaf tissues in response to waterlogging

Transcriptome analysis using four samples (S1, S2, S3, S4) having leaf tissue of control and waterlogging induced plant, CoLk 94184 and CoJ 64 varieties revealed a total of 295618 unigenes. These were further processed using seven databases (Nr, Uniprot, GO, KOG, PFAM, KEGG and Transcription factor) (Table 4.3). Unigenes showed 49.2% similarity with Sorghum bicolor, 14.9%% with *Zea mays*, 2.1% with *Oryza sativa*, 4.1% with *Setaria italics*, 1.87% with Saccharum hybrid and 19.48% with others (Nr annotation). Based on GO annotation, genes are grouped under three different components, Biological process (BP), Cellular component (CC) and molecular function (MF). The most enriched KOG category was "Signal transduction mechanisms (T)" followed by "General function prediction only (R)" and "Posttranslational modification, protein turnover, chaperones (O). In Pfam analysis, most abundant domains identified were representing "Protein kinase domain" followed by "Protein tyrosine kinase", "Cytochrome P450" and RNA recognition motif. The most abundant transcription factor families enriched were bHLH followed by WRKY, NAC and MYB_related.

Table 4.3. Number of Unigenes annotated with different sets of databases

	No of Unigenes	Percentage (%)
Annotated in NR	66731	22.6
Annotated in Uniprot	47817	16.2
Annotated in GO	31893	10.8
Annotated in KOG	29933	10.1
Annotated in Pfam	29243	9.89
Annotated in Transcription factor database	33082	11.19
Annotated in KEGG	10380	3.51
Annotated with all 4 databases	20261	6.85
Annotated with at least 1 database	66785	22.59
Total no of Unigenes	295618	

Differentially expressed genes (DEGs) were identified in four sets of samples (S1 vs S2, S1 vs S3, S2 vs S4 and S3 vs S4) using total RNA of both the varieties planted under control and waterlogged conditions, as per the DESeq R/Bioc package (Fig 4.8).

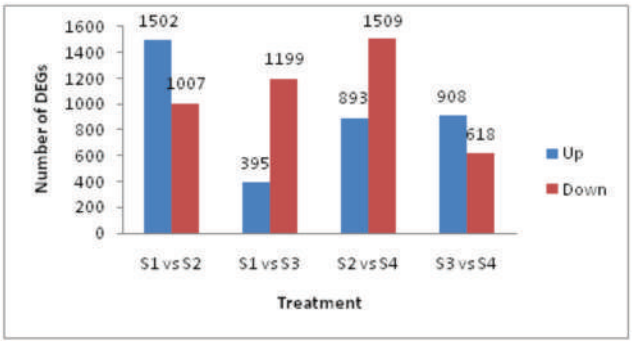


Fig. 4.8. Differentially expressed genes (DEGs) of four sets of sample
S1 = CoLk94184 Control leaf tissues; S2 = CoLk94184 waterlogging exposed leaf tissues
S3 = CoJ 64 control leaf tissues; S4 = CoJ 64 waterlogging exposed leaf tissues

Among significantly expressed gene, a total of 30 transcripts associated with carbohydrate metabolism, environmental adaptation and transcription factor genes were used and primer pairs were designed to validate those using different sets of RNA samples isolated from both the varieties. Validated 15 designed primers based on novel transcripts sequence using total RNA isolated from sugarcane leaf. qRT-PCR performed using total RNA of leaf tissue of both the varieties indicated higher expression of uncharacterized protein (Unigene5311), ADH gene, lower expression of metal-nicotianamine transporter YSL16 (Unigene 192156) in both the varieties and higher expression of transcription factor bHLH30 (Unigene 223205) in variety CoJ 64 under waterlogged condition.

Transcriptome analysis using root tissue in response to waterlogging

- An Illumina based comparative differential transcriptomic analysis was performed using root samples of sugarcane variety; CoJ 64 subjected to waterlogging (R2) along with untreated control (R1).
- Raw reads were deposited in NCBI data base. Accession number received as SAMN40759780 and SAMN40759781

- Overall, a total of 156951 transcripts were identified with an average length of 429 bp & N50 length of 527 bp.
- The most abundant transcription factor families enriched were bHLH followed by MYB, NAC and ERF related.
- Differentially expressed genes (DEGs) were identified in *R1 vs R2* samples using total RNA of root tissues of variety CoJ 64 planted under control and waterlogged conditions, as per the DESeq R/Bioc package (Table 4.4).

Table 4.4. Differential gene expression statistics

Combination	R1 - *Vs*-R2
Total Differentially expressed gene	25357
Down-regulated	20589
Up-regulated	4768
Significant-Downregulated	9863
Significant-Upregulated	2622

Microbial diversity of rhizospheric soil

Microbial diversity of rhizospheric soil of waterlogged and control plots of plant and ratoon crop were analysed based on the 16S rRNA gene.

Raw reads were deposited in NCBI metagenome SRA module. Accession number received under Bio-project PRJNA1020738 as: SRR26190803 (control ratoon crop), SRR26190804 (control Plant crop), SRR26190805 (waterlogged plant crop) and SRR26190806 (waterlogged ratoon crop)

New Initiative

Green synthesis of silver nano particles (AgNPs) using sugarcane leaves and sugarcane bagasse powder

AgNPs are being used in several medical fields due to its unique antibacterial, antiviral qualities as well as other therapeutic effects. The secondary compounds

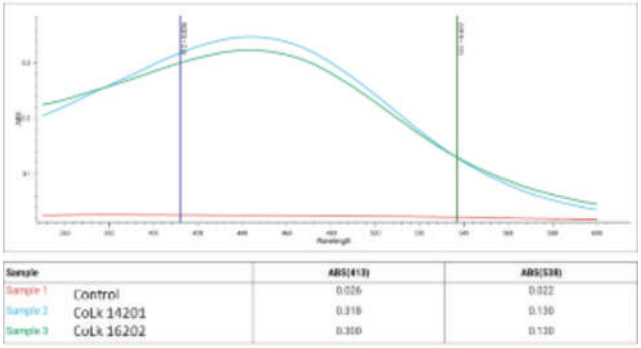


Fig 4.9. UV visible spectra of AgNPs synthesized from sugarcane leaf extract

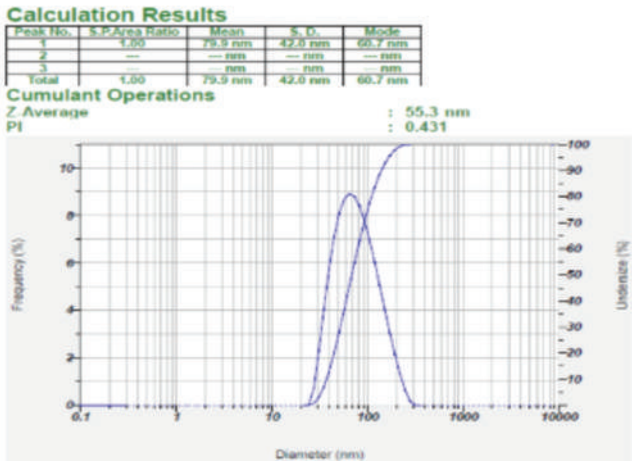


Fig 4.10. Particle size analysis of AgNPs synthesized from sugarcane leaf extract

such as flavonoids, aldehydes, tannins, phenolics act as catalyst in converting Ag^{+} to Ag^{0} during synthesis of AgNPs. As the sugarcane is rich in these secondary metabolites, aqueous leaf extracts and bagasse powder extractswere used to convert silver nitrate to silver nanoparticles (AgNPs). These synthesized AgNPs were characterized using UV visible spectra which showed the presence of AgNP specific peak in the range of 430-450 *nm* (Fig 4.9). Also, the size analysis of AgNPs produced using the aqueous leaf extract of different varieties of sugarcane confirmed their size as 36-58 *nm* (Fig 4.10). These AgNPs will be further characterized and the antibacterial as well as antimicrobial activities will be examined.

CHAPTER 5

Mechanization of Sugarcane Farming

Development of cane node planter

A prototype of tractor-operated cane node planter was developed and fabricated based on CAD models (Fig. 5.1). This prototype of planter is three point linkage mounted machine having ground wheel driven metering mechanism, designed for precise planting of single cane nodes in deep furrows. The machine includes two furrow openers for cane node placement at deep, node metering mechanism for controlled node delivery, fertilizer placement and soil covering unit. These components work in sequence to ensure uniform placement and proper soil contact of the cane nodes, enhancing germination and crop establishment. Machine performs deep furrow opening, metering of pre-soaked cane nodes, fertilizer application and soil covering over planted cane nodes, simultaneously in a single pass. Field evaluation was conducted at the ISRI Research Farm to determine optimal forward travel speed and node metering mechanism. The statistical analysis confirmed that both parameters significantly ($p<0.05$) affected performance of the machine, with non-significant interaction effects. The effect of forward travel speed (FTS) and cane node metering mechanism (CNM) on various dependent parameters are shown Fig. 5.2.

Fig. 5.1 Tractor operated cane node planter with modified cane metering mechanism

The miss index indicates the failure rate in picking and delivering cane nodes by the metering mechanism. It was evaluated across three forward travel speeds (FTS1, FTS2, FTS3) and three cane node metering units (CNM1, CNM2, CNM3). The lowest mean miss index

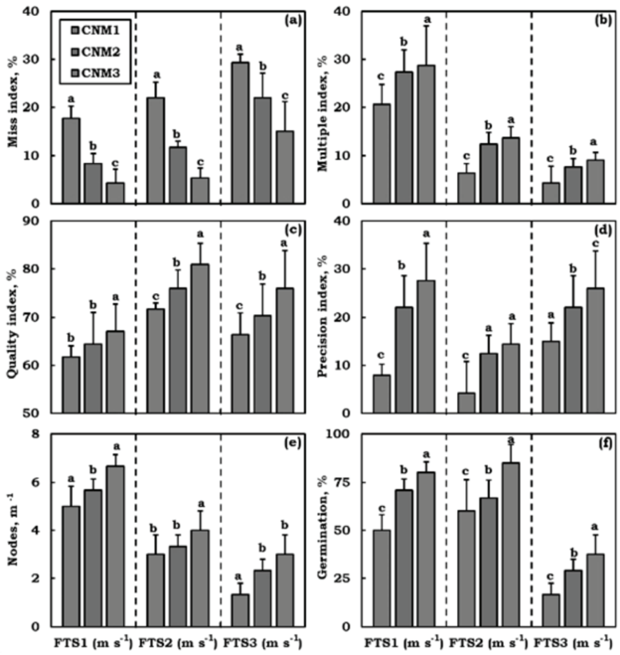


Fig. 5.2. Effect of FTS and CNM on various dependent parameters (a) miss index, (b) multiple index, (c) Quality feed index, (d) precision, (e) noes per meter and (f) germination. Tukey's test among FTS, within the particular CNM level indicates that means with same letter are not significantly ($p>0.05$) different

was recorded at CNM3 with FTS1 (4.3%), followed closely by CNM3 with FTS2 (5.3%), indicating that CNM3 performed the best, especially at lower speeds. Conversely, the highest miss index was observed at CNM1 with FTS3 (29.3%), highlighting poor performance at higher speeds and with less effective metering designs. The data revealed that the highest multiple index was observed at CNM3 with FTS1 (28.7%), followed by CNM2–FTS1 (27.3%) and CNM3–FTS2 (13.7%). The lowest value occurred at CNM1 with FTS3 (4.3%). An overall decreasing trend in multiple index with increasing FTS was observed for all CNM configurations, while multiple index increased from CNM1 to CNM3 at each FTS level. This suggests that lower travel speeds tend to retain cane nodes within the metering unit for a longer duration, increasing the chances of multiple pickups per cycle. From the data, it is evident that CNM3 achieved the highest quality feed index at FTS2 (81.0%), followed by CNM3–FTS3 (77.7%) and CNM2–FTS2 (76.0%). The lowest values were observed at CNM1–FTS1 (61.7%) and CNM1–FTS3 (66.3%). This indicates a general increasing trend in quality feed index with improved CNM types, and optimal results around medium travel speed (FTS2). CNM3 consistently outperformed CNM1 and CNM2 at all speed levels, showing that its design—incorporating a round cup and positive feed mechanism—was more effective in accurately feeding and spacing cane nodes. The data show that CNM3 consistently achieved the highest precision across all forward travel speeds, with the highest value at FTS3 (27.9%), followed by CNM3–FTS1 (27.5%) and CNM3–FTS2 (14.4%). CNM2 also performed moderately well, with precision ranging from 12.5% to 22.0%. In contrast, CNM1 exhibited the lowest precision, particularly at FTS2 (4.2%) and FTS1 (7.9%), indicating less consistency in spacing due to its basic metering mechanism and lack of a positive push feature. Node density measure reflects both the effectiveness of the feed mechanism and the influence of forward travel speed (FTS) on node placement frequency. The results show that CNM3 consistently placed the highest number of nodes per meter across all speeds, with 7.00 N/m at FTS1, followed by 4.00 N/m at FTS2, and 3.00 N/m at FTS3. CNM2 also performed well, though slightly lower than CNM3, ranging from 6.00 N/m at FTS1 to 2.33 N/m at FTS3. CNM1 placed the fewest nodes, especially at higher speeds, with a sharp decline from 5.67 N/m at FTS1 to only 1.33 N/m at FTS3. Germination percentage reflects the proportion of planted cane nodes that successfully sprout and establish, serving as a key indicator of overall planting effectiveness and biological viability. This parameter is influenced by accurate node placement, spacing, and minimal mechanical damage during metering. From the data, the highest germination percentage was achieved by CNM3 at FTS1 (83.80%), followed closely by CNM3–FTS2 (80.00%) and CNM2–FTS1 (75.00%). In contrast, the lowest germination rate was observed with CNM1 at FTS3 (16.67%), showing the negative impact of metering design and high travel speed on node viability.

The above findings revealed that round shaped metering mechanism with active pushing mechanism at forward travel speed of 2.5 km h^{-1} as the most optimized setting, combining mechanical efficiency with agronomic effectiveness for precision cane node planting. The machine achieved an average node-to-node spacing of 300 mm with 81.0 % quality feed index, lowest miss index of 4.3 %, and ~7.0 nodes/m. It consumed 4.45 L h^{-1} fuel with an effective field capacity of 0.3 ha/h at 80% field efficiency. The performance of the cane node planter was satisfactory with the modified metering mechanism.

Development of sugarcane trash management machinery

The prototype machine was modified, decomposer spraying unit was relocated and horizontal tank was fitted. With this modification the trash management in sugarcane ratoon crop was field tested. It worked well and performed ratoon initiation operations as well as trash management in sugarcane. It comprises of tractor-drawn trash mulcher with an optional attachment of stubble shaver and liquid decomposer/ chemical spraying unit for trash size reduction and easy decomposition. Different treatment combinations for trash decomposer along with trash management machine were made for field testing using Pusa decomposer as a standard control. Observations were recorded at initial stage, at 30 days and 45 days after spraying (Fig. 5.3). It was recorded that ISRI trash decomposer fastened the trash decomposing activities as compared to standard control. The brittleness and trash colour were changed dramatically using ISRI trash decomposer.

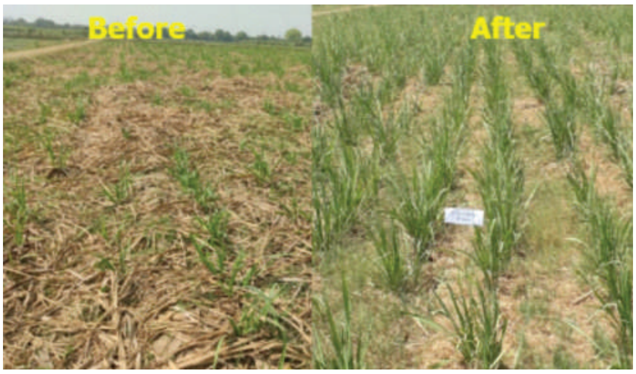


Fig. 5.3. Before and after (30 days) effect of operation of ISRI Trash Mulcher-cum-stubble shaver

Development of e-Powered multipurpose equipment adapted to controlled traffic farming for sugarcane

Design development of the matching implements i.e. tractor operated two rows furrower-cum-packer machine, tractor operated two rows fertilizer-cum-herbicide applicator and tractor-operated rotary weeder for various farm operations in the field for CTF was conceptualised and fabricated in the divisional workshop (Fig. 5.4). The performances of these newly developed implements were satisfactory in accomplishing the desired unit operations.

A field experiment was laid in the ISRI farm for one hectare to study the CTF and conventional sugarcane cultivation. The sugarcane yields under fields of controlled farming were almost double compared to normal managed field. The soil samples for bulk density measurements were collected and are being analysed.

Fig. 5.4. Fabrication of matching implements for various farm operations in the field for CTF

Ergonomic evaluation of tools and equipment for drudgery reduction in sugarcane cultivation

The sugarcane stripper-cum-detopper is used to remove dry and green leaves from harvested cane while also cutting the green top. Initially developed of high-carbon steel and weighing 225 g, the blade has been upgraded to high-speed steel for auto sharpening (Fig. 5.5). The original ergonomic design of this model limited usability to either left- or right-handed users, but further universal model has been developed to enhance accessibility. The new design improves efficiency by enabling a single-pass operation, unlike the previous model, which required two passes. This was achieved by introducing a fork-type detrasher, allowing leaves to be removed in one action (Figs. 5.5 & 5.6). A performance study involved 20 subjects (10 male, 10 female) operating the tool for 20 minutes. The number of setts cut varied based on the sugarcane variety. Physiological responses were also recorded by fixing an HR monitor (Polar V800, accuracy: ±1% or 1 bpm, range: 15–240 bpm) having transmitter with an in-built electrode on the chest of subjects. Both designs were found similar in achieving the quality of cane detrashing. Testing of this was conducted at the Institute farm for more than 30 hours by male and female farm workers. The average 90.1-115.5 kg canes stripped and detopped per hour by female and male subjects.

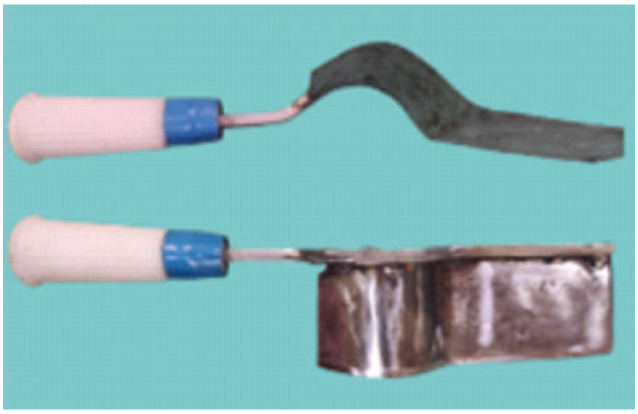


Fig. 5.5. Modified manual sugarcane stripper-cum-detopper

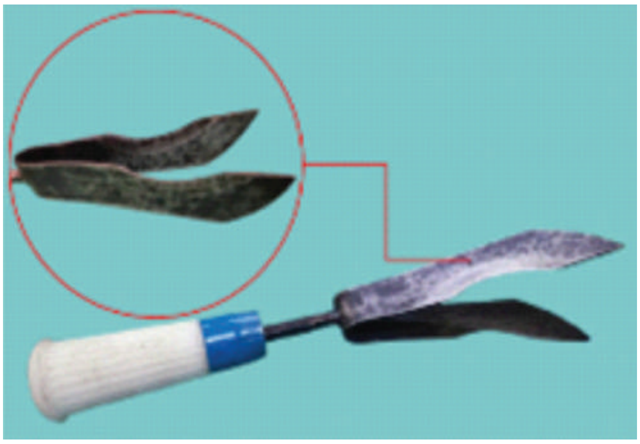


Fig. 5.6. Newly developed manual sugarcane stripper-cum-detopper

The average heart rate of male and female farm workers was within the acceptable limit. The energy expenditure rate was 7.14 and 7.89 kJ/min with male and female farm workers for old design whereas for new design 7.15 and 7.91, respectively. Physiological workload was in the light category with male workers.

Table 5.1. Test results of sugarcane stripper-cum-detopper (Variety: CoPK 5191)

Parameters	Model I		Model II		Model III		Model IV	
	Male	Female	Male	Female	Male	Female	Male	Female
No. of cane stripped & de-topped/h	321	195	258	198	348	297	350	300
Weight of the clean cane, kg/h	144	87	144	93	150	135	151	140
Green top weight, kg/h	31.5	21	22.5	27	45	30	45	32
Dry trash, kg/h	17.2	12.6	12.9	16.2	27.3	16.6	27.3	17.3

Development of inter-intra row weeding system for transplanted sugarcane

The fabrication of the main framework and inter row weeding unit has been completed, along with the finalization of the sensor based obstacle identification system. The fabrication of the intra-row weeding system is currently in progress, incorporating components such as a hydraulic cylinder, hydraulic tank, hydraulically powered rotary weeder, and an electronic control unit powered by a battery.

Testing, evaluation and demonstration of different applications of spraying drone in sugarcane

This study aimed to evaluate and optimize the spray deposition pattern of agricultural drone spraying for effective weed management in sugarcane cultivation (Fig. 5.7). The optimization parameters included drone speed, spraying height and herbicide combinations. Herbicide combinations were 2, 4-D at 3.0 L/ha combined with Metribuzin (1.5 kg/ha) and Halosulfuron methyl (0.09 kg/ha) combined with Metribuzin (1.5 kg/ha). The experiment was carried out 90 days after planting (DAP) during the active growth stage of the sugarcane crop, with each treatment replicated three times. Results indicated that as drone spraying speed increased, droplet density decreased. The optimal spray height of 1.0 m and speed of 3.0 m/s yielded the best deposition compared to higher spray heights (up to 2.0 m) and higher speeds (up to 5.0 m/s). Further, the comparative evaluation of drone spraying with traditional knapsack sprayer was carried out with above selected parameter.

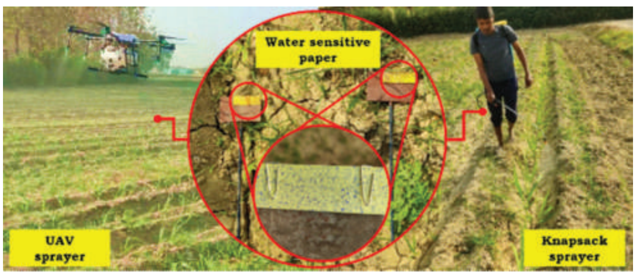


Figure 5.7. Spraying of herbicides using UAV and manual knapsack and their spray deposition on WSPs

Balancing spray efficacy, coverage, and drift control is crucial for achieving sustainable and effective herbicide application. Present study demonstrated that UAV-based herbicide application in sugarcane offers efficient alternative to traditional manual knapsack spraying, particularly for wide-row planting systems where weed pressure is high. The optimized UAV spray conditions, flight speed of 3.0 m s^{-1} and flight height of 1.0 m using a combination of Halosulfuron methyl and Metribuzin resulted in uniform spray deposition with adequate droplet deposition with droplet density of 45.4–46.4 droplets cm^{-2}, and acceptable droplet sizes (NMD: 107.6–109.7 µm; VMD: 273.7–276.0 µm) and minimal drift (<15%). This approach achieved weed control efficiency comparable to farmers' practice (~80%) while offering improved precision, reduced labor, and better operational efficiency. Although the droplet density of UAV spraying is lower than that of manual knapsack sprayers, UAV spraying offers higher herbicide concentration. Moreover, the UAV-based system operated with a field capacity of 2.6 ha h^{-1}, incurred a lower operational cost of ₹ 380.9 ha^{-1}, and achieved substantial resource savings such as 89.0% in water use and 81.6% in input costs as compared to farmers' practice. The herbicide droplets exhibit diffusing and osmotic effects, along with selective and systemic properties, which enhance droplet density on weeds. This increases the effective killing radius, ensuring satisfactory weed control. When droplets achieve an appropriate deposition density on the targeted area (weed leaves), optimal control outcomes can be achieved while eliminating the need for traditional large-capacity leaching spray technologies. Similarly, drone-based spraying demonstrated an 86-88% effectiveness in managing binding weeds in sugarcane crops. Another study was conducted to evaluate the efficacy of drone-based fungicide application for managing the secondary spread of red rot in sugarcane (cultivar Co 0238) using Thiophanate Methyl (70WP) at 1.3g/L (0.1%) with suitable wetting agents, applied at a flying height of 1.5 m and speed of 4 m/s under wind conditions below 8.0 km/h, with conventional high-volume sprays for comparison. Leaf bioassays, challenge inoculation, and histopathological studies revealed that afternoon drone sprays were the most effective, as they resulted in the smallest lesion length

(1.4 cm) and width (0.49 cm) on Top Visible Dewlap 1 leaf at 72 hours, the least pathogen spread across nodes, and minimal acervuli formation, confirming the superior efficacy of afternoon application. Similarly, the study has been taken up for spraying of crop growth promoters.

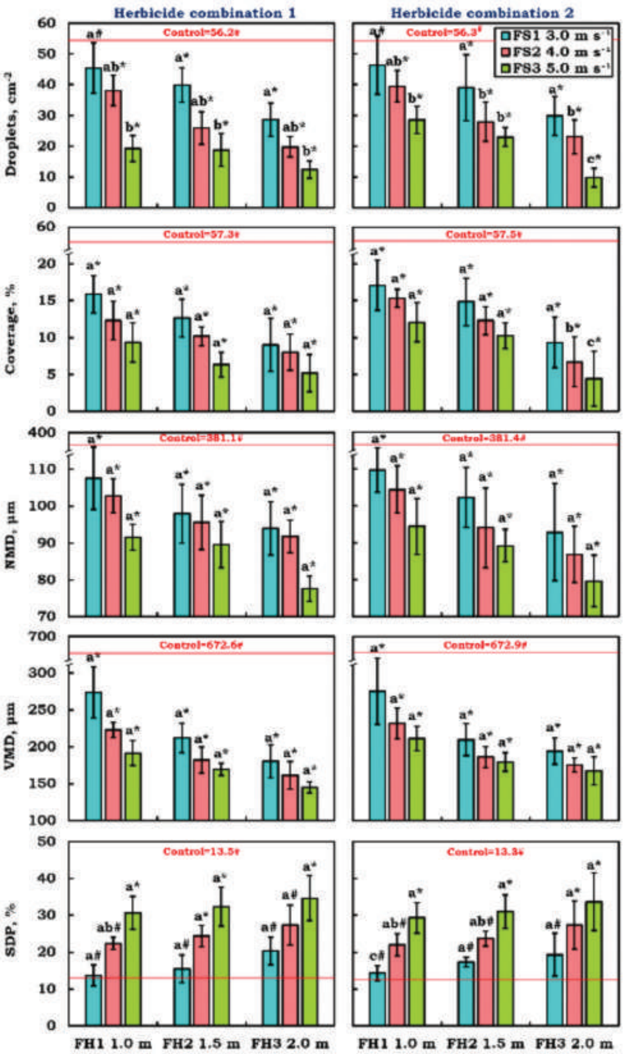


Figure 5.8. Effect of FS, FH and HC on various dependent parameters (a,b) droplet deposition, (c,d) spray coverage, (e,f) NMD (g,h) VMD, and (i,j) SDP. Tukey's test was used to compare FS levels within a specific FH, with means sharing the same letter not significantly different (p>0.05). Dunnett's test compared UAV spray combinations against the control, where means marked with the same symbol were not significantly different (p>0.05)

AICRP on Farm Implements and Machinery (FIM)

Role of mechanization in productivity of selected sugarcane varieties

The sugarcane crop under the present study was planted during 4–7 November, 2025 under both mechanized and conventional farming systems using

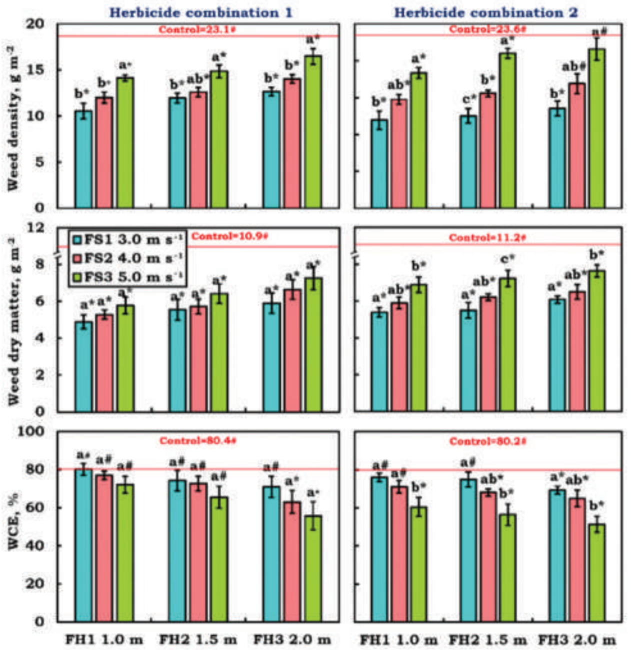


Figure 5.9. Effect of FS, FH and HC on various dependent parameters (a,b) weed density, (c,d) weed dry matter and (e,f) WCE. Tukey's test was used to compare FS levels within a specific FH, with means sharing the same letter not significantly different (p>0.05). Dunnett's test compared UAV spray combinations against the control, where means marked with the same symbol were not significantly different (p>0.05)

Figure 5.10. Comparison of herbicide spraying using UAV

the selected varieties. Following planting, the crop has successfully germinated, indicating favourable field conditions and proper execution of planting operations. At this stage, data collection is ongoing, and detailed quantitative observations on germination percentage, early crop vigour, and stand establishment are in progress. Before the main experiment, the crop was also planted for preliminary observations, and Fig. 5.11 depicts the early establishment of sugarcane under initial trials. These preliminary results indicated satisfactory germination and provided confidence for undertaking the detailed comparative study on mechanized and conventional practices. As the crop advances through subsequent growth stages, comprehensive data on productivity, operational efficiency, energy use, and economics will be analyzed. The final results will enable a robust assessment of the role of mechanization in enhancing germination, crop establishment, and overall productivity of the

Fig. 5.11. Establishment of sugarcane under initial trials

selected sugarcane varieties. Sugarcane crop shows good growth and uniform establishment; mechanized and manual planting germination is being compared under a split plot experimental design during initial stages.

Manufacturing of prototypes for conducting field adaptability trials under varying agro-climatic and soil conditions

Prototype fabricated

A. Prototype Manufacturing Workshop			
S. No.	**Machine/Implement**	**Source of Power**	**Target (No.)**
1	ISRI-Raised bed seeder-cum-fertilizer applicator	Tractor	01
2	ISRI-Disc type sugarcane ratoon management device	Tractor	01
3	ISRI-Deep furrow sugarcane cutter planter-cum-multicrop raised bed seeder	Tractor	01
4	Deep furrow sugarcane cutter planter	Tractor	02
5	e-Powered Tiller-cum-Seeder	e-Powered	01
6	Manually Operated Winnower	Manual	01
7	Tractor rear mounted mini sugarcane harvester	Tractor	01
	Total		**08**

Prototypes supplied

S. No.	Name of prototype	Number	Supplied to;
1	ISRI-Raised bed seeder-cum-fertilizer applicator	01	JAU Junagadh
2	ISRI-Disc type sugarcane ratoon management device	01	JAU Junagadh
3	ISRI-Deep furrow sugarcane cutter planter-cum-multicrop raised bed seeder	01	Lokbharti Gram-vidyapith Trust, Kodinar, Gujrat
	Total	**03**	

Prototype feasibility testing

Prototype Feasibility Testing of Automatic potato-cum-sugarcane trench planter

Prototype feasibility testing of tractor-operated automatic potato-cum-sugarcane trench planter was conducted at ISRI farm (Fig. 5.12). It performed planting of single paired rows of sugarcane in trench furrows and two rows of potato on ridges simultaneously. Mean values of cut cane seed-sett length was 350 mm. At forward speed of 0.5 m s^{-1}, mean overlapping between two successive setts was 68 mm, which was within the desired overlapping range of 50-100 mm for the study area. Mean tractor wheel slippage at load was 5.4%. Soil cover on setts and seed potato tubers was 45 and 40 mm respectively. The average spacing between seed potato tubers was 192 mm. missing of seed potato tubers in the cups of metering unit was 7.2%. Picking of more than one seed potato tubers was 5.3%. Missing and multiple picking of seed potato tubers complemented each other and therefore desired seed rate was maintained. The slight variation due to missing and multiple picking did not affect the uniformity of the crop stand. Theoretical field capacity of the planter was 0.27 h^{-1}. Time lost in filling of seed, insecticide solution, turning, miscellaneous settings and other activities in terms of total planting time was 47 per cent of total operating time. It was observed that maximum time was lost in filling of inputs followed by turning of the tractor. The effective field capacity of the planter was 0.127 ha h^{-1}, thus to plant one hectare area would take approximately 8 h time. The cost of planting operation with developed planter

Fig. 5.12 Automatic potato-cum-sugarcane trench planter under field operation

was ₹ 3500 ha^{-1} whereas it was ₹ 13600 ha^{-1} when planting was done manually. Thus, there was 74.20% cost saving in planting with developed machine. The labour requirement with planter was significantly low as compared to manual planting. It required 56 man-h ha^{-1} to plant with developed planter whereas manual planting required 567 man-h ha^{-1}. Thus, saving in labour by planting with developed machine was 90.1%.

Prototype Feasibility Testing of Application of drone for sugarcane

Prototype Feasibility Testing of drone for spraying of herbicide was carried out at ISRI farm (Fig. 5.13). One of the key advantages of drone spraying lies in resource conservation. Drones require only 45-50 liters of water per hectare, a staggering 88-90% reduction compared to the 450-500 liters needed for traditional methods. The drone has field capacity of 2.6 ha h^{-1}, about 11 times higher than that of manual spraying, which operated at just 0.24 ha h^{-1}. In terms of cost economics, the UAV system incurred an operational cost of ₹ 380.9 ha^{-1} significantly lower than the ₹ 2072.8/ha required for manual spraying. Additionally, the drone application reduced water usage by 88-90% and reduce labor costs by up to 86%.

Fig. 5.13 Drone for spraying of agro-chemicals under field operation

Centre of excellence in farm machinery

Development of weeder cum seeder

An e powered weeder cum seeder was developed for the small land holding farmers (Fig. 5.14). This system is powered by a 24 volt battery and is equipped with three wheels. The seed box has a capacity of 4 kg (2+2). The frame constructed by mild steel. Two front wheels are cycle wheels whiles of diameter 48 cm the rear wheel is made of solid rubber. The distance between the front and rear wheels is 55 cm. The battery and motor are mounted on the main frame. Power transmitted to the front wheel from motor by chain sprocket system. The furrow openers are positioned at back side of main frame that opens the furrows and places the seed in soil at 3-5 cm depth. A push button located on the machine's handle allows the operator to control the machine. This machine is designed for operation by a single individual. The urad bean was sown with this machine and its performance was at par with manual method (Fig. 5.14). It has field capacity of 0.1 ha/h and cost ₹ 32,000/-.

Fig. 5.14. A view of working of E-powered weeder cum seeder for intercropping in sugarcane

RKVY funded 'Agri Drone Project'

Agricultural Spray Drone was demonstrated to 55 farmers from various states for agrochemical spraying in sugarcane crop at ICAR-ISRI, Lucknow, from Jan 2025 to Dec 2025.

Frontline Demonstrations

Frontline Demonstrations of ISRI Tractor operated modified sugarcane cutter planter

ISRI tractor-operated modified sugarcane planter was demonstrated at farmers field of Hardoi and Lakhimpur Khiri in 28.24 ha area covering 126 farmers (Fig. 5.15). It performs all the unit operations involved in sugarcane planting simultaneously in a single pass of the equipment. It covers two rows at variable row spacing of 75 or 90 cm. The performance of the planter was satisfactory for planting of sugarcane. There was a saving of 60-65% in cost of operation and

Fig. 5.15. ISRI tractor operated modified deep furrow sugarcane planter in field operation

90-92% in labour requirement while using this planter as compared to conventional method.

Frontline Demonstrations of ISRI Tractor operated two row Disc Type ratoon management device

ISRI two row disc type ratoon management device (Disc RMD) demonstrated at Sitapur and Lakhimpur Khiri districts (Fig. 5.16). A total of approximately 6.5 ha area was covered in 13 farmers fields. The machine performs the cultural operations of stubble shaving, off barring, interculturing, fertilizer and insecticide application after the harvest of sugarcane for improved initiation of the ratoon crop. The effective field capacity of the machine was 0.30 ha/h.

Fig. 5.16. ISRI tractor operated two row disc type ratoon management device in field operation

Frontline demonstrations of ISRI tractor operated deep furrow sugarcane cutter planter-cum- raised bed multi-crop seeder

Demonstration of ISRI tractor operated raised bed seeder-cum-sugarcane planter was conducted at farmers field of Biswa sugar mill area of Sitapur district in 5.5 ha area covering 16 farmers (Fig. 5.17). It covers two rows of cane planting in deep furrows and two rows (one full raised bed and two half raised beds on either side of furrows) of sowing of intercrop simultaneously in single pass of the machine. Performance of the planter was satisfactory with effective field capacity of 0.20 ha/h. Saving in cost of operation was up to 70-72%.

Fig. 5.17. ISRI Tractor Operated Deep Furrow Sugarcane Cutter Planter –Cum- Multicrop Raised Bed Seeder in field operation

Frontline Demonstrations of ISRI Tractor operated multipurpose interculturing equipment

Demonstration of ISRI tractor operated multipurpose interculturing equipment was conducted at farmers field at farmers field of Sitapur district in 6.0 ha area for 10 farmers (Fig. 5.18 and 5.19). Equipment covered two inter rows for interculturing and intra-row weeds were killed by spraying herbicide. Thus, it facilitated inter-row interculturing as well as intra row weeding and also fertilizer application near to root zone simultaneously in single pass of the equipment. The effective field capacity of the equipment was 0.30 ha/h. The cost of operation in performing combination of operations during weeding/interculturing and fertilizer application in the conventional system was Rs 4328 per ha whereas with the developed equipment it was Rs 1841/ha. The saving in cost of operation was 57%.

Fig 5.18. Multipurpose interculturing equipment in field operation

Fig 5.19. Multipurpose interculturing equipment during earthing up mode

CHAPTER 6

Diversification and Value-addition in Sugarcane

Refinement of sugarcane cleaner cum washer for jaggery

Sugarcane cleaner-cum-washer (Fig 6.1 & 6.2) performed well during testing removing considerable amount of impurities. The capacity of machine was found to be 1000-1100 kg cane per hour in single pass matching with capacity of 3-roller horizontal power driven crusher installed in jaggery Unit of the Institute. It can accommodate 4-5 canes at a time. However, certain observations have been made:

- During testing, it was further observed that linear speed of scrapping rollers is considerably more and therefore canes take lesser time to work upon. Therefore, reduction in linear speed of scrapping rollers is required without changing the rpm. For this, roller diameter is to be reduced.
- There is scratching of canes, which is not desired. It is due to hardness of wire used as bristles on rollers. Therefore, to avoid scratching of canes, thinner bristles with more flexibility is to be provided.

Fig. 6.1. Sugarcane cleaner-cum-washer with protective cover (Front and back view)

Optimization of jaggery production from sweet sorghum

Development of an efficient and sustainable process for producing jaggery from sweet sorghum as an alternative to conventional sugarcane jaggery. During the reporting period, different sweet sorghum

Fig. 6.2. Sugarcane cleaner-cum-washer (Inside view)

varieties were evaluated under field conditions with replicated experimental plots and two planting dates to assess their growth performance, yield, and juice quality parameters. Observations on vegetative traits, pest and disease incidence, and physiological characteristics such as total soluble solids (TSS), sucrose concentration, purity percentage, and colour values were recorded systematically. During jaggery preparation trials, certain processing challenges were encountered due to the relatively high starch content present in sweet sorghum juice, which affected crystallization and proper solidification of jaggery. To address this issue, an optimized processing protocol involving juice clarification, pH adjustment, controlled heating, starch settling, and siphoning of clear supernatant was developed. This improved process enhanced the clarity, texture, and stability of the final jaggery product. Using the revised protocol, both liquid and solid jaggery samples were successfully prepared and subsequently analyzed for their physicochemical properties. The findings indicated that some varieties exhibited superior juice quality, and the planting dates influenced crop growth as well as juice characteristics, demonstrating the potential of sweet sorghum as a viable raw material for value-added jaggery production.

Development of solar powered water recovery system for open pan jaggery making process

The conceptualized design of water recovery unit consists of a water vapour collection hood, a fan for sucking in vapours run by electrical/solar power and a vapour condensing and collection unit. A miniature unit for verification of concept has been fabricated and tested where following difficulties were felt:

- Provision of hood makes hindrance in working hence a system for lowering and lifting of system is essentially required.
- There is residual water left in the pipe, which may attract contamination. Thus concept of getting pure distilled water is partially forfeited.

There is a problem in condensation of water vapours.

AICRP on PHET

Development of induction based jaggery making system

The induction power required to concentrate 100 liter of juice in 30-40 minutes was calculated which comes out to be 30KW. Presently in our jaggery unit there is provision to run at most 15KW three phase machinery so the capacity of the unit was reduced to 50 liters and induction capacity was fixed at 15KW. The vessel capacity was kept at 100 liters only and process temperature mapping was finalized, identifying approximately 80-85°C for clarification and 118–125°C for concentration. Based on these inputs conceptual control logic architecture for programmable temperature regulation was prepared. The SS 304 vessel compatible with the induction surface was designed at CAD level, and dimensional optimization was initiated to enhance heat transfer efficiency. A provision of automatic clarification and jaggery production in closed system is being discussed with manufactures and being finalized. To attach an automatic clarifier one manufacturer has suggested some design change in vessel which is being looked into. Indent for SS-304 vessel along with agitator has been submitted.

AI-Assisted bud cutter to transform sugarcane planting practices

During the reporting period, significant progress has been achieved in the development of the AI-assisted

New products/ technologies developed:

S. No.	New Products/ Technologies	Details
1.	**Jaggery-coated Gram (Chana)**	Jaggery-coated gram (chana) was prepared by heating 200 g of jaggery on a low-medium flame to form thick syrup, which reached the brittle stage at around 124 °C. The hot syrup was evenly mixed with 100 g of roasted gram (chana) using the ISRI-designed jaggery coating machine to ensure uniform coating. The coated gram was then cooled for 10–15 minutes to allow the jaggery to set into a crisp layer and stored in airtight containers to retain freshness and crunchiness.
2.	**Jaggery coated Popcorn**	A jaggery-coated popcorn snack was prepared by first melting 200 g of jaggery to form syrup, heated to about 124 °C until it reached a brittle consistency. The syrup was then evenly coated over 100 g of popcorn using the ISRI-designed manually operated jaggery coating machine, ensuring uniform coverage. The coated popcorn was cooled for 10–15 minutes to allow the jaggery to harden, resulting in a crisp, sweet snack stored in airtight containers.

Jaggery-coated Gram (Chana)

Jaggery coated Popcorn

sugarcane bud cutting system. A controlled whole-cane imaging setup was successfully designed and established, and a comprehensive image dataset was prepared for node localization and bud health assessment. An initial AI model was developed and tested under controlled conditions, demonstrating encouraging performance in accurate node detection and identification of unhealthy buds. Parallelly, the mechanical cutting module was conceptualized with a stepper motor–driven precision cutting mechanism, and detailed CAD drawings were prepared for the cutting and automated sorting components. Bench-level trials confirmed consistent separation accuracy and highlighted the importance of precise mechanical alignment for uniform cutting. The overall system architecture integrating imaging, AI-based decision logic, and the cutting mechanism has been defined conceptually,withhardware–softwarecommunication workflow structured. While the imaging system, AI model (initial version), and mechanical design have been completed and validated at bench level, full prototype integration is currently in progress. Tested the detection of nodes using strain gauge sensor being low cost but due to minor variations in surface height of node and internodes the noise in the signal was very high so the next iteration will be tested with IR sensor to differentiate the node and internodes. The development of the alpha prototype marks the establishment of a strong technical foundation for an integrated AI-enabled automated bud cutting system for efficient sugarcane planting applications.

- Value added Jaggery technology was transferred to two entrepreneurs.
- Improved Jaggery making technology has been demonstrated to visitors at several occasions.

Activities under NAIF-II (ABI)

Entrepreneurs/Incubators admitted for incubation:

S. No.	Name of Entrepreneurs/ Incubators	Contact Details
1.	NOPS Foods Pvt. Ltd.	Rohtak, Haryana
2.	Unati Agri Allied and Marketing Multistate Cooperative Society Ltd.	Hoshiarpur, Punjab
3.	M/s Granny's Lucknow	Lucknow, Uttar Pradesh

Entrepreneurs/Incubators graduated:

S. No.	Name of Entrepreneurs/ Incubators	Contact Details
1.	NOPS Foods Pvt. Ltd.	Rohtak, Haryana
2.	Unati Agri Allied and Marketing Multistate Cooperative Society Ltd.	Hoshiarpur, Punjab

Technology Licensed and Commercialized

S. No.	Name of Technology	Name of Entrepreneur	License fee of Technology (₹)
	Moulding Frame	M/s Adinath Engineering Company, Mumbai	30000.00
		K S Projects and Process Engineers Pvt. Ltd.	
		M/s Patel Manufacturing Company, Rajkot, Gujarat	
		Mr. Shiv Kumar Maurya, Gonda, Uttar Pradesh	
		Mr. Arvind Kumar Yadav, Azamgarh, Uttar Pradesh	

MoA's Signed under AICRP on PHET

S. No.	Name and Address of Entrepreneur	Date of Establishment	Products Manufactured	Whether Training of Entrepreneurs was done
1.	NOPS Foods Pvt. Ltd., Rohtak, Haryana	15.01.2025	Research Collaboration	Yes
2.	Unati Agri Allied and Marketing Multistate Cooperative Society Ltd.,Hoshiarpur, Punjab	13.02.2025	Research Collaboration	Yes

Entrepreneur/ Startups initiated their business:

S. No.	Name of Entrepreneurs/Incubators	Contact Details
1.	NOPS Foods Pvt. Ltd.	Rohtak, Haryana
2.	Unati Agri Allied and Marketing Multistate Cooperative Society Ltd.	Hoshiarpur, Punjab

Externally funded projects

Establishment of Agri Business incubation center at ICAR-ISRI, Lucknow under National Agriculture Innovation Fund (NAIF)

The Agri-Business Incubation (ABI) Center at ICAR–Indian Institute of Sugarcane Research (ISRI), Lucknow has actively promoted agripreneurship and innovation in the sugarcane sector. During the reporting period, 3 entrepreneurs were admitted for incubation, and 2 entrepreneurs successfully graduated and initiated their business operations. Under incubation support, 1 technology (Highly Efficient Low-Cost Bagasse Dryer for Jaggery Production Units) and 02 value-added products (jaggery-coated gram and jaggery-coated popcorn) were developed. The center also organized 05 Agri-business Development/Awareness Programmes to promote jaggery value addition and agri-processing technologies among farmers and entrepreneurs. In addition, 17 visitors including technology seekers, inventors, and business stakeholders visited the ABI Center, strengthening industry–institution interaction. Through its incubation activities, the center generated ₹ 20,000 as revenue through registration fees, contributing to the promotion of agribusiness development and technology dissemination.

CHAPTER 7

Agricultural Knowledge Management Unit (AKMU)

Economic analysis of organic farming systems for sustainable sugarcane production in India

The concept of organic farming has to combine tradition knowledge, innovation and modern agricultural science approaches. The reviewed studies highlights that the history of organic movement in agriculture was recognized in 1905. In 1905, British botanist Sir Albert Howard known as father of modern organic agriculture, documented that traditional Indian cultivation practices were superior in crop production and protection techniques as compare to modern agriculture science practices. Masanobu Fukuoka (1940), microbiologist, had quit his job of research scientist to return to his family farm, devoted 30 years to develop a vital no-till organic method to cultivate food grains, known as *"Fukuoka farming"*. The number of non-conventional methods such as Rishi krishi, Subhas Palekar natural farming, homa farming, panchagavya krishi and paarmparagat farming are related to organic crop and livestock rearing. Zero Budget Natural Farming (ZBNF), promoted by Shri Subhash Palekar offers an alternative by reducing input costs and promoting soil health (Shankaranna, 2018). The Indian Prime Minister also encouraged natural farming to reduce costs and boost yield. Natural farming, based on Masanobu Fukuoka's principles emphasizes minimal monetary investment and self-reliance. ZBNF includes four key components:

- ❖ Beejamritha- Seed treatment using cow dung and urine.
- ❖ Jeevamrita- A mixture to enhance microbial activity and soil health
- ❖ Acchadana- Mulching to retain soil moisture
- ❖ Whapasa- Optimal soil conditions for root development

Natural and organic farming has gained momentum in major sugarcane producing states such as Maharashtra, Uttar Pradesh and Karnataka. The efforts of Karnataka Rajya Raita Sangha (KRRS), which advocated for this practice as an alternative to chemical based conventional sugarcane agriculture. The Govt. of Karnataka has strongly promoting organic cum natural farming practices through its initiatives ***"Zero Budget Natural Farming Project"*** (2018) and ***"Chief Minister's Natural Farming Scheme"*** (2022-23) with the objective of improve soil health, sustain crop productivity and reduce input cost in sugarcane farming systems. It was implemented through the state agricultural universities (SAUs), which involves participatory research on 2000 ha in the each agro-ecological zone (AEZ) across the five agricultural universities in Karnataka.

The comparative economic competitiveness of organic andinorganic sugarcane production was worked out in Mandya district of Karnataka as it has sizeable number of organicsugarcane growers. They utilizes organic sugarcane for production of the organic quality jaggery and its value added products for catering consumers demand of health conscious through high-end super malls and direct selling through online portal such as flip cart, swiggy, zomato etc., The primary data was collected from 60 respondents regarding sugarcane cultivation for theagricultural year 2024-2025. The respondents were 30 farmers each practising organic and inorganic sugarcane production methods. The results reveal that the sugarcane cost of production in organic farming was ₹ 2,19, 094 per ha, as compared to conventional inorganic farming ₹ 2,64,788 per ha. The cost variation was due to lower variable costs and efficient input utilization in organic sugarcane production. The sugarcane productivity in organic farming was less (98.58 tons/ha), but it fetch higher price per tonne (₹ 4,250 versus ₹ 3,550). Though the averageyield was high (122.65Ton/ha) in conventional farming, gross returns ₹ 4, 18,965 and net returns ₹ 1,99,871/ha was more as compared to ₹ 1,58,355/ha in conventional method. The cost of sugarcane cultivation on per tonne basis was also higher in organic farming (₹ 2,223) as compared to conventional farming (₹ 2,159). However, the overall returns per rupee expenditure (BC Ratio) was better in organic farming (1.91) than the conventional farming (1.65) as depicted in Table 7.1 and Table 7.2. The findings of the study concludes that the necessary measures should be made by concerned departments, organizations and institutions to create awareness and motivate sugarcane farmers to adoption organic sugarcane cultivation on large scale.

Analysis of cost of cultivation of sugarcane in Uttar Pradesh during 2025-26

The cost of sugarcane cultivation in Uttar Pradesh for the crop season 2025-26 was estimated on the basis of primary data collected from 60 farmers from 6 district (Three district each from Western, and Central Region) on the basis of PRA techniques during May-

Table 7.1. Cost of sugarcane cultivation under Natural and Conventional farming in Mandya

(₹/ha)

S.N.	Particulars	Organic/ Natural farming (N=30)		Inorganic farming (N=30)	
		Value (₹)	Percent	Value (₹)	Percent
(I)	Variable cost				
(A)	Material cost				
1	Expenses on tillage/field preparation	15268.00	6.97	15982.00	6.04
2	Sugarcane seed	21940.00	10.01	23245.00	8.78
3	Seed treatment (Fungicide/ Beejamruth/ Trichderma)	2983.00	1.36	1458.00	0.55
4	Press mud/FYM/Ganajeevamruth	17232.00	7.87	11699.00	4.42
5	Bio-fertilizer and organic manure/Chemical fertilizer	7879.00	3.60	17168.00	6.48
6	Bio-pesticides/ Neemastra/ Plant protection chemicals	2263.00	1.03	4428.00	1.67
7	Mulching/ Achhadan/ Irrigation exps.	6542.00	2.99	18108.00	6.84
8	Miscellaneous cost	2408.00	1.10	3206.00	1.21
	Sub Total (A)	76515.00	34.92	95294.00	35.99
(B)	Labour cost				
1	Hired labour	33882.00	15.46	41672.00	15.74
2	Machine labour	14895.00	6.80	18252.00	6.89
3	Harvesting and transportation cost	24648.00	11.25	38491.00	14.54
4	Interest on working capital @ 6 %	8714.00	3.98	11615.00	4.39
	SubTotal (B)	82139.00	37.49	110030.00	41.55
	Total operational cost (A+B)	158654.00	72.41	205324.00	77.54
(II)	Fixed cost				
1	Land revenue	91.00	0.04	90.00	0.03
2	Rental value of land	54894.00	25.05	53586.00	20.24
3	Depreciation	1874.00	0.86	2131.00	0.80
4	Interest on fixed capital @ 8%	3581.00	1.63	3657.00	1.38
	Total fixed cost	60440.00	27.59	59464.00	22.46
	Total cost of cultivation (I+II)	219094.00	100.00	264788.00	100.00

Table 7.2. Comparative economic analysis of Organic and conventional sugarcane farming

S.No.	Economic Parameters	Unit	Organic/Natural farming	Chemical farming
1	Average crop productivity	Ton/ha	98.58	122.65
2	Price	₹/Ton	4250	3450
3	Gross return	₹/ha	418965	423143
4	Cost of cultivation	₹/ha	219094	264788
5	Cost of production	₹/Ton	2223	2159
6	Net return	₹/ha	199871	158355
7	Benefit-Cost Ratio (BC Ratio)		1.91	1.60

Oct. 2025. The estimated cost of sugarcane cultivation were communicated to the Cane Commissioner, Sugar Industry and Sugarcane Department, Government of U.P. as an advisory note for its consideration during the meeting for the fixation of State Advised Price (SAP) for sugarcane in UP during October 2025. The cost of cultivation for plant and ratoon crop was ₹ 3470 and ₹ 3180 per ton, respectively. The average cost of sugarcane cultivation was ₹ 3340 per ton and average productivity was 80.5 ha^{-1} and cost of production on Cost A_2+FL and Cost C_2 was ₹ 228308 and ₹ 268870 per ha respectively. The average sugarcane productivity in U.P. during 2025-26 declined due to wide spread red rot diseases in variety Co 0238 in western U.P. The area of variety Co 0238 in U.P. has also declined from 42.9 to 29.2 as compared to past year. These estimates of sugarcane cost of production was submitted to the UP Sugarcane Department for State Advised Price

Fixation Recommending Committee held under chairmanship of Chief Secretary, Govt. of UP.

Development and evaluation of sugarcane crop image dataset for varietal identification

Field trial of 24 early and mid-late sugarcane varieties recommended for Subtropical India has been conducted in two replications. Varieties undertaken in early group are CoLk14201, CoLk15466, CoLk11203, CoS17231, CoLk9709, CoLk16202, CoLk15201, CoS13235, Co0118, CoLk94184, CoLk12207, Co0238 while in midlate group are CoS767, CoS08279, CoLk09204, CoLk11206, CoLk15207, Co05011, CoPant97222, CoLk12209, CoLk14204, ColLk15206, CoLk16030, CoPb14185. Following activities were performed to study sugarcane maturity based on HSV data of crop images:

- Collected images of sugarcane crop along with brix @

  10-14 days interval (7 stages starting 25 Sept, 2025)

  12 early and mid-late varieties

  30-40 images / variety / stage
- Adopted image processing techniques to reduce noise and size of images.
- Collected HSV data of images.
- Analyzed data to get HSV and Hue frequency of images at above interval

Preliminary investigations were made about HSV values trend in sugarcane crop images collected at seven stages of crop from September onwards for maturity identification. Data of early sugarcane varieties shows that hue values in range of 40-90 has decreasing frequency trend during September to early December of maturity period, while hue in range of 5-39 has increasing frequency trend (Table 7.3). However, these trends need to be further investigated with complete HSV data of entire maturity period of sugarcane crop along with juice analysis record of the crop.

Development of Trait-Specific Genomic Database for Sugarcane

The project aims to develop a centralized and accessible repository of sugarcane genomic data associated with the important traits, i.e., yield, disease resistance, abiotic stress resistance and sugar content etc. This project intends to bridge existing knowledge and technological gaps by developing a trait-specific database that integrates SNP and CNV data related to sugarcane from NCBI and other public resources. By focusing on trait-specific analysis and providing a user-friendly interface, the database will enable researchers to access consolidated genomic information relevant to sugarcane improvement and crop management.

Work completed so far includes:

- Sugarcane RNA sequencing data has been downloaded from the NCBI SRA database for various biotic and abiotic stress conditions and sucrose content.
- The raw sequencing data is quality-checked using the FASTQC tool and then trimmed to remove low-quality sequences and adapters using the Trimmomatic tool.
- For each Bio project, assembly is performed on the quality-checked data using HISAT2 and String Tie tools.

Table 7.3. Percentage frequency of hue values observed in sugarcane crop images of early varieties

Hue Range	Cane maturity stages during 25 Sept to 04 Dec, 2025						
	I	II	III	IV	V	VI	VII
0-9	0.36	0.34	2.02	4.09	3.59	7.08	5.99
10-19	5.06	5.88	17.44	28.79	25.46	30.83	35.76
20-29	8.30	10.26	14.35	18.07	15.46	18.02	18.58
30-39	14.10	10.93	25.75	28.64	21.55	21.97	17.10
40-49	36.32	30.67	24.86	16.32	15.69	12.07	8.44
50-59	16.70	17.90	6.36	3.75	4.03	3.99	2.63
60-69	4.76	5.22	1.06	0.40	0.90	0.65	0.70
70-79	1.86	2.68	0.66	1.43	0.79	0.72	0.52
80-89	2.64	3.72	1.08	1.15	1.91	1.04	1.47
90-99	3.52	5.52	3.39	0.31	4.06	3.19	3.95
100-109	6.74	7.21	5.04	0.68	9.85	7.24	10.84

Table 7.4. Details of the DEGs obtained from RNA sequencing data of different traits

S. No.	Traits	Bio-project-ID (NCBI)	DEGs	Up-regulated Genes	Down-regulated Genes
1	Smut resistance	PRJNA291816	843	470	373
2	Cold tolerance	PRJNA319158	15555	8258	7297
3	Water logging tolerance	PRJDB14242	186	70	116
4	Moisture stress tolerance	PRJNA317338	726	386	340
5	Leaf abscission	PRJNA293771	1288	946	342
6	Bacterial resistance	PRJNA1010968	464	176	288
7	Drought tolerance	PRJNA590595	8650	4772	3878

- ➢ Reference assembly is carried out using the latest release of the sugarcane reference genome by CIRAD (Sugarcane Genome Hub, https://sugarcane-genome.cirad.fr/).
- ➢ Identification of DEGs
- ➢ For each experiment, differentially expressed genes (DEGs) are identified from the assembled reads.
- ➢ Gene-level quantification files generated through StringTie are processed using the DESeq2 and/or EdgeR pipeline to identify DEGs across different trait-specific conditions.

The collection of Previously Reported DEGs from Literature: To enrich the genomic repository, DEGs previously identified in published sugarcane transcriptomic studies were systematically collected from peer-reviewed literature.

Table 7.5. Details of the DEGs obtained from literature review

S. No	Traits	DEGs	Up-regulated Genes	Down-regulated Genes
1	Twisted leaf disease resistance	64058	40198	23860
2	Drought tolerance	3389	1772	1617
3	Smut resistance	5580	-	-
4	Salinity stress tolerance	1150	708	410
5	Disease Resistance (response to salicylic acid, methyl jasmonate, and smut pathogen stress)	688	-	-
6	Streak Mosaic Virus resistance	4982	72	4910

UPCST Externally Funded Project: Rhizospheric metagenomic study to identify beneficial microbes for sustainable management of sugarcane smut in Uttar Pradesh

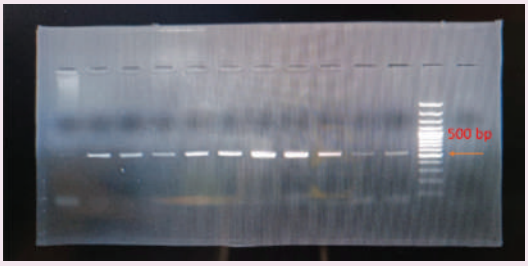
The comprehensive surveys was conducted in major sugarcane growing areas of district Ayodhya, Gonda, and Meerut to locate hot spot zones of smut incidence and collected representative material.

Figure 7.1. a. Typical smut symptom on variety CoLk 11203 in Ayodhya; b. Collection of smut and soil samples by PI and Co-PI team in Masodha; c. Top of Co0238 is extensively deformed by smut infection d. CoS 13235 affected with smut in Meerut; e. Complete drying of secondary tillers; f. pure culture of *Sporisorium scitamineum*; Teliospores harvested from infected whips of CoLk 11203.

Twelve samples were collected for the metagenomic study (rhizosphere soil + associated smut-infected plant material) following the survey plan. First, infected plants were uprooted and loose topsoil were removed to place taproots/soil into sterile 50 mL tubes with sterile water and processed to recover the rhizosphere fraction. Field metadata (location, genotype, disease index, date) has been collected.

Microscopy and morphological characterization were performed on the fungal material recovered from infected plants and morphology matched with expected smut features.Molecular assays (PCR/ sequencing) were carried out on the isolated pathogen and molecular data corroborated morphological ID and the pathogen identity was confirmed.

Table 7.6. Smut specific primers targeting the bE mating type region and ITS region were used.

S. No	Gene	Sequence	Amplicon size	Tm [₹ C]
1	bE4	5′-CGCTCTGGTTCATCAACG-3′	459 bp	55.97
2	bE8	5′-TGCTGTCGATGGAAGGTGT-3′	459 bp	56.67
3	SL1	5`-CAGTGCACGAAAGTACCTGTGG-3`	530 bp	62.12
4	SR2	5`-CTAGGGCGGTGTTCAGAAGCAC-3`	530 bp	63.98
5	ITS 1	5′-TCCGTAGGTGAACCTGCGG	550 bp	60.99
6	ITS4	5′-TCCTCCGCTTATTGATATGC	550 bp	55.25
Amplification of ITS region of *S. scitamineum*				

CHAPTER 8

ICAR-ISRI Regional Centre, Motipur (Bihar)

During the year 2025, Indian Sugarcane Research Institute Regional Centre, Motipur made notable contributions toward strengthening sugarcane productivity and varietal improvement in the North Central Zone (NCZ) through focused research, seed production, and adaptive evaluation programmes. The centre advanced seven promising sugarcane clones comprising early and mid-late maturity groups to the Zonal Varietal Trials under the AICRP (S) network based on their superior performance for cane yield, CCS yield, sucrose content, and moderate resistance to red rot disease. All assigned AICRP experiments were executed successfully with timely planting, scientific crop management, and effective ratoon maintenance, resulting in healthy crop stands and positive observations during monitoring visits. Under the Breeder Seed Production Programme implemented in collaboration with the Sugarcane Industries Department, Government of Bihar, the centre produced more than 18,300 quintals of quality breeder seed despite adverse climatic conditions including erratic rainfall and prolonged waterlogging. In view of the frequent flood situations prevailing in North Bihar, multi-location outreach trials were also conducted to assess the performance of advanced sugarcane clones under waterlogged conditions. Several ISRI-developed clones exhibited stable juice quality and recovery under stress environments, highlighting their potential for climate resilience and sustainable cultivation. The achievements of the centre during the reporting year reflected steady scientific progress, strengthened collaboration with the sugar industry, and continued commitment toward enhancing sugarcane productivity and sustainability in the NCZ.

Programme-wise Research Achievements

Development of Sugarcane Clones/ Varieties for North Central Zone

The major breeding programme at the Regional Centre focused on the development of high-yielding, red rot-resistant, and waterlogging-tolerant sugarcane varieties for the North Central Zone (NCZ). During 2025, a total of 56 crossing programmes comprising biparental (43), general cross (10), and poly-cross (3) combinations were attempted. The resultant fluff was sown and approximately 7,426 healthy seedlings were raised and evaluated through successive clonal stages. Based on morphological characters and juice quality parameters, 520 clones were initially selected from earlier seedling populations, of which 128 promising clones were advanced to the C3 stage after rigorous screening and evaluation.

A Station Trial consisting of 21 entries along with four checks was established in Randomized Block Design (RBD) with three replications at RC, Motipur based on previous year juice analysis and field performance. Six elite clones *viz*., CoLk 25466, CoLk 25467, and CoLk 25468 in the early group, and CoLk 25469, CoLk 25470, and CoLk 25471 in the mid-late group were accepted for Zonal Varietal Trials (NCZ) during the AICRP (S) Workshop held in 2025. These clones exhibited superior CCS yield, improved sucrose content, and moderate resistance to red rot over existing standards. In addition, two mid-late clones were promoted from IVT to AVT, while four clones across early and mid-late groups advanced to AVT II, reflecting steady progress in the varietal development programme.

AICRP (Sugarcane) Zonal Varietal Trials (ZVT) for NCZ (B II)

The Regional Centre successfully conducted all assigned Zonal Varietal Trials (ZVTs) under AICRP (Sugarcane) as per the approved technical programme of Plant Breeding. A total of eight trials comprising IVT (Early), AVT (Early) I Plant, AVT (Early) II Plant, AVT (Early) Ratoon, IVT (Mid-late), AVT (Mid-late) I Plant, AVT (Mid-late) II Plant, and AVT (Mid-late) Ratoon were conducted during the reporting period. Timely planting, effective ratoon management, and adoption of recommended agronomic practices ensured healthy crop establishment and accurate recording of morphological and juice quality observations. In addition to ZVTs, one Station Trial consisting of 21 clones and one Pathology Trial comprising 48 clones were also established at the centre.

The monitoring team constituted by the Project Coordinator (Sugarcane) visited the Regional Centre and appreciated the experimental precision, crop health, and overall maintenance of the trials. Reports of all ZVTs were submitted timely to the Principal Investigator, Plant Breeding. Further, eight ZVT trials for the 2026–27 season were also established for additional evaluation. Under seed multiplication activities, planting of AICRP (S) clones for next season trials, distribution of seed material among NCZ centres, and multiplication of newly accepted clones were undertaken successfully. Sugarcane seed

Fig. 8.1. Monitoring of AICRP (S) ZVT trials at ISRI RC, Motipur

material collected from SRI, Pusa, Samastipur, Seorahi, and Buralikson was utilized for the establishment of ZVT trials.

Bihar Sugarcane Breeder Seed Production Programme

The Bihar Sugarcane Breeder Seed Production Programme, funded by the Sugarcane Industries Department (SID), Patna, was initiated during 2024–25 as the third phase of the programme after the successful completion of earlier phases during 2012–13 to 2017–18 and 2019–20 to 2023–24. The programme focuses on strengthening the sugarcane seed chain in Bihar through the production and supply of quality breeder seed of improved sugarcane varieties. During the 2025–26 season, a total of 18,300 quintals of breeder seed were produced over 29 hectares covering ten sugarcane varieties viz., CoLk 94184, CoLk 12207, CoLk 12209, CoLk 15466, CoLk 16466, CoLk 16470, CoLk 14201, Co 0118, Co 15023 and CoP 9301. Breeder seed production was undertaken at four centres namely Indian Sugarcane Research Institute Regional Centre, Motipur; New Swadeshi Sugar Mills, Narkatiaganj; Harinagar Sugar Mills, Harinagar; and Tirupati Sugars Ltd., Bagaha. ISRI Regional Centre, Motipur recorded seed yield exceeding 75 tonnes per hectare during the previous season.

Erratic and heavy rainfall during the last two years adversely affected sugarcane cultivation and breeder seed production due to prolonged waterlogging conditions in Bihar. Despite these challenges, breeder seed production was successfully maintained and, as per the indent of SID, Patna, the produced breeder seed was distributed among sugar mills of Bihar and other stakeholders for further multiplication of foundation seed. During the current year, two new varieties, CoLk 14201 and Co 15023, were also included in the seed chain under the programme. The programme will further strengthen the quality sugarcane seed system in Bihar and support the rapid dissemination of high-yielding and disease-tolerant varieties for improving cane productivity and sugar recovery in the state.

Waterlogging Outreach Programme at Sugar Mills of Bihar

Outreach trials for evaluation of suitable sugarcane clones/varieties under waterlogging conditions of Bihar were conducted during 2025–26 at Tirupati Sugars Ltd., Bagha; Harinagar Sugar Mills, Harinagar and New Swadeshi Sugar Mills, Narkatiyaganj. Fifteen advanced clones, including RC, Motipur developed, along with standard checks Co 0118 and CoP 9301, were evaluated under prolonged water stagnation for metric traits and juice quality. Several clones maintained stable juice quality and sugar recovery under waterlogged conditions, indicating good adaptability to flood-prone agro-ecologies of North Bihar. Among them, CoLk 16468 and CoLk 15466 emerged as superior clones with consistently high brix, purity and recovery across locations. While, clone CoLk 20466 also exhibited stable and superior performance with comparatively higher brix (19.93%),

Table 8.1 Performance of Clones at NSSM, Narkatiyaganj; HSM, Harinagar; TSL, Bagaha

Clone/Variety	Brix (%)	Purity (%)	Pol in Cane (%)	Recovery (%)	Overall Performance
CoLk 16468	19.22	89.64	13.11	11.19	Excellent
CoLk 15466	20.43	88.37	13.06	11.12	Excellent
CoLk 20466	19.93	89.18	12.63	10.64	Very Good
CoLk 20468	18.01	85.13	11.56	9.55	Very Good
CoLk 16470	18.89	85.31	12.01	10.07	Good
CoLk 16466	18.16	83.53	11.51	9.52	Moderate
CoLk 20467	17.62	83.55	11.25	9.28	Moderate
CoLk 20469	16.77	79.56	10.42	8.31	Poor
CoP 9301	18.72	88.21	12.64	10.74	Very Good
Co 0118	20.69	90.92	13.96	11.40	Good

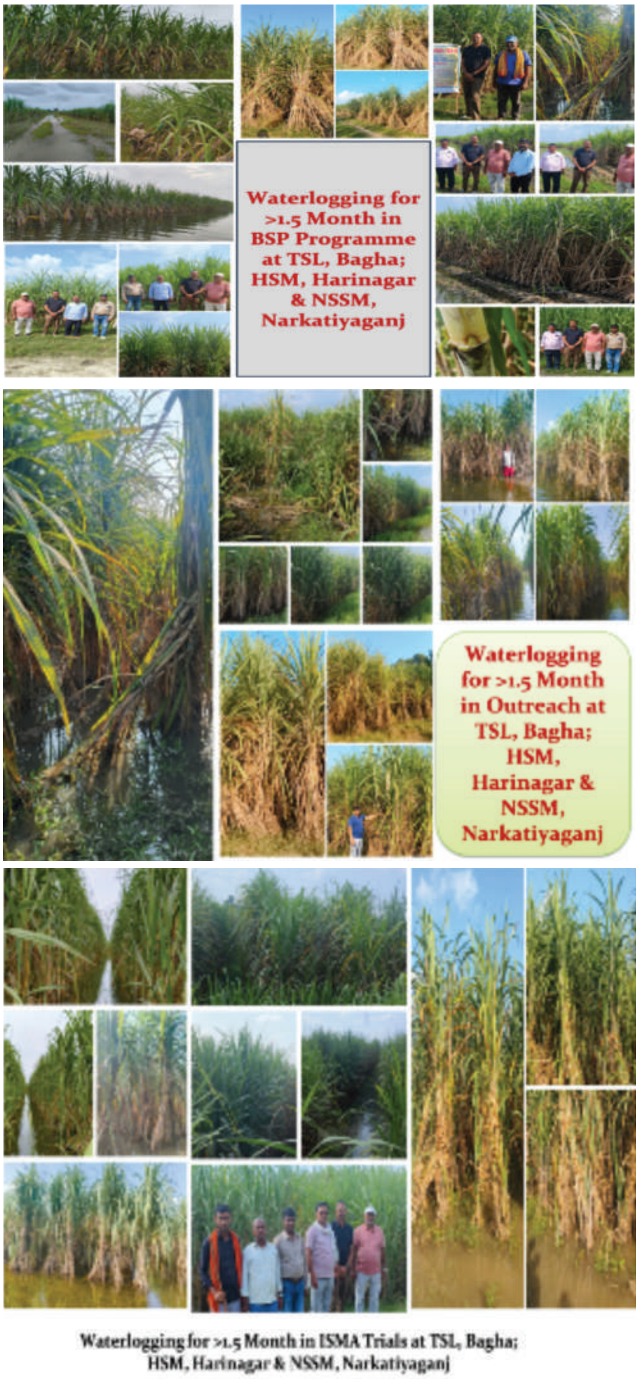


Fig. 8.2: Waterlogging for > 1.5 month

purity (89.18%) and recovery (10.64%), indicating strong commercial potential under North Bihar conditions. Furthermore, CoLk 20468 demonstrated stable performance under waterlogging-prone environments with average brix of 18.01 per cent, purity of 85.13 per cent, pol in cane of 11.56 per cent and recovery of 9.55 per cent across locations, supporting its suitability for flood-affected areas of Bihar. While, CoLk 16470 also showed reasonably good juice quality and recovery under stress conditions.

Linkages

Strong collaborative linkages were maintained with the Sugarcane Industries Department, Patna (Government of Bihar), and sugar mills across Bihar, including Tirupati Sugars Ltd. Bagha, Harinagar Sugar Mills Ltd., Harinagar and New Swadeshi Sugar Mills, Narkatiyaganj. The centre also actively contributed to the AICRP (S) network through coordinated varietal evaluation at the national level.

Consultancy, Contract Research and Patents

- The BSP programme under the MoU with the Sugarcane Industries Department, Bihar, was successfully implemented, with continuous technical support to sugar mills on varietal composition, disease surveillance, waterlogging management, and crop improvement. A field visit to Riga Sugar Mill (13–14 Dec. 2025) covered ~12,300 ha of cane area, leading to recommendations on varietal replacement, removal of red rot–susceptible varieties, seed system strengthening, and adoption of improved agronomic practices.
- Waterlogging assessment in Sitamarhi and adjoining command areas (Bagmati, Lakhandei, Adhwara basins) identified 30–60 days of stagnation in Chaur lands affecting crop performance. Recommendations included use of waterlogging-tolerant varieties, avoiding seed production in chronically affected zones, improving drainage, and strengthening mill–institute coordination. No patents were filed during the reporting period.

Research Evaluation Committee

Research progress and field trials were evaluated during monitoring visits, and overall performance of the centre was found satisfactory with commendable progress in varietal advancement and seed production.

CHAPTER 9

Harnessing the potential of Sugar beet for Indian Agro-Climate

Programme-wise Research Achievements

Germplasm Conservation and Seed Production

Sugar beet germplasm regeneration was undertaken using a two-stage steckling technique involving root production at Lucknow followed by transplantation at Mukteshwar (>5000 amsl). This method reduced the seed production cycle by 5–6 months and ensured genetic purity. Seeds of LS 6 (14.2 kg) and IISR Comp 1 (1.5 kg) were produced for distribution. Indigenous LKC series genotypes were maintained for drought tolerance, ethanol recovery, and pest resistance studies.

Screening against insect pests and diseases

Forty-eight genotypes were evaluated under field conditions. *Cercospora* leaf spot was the predominant disease. Fusarium and Sclerotium root rots were recorded under fluctuating moisture conditions. Spodoptera litura infestation reached 90–98% severity in susceptible lines. Genotypes SYT/06/10, L 33, and LKC 2000 showed strong resistance and are promising for resistance breeding.

Evaluation under irrigated and water limiting conditions

Under irrigated conditions, LKC 2006 recorded the highest single root weight (1.41 kg) with 16.92% sucrose and 91.20% purity. LKC 95 exhibited maximum sucrose (18.12%) and Brix (20.10%). Under drought stress, overall reduction in yield and sugar content was observed; however, LKC 95 and LKC 2006 maintained relatively higher sucrose (>15.7%) and purity (>90%), demonstrating superior drought tolerance and stability.

Performance of indigenous sugar beet genotypes with sugarcane intercropping

Integrating sugar beet with sugarcane through intercropping can enhance land use efficiency, increase farmers' income, and provide an additional source of sugar during the crushing season. However, the performance of sugar beet varies across different agro-climatic conditions, particularly with respect to important yield and quality parameters such as root weight, juice content, Brix, pH, Pol (%), and juice purity, which are critical for industrial sugar recovery. Therefore, the present study was conducted to evaluate the yield and quality performance of sugar beet variety LS 6 grown in an intercropping system with sugarcane across different factory command areas of Uttar Pradesh. The experiment assessed variations in agronomic and juice quality traits to identify suitable locations for sugar beet cultivation and to examine its potential integration into sugarcane-based cropping systems (Table 9.1). The results indicate successful high yield achievement of sugar beet in sugar beet and sugarcane intercropping system.

Table 9.1 Effect of different locations/factory areas on yield and quality of sugar beet (LS 6) in an intercropping system with sugarcane

Name of Location/Factory Area	Yield (t/ha)	Wt. (kg)	Juice (%)	Brix (%)	pH	Pol (%)	Purity (%)	Pol (%)
Dalmia Bharat Sugar and Industries Ltd., Ramgarh, Sitapur	55	3.80	46.80	17.10	5.80	13.80	80.70	12.78
Seksaria Sugar Factory, Biswan, Sitapur, U.P.	52	3.10	48.50	18.0	5.85	16.50	91.66	15.12
DCM Shriram Factory Ltd., Rupapur, Hardoi, U.P.	45	3.25	51.20	16.80	5.80	14.82	88.21	13.70
K M Sugar Mill Ltd., Ayodhya, U.P.	45	2.85	50.20	18.0	5.90	16.10	89.44	14.40
NSI, Kanpur, U.P.	55	3.68	52.80	19.0	5.80	17.0	89.47	15.10

Performance of indigenous sugar beet genotypes across distinct Indian regions

The performance of four indigenous sugar beet genotypes was evaluated across diverse agro-climatic conditions to determine their adaptability, sugar quality, yield potential, and ethanol production efficiency (Table 9.2 and 9.3). At E1 (ARS, Basanthpur) under high temperature conditions, LS 6 (18.9% sucrose; 21.8% Brix) and IISR Comp 1 (18.8%; 21.7%) recorded the highest sugar accumulation, followed by LKC 2006 (18.3%; 21.1%) and LKC 2020 (18.1%; 21.4%). Juice purity remained stable (84.58–86.72%). LS 6 and IISR Comp 1 also produced the highest root yield (73.9 t ha^{-1}), indicating better heat tolerance, although biomass accumulation remained comparatively lower. Under tropical conditions at E2 (VSI, Pune), sucrose levels declined slightly; however, LKC 2006 and LS 6 maintained the highest sucrose (16.83%). LKC 2020 (97.91%) and IISR Comp 1 (96.84%) exhibited superior juice purity, while LKC 2020 recorded the highest yield (145 t ha^{-1}), demonstrating strong adaptability. At E3 (ICAR-ISRI, Lucknow) under irrigated conditions, LKC 2020 performed best with 17.42% sucrose, 19.18% Brix, and 141 t ha^{-1} yield, followed by LKC 2006 (138 t ha^{-1}). Under water-limiting conditions, LKC 2006 maintained the highest sucrose (16.37%) and purity (91.44%), while IISR Comp 1 produced the highest yield (105 t ha^{-1}).At E4 (NSI, Kanpur), LKC 2020 showed the greatest ethanol potential with TRS 16.34 g/100 ml, 8.5% actual ethanol, and 127.5 L t^{-1} alcohol yield, followed by LS 6, confirming its suitability for bioethanol production

Location-Specific Performance Results

Highest yield recorded at NSI, Kanpur (106 t/ha). Highest sucrose recorded at ARS, Basanthpur (18.9%). Stable performance across semi-arid (Pune) and intercropping systems confirms adaptability (Table 9.4).

Sugar beet Trials under AICRP on Forage Crops

The AICRP on Forage Crops conducted Initial Varietal Trial (IVT) in sugar beet with the objective of identifying promising genotypes suitable for different agro-climatic zones of India. The trial has been designed to evaluate the performance of sugar beet entries contributed by the Indian Sugarcane Research Institute (ISRI), Lucknow. A total of 10 sugar beet germplasm exluding two checks, namely LS 6 and IISR Comp 1, have been included for comparative assessment. The experiment will be conducted in a Randomized Block Design (RBD) with three replications to ensure statistical reliability of

Table 9.2 Performance of indigenous genotypes across different locations & conditions

Location/ Environment	Genotype	Sucrose (%)	Brix (%)	Purity (%)	Root Yield (t ha^{-1})
E_1–ARS, Basanthpur (High temperature)	LKC 2006	18.3	21.1	86.72	–
	LKC 2020	18.1	21.4	84.58	–
	IISR Comp 1	18.8	21.7	85.63	73.9
	LS 6	18.9	21.8	85.7	73.9
E_2–VSI, Pune (Tropical condition)	LKC 2006	16.83	–	–	–
	LKC 2020	15.93	–	97.91	145
	IISR Comp 1	16.59	–	96.84	–
	LS 6	16.83	–	–	–
E_3–ISRI, Lucknow (Irrigated)	LKC 2006	16.51	18.05	91.48	138
	LKC 2020	17.42	19.18	–	141
	IISR Comp 1	16.09	18.17	–	–
	LS 6	16.28	17.19	94.88	–
E_3–ISRI, Lucknow (Water limiting)	LKC 2006	16.37	–	91.44	–
	LKC 2020	15.23	–	89.06	68
	IISR Comp 1	11.03	–	82.29	105
	LS 6	14.05	–	82.89	98
E_4–NSI, Kanpur (Ethanol evaluation)	LKC 2006	–	–	–	–
	LKC 2020	–	–	–	–
	IISR Comp 1	–	Highest Brix	–	–
	LS 6	–	–	–	–

Table 9.3 Ethanol production parameters (NSI, Kanpur)

Genotype	TRS (g/100 ml)	RS (g/100 ml)	FS (g/100 ml)	Theoretical Ethanol (%)	Actual Ethanol (%)	Fermentation Efficiency (%)
LKC 2006	12.52	0.46	12.06	7.6	5.9	77.63
LKC 2020	16.34	0.23	16.11	9.9	8.5	85.86
IISR Comp 1	13.64	0.50	13.14	8.3	7.2	86.75
LS 6	15.06	0.40	15.02	9.6	7.9	82.29

Table 9.4 Comparative performance across locations

Location	Geno-type	Yield (t/ha)	Sucrose (%)	Brix (%)
ARS, Basanthpur	LS 6	73.9	18.9	21.8
NSI, Kanpur		106	16.1	21.0
VSI, Pune		71.7	15.8	18.7

the observations. Each experimental plot will have a size of 3.0 × 4.0 m with row-to-row spacing of 50 cm, accommodating six rows of 4 m length. Recommended nutrient application for the trial includes 120 kg nitrogen, 60 kg phosphorus, and 60 kg potassium per hectare. The trial will be conducted across multiple locations representing diverse agro-climatic zones of the country. These include hill, north-western, north-eastern, central, and southern zones, covering important research centres such as Palampur, Srinagar, Almora, Pantnagar, Bikaner, Ludhiana, Ranchi, Faizabad, Imphal, Jorhat, Jhansi, Anand, and Urulikanchan. The programme is expected to generate valuable data on growth, adaptability, fodder yield, and related agronomic traits of sugar beet genotypes under varying environmental conditions. The experimental observations recorded during the Rabi 2025–26 season will be systematically compiled and analyzed. Furthermore, the data generated from these coordinated trials will be critically evaluated during the next year for identifying superior and stable entries suitable for advancement and recommendation in different agro-climatic regions of India.

Technology Developed

- Identification of drought-tolerant genotypes (LKC 95, LKC 2006).
- Identification of *Spodoptera*-resistant germplasm (LKC 2000, SYT/06/10).

Transfer of Technology

Seeds and package of practices were supplied to ARS, Basanthpur; NSI, Kanpur; VSI, Pune; ANGRAU; S. Nijalingappa Sugar Institute; and KIAAR, Karnataka. Multi-location adaptive trials strengthened regional validation of indigenous varieties.

CHAPTER 10

AICRP on Sugarcane

Research Achievements

Sugarcane continues to play a pivotal role in India's agricultural economy, contributing significantly to sugar and bio-energy production. In recent years, national sugarcane productivity has remained around 80–82 t/ha, with sugar recovery in the range of 10.0–10.5%. These stable production levels are supported by the widespread adoption of improved sugarcane varieties and production technologies developed through the All India Coordinated Research Project on Sugarcane . The coordinated system has enabled the continuous supply of high yielding, high sugar, and stress tolerant varieties and management practices suited to diverse agro-climatic regions.

The All India Coordinated Research Project on Sugarcane, initiated by ICAR in 1970, serves as the national platform for multi-location testing, varietal improvement, crop production and protection research, and the development of region specific sugarcane technologies across the tropical and subtropical zones of India. With its network of research centres and coordinated trials, the project continues to strengthen India's sugarcane research system by integrating Crop Improvement, Crop Production, Plant Pathology and Entomology efforts to enhance productivity, sustainability, and resilience of the sugarcane production system.

A. Crop Improvement:

During the 94th meeting of the Central Subcommittee on Crop Standards, four sugarcane varieties viz., CoS 17231 (Bismil), Co 18022 (Karan-18), CoPb 18213 (CoPb 100), and CoH 17261 (CoH 179) have been released and notified by CVRC.

In crop improvement, 450 parental clones were planted in the National Hybridization Garden, including eight new proposals. A total of 382 clones flowered, achieving 84.89% flowering intensity, and ICAR–SBI, Coimbatore facilitated fluff supply to 22 participating centres. Under the new targeted pre-breeding initiative aimed at developing climate-smart genetic stocks, 44 crosses (26 red rot–resistant and 18 drought-tolerant) were supplied to collaborating centres. The Varietal Identification Committee (VIC) meeting (April 2025) identified four varieties—CoS 17231, Karan-18 (Co 18022), CoPb 100 (CoPb 18213), and CoH 179 (CoH 17261)—for the North West Zone. During 2024–25, two varieties were released by the CVRC for national cultivation and nine additional varieties were released by the respective SVRCs for commercial planting in the respective states.

B. Crop Production:

In crop production, multi-location trials indicated that higher RDF significantly improved cane yield in the North West and Peninsular Zones, while the East Coast Zone showed negligible response. Moisture stress during the pre-monsoon phase caused 5–35% yield reduction, though adequate rainfall enabled strong compensatory growth. Studies on liquid nano urea revealed comparable results to granular urea across several centres, with specific advantages at Kolhapur and in the acidic soils of Nayagarh. Integration of microbial consortia enhanced yields and enabled up to 25% reduction in N fertilizer at some locations. Weed management trials highlighted severe yield penalties (15–75%) under uncontrolled weeds; however, a range of pre- and post-emergence herbicides provided effective control and higher economic returns.

C. Plant Pathology:

The Plant Pathology programme engaged 16 centres across eight projects. A total of 135 new red rot isolates were characterized, with early indications of potentially emerging pathotypes in the Peninsular Zone. Extensive screening in zonal varietal trials identified several resistant/moderately resistant entries to major diseases including red rot, smut, wilt, YLD, brown rust, and Pokkah boeng. Disease surveillance highlighted region-specific vulnerabilities, particularly red rot and wilt in subtropical India and foliar diseases in Kerala. Tissue culture-based management strategies for YLD continued to show effectiveness across zones.

D. Entomology:

The Entomology discipline implemented nine projects across 12 centres. Genotype screening in different zones identified several entries showing MS/HS reactions to key pests such as early shoot borer, internode borer, and mealy bugs. Surveys recorded major pests at manageable levels except isolated severe top borer outbreaks, with emerging pests like *Phenococcus saccharifolii* and spiralling whitefly noted in some regions. Advances in bio-agent mass multiplication techniques improved production efficiency for agents such as *Tetrastichus howardi* and *Telenomus dignus*. White grub management trials achieved up to 53% reduction in grub incidence in treated plots. Multi-location borer loss assessment confirmed superior yield and quality improvements under combined pest-management approaches, and economic injury levels for Plassey borer were established to guide timely interventions.

3. Technology Developed:

(A) Four Sugarcane Varieties released & notified by CVRC

(i) CoS 17231 (Bismil), Parentage : CoV89101 X CoS96260

This sugarcane variety has been released and notified by CVRC in 2025 for North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is a early maturing variety having cane yield (86.35 t/ha), CCS (11.17 t/ha), Sucrose (%) in juice (18.52) and Pol (%) in cane (13.97). Reaction against red-rot and smut was Resistant (R) and the reaction against major insect-pests was found less susceptible (LS) and tolerant to drought & salinity. This variety was recommended for growing under irrigated condition.

(ii) CoH 17261 (CoH 179), Parentage : CoH 102 GC

This sugarcane variety has been released and notified by CVRC in 2025 for North West Zone comprising states of Punjab, Haryana and Rajasthan only. It is a mid-late maturing variety having cane yield (89.42 t/ha), CCS (11.15 t/ha), Sucrose (%) in juice (18.32) and Pol (%) in cane (13.79). Reaction against red-rot & smut was Resistant (R) and the reaction against major insect-pests was found less susceptible (LS). This variety was recommended for growing under irrigated condition.

(iii) Co 18022 (Karan-18), Parentage: CoS 8436 X Co89003

This sugarcane variety has been released and notified by CVRC in 2025 for North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is an mid-late maturing variety having cane yield (86.86 t/ha), sucrose (%) in Juice (18.87), CCS (11.33 t/ha) and Pol (%) in cane (13.90). Reaction against the red rot was moderately resistant (MR), smut was resistant (R) and reaction against major insect-pests was found less susceptible (LS). This variety is tolerant to salinity stress and resilience to drought condition. This variety was recommended for growing under irrigated condition.

(iv) CoPb 18213 (CoPb 100), Parentage: CoJ 72 X Co 1148

This sugarcane variety has been released and notified by CVRC in 2025 for North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is a mid-late maturing variety having cane yield (86.86 t/ha), sucrose (%) in juice (18.87), CCS (11.33 t/ha) & Pol (%) in cane (13.90). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests. This variety is Tolerant to salinity stress and drought. The variety was recommended for growing under irrigated condition.

(B) Eight Sugarcane Varieties Identified by AICRP (S)

(i) Co 09004 (Amritha), Parentage: CoC 671 X CoT 8201

This sugarcane variety has been identified by AICRP(S) for release & notification in East Coast Zone comprising states of Coastal Tamil Nadu & Andhra Pradesh and Odisha. It is an early maturing variety having cane yield (110.45 t/ha), sucrose % in juice (18.68), CCS (14.45 t/ha) and Pol % in cane (14.26). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

(ii) Co 18003 (Aroh), Parentage: CoM 0265 X Co 99006

This sugarcane variety has been identified by AICRP(S) for release & notification in Peninsular Zone comprising states of Interior Tamil Nadu, Kerala, Karnataka, Telangana, Gujarat, Maharashtra, Madhya Pradesh and Chhattisgarh for 360 days maturity group. This variety having cane yield (116.98 t/ha), sucrose % in juice (20.20), CCS (16.72 t/ha) and Pol % in cane (15.32). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

(iii) CoP 18437 (Rajendra Ganna-3), Parentage: CoPant 1216 X Co 1148

This sugarcane variety has been identified by AICRP(S) for release & notification in North Central & North Eastern Zones comprising states of Eastern Uttar Pradesh, Bihar, West Bengal and Assam. It is an early maturing variety having cane yield (86.31 t/ha), sucrose % in juice 18.19), CCS (10.98 t/ha) and Pol % in cane (13.33). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

(iv) Co 19017 (Karan-19), Parentage: Co 88006 X Co 86011

This sugarcane variety has been identified by AICRP(S) for release & notification in North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and

Rajasthan. It is a mid-late maturing variety having cane yield (90.19 t/ha), sucrose % in juice (18.76), CCS (11.90 t/ha) and Pol % in cane (13.93). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

(v) CoPb 19182 (CoPb 101), Parentage: Co 98010 X Co 1148

This sugarcane variety has been identified by AICRP(S) for release & notification in North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is a mid-late maturing variety having cane yield (88.93 t/ha), sucrose % in juice (18.85), CCS (11.72 t/ha) and Pol % in cane (13.87). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

(vi) CoLk 19204 (Ikshu-18), Parentage: CoS 8436 X CoSe 92423

This sugarcane variety has been identified by AICRP(S) for release & notification in North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is a mid-late maturing variety having cane yield (87.33 t/ha), sucrose % in juice (18.59), CCS (11.33 t/ha) and Pol % in cane (12.92). Reaction against red rot was resistant (R), smut was moderately susceptible (MS). The variety showed less susceptible (LS) in reaction of major insect-pests.

(vii) CoS 19235 (Shekhar), Parentage: Co 0238 X CoSe 92423

This sugarcane variety has been identified by AICRP(S) for release & notification in North West Zone comprising states of Central & western part of Uttar Pradesh, Punjab, Haryana, Uttarakhand and Rajasthan. It is a mid-late maturing variety having cane yield (92.69 t/ha), sucrose % in juice (18.87), CCS (12.16 t/ha) and Pol % in cane (13.66). Reaction

against red rot was moderately resistant (MR), smut was moderately susceptible (MS). The variety showed less susceptible (LS) in reaction of major insect-pests.

(viii) CoA 20322 (2014A 142), Parentage: CoV 89101 X ISH 69

This sugarcane variety has been identified by AICRP(S) for release & notification in East Coast Zone comprising states of Coastal Tamil Nadu & Andhra Pradesh and Odisha. It is a mid-late maturing variety having cane yield (117.01 t/ha), sucrose % in juice (17.24), CCS (14.05 t/ha) and Pol % in cane (13.25). Reaction against red rot was moderately resistant (MR), smut was resistant (R). The variety showed less susceptible (LS) in reaction of major insect-pests.

CHAPTER 11

ICAR-Krishi Vigyan Kendra-I, Lucknow

On Farm Testing/Trials (OFTs)

OFTs are most important mandatory component of KVK under which evaluation of recent developed technologies or varieties in specific agroclimatic condition for future recommendations or popularization is done. Three OFTs pertaining to various disciplines as per identified major thrust areas were conducted during the year as per the details given below:

Assessment of different canopy management system in mango tree

Orchardist of Lucknow district not follow the canopy management practices, so they may get unsatisfactory production. Therefore, we conducted an OFT for assessment of different canopy management system in mango tree. OFT has been conducted at farmers field and results are awaited.

Performance of artificial insemination through sex sorted semen in cows to increase the female calving ratio and milk production of Lucknow district

An OFT has been conducted to evaluate the performance of different types of sex sorted semen with particular reference to Gir and Sahiwal breed semen. Results are awaited.

OFT has been conducted regarding reduction of wheat yield due to farmers delay in first irrigation (crown root initiation stage) and avoid irrigation during dough stage causes low yield of wheat due to less tillering and shrinking of grains due to terminal heat stress and result are awaited.

Frontline demonstrations

Cluster Frontline Demonstration on mustard, wheat and berseem were conducted at 652 farmer's field in 151.0 ha area.

Frontline demonstrations on oilseed, cereals and fodder crops

Crop	Thematic Area	technology demonstrated	Variety	No. of Farmers	Area (ha)	Yield (q/ha)				% Increase in yield	Economics of demonstration (Rs./ha)				Economics of check (Rs./ha)			
						Demo			Check		Gross Cost	Gross Return	Net Return	BCR (R/C)	Gross Cost	Gross Return	Net Return	BCR (R/C)
						High	Low	Average										
Mustard	ICM	Improved variety	Giriraj	267	100	Result Awaited												
Mustard	ICM	Improved variety	RH-725	115	23.5	Result Awaited												
Wheat	ICM	Improved variety	DBW-327	174	25	Result Awaited												
Berseem	ICM	Improved variety	BL-42	96	2.5	Result Awaited												

Training Pogrammes

Krishi Vigyan Kendra has conducted 28 training programmes for 745 participating farmers and farm women, rural youth and extension functionaries on various topics with an objective to improve skill and upgrade their knowledge about developed and potent product. All training programmes were fully skilled oriented and conducted following the principles of "Learning by doing".

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	21	466	52	518
Sponsored and RAWE Student Training	5	107	56	163
Extension Functionaries	2	64	0	64
Total	28	637	108	745

Other Extension activities conducted by KVK

Activities	No. of programmes	No. of farmers	No. of Extension Personnel	TOTAL
Advisory Services	4342	6106	0	6106
Group discussions	5	112	6	118
Kisan Ghosthi	3	968	87	1055
Radio Talk	6	Mass	Mass	Mass
Exhibition	1	500	67	567
Scientists' visit to farmers field	59	307	136	443
Method Demonstrations	29	2382	190	2572
Celebration of important days	3	280	68	348
Lecture Delivered	137	12142	971	13113
Live telecast of Pradhan Mantri Dhan Dhanya Krishi Yojana	1	153	5	158
World Soil Day	1	40	2	42
Kisan Diwas	1	160	5	165
Viksit Krishi Sankalp Abhiyan	135	14126	1058	15184
Other	5	1026	125	1151
Total	**4728**	**38302**	**2720**	**41022**

Farm production

Crop	Name of the crop	Name of the variety	Name of the hybrid	Quantity of seed (q)
Cereals	Wheat	DBW-187		20.0
	Paddy	PB-1		20.0
	Barley	--		15.0
Oilseeds	Mustard	Giriraj		11.8
Total				**66.8**

Production of planting materials by the KVKs

Crop	Name of the crop	Name of the variety	Name of the hybrid	Number
Fruits	Mango			1000
	Bael			500
	Guava			500
Total				**2000**

Production of Bio-Products

Bio Products	Name of the bio-product	Quantity Kg	Value (Rs.)	No. of Farmers
Bio Fertilisers	Vermicompost	1000	15000	
	Cow Milk (Liter)	4285	214250	

On Farm Trials

Centre opening of mango tree

Training programme on Natural Farming and Live telecast of 19th PM Kisan Samman Nidhi Yojana under the Chairmanship of MLA, Mohanlalganj, Lucknow U.P.

Viksit Krishi Sankalp Abhiyan -2025

Live telecast of 21th PM Kisan Samman Nidhi Yojana under the Chairmanship of Director, ISRI, Lucknow

CHAPTER 12

ICAR- ISRI, Krishi Vigyan Kendra-II, Lakhimpur Kheri

Executive Summary

SL No	Detail of events	Number of training		Beneficiary	
		Target	Achievements	Target	Achievements
1	Training	65 Nos	44 Nos	1300	1159
2	Trainings under SCSP	-	5 Nos	-	260
3	Natural Farming Training	-	3 Nos	-	3
4	FLD	07 ha/100 Nos	07 ha/100 Nos	196	220
5	OFT	08 Nos	08 Nos	57	64
6	Field Day	8 Nos	8 Nos	160	220
7	Kisan Goshthi	7 Nos	19 Nos	350	700
8	Exhibition	12 Nos	12 Nos	95	95
9	Film Show	05 Nos	05 Nos	136	136
10	Group Meetings	36 Nos	36 Nos	1100	1209
11	Lectures Delivered as resource persons	80 Nos	80 Nos	1600	3811
12	Newspaper coverage	-	11 Nos	-	-
13	Advisory Services	-	788 Nos	-	788
14	Scientisits Visit to farmers filed	180 Nos	210 Nos	900	1240
15	Farmer Visit to KVK	-	1700 Nos	-	1700
16	Animal Health Camp	02 Nos	02 Nos	80	153
17	Celebration of Important Days	08 Nos	08 Nos	670	700
	Total			**6644**	**12458**

Achievements under SCSP scheme:

- Successfully distributed 188 Qt. of wheat seed variety DBW-187, DBW-327, DBW-370, DBW-371 and WH-1270 to 701 SC farmers under SCSP.
- Successfully distributed new varieties of 2 Qtl Field pea (Variety-IPFP12-2), 1.5 Qtl Gram (CVG-202), 05 Qtl Lentil (Variety L-4729), 02 Qtl Mustard RH-749 among 395 SC Farmers for increasing the yield and doubling farmer's income under FLD programme.

Research Achievements :

Technology Transfer

Performance Evaluation on Assessment of High yielding bacterial wilt resistant varieties of Brinjal):

To increase Brinjal production of the district was carried out. Here, this OFT was carried out because Non availability of quality seeds and unawareness of scientific cultivation practices to the farmers therefore, the trial was taken through adopting scientific cultivation practices in which farmers were

given advice's regarding used of HYVs, trainings, and method demonstration to the farmers. Result still awaited.

Assessment of high yielding variety of Tomato var- Arka Abhed:

On Farm Testing on Evaluation of high yielding variety of Tomato (Var- Arka Abhed) to increase tomato production of the district was carried out. Here, this OFT was carried out because non-availability of quality seeds and unawareness of scientific cultivation practices to the farmers therefore the trial was taken through adopting scientific cultivation practices in which farmers were given advice's regarding used of HYVs, trainingsand method demonstration to the farmers. Result still awaited.

Assessment of Feeding of balance ratio and mineral mixture to buffalo heifers for early onset of heat:

On farm testing on Assessment of Feeding of balance ratio and mineral mixture to buffalo heifers for early onset of heat was done. The problem was identified of slow weight gain and late onset of heat in buffalo heifers which ultimately imposes the economic loses to the farmers. Here in farmers practice only green fodder was offered to the animals while in technology under assessment the animals were offered green

fodder, 1.5 Kg concentrate feed and 50 gm mineral mixture per day for one year. Farmers are happy with the result. The BC ratio of trial was observed 1:1.50 in comparison to controlled 1:2.03.

Assessment of Feeding of Linseed Cake to repeat breeder buffaloes:

On farm testing on Assessment of Feeding of Linseed Cake to repeat breeder buffaloes was done. The Problem was identified in the field that the buffaloes are not conceiving after getting the service i.e. repeat breeding happens. This increases the inter-calving period ultimately imposes the economic loses to the farmers. Here in farmers practice only green fodder and concentrate feed was offered to the animals while in technology under assessment the animals were offered green fodder, 1.5 Kg concentrate feed and 1 Kg Linseed Cake per day for 20 days. Farmer is happy with the result. The BC ratio of trial was observed 1:1.95 in comparison to controlled 1:7.31.

Integrated management of Pod Borer (*Helicoverpa armigera*) in Urdbean:

Pod Borer (*Helicoverpa armigera*) being a polyphagous pest of agricultural crops which may cause of serious losses in urdbean production. The immature larvae feed on crops at all stages of plant development, damaging flowers and pods. The pest gained importance in all growing areas, where it led to complete crop failure. Pod Borer cause loss es up to 60 per cent leading to the discouragement of growers of the crops. We conducted two technology option at 10 farmers field. Technical option-1 Deploy pheromone trap @ 5 /ha+ Spray HaNPV @ 1ml/l+ Spray of emamectin benzoate 5 SG @ 0.2 g/l and Technical option-2 Deploy pheromone trap @ 5 /ha+ Neem oil 3000ppm @ 20 ml/l + Spray HaNPV @ 1ml/l + border crops at 10 farmers field. Farmer are happy with the result. The BC ratio of trial was observed 1:1.39 in comparison to controlled 1:1.89.

Evaluation of agrowaste for oyster mushroom (*Pleurotus* ostreatus var. *florida*) cultivation.

Agricultural wastes disposal is of primary concern in today's world as they are rich in nutrient and their disposal without pre-treatment can cause leaching in field, which can cause environment pollution. To overcome this problem, mushroom cultivation on these agricultural wastes is the most ecofriendly method to reduce the level of nutrients at acceptable range to be used as manure. Besides overcoming this problem defined combination of agricultural wastes also gives high yield of mushroom in a cost effective manner. We conducted three technology options at 05 farmers field. Technology Option-1- Paddy straw, Technical Option–II: Sugarcane straw + Banana straw + Sugarcane Bagasse, Technical Option–III: Lentil + mustard+ Pegion pea husk so we get highest B:C Ratio is 1.18.

3. Technology Developed: NIL

Transfer of Technology through FLDs

4.1 Transfer of technology on "Popularization of Broccoli Var Saki" was done to popularize the broccoli cultivation in the district. Broccoli

Var- Saki planted during rabi season. Now farmers get aware and it's a beneficial crop for Lakhimpur Kheri farmers. Total Twenty (20) numbers of Farmers directly benefited. Result is still awaited.

4.2 Transfer of technology on Popularization of Chilli Variety Arka Tejaswi also done to demonstrate the high yielding varieties of Chilli at farmers field with recommended spacing. Usually farmers cultivating local cultivars and not maintaining the proper spacing in the district. Variety grown successfully and farmers are showing big interest to adopt the technology. Total Twenty (20) numbers of Farmers direct benefited. . Result is still awaited.

4.3 Transfer of technology on production potential of animal husbandry, 100 demonstrations was conducted on deworming of buffalo calves.

4.4 Transfer of technology on "Popularization of Fodder Variety Hybrid Napier Bazra IGFRI6. We archived great success in this filed. B:C Ratio is 1:2.30

Training Organized:

Capacity building of Farmers, Farm women, rural youth, extension functionaries and other stake holders :

To upgrade the knowledge of farm and farm women and rural youth KVK organized 44 no of Trainings

Program Total 1159 farmers including farm women and rural youth were benefited which cover plant protection, horticultural and animal science aspects.

Discipline	Trainings	Male	Female	Total
Agronomy	8	241	23	264
Horticulture	14	209	122	331
Animal Science	10	236	28	264
Plant Protection	12	230	70	300
Grand Total	**44**	**916**	**243**	**1159**

Training under SCSP:-

Training programme for SC farmers.

Discipline	Trainings	Male	Female	Total
Agronomy	1	45	6	51
Plant Protection	2	88	19	107
Horticulture	1	49	7	56
Animal Science	1	44	2	46
Grand Total	**5**	**226**	**34**	**260**

Information of Natural Farming

Sl. No.	Name of the District	Name of the Farmers	No. of desi (indigenous) cows	Land holding (ha)	Crops Grown	No. of Years in Natural Farming	Area Covered under Natural Farming	Crops Grown under Natural Farming	Any significant achievements under natural farming
1	Lakhimpur Kheri	Shri Jagtaar Singh	4	-	Wheat	4	1.0 ha	Wheat Var. (Sona Moti)	Natural farming has led to improvements in soil health
2	Lakhimpur Kheri	Dr. Harish Singh	2	-	Wheat	2	0.5 ha	Wheat Var. (Sona Moti)	Natural farming has led to improvements in soil health
3	Lakhimpur Kheri	Smt. Meena Singh	2	-	Wheat	2	0.5 ha	Wheat Var. (Sona Moti)	Natural farming has led to improvements in soil health

Glimpse of Training programmes


Metabolic disease management of dairy animals


Management of dairy animals before and after parturition

Agro waste management through oyster mushroom cultivation

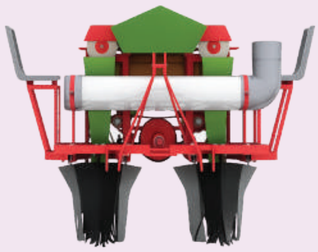
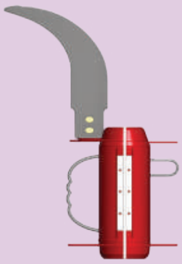
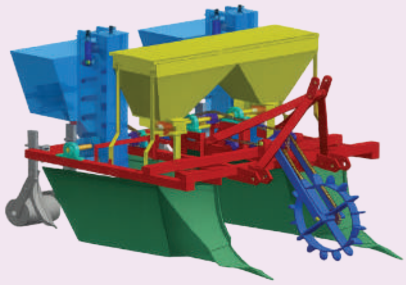

Integrated disease management in sugarcane

CHAPTER 13

Patent, Copyright & Technologies

1. Patent Filled : Nil

2. Design registration

Name of Innovation/ Technology	Date of Filing	Specification	Status
Tractor Operated Sugarcane Single Bud Sett Cutter Planter	6/01/2025		FER Filled (04/04/2025)
Manual Sugarcane Stripper- Cum- Detopper	6/01/2025		FER Filled (04/04/2025)
Tractor Operated Cane Node Planter	14/ 10 / 2025		FER Filled (05/01/2026)

3. **Copyright :** A total of 27 copyright granted and 44 copyright under Scrutiny

4. **Technology developed/Commercialized**

Name of the Technology	Year	Name of the Industry Partner	Amount of Licensing Fee (Rs.)
Disc type ratoon management device (disc RMD)	2025	M/s Punjab Engineers, Meerut	10,000
Deep furrow sugarcane cutter planter (two row automatic sugarcane cutter planter)	2025	M/s Punjab Engineers, Meerut	10,000
Tractor operated trash mulcher-cum-stubble shaver device for sugarcane ratoon crop	2025	M/s Punjab Engineers, Meerut	50,000
Tractor operated deep furrower (ridger)	2025	M/s Punjab Engineers, Meerut	50,000
Tractor-operated ring pit digger	2025	M/s Punjab Engineers, Meerut	10,000
Single bud/node cutter (manual)	2025	M/s Punjab Engineers, Meerut	10,000

Tractor-operated trench opener	2025	M/s Punjab Engineers, Meerut	10,000
Sugarcane stripper-cum-detrasher (manual)	2025	M/s Punjab Engineers, Meerut	10,000
Seed drill (manual)	2025	M/s Punjab Engineers, Meerut	10,000
Disc type ratoon management device (disc RMD),	2025	M/s Punjab Engineers, Meerut	10,000
Disc type ratoon management device (disc RMD)	2025	M/s Upadhyay Manufacturers, Agra, Uttar Pradesh	10,000
Deep furrow sugarcane cutter planter (two row automatic sugarcane cutter planter)	2025	M/s Upadhyay Manufacturers, Agra, Uttar Pradesh	10,000
Tractor operated trash mulcher-cum-stubble shaver device	2025	M/s Upadhyay Manufacturers, Agra, Uttar Pradesh	50,000

5. **MOUs with University/Institution/Organisations**

Sl. No.	University	Date
1	M/s Jarbits Pvt Ltd, Lucknow, Uttar Pradesh	March 28, 2025
2	Indian Farmers Fertiliser Cooperative Limited, New Delhi	April 01, 2025
3	Dr. Bangali Baboo to Promote Jaggery Innovations by Instituting the “Dr. Bangali Baboo Jaggery Innovator Award":	April 17, 2025
4	Zuari Industries Pvt Ltd (ZIL), Aira, Lakhimpur Khiri, Uttar Pradesh	April 23, 2025
5	Pragmatix Research & Advisory Services Private Limited, New Delhi	April 29, 2025
6	Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110	July 23, 2025
7	Cane Development & Sugar Industries Department, Udham Singh Nagar, North-West Zone Uttarakhand	November 19, 2025

CHAPTER 14

Human Resource Development

1. Capacity Building of ISRI Officials

Name	Training Programme	Venue	Date
Y. E. Thorat	Molecular taxonomy and DNA Barcodes	ICAR-CIFE, Mumbai	20th-27th Jan., 2025
Sayanti G. Majmudar	NAAS - 8th Pedagogy development programme on enhancing pedagogical competencies for agricultural education.	National Academy of Agricultural Sciences Complex, New Delhi	28th Jan-1st Feb., 2025
Srinivas K.	Technology forecasting and foresight methods with applications agriculture and allied sectors	ICAR-NAARM, Hyderabad	03rd-07th Feb., 2025
Shweta Singh	Training on virome profiling in plants: advanced methods for discovery and analysis under the national professor programme	Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, New Delhi	10th -11th March, 2025
Srinivas K.	Chemical Ecology: insect-plant-microbe interaction	ICAR-IIHR, Bangalore	17th – 26th March 2025
Sayanti G. Majmudar	21-day Online training on advanced statistical and machine learning techniques for data analysis using open-source software for abiotic stress management in agriculture"	ICAR-NIASM, Baramati	16th July – 5th Aug., 2025
Newly joined Technicians	21-Day Training Programme for Newly Recruited Technicians	ICAR-ISRI, Lucknow	06th Aug.- 04th Sept., 2025
Y. E. Thorat	Standardization of techniques for nematode killing, fixing, and mounting for morphological observations, especially the techniques of hydration and rehydration of each stage of EPN and morphometric measurement, SEM microscopy and imaging	ICAR-NBAIR, Bengaluru	15th-20th Sept., 2025
Y. E. Thorat	Master training programme organised by Syngenta India Foundation Ltd.	MPKV, Rahuri	15th Oct., 2025.

2. Training/Workshop to Farmers/Students

S. No.	Title	Date	No. of Participants			
			Male	Female	Student	Total
1.	Value added jaggery training programme of Farmer form Motihari, Bihar under ATMA at ISRI, Lucknow	06th Jan., 2025	15	05	06	26
2.	One day training programme on Biological Control of pests in sugarcane under SCSP at command area of Krantiagarani Dr. G. D. Bapu Lad Cooperative Sugar Factory, Kundal, Sangli, Maharashtra	07th Jan.,2025				100
3.	Farmers training programme on sugarcane and jaggery production technology to farmers of Hazaribagh under NABARD, at ISRI, Lucknow	21st Jan., 2025	25	00	04	29
4.	IPWG Workshop on multidisciplinary approaches toward phytoplasma associated diseases detection and management	23rd -28th Feb., 2025	16	14	05	35
5.	Training program on " उच्च गुड़वत्ता से बने गुड़ के मूल्य वर्धित उत्पाद" for the SC beneficiary group at Bhairampur, Block Mohanlalganj, Lucknow	04th March, 2025	0	20	03	23

6.	One day training programme on Healthy Seed cane production in sugarcane for the farmers from the command area of Krantiagarani Dr. G. D. Bapu Lad Cooperative Sugar Factory, Kundal, Sangli, Maharashtra	07th March, 2025				
7.	Technology Demonstration Mela at ISRI, Lucknow	13th March., 2025	100	30	40	170
8.	Training programme on Small- scale start-ups and entrepreneurship in bio-control agents mass production for the management of insect pests and diseases for sustainable and eco-friendly agriculture sponsored by sponsored by MSME, Govt. of India, New Delhi	17th - 23rd March , 2025	15	17	0	32
9.	Training cum exposure visit of B.Sc (Hons) Ag. Students of SHUATS, Naini, Prayagraj for Sugarcane and its Value added product	23rd March., 2025	17	17	34	34
10.	One day training programme on Backyard Poultry Farming under SCSP for the command area of Loknete Marutrao Ghule Patil Dnyaneshwar Cooperative Sugar Mill, Newasa, Ahilyanagr	24th March, 2025		100		100
11.	Training programme on processing and value addition of mango under SCSP Scheme	30th June-4th July, 2025	0	20	05	25
12.	Demonstration and exposure visit of newly recruited agriculture graduates under Dalmia Bharat sugar and industry ltd. at ISRI, Lucknow	21st -26th July, 2025	04	02	0	06
13.	Awareness programme on jaggery value addition at ISRI, Lucknow	31st July, 2025	0	0	20	20
14.	Demonstration on jaggery production technology to student from narayan institute of agricultural sciences GNSU, sasaram rohtas, Bihar, at ISRI, Lucknow	12th Aug., 2025	17	10	27	27
15.	Demonstration on jaggery production technology to officers from sugarcane industries department, Govt. of Bihar at ISRI, Lucknow	10th Sept., 2025	10	0	0	10
16.	One-day workshop on biotechnology popularization and skill development for school students in collaboration with the biotech research society, India (BRSI)	12th Sept., 2025	0	0	52	52
17.	Training programme cum demonstrating on sugarcane jaggery and its value added products to farmers of kashipur, udham singh nagar, Uttarakhand at ISRI, Lucknow	31st Oct., 2025	17	02	0	19
18.	Training programme on उच्च गुड़वत्ता से बने गुड़ के मूल्य वर्धित उत्पाद under SCSP Scheme	17th - 21st Nov., 2025	0	20	05	25
19.	Training programme on production techniques of biocontrol agents, pheromones and plant based insecticides	02nd - 04th Dec., 2025	17	5	0	22
20.	Practical training and demonstration on agricultural mechanization for advanced sugarcane cultivation and jaggery processing under SCSP	08th - 12th Dec., 2025	14	04	0	18
21.	Winter school on hands on training- innovative culturing approaches for quality mass production of biological control agents and biopesticides	09th - 18th Dec., 2025	16	06	0	22

Winter school on Hands on training- Innovative culturing Approaches for quality mass production of biological control agents and biopesticides during 09th – 18th December, 2025

IPWG Workshop on Multidisciplinary approaches toward phytoplasma associated diseases detection and management held during February 23rd -28th, 2025 at ICAR-ISRI, Lucknow Uttar Pradesh

Technology Demonstration Mela at ISRI, Lucknow

CHAPTER 15

Honors/ Awards/ Recognition

Dr. Dinesh Singh (Head)

- Elected as President, Indian Phytopathological Society, New Delhi (2025-26).
- Prof. R. P. Purkayastha Memorial Lecture Award (2025) by the Indian Mycological Society, Kolkata (West Bengal).

Prof. R. P. Purkayastha Memorial Lecture Award (2025)

Dr. Tapendra Kumar Srivastava

- Section Editor, Indian Journal of Agricultural Sciences (ICAR-DKMA, New Delhi)
- Expert Panel Member, UPCAR (Research Project Evaluation)
- Member, Varietal Identification Committee (AICRP on Sugarcane)
- PhD thesis Examiner/Evaluator (IARI, CSAU&T, DRPCAU)
- Member, Rajya Krishi Salahkar Samiti

Dr Lal Singh Gangwar

- External Examiner at ICAR–IVRI, Bareilly for M.Sc. (Agricultural Economics) examinations, including oral comprehensive and thesis viva-voce (two students).
- Examiner at Lucknow University for B.Sc. (Hons.) Agriculture examination.
- Awarded SERB-DST sponsored Vritika Internship on AI-based sugarcane crop monitoring; organized programme for four interns.
- Received Best Research Paper award for work on deep learning-based identification of promising sugarcane genotypes (Society for Sugarcane Research and Development).

Dr. Swapna M.

- Coordinator, UG Programme, IARI Academic Hub (up to Sept. 2025)
- Member, Board of Studies, IARI Lucknow Hub
- Member, Institute Management Committee, ICAR-IGFRI, Jhansi

Dr. Manoj Kumar Tripathi

- Editor of Hindi magazine IKSHU, ICAR-ISRI, Lucknow
- MSc (Ag.) & PhD thesis examiner/evaluator (GBPUAT, Pantnagar)

Dr. Sanjeev Kumar (Biotech)

- Coordinator, PG Programme (IARI–Lucknow Academic Hub) up to Sept. 2025
- DBT Nominee, Institute Biosafety Committee (ICAR-IIPR, Kanpur)
- Expert Member, Central Compliance Committee (RCGM, DBT) for GE cotton trials (2024–2027)
- Member Secretary, Research Advisory Committee (ICAR-ISRI, Lucknow) (2023–2026)
- Member, Board of Studies, IARI–Lucknow Hub

Dr. Saiyed Irfan Anwar

- Member of the Organizing Committee for the 37th National Convention of Agricultural Engineers and National Seminar on "Innovative Approaches in Agricultural Engineering for Agriculture of Viksit Bharat – A Roadmap towards 2047", organized by the Institution of Engineers (India) from 29th-30th August, 2025.
- Elected as a Member (Agricultural Engineering) in the State Centre Committee of the Institution of Engineers (India).
- Serving as Secretary, Lucknow Chapter of the Indian Society of Agricultural Engineers.

Dr. Syed Sarfaroz Hasan

- Examiner at Integral University, Lucknow for BSc (Hons) Agriculture examination.

Dr. Ashutosh Kumar Mall

- Editorial Board Member viz., Sugar Tech, Springer Publications, BMC Plant Biology, Springer Publications, Frontier in Plant Sciences
- Institute management Committee (IMC), Member, ICAR-National Research Centre on Litchi Muzaffarpur (Bihar)
- Councilor (Mid-Eastern Zone), Executive Council of Indian Society of Genetics & Plant Breeding for 2023-2025.

Dr. Rakesh Kumar Singh, Senior Scientist & Head

- Best Poster Award at the National Seminar on “Agri-diversification and Eco-regional Farming” held at ICAR–MGIFRI, Piprakothi, Motihari, Bihar from 4th-5th March 2025.
- Best Oral Presentation Award–2025 at the 4th International Conference on “Recent Trends and Development in Agricultural, Biological and Environmental Sciences” held at Hindustani Academy, Prayagraj, Uttar Pradesh from 13th-14th August 2025.
- Outstanding Scientist Award–2025 at the National Conference on “Transdisciplinary Innovations for Sustainability: Advances in Environmental, Agricultural, Biological, and Sugarcane Sciences (TISAEABSS-2025)”, organized in hybrid mode by Environment, Agriculture and Education Society, Bareilly, in collaboration with ICAR–Indian Sugarcane Research Institute, Lucknow, and other partner institutions on 23rd August 2025.
- Best Poster Presentation Award at the 1st International Farming Systems Conference (IFSC-2025) on “Transforming Food, Land and Water Systems under Global Climate Change” held at Modipuram, Meerut from 7th -9th March 2025.
- Best KVK Senior Scientist Award (Animal Nutrition) at the International Conference on “Sustainable Environments for Agriculture, Biodiversity, Technology and Market for Next Generation (SEABTMG-2025)”, jointly organized by Himachal Pradesh University, Shimla, and collaborating institutions from 13th -14th September 2025.

Dr. Rahul Kumar Tiwari

- Indian Potato Association–Kausalya Sikka Team Research Award (2024) at ICAR-CPRS, Modipuram on 30th January, 2025.
- Young Scientist Award from the Environment, Agriculture and Education Society, Bareilly (U.P.) on 23rd August, 2025.

Dr. Shweta Singh

- Indian National Science Academy Visiting Scientist Fellowship 2024-2025, sponsored by INSA, New Delhi.
- Best Oral Presentation Award for the research titled “Data-driven genome editing in eIF4E-2 in sugarcane for Polerovirus resistance” at the International Congress on Unlocking Artificial Intelligence and Robotics Driven Smart Agriculture for Viksit Bharat, held at Integral University, Lucknow during 23rd –24th December 2025.
- Best Poster Award at IPWG-2025.
- Best Young Scientist Award at ICAR–ISRI, Lucknow, on the occasion of its 74th Foundation Day held on 16th February 2025.

Dr. Rajeev Kumar

- **Outstanding Scientist Award–2025** by the Environment, Agriculture and Education Society, Bareilly (U.P.) in association with the Association for Indian Cryptogams, Lucknow (U.P.).

Dr. Sayanti Guha Majmudar

- Best Oral Presentation Award at the National Conference on “Transdisciplinary Innovations for Sustainability: Advances in Environmental, Agricultural, Biological, and Sugarcane Sciences (TISAEABSS-2025)”, held at ICAR–Indian Sugarcane Research Institute, Lucknow on 23rd August 2025.
- Best Paper Presentation Award at the AAAS National Conference on “Transformative Approaches and Smart Technology in Plant and Animal Health for Sustainable and Climate-Ready Agriculture”, organized at Palli Siksha Bhavana, Visva-Bharati University, West Bengal from 18th –19th September 2025.

Dr. Yogesh Ekanathrao Thorat

- Thorat Y. E., D. N. Borase, and Aruna Baitha (2025) received the Best Oral Paper Presentation Award for their paper titled "Field Efficacy of *Heterorhabditis indica* (Entomopathogenic Nematodes) against White Grubs in Sugarcane" at the 3rd International Conference on "Innovations in Biotechnology Research for Sustainable Bioresources and Bioeconomy: Challenges and Practices", held at Kopargaon on 28th –29th March 2025.
- Yogesh E. Thorat, Dnyaneshwar N. Borase, Arun Baitha, and Dinesh Singh (2025) received the Best Oral Paper Presentation Award for their paper titled "Susceptibility of White Grubs to Indigenous Strains of Entomopathogenic Nematodes from Maharashtra" at the National Nematology Symposium–2025, held at ICAR–IIOR, Hyderabad, from 26th –28th November 2025.
- Y. E. Thorat served as a reviewer for the *Journal of Environmental Science and Plant Disease*, an External Member of the Board of Studies (Agricultural Entomology) at MPKV, Rahuri, and a Member of the Editorial Board (Plant Protection) of *Food and Scientific Reports:* A multidisciplinary electronic magazine (ISSN 23582-5437).

CHAPTER 16

Research Publications

- Ahmed S, Priyadarshini P, Indu, Rana M, Yadav G, Rai AK and Singhal RK. (2025). Effect of salinity stress on growth, physio-biochemical and ion homeostasis and activation of antioxidant defense responses in Avena spp. *Cereal Research Communications*, *53*(4): 2237-2256 (**NAAS: 7.9**)
- Ainmisha, Singh D, Modnal KK, Pankaj, Padaria JC, Vignesh M, Bashyall BM, Kamra A, Nivedita, Shreya, Sharma S, Patidar R, Gupta N and Dhiman S. (2025). Molecular characterization of plant growth promoting rhizobacteria associated with bacterial stalk rot disease in maize by using 16S rRNA sequence analysis. *Ama, Agricultural Mechanization in Asia, Africa and Latin America*, 56(1): 19905-19912. DOI: 13377 / Ama.31.12.2024.01. (**NAAS: 6.40**)
- Amaresh G, Nunavath A, Appunu C, Viswanathan C, Kumar R, Gujjar RS and Manimekalai R. (2025). Advanced genome editing technologies: potentials and prospects in improvement of sugar crops. *Sugar Tech, 27*(1): 14-28. https://doi.org/10.1007/s12355-024-01447-4 (**NAAS: 7.80**)
- Anam, Yadav K, Singh P and Singh RK (2024). Navigating sugarcane's growth matrix for yield maximization through ethrel and GA3- Beyond tradition. *Acta Scientific Agriculture*, 8 (10):50-69.
- Anam, Yadav K, Srivastava TK, Singh P and Singh RK. (2025). Ethrel and GA3 induced physiobiochemical alterations in sugarcane for maneuvering the biometric traits for enhancing cane and sugar yield. *Indian Journal of Agricultural Research*, 1–7. (**NAAS: 5.60**)
- Avashthi H, Angadi UB, Majumdar SG, Bhati J, Singh DB, Chandra M, Singh JK, Sinha A, Shah S and Mishra DC. (2025). A systematic review on revolutionizing veterinary drug discovery: harnessing omics data to combat complex diseases in domestic animals. *Network Modeling Analysis in Health Informatics and Bioinformatics*, 14(1):60.
- Basu T, Singh A, Patil VU, Tiwari JK, Gujjar RS and Upadhyay AK. (2025). Comparative transcriptome analysis of potato (*Solanum tuberosum* L.) tubers at different developmental stages of the cryopreserved germplasm. *Potato Research*, 68(4): 1-19. https://doi.org/10.1007/s11540-024-09843-9 (**NAAS: 8.3**)
- Batra S, Gujjar RS, Kumar R, Goswami SK, Tiwari RK, Chinnaswamy A, Manimekalai R, Ramanathan V and Kumar S. (2025). *Colletotrichum falcatum* proteome unraveled the promising functions of Myosin-1 and polyketide synthase proteins in instigating the pathogen virulence. *Journal of Crop Health*, 77(3):81. https://doi.org/10.1007/s10343-025-01148-2 (**NAAS: 8.7**)
- Ceasar SA, Sharma A, Pandey H, Devadas VS, Kesavan AK, Heisnam P, Vashishth A, Misra V, Mall AK (2025). Millets: Nutrient-rich and climate resilient crops for sustainable agriculture and diverse culinary applications. *Journal of Food Composition and Analysis*, 137: 106984. (**NAAS: 10.6**)
- Chaitanya M, Suroshe SS, Kirankumar GN, Srinivas K and Venkanna Y. (2025). Predatory efficiency of six spotted ladybird beetle, *Cheilomenes sexmaculata* (Fabricius) against the mixed prey densities: a functional response analysis. *Phytoparasitica,* 53(1):5. (**NAAS: 7.50**)
- Chaitanya M, Suroshe SS, Kumar GNK, Keerthi MC and Srinivas K. (2025). Foraging behaviour of *Cheilomenes sexmaculata* Fabricius (Coleoptera: Coccinellidae) against the *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Pseudococcidae). *National Academy Science Letters*. https://doi.org/10.1007/s40009-025-01821-0. (**NAAS: 7.20**)
- Chand S, Kumar S, Roy AK, Vijay D, Choudhary BB, Indu and Panchta R. (2025). Analyzing trends and future projections in fodder oats (*Avena sativa* L.) for quality seed production in India. *Frontiers in plant science*, 16, (**NAAS:10.80**)
- Chandrashekara KM, Suroshe SS, Hithesh GR, Chander S, Kumar R, Nagaraju KG, Srinivas K, Siddaswamy RH, Mallanagouda C, Madhuri EV, Rupali JS, Ramakrishnan L and Venkatachalapathi HH (2025). Floral diversity shapes herbivore colonization, natural enemy performance, and economic returns in cauliflower. *Horticulturae*, *11*(9): 1045. https://doi.org/10.3390/ horticulturae 11091045. (**NAAS: 9.10**)
- Choudhary P, Chakdar H, Verma S, Goswami S and Srivastava AK (2025). *Fungal specific lectin FGB1 based LAMP assay for specific detection of*

Fusarium oxysporum f. sp. *ciceris* causing Fusarium wilt in chickpea. *Journal of Plant Pathology*, 107(1). https://doi.org/10.1007/s42161-025-01882-6 (**NAAS: 8.20**).

- Chugh R, Sandhir Y, Gujjar RS, Handa V and Upadhyay AK (2026). Exploring the potential cross reactivity of allergenic proteins from *Anacardium occidentale* using in-silico approaches. *Journal of Proteins and Proteomics,* 17, 73-87. https://doi.org/10.1007/s42485-025-00202-x (**NAAS: 7.0**)
- Dubey AK, Jha PK, Shubha K, Singh RN, Tamta M, Sah S, Kumar S, Kumar S, Kumar, R, Saurabh K, Kumar R, Das A, Prasad PVV and Choudhary AK (2025). Predicting yellow mosaic disease severity in yardlong bean using visible imaging coupled with machine learning model. *Scientific Reports*, *15*(1): 24886. (**NAAS: 9.80**)
- Dnyaneshwar N. Borase, Yogesh E. Thorat, Bharat M. Bhalerao, Rajeev Kumar, Rajesh U. Modi, Dinesh Singh, Arjun Singh, Santosh G. Watpade, Prashant P. Patil (2026). Post-Harvest deterioration in sugarcane juice quality and sucrose under different harvesting methods and storage duration in the tropical conditions. *Sugar Tech*. https://doi.org/10.1007/s12355-026-01727-1 (**NAAS: 8.0**)
- Dwivedi AP, Shukla SK, Jaiswal VP, Singh VP, Singh AK, Tripathi MK, Yadav SK, Singh SR, Singh KK, Srivastava TK, Sharma L, Nagargade M, Kumari K, Kumar S, Kumar R, Singh SP, Dubey AK, Singh RK, Singh RP, Patra A and Kumar R. (2025). Soil quality parameters, crop yields and economics as influenced by intercropping with autumn sugarcane in subtropical India. *Sugar Tech, 27*, 1141–1153. https://doi.org/10.1007/s12355-025-01560-y. (**NAAS: 7.80**)
- Gangwar LS, Hasan SS and Singh K (2025). Significance of information communication technologies in sugarcane production management and marketing of sweetener products in India. *Indian Journal of Agricultural Marketing*, 39(1): 157-158 (**NAAS: 4.42**)
- Ghosh T, Atta K, Mondal S, Bandyopadhyay S, Singh AP, Jha UC, Kumar R and Gujjar RS (2025). Hormonal signaling at seed germination and seedling stage of plants under salinity stress. *Plant Growth Regulation, 105, 583-600.* https://doi.org/10.1007/s10725-025-01305-7 (**NAAS: 9.5**)
- Goswami SK, Singh D, Singh SP, Kumar R, Gujjar RS, Raj C and Viswanathan R (2025). Dual function of *Chaetomium globosum* CGSR13: Antifungal agent against wilt caused by *Fusarium sacchari* and promoter of sugarcane growth. *Sugar Tech, 27*(2): 506-516. https://doi.org/10.1007/s12355-024-01522-w (**NAAS: 7.80**)
- Gujjar RS, Joshi D, Goswami SK, Kumar R, Singh A and Upadhyay AK. (2025). Unravelling the proteome of *Saccharum officinarum* cv. BO91 for novel defense related proteins during *C. falcatum* infection. *Acta Physiologiae Plantarum, 47*(2):20. https://doi.org/10.1007/s11738-025-03766-9 (**NAAS: 8.4**)
- Gujjar RS, Kumar R, Goswami SK, Kumar S, Chinnaswamy A, Manimekalai R and Ramanathan V (2025). Catalases are induced during fungal infections in sugarcane to instigate the defense responses during red rot and wilt disease. *Journal of Crop Health,* 77(1): 1-13. https://doi.org/10.1007/s10343-024-01084-7 (**NAAS: 8.7**)
- Gujjar RS, Kumar R, Goswami SK, Tiwari RK, Kumar A, Kumari M and Atta K. (2025). Approaches to enhance bioethanol production from sugarcane biomass by manipulating the lignin content. *Biofuels, Bioproducts and Biorefining, 19*(6): 2631-2645. https://doi.org/10.1002/bbb.70018. (**NAAS: 8.90**)
- Gujjar RS, Sherin S, Batra S, Mahto A, Goswami SK, Kumar R and Kumari M (2025). Emerging trends in the development of efficient CAS nucleases for meticulous gene editing in plants. *Plant Science*, 112820, https://doi.org/10.1016/j.plantsci.2025.112820 (**NAAS:10.20**)
- Gujjar RS, Supaibulwatana K, Srivastava S and Upadhyay AK. (2025). Regulation of stress responsive transcription factors of rice by CPPU, a synthetic cytokinin, during water deficit stress at protein level. *Cereal Research Communications*, 53: 291-307 https://doi.org/10.1007/s42976-024-00540-4 (**NAAS: 7.6**)
- Gujjar RS, Worakan P, Chuekong W, Sankhuan D, Chanapanchai S, Roytrakul S and Supaibulwatana K. (2025). Rice proteome revealed antagonistic interactions between signaling components of cytokinin and ABA phytohormones during drought stress. *Journal of Proteomics, 320:* 105489. https://doi.org/10.1016/j.jprot.2025.105489 (**NAAS: 9.8**)
- Indu Khokhar Y, Singh M, Ahmed S, Rana M, Chand S and Singhal RK. (2025). Antioxidant defense system mediating water stress tolerance through improving growth attributes in fodder sorghum (*Sorghum bicolor* L. Moench). *Russian Journal of Plant Physiology*, *72*(4): 99 (**NAAS: 7.10**)
- Jain R, Srivastava MK, Banerjee N, Kumar S and Kumar R. (2025). Microbial diversity of rhizosphere soils of sugarcane fields under

waterlogged conditions. *Journal of Advances in Microbiology* 25(4): 36-50. https://doi.org/10.9734/jamb/2025/v25i4916 (**NAAS: 5.14**)

- Jaiswal V. P., Shukla Sudhir Kumar, Sharma Lalan, Pathak A. D., Gaur Asha, Srivastava Abhay Kumar, Kumar Rishi and Chaoudhary Mamta (2025). Integration of bioproducts with NPK for improving physiological efficiency of sugarcane and sustaining soil quality parameters in subtropical India. *Sugar Tech*, 27(2). https://doi.org/10.1007/s12355-025-01537-x. (**NAAS Rating: 7.80**).
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5. Training Manual

- Gangwar LS, Hasan SS, Majmudar SG and Singh K. (2025). Entrepreneurship development opportunities in bio-control agents for sugarcane insect pests and diseases management**.** ICAR-ISRI, Lucknow
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6. Annual Report:

- Viswanathan R, Srivastava S, Srivastava TK, Swapna M, Modi RU, Srivastava Abhay Kumar and Amit Srivastava (editors). Annual Report 2024.

Besides, 55 abstract papers were published in different symposia and seminars during the period.

CHAPTER 17

Review, Monitoring and Evaluation

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) Meeting 2025 of the ICAR- Indian Sugarcane Research Institute (ISRI), Lucknow, was conducted under the chairmanship of Dr. Dinesh Singh, Director of the Institute on 26th August 2025, 9th-10th December 2025 & 3rd Feb 2026. The meeting was convened to review the progress of ongoing research projects on sugarcane and sugar beet at the Institute and to deliberate on the technical programme for the coming year. A total of 56 institute funded projects were discussed during the meeting. Out of these, 15 projects were closed, and 15 new projects were approved.

Quinquennial Review Team Meeting

The review process was accomplished through a series of meetings conducted at different locations across the country during 2025. The process commenced with a planning meeting held on 08th July, 2025 at ICAR, New Delhi involving the DDG (CS), Chairman of QRT, ADG (CC) and Director, ICAR-ISRI, Lucknow. Subsequently, the QRT reviewed all Divisions, Sections and Units of ICAR-Indian Sugarcane Research Institute, including AICRP on Sugarcane, KVK and administrative units during the meeting held from 04th–05th August, 2025 at Lucknow. The team also visited field experiments and laboratories of the Institute.

Further, a review meeting was organized at ICAR-Central Marine Fisheries Research Institute during 23rd –24th September, 2025, wherein AICRP(S) centres from the Peninsular Zone namely Sugarcane Breeding Institute, Coimbatore; Zonal Agricultural Research Station, Mandya; and Sugarcane Research Station, Thiruvalla were reviewed. The committee also visited field experiments and the jaggery unit at Thiruvalla.

Another review meeting was conducted from 29th November to 1st December, 2025 at Assam Agricultural University covering AICRP(S) centres from North Central, Eastern and Peninsular Zones including RPCAU, Pusa; Bethuadahari (West Bengal); Buralikson (Assam); Navsari; and Powerkheda. Field visits to experimental farms and sugarcane farmers' fields were also undertaken as part of the review process.

Group Meeting of AICRP on Sugarcane

The Group Meeting of the All India Coordinated Research Project (AICRP) on Sugarcane was organized during 27th –28th November, 2025 at Assam Agricultural University (AAU), Jorhat, Assam.

The dignitaries highlighted the importance of improved varieties, sustainable production systems, precision farming, mechanization, drone technology, and digitalization of AICRP(s) data. Emphasis was also laid on target based breeding, biofortification, nutrient use efficiency, and development of disease and pest resistant varieties.

During the inaugural session, two publications namely Annual Report of AICRP on Sugarcane, 2025 and the technical bulletin "*Hundred Years of Sugarcane Research at AAU-SMAPRS*" were released. Three eminent sugarcane breeders of AAU, namely Dr. Govind C. Bora, Dr. Prakash Bora and Dr. Prasant K. Goswami, were felicitated for their contributions to sugarcane research.

The meeting provided an important platform for deliberations on research priorities, collaborative strategies, and technological interventions for enhancing sustainable sugarcane production in the country.

CHAPTER 18

Participation in Seminars/Webinars/Symposia/Conferences etc.

Name	Seminars/Webinars/Symposia/ Conferences/ Meetings	Venue/Organizer	Date
Dinesh Singh (Head), S. K. Goswami and Chandramani Raj	National conference on plant microbes interaction for sustainable agriculture and food security & IPS mid- eastern zone (MEZ)	Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh	03rd -04th Jan., 2025
M.K. Singh	38th Workshop of AICRP on farm implements & machinery (FIM)	PJTSU, Hyderabad	07th - 09th Jan., 2025
L.S. Gangwar	Presented a research paper in the 38th National Conference of Indian Society of Agricultural Marketing	UAS, Bengaluru	09th -11th Jan., 2025
Sanjeev Kumar (HoD) and Arun Baitha	Zonal breeder's and plant protection scientists meet of AIRCP Sugarcane	ICAR-SBI Research Centre, Kannur	17th Jan.,2025
Dinesh Singh (Head) and S.K. Goswami	National conference on emerging issues and sustainable strategies in plant health management: A global perspectives	ICAR- Central Citrus Research Institute, Nagpur, Maharashtra, India	19th-21st Jan., 2025
Sanjeev Kumar (HoD)	Attended the review meeting of DUS testing centers	PPVFR Authority HQ, New Delhi	30th-31th Jan., 2025
Y. E. Thorat	National nematology symposium on TYMIRIUM technology organised by Syngenta Pvt. Ltd.	Goa	04th Feb., 2025
L.S. Gangwar	Attended a roundtable discussion on "Sustainability of the sugarcane value chain: balancing energy efficiency, decarburization and equitable value distribution".	Hotel Radisson Blue, Dwarka, New Delhi	13th Feb., 2025
Dinesh Singh (Head), S.K. Goswami, Lalan Sharma, Arun Baitha, Rakesh Kumar Singh, Rahul Kumar Tiwari, Chandramani Raj, Shweta Singh, Srinivas, K., L.S. Gangwar, S.S. Hasan, Sayanti G. Majudar and A.K. Mall	International phytoplasmologist working group workshop and training course	ICAR-Indian Sugarcane Research Institute, Lucknow	25th – 28th Feb., 2025
Y. E. Thorat	3rd International Conference on Innovations in Biotechnology Research for Sustainable Bio resources and Bio economy: Challenges and Practices.	Kopargaon	28th -29th March 2025
All Scientists of ICAR-ISRI, Lucknow	National seminar on "Sustainable sugarcane production & management" organized by UPSMA and ICAR-ISRI, Lucknow	ICAR-Indian Sugarcane Research Institute, Lucknow	11th April, 2025

Name	Seminars/Webinars/Symposia/ Conferences/ Meetings	Venue/Organizer	Date
All Scientists of ICAR-ISRI, Lucknow	Transforming Agriculture for Viksit Krishi-Viksit Bharat@2047 during organized by UP Council of Agricultural Research, Lucknow (UP)	ICAR-Indian Sugarcane Research Institute, Lucknow	08th -10th April, 2026
Sanjeev Kumar (HoD)	40th AGM of AICRP on Seed (Crops)– (online mode)	-	14th -15th May, 2025
D. N. Borase	61st and 62nd Board of Studies (BOS) meeting in Plant Pathology, Mycology, Microbiology, Bacteriology, Seed Pathology and Virology	Department of Plant Pathology and Agril. Microbiology, MPKV Rahuri	26th May -27th May, 2025 and 29th-30th Dec., 2025
All Scientists of ICAR-ISRI, Lucknow	Viksit Krishi Sankalp Abhiyan (VKSA) to disseminate technological interventions in *kharif* crops among farmers and stakeholders	Four districts namely Barabanki, Lucknow, Gonda and Ayodhya	29th May to 12th June, 2025
Sanjeev Kumar (HoD)	Stakeholders brainstorming on sustainable sugarcane productivity enhancement in India	ISMA, New Delhi	12th June, 2025
Shweta Singh	6th National Workshop on “Genome editing: tools, experimental design, and its applications”	NGETC, BRIC-NABI	01st - 04th July, 2025
All Scientists of ICAR-ISRI, Lucknow	One day seminar on Viksit Krishi Viksit Uttar Pradesh@2047	ICAR-Indian Sugarcane Research Institute, Lucknow	22nd July, 2025
A.K. Mall	83rd STAI Annual Convention organized by The Sugar Technologists Association of India, New Delhi	Bharat mandapam convention centre, New Delhi	24th-26th July 2025
Sanjeev Kumar (HoD)	National seminar on advanced technologies of sugarcane production in relation to climate resilience	VSI, Pune	30th -31st July, 2025
Rakesh Kumar Singh	4th International Conference on “Recent Trends and Development in Agricultural, Biological and Environmental Sciences” Organized by Society of Biological Sciences and Rural Development, in Collabroration with ZSI, Kolkata (W.B.)	Prayagraj, (U.P.)	13th & 14th Aug., 2025
A.K. Mall and Sayanti G. Majmudar	Transdisciplinary innovations for sustainability: advances in environmental, agricultural, biological and sugarcane sciences (TISAEABSS-2025)	ICAR-Indian Sugarcane Research Institute, Lucknow	23rd Aug., 2025
M.K. Singh, S. I. Anwar, H.S. Pandey, Shyam Nath, Rajesh U. Modi and L.S. Gangwar	37th National convention of agricultural engineers and national seminar on "innovative approaches in agricultural engineering for agriculture of Viksit Bharat – a roadmap till 2047"	Institution of Engineers (India), Lucknow, Uttar Pradesh	29th - 30th Aug., 2025
H.S. Pandey	Agriculture 4.0: Empowering the Indian Agricultural System through innovative and future-oriented technologies for sustainable crop production	ICAR–Central Institute of Agricultural Engineering, Bhopal	18th Sept., 2025

Name	Seminars/Webinars/Symposia/ Conferences/ Meetings	Venue/Organizer	Date
Sayanti G. Majmudar	National Conference on transformative approaches and smart technology in plant and animal health for sustainable and climate-ready agriculture	Palli Siksha Bhavana, Visva Bharati University, West Bengal	18th -19th Sept., 2025
L.S Gangwar, S.S. Hasan and Sayanti G Majudar	SISSTA 54th annual convention	Shree Convention, Tirupati, Andhra Pradesh	19th - 20th Sept, 2025
L.S. Gangwar	12th meeting of expert committee for approval of Indian Sugar Standards for sugar season 2025-26	NSI Kanpur	30th Sept., 2025
L.S. Gangwar	Attended the meeting under the Chairmanship of Cane Commissioner for recommending Sugarcane SAP for the season 2025-26	Cane Commissioner Office, Lucknow	8th Oct., 2025
Sanjeev Kumar (HoD) and A K Mall	Review meeting of ICAR-ISMA collaborative project	DSCL Unit Ajbapur	13th Oct., 2025
L.S. Gangwar	SAP recommendation committee meeting under the Chairmanship of Chief Secretary, Govt. of U.P. for recommending Sugarcane SAP for the season 2025-26	Lok Bhawan, Chief Secretary Office, Lucknow	16th Oct., 2025
Sayanti G. Majmudar	International Conference on mathematical and computational frontiers for sustainable development	ABV-IIITM, Gwalior	16th -17th Oct., 2025
L.S. Gangwar	Attended a meeting with officers of States and other stakeholders headed by Chairman CACP for formulating recommendation on *"Price Policy for Sugarcane 2026-27 Sugar Season"*	Krishi Bhawan, New Delhi	30th Oct., 2025
Dinesh Singh (Head)	National seminar on new paradigm of plant health management: mitigating the impact of climate change on food security & IPS-NEZ annual meeting	College of Agriculture, CAU (Imphal), Pashighat, Arunachal Pradesh	7th-9th Nov., 2025
M.K. Singh, S. I. Anwar, H.S. Pandey and Rajesh U Modi	59th ISAE Annual Convention on engineering innovations for agriculture 5.0	ICAR–Central Institute of Agricultural Engineering, Bhopal	10th -12th Nov., 2025
Dinesh Singh (Head)	National conference on "Harnessing microbes for sustainable farming system in the era of climate and pathogen population change"	Kalimpong Science Centre, Kalimpong, West Bengal	15th -16th Nov., 2025
Swapna M and NKK Rathod	Participated in crossing work at National Hybridization Garden	ICAR-SBI, Coimbatore and the SBI-Research Centre, Agali, Palakkad, Kerala	20th- 25th Nov., 2025
T.K. Srivastava	Sixth International Agronomy Congress on 'Re-envisioning agronomy for Smart Agri-food systems and Environmental Stewardship'	New Delhi	24th -26th Nov., 2025

Name	Seminars/Webinars/Symposia/ Conferences/ Meetings	Venue/Organizer	Date
Y. E. Thorat	National nematology symposium organised by the Nematological Society of India	ICAR-IIOR, Hyderabad	26^{th}-28^{th} Nov., 2025
Sanjeev Kumar (HoD), N.K.K. Rathod, T.K. Srivastava, Dinesh Singh (Head), Lalan Sharma and A K Mall	Annual Group Meeting of the All India Coordinated Research Project on Sugarcane	AAU, Jorhat, Assam	27^{th} -28^{th} Nov., 2025

CHAPTER 19

Events Organized

During the year, a number of events were conducted/organized in the Institute. The details are mentioned below.

SI.No.	Events	Date
1.	74th Foundation Day of Institute	16th Feb., 2025
2.	International Conference on IPWG Workshop & Training Course on Phytoplasma Associated Diseases	23rd –28th Feb., 2025
3.	PM-Kisan Samman Nidhi Programme	24th Feb., 2025
4.	MSME-Sponsored Training Program on Bio-control Entrepreneurship	17th –23rd March 2025
5.	Kisan Samriddhi Utsav was jointly organized in collaboration with Krishi Jagran Manch	08th May 2025
6.	World Environment Day	05th June 2025
7.	The Half-Yearly Meeting of the Nagar Rajbhasha Karyanvayan Samiti (Office-3) at ICAR–Indian Sugarcane Research Institute (ICAR-ISRI), Lucknow	16th June & 19th Nov., 2025
8.	"Yoga Sangam" International Yoga Day	21st June 2025
9.	Hindi Workshop	30th June 2025
10.	National Seminar on "Viksit Krishi – Viksit Uttar Pradesh 2047", jointly with the Uttar Pradesh Council of Agricultural Research (UPCAR)	22nd July 2025
11.	PM-Kisan Samman Nidhi "20th Instalment live telecast"	02nd Aug., 2025
12.	Tree Plantation Programme in collaboration with National Disaster Response Force (NDRF)	14th Aug., 2025
13.	A National Conference on "Transdisciplinary Innovations for Sustainability: Advances in Environmental, Agricultural, Biological and Sugarcane Sciences (TISAEABSS-25)"	23rd Aug., 2025
14.	A one-day programme on "Biotechnology Popularization and Skill Development for School Students" in collaboration with the Biotech Research Society, India (BRSI)	12th Sept., 2025
15.	Gandhi Jayanti and Swachh Bharat Diwas	2nd Oct., 2025
16.	Rashtriya Ekta Diwas	31st Oct., 2025
17.	ICAR Inter-Zonal Sports Meet 2024	04th –07th Nov., 2025
18.	A ten-day hands-on Winter School Training Programme on "Innovative Culturing Approaches for Qualitative Mass Production of Biological Control Agents and Bio-pesticides"	09th –18th Dec., 2025
19.	Swachhata Pakhwada	16th –31st Dec., 2025

Viksit Krishi Sankalp Abhiyan

ICAR-Indian Sugarcane Research Institute, Lucknow actively participated in the "Viksit Krishi Sankalp Abhiyan" during 29th May to 12th June 2025 across the four districts of Lucknow *viz.*, Lucknow, Ayodhya, Barabanki and Gonda. During the campaign, teams of scientists conducted extensive farmer interaction programmes in villages covering different blocks of the four districts.

Scientists created awareness among farmers on improved agricultural practices, integrated nutrient and pest management, soil health management, natural farming, crop diversification, mechanization, sugarcane production technologies, integrated farming systems, animal husbandry and various Government schemes related to agriculture and farmer welfare. Demonstrations and advisory services on disease and pest management, seed treatment, drone application, balanced fertilizer use and sustainable farming practices were also provided.

The campaign witnessed active participation of scientists from ICAR-ISRI, KVKs, line departments and progressive farmers. Thousands of farmers, including women farmers, benefited through direct interaction.

राजभाषा प्रभाग कि गतिविधियाँ

- भारतीय गन्ना अनुसंधान संस्थान, लखनऊ में 14–30 सितम्बर 2025 तक हिंदी पखवाड़ा समारोह का आयोजन किया गया, जिसमें विभिन्न प्रतियोगिताएँ, हिंदी कार्यशालाएँ, अखिल भारतीय कवि सम्मेलन, स्वरचित कविता पाठ तथा राजभाषा संबंधी कार्यक्रम आयोजित किए गए। लगभग 150–170 कार्मिकों ने भाग लिया तथा 93 प्रतिभागियों को पुरस्कार प्रदान किए गए।
- संस्थान में वर्ष 2025–26 के दौरान चार हिंदी कार्यशालाओं का आयोजन किया गया, जिनमें कुल 173 कार्मिकों ने भाग लिया। साथ ही "इक्षु" पत्रिका के दो अंकों का विमोचन माननीय मुख्यमंत्री योगी आदित्यनाथ एवं लखनऊ की महापौर सुश्री सुषमा खर्कवाल द्वारा किया गया |
- संस्थान ने नराकास (कार्यालय-3) की बैठकों का आयोजन कर हिंदी में उत्कृष्ट कार्य करने वाले कार्यालयों को सम्मानित किया। इसके अतिरिक्त हिंदी भाषा, कृषि, जल प्रबंधन, योग, साइबर सुरक्षा एवं नई शिक्षा नीति जैसे विषयों पर अनेक लेख "इक्षु" एवं "मत्स्य लोक" पत्रिकाओं में प्रकाशित किए गए।

Glimpses of Activities

Institute 74th Foundation Day Celebration

Launching of the IKSHU-Cane Sugarcane model

PM-Kisan Samman Nidhi Programme

Kisan Samriddhi Utsav

National Seminar on “Viksit Krishi – Viksit Uttar Pradesh 2047

World Environment Day Celebration

National Conference (TISAEABSS-25)

International Yoga Day Celebration (Yoga Sangam 2025)

ICAR Inter-Zonal Sports Meet 2024

CHAPTER 20

Distinguished Visitors

SI.No.	Name and address of the visitors	Date of visit
1.	Shri Thiru. C. Djeacoumar, Hon'ble Minister for Agriculture and Farmers Welfare, Puducherry	4th March 2025
2.	Mr. Prakash Naiknavare, Managing Director, National Cooperative Sugar Federation (NCSF), New Delhi, and Dr. R.B. Doule, Chief Cane Adviser, National Cooperative Sugar Federation (NCSF), New Delhi	9th April 2025
3.	Prof. Panjab Singh, Former DG, ICAR & Secretary, DARE	22nd April, 2025
4.	Dr. Devendra Kumar Yadava, DDG, Crop Science, ICAR New Delhi	30th April 2025
5.	Hon'ble Shri Sudhakar Singh, Member of Parliament and Member, Parliamentary Standing Committee on Agriculture, Animal Husbandry and Food Processing	15th June, 2025
6.	Dr. Himanshu Pathak, DG, ICRISAT and Former DG, ICAR & Secretary, DARE	9th July, 2025
7.	Hon'ble Agriculture Minister Shri Surya Pratap Shahi visited at ICAR-ISRI, KVK II, Lakhimpur Kheri	16th July 2025
8.	Hon'ble Chief Minister of Uttar Pradesh Shri Yogi Adityanath	22nd July 2025

CHAPTER 21

Personnel

Dr. Dinesh Singh	Director (Acting)
Division of Crop Improvement	
Scientist	
Dr. Sanjeev Kumar	Principal Scientist (Plant Breeding) & Head
Dr. Sangeeta Srivastava	Principal Scientist (Genetics & Cytogenetics)
Dr. Swapna M	Principal Scientist (Genetics)
Dr. Sanjeev Kumar	Principal Scientist (Agricultural Biotech)
Dr. Ashutosh Kumar Mall	Principal Scientist (Genetics & Plant Breeding)
Dr. Ranjit Singh Gujjar	Senior Scientist (Agricultural Biotech)
Dr. Indu	Scientist (Genetics & Plant Breeding)
Dr. N Krishna Kumar Rathod	Scientist (Genetics & Plant Breeding)
Dr. Kartik Kumar M.	Scientist (Genetics & Plant Breeding)
Technical	
Mr. Ajeet Pratap Singh	Chief Technical Officer
Mr. Abhay Kumar Srivastava	Technical Officer
Mr. Anil Kumar Maurya	Technical Officer
Mr. Raja Ram	Senior Technician
Mr. Santosh Kumar	Senior Technician
Mr. Virendra Kumar Patel	Technician
Mr. Ankit Kumar Gautam	Technician
Mr. Raghvendra Pratap Singh	Technician
Division of Crop Production	
Scientist	
Dr. Ved Prakash Singh	Principal Scientist (Agronomy) & Head
Dr. S.K. Shukla	Principal Scientist (Agronomy)
Dr. Tapendra Kumar Srivastava	Principal Scientist (Agronomy)
Dr. Kranti Kumar Singh	Principal Scientist (Agronomy)
Dr. Manoj Kumar Tripathi	Principal Scientist (Agronomy)
Dr. Barsati Lal	Principal Scientist (Agriculture Extension)
Dr. Kamta Prasad	Principal Scientist (Agriculture Extension)
Dr. Shiv Ram Singh	Principal Scientist (Soil Science)
Dr. Vinay Kumar Singh	Principal Scientist (Agronomy)
Dr. Ram Ratan Verma	Principal Scientist (Soil Science)
Dr. Aditya Prakash Dwivedi	Principal Scientist (Agronomy)
Dr. Dileep Kumar	Senior Scientist (Agronomy)
Dr. Kavita Kumari	Scientist (Agronomy)

Technical	
Dr. Gaya Karan Singh	Chief Technical Officer
Dr. Anita Sawnani	Chief Technical Officer
Dr. Ram Khilari Singh	Assistant Chief Technical Officer
Dr. Ram Kishor Tripathi	Assistant Chief Technical Officer
Mr. Sanjay Gautam	Senior Technical Officer

Mr. Mahendra Pratap Tripathi	Senior Technical Assistant
Mr. Upendra Kumar Yadav	Technical Assistant
Mr. Rajendra Kumar	Senior Technician
Mr. Neeraj Kumar Singh	Technician
Mr. Pankaj Patel	Technician
Mr. Manish Kr. Sah	Technician
Mr. Syed Furkan Miyan	Technician
Division of Crop Protection	
Scientist	
Dr. Dinesh Singh	Principal Scientist (Plant Pathology) & Head
Dr. Arun Baitha	Principal Scientist (Agricultural Entomology)
Dr. Sanjay Kumar Goswami	Senior Scientist (Plant Pathology)
Dr. Shweta Singh	Scientist (Plant Pathology)
Dr. Chandra Mani Raj	Scientist (Plant Pathology)
Dr. Rahul Kumar Tiwari	Scientist (Plant Pathology)
Dr. K Srinivas	Scientist (Agricultural Entomology)
Technical	
Mr. Anuj Kumar	Technical Assistant
Mrs. Rita	Technical Assistant
Ms. Soni Devi	Technical Assistant
Mr. Sujeet Kumar	Technician
Mr. Krishna Kumar Varma	Technician
Mr. Shereyansh Kumar	Technician
Division of Plant Physiology & Biochemistry	
Scientist	
Dr. Manoj Kumar Srivastava	Principal Scientist (Biochemistry/Plant Science) & Head
Dr. Pushpa Singh	Principal Scientist (Organic Chemistry)
Dr. Surendra Pratap Singh	Principal Scientist (Plant Physiology)
Dr. Rajeev Kumar	Scientist (Biochemistry)
Technical	
Mr. Kamal Kumar Suman	Asst. Chief Technical Officer
Mr. Rajendra Kumar Singh	Senior Technical Officer
Mr. Pillu Meena	Technical Assistant
Mrs. Santosh Kumari Gautam	Senior Technician
Mr. Sunil Kumar Pandey	Technician
Mr. Rahul Kumar	Technician
Administration Ram Sanwarey Chaurasia	Personal Asssistant
Division of Agricultural Engineering	
Scientist	
Dr. Mrityunjai Kumar Singh	Principal Scientist (FMP) & Head
Dr. Saiyed Irfan Anwar	Principal Scientist (FMP)
Dr. Dilip Kumar	Principal Scientist (AS& PE)
Dr. Shyam Nath	Scientist (FMP)
Dr. Rajesh U Modi	Scientist (FMP)
Dr. Himanshu Shekhar Pandey	Scientist (FMP
Technical	
Mrs. Mithilesh Tiwari	Chief Technical Officer

Dr. Veenika Singh	Subject Matter Specialist (Home Science)
Mr. Rajiv Ranjan Rai	Chief Technical Officer
Mr. Chaman Singh	Assistant Chief Technical Officer
Mr. Saryu Prasad	Senior Technical Assistant
Mr. Sushil Kumar Sharma	Senior Technician
Mr. Shailesh Kumar	Technician
Mr. Alok Bind	Technician
Mr. Sachin Kumar	Technician
Mr. Abhay Singh Pal	Technician
PME Cell	
Scientist	
Dr. Manoj Kumar Tripathi	Principal Scientist & Incharge
Dr. Rahul Kumar Tiwari	Scientist (Plant Pathology)
Technical	
Dr. Gaya Karan Singh	Chief Technical Officer
Mr. Amit Srivastava	Chief Technical Officer
Mr. Ranu Verma	Technician
Agricultural Knowledge Management Unit (AKMU)	
Scientist	
Dr. Lal Singh Gangwar	Principal Scientist (Agriculture Economics) & Incharge
Dr. Syed Sarfaraz Hasan	Principal Scientist (Computer Applications)
Dr. Sayanti Guha Majumdar	Scientist (Bioinformatics)
Technical	
Mr. Alok Kumar Singh	Technical Assistant
Mr. Jais Ahmad	Technician
Mr. Mithlesh Kumar	Technician
Rajbhasha	
Dr. Manoj Kumar Tripathi	Principal Scientist (Agronomy) & Incharge
Technical	
Mr. Abhishek Kumar Singh	Assistant Chief Technical Officer
Juice Quality Lab	
Scientist	
Dr. Manoj Kumar Srivastava	Principal Scientist (Biochemistry/Plant science) & Incharge
Technical	
Mrs. Pallavi Rai	Technical Assistant
Mr. Gulam Rab	Technician
Farm Section	
Scientist	
Dr. Ved Prakash Singh	Principal Scientist (Agronomy) & Incharge
Technical	
Mr. Surendra Pratap Prajapati	Technical Officer & Farm Manager
Dr. Mukund Kumar	Technical Officer
Mr. Umesh Chandra Pandey	Senior Technical Assistant
Mr. Sudhir Kumar Singh	Senior Technical Assistant
Mr. Dharmendra Kumar	Technician
Mr. Vikram Saroj	Technician

Mr. Arjun Kumar	Technician
SWPAM Lab	
Scientist	
Dr. V. P. Singh	Principal Scientist (Agronomy) & Incharge
Technical	
Mr. Dileep Kumar Bind	Technician

HRD Cell	
Dr. Sangeeta Srivastava	Nodal Officer
Dr. Rahul Kumar Tiwari	Co-Nodal Officer
AICRP on Sugarcane **Scientist**	
Dr. Dinesh Singh	Project Coordinator (Sugarcane)
Dr. Sanjay Kumar Yadav	Senior Scientist (Agronomy)
Dr. Lalan Sharma	Senior Scientist (Plant Pathology)
Technical	
Mr. Dushyant Mishra	Technical Officer
Mr. Sanjay Lal Srivastava	Technical Assistant
Mr. Himanshu Raj	Technician
Krishi Vigyan Kendra (KVK), Lucknow	
Dr. Akhilesh Kumar Dubey	Senior Scientist & Head
Technical	
Dr. Ram Prakash Sahu	Subject Matter Specialist
Mr. Ajay Kumar Rai	Subject Matter Specialist
Mr. Deep Kumar	Senior Technical Officer
Mr. Ram Lakhan	Technical Officer
Krishi Vigyan Kendra (KVK), Lakhimpur Kheri	
Dr. Rakesh Kumar Singh	Senior Scientist & Head
Technical	
Dr. Arbind Kumar Verma	Subject Matter Specialist
Dr. Vivek Kumar Pandey	Subject Matter Specialist
Mr. Arya Desh Deepak Misra	Assistant Chief Technical Officer
Mr. Sanjeev Kumar Singh	Technical Officer
Art & Photography	
Dr. Manoj Kumar Tripathi	Principal Scientist & Incharge
Technical Mr. Avadhesh Kumar Yadav	Chief Technical Officer
Library	
Scientist	
Dr. Manoj Kumar Tripathi	Principal Scientist & Incharge
Technical Mr. Rajnarayan Prasad Bharti	Assistant Chief Technical Officer
Mr. Ashish Singh Yadav	Technical Officer
Security	
Dr. Dinesh C Rajak	Chief Technical Officer
Vehicle Section	
Mr. Ganesh Singh Negi	Asst. Administrative Officer

Mr. Kalpnath	Technical Officer
Mr. Suresh Kumar	Technical Officer
Mr. Kulpreet Singh	Technical Assistant
Mr. Nand Kishor Yadav	Technical Assistant
Dispensary	
Dr. Sanjay Kumar Goswami	Senior Scientist & Incharge
Landscaping	
Mr. Abhishek Srivastava	Chief Administrative Officer (SG) & Incharge
Mr. Rajiv Ranjan Rai	Chief Technical Officer
Estate & Management Unit	
Mr. Abhishek Srivastava	Chief Administrative Officer (SG) & Incharge
Er. Krishna Nand Singh	Chief Technical Officer
Mr. Mukund Narayan	Assistant Chief Technical Officer
Mr. Rakesh Kumar Srivastava	Senior Technician
Mr. Kuldeep	Technical Assistant
Mr. Ankur Kumar Yadav	Technician
Mr. Ajay Kumar Bharati	Technician
Regional Station, Motipur (Bihar)	
Scientist	
Dr. Ashutosh Kumar Mall	Principal Scientist & Incharge

Technical	
Mr. Bikarama Dutt Singh	Assistant Chief Technical Officer
Mr. Dhirendra Kumar	Technical Assistant
Mr. Subham Kumar	Technician
Administration Mr. Ram Vijay Dwivedi	Asst. Administrative Officer
ISRI Biological Control Center, Pravaranagar (Maharashtra)	
Scientist	
Dr. Dnyaneshwar Namdeo Borase	Scientist (Microbiology) & Incharge
Dr. Yogesh Ekanathrao Thorat	Scientist (Nematology)
Sugar beet Breeding Outpost, Mukteshwar	
Dr. Ashutosh Kumar Mall	Principal Scientist & Incharge
Guest House	
Mr. Ganesh Singh Negi	AAO & Incharge
Administration	
Mr. Abhishek Srivastava	Chief Administrative Office (SG)
Mr. Chandan Kumar Tiwari	Finance & Account Officer
Mr. Awadhesh Kumar	Administrative Officer
Mr. Manish Kumar	Administrative Officer
Mr. Ashutosh Sahi	Asst. Finance & Account Officer
Mrs. Mamta Chakraborty	Principal Private Secretary
Mr. Prem Chand	Principal Private Secretary
Mrs. Rashmi Sanjay Srivastava	Private Secretary
Mr. Ganesh Prasad	Personal Assistant
Mr. Ram Sanwarey Chaurasia	Personal Assistant
Mr. Ram Vijay Dwivedi	Asst. Administrative Officer

Mr. Prashant Kamal Srivastava	Asst. Administrative Officer
Mr. Hem Chandra Pandey	Asst. Administrative Officer
Mr. Nag Chand Chauhan	Asst. Administrative Officer
Mr. Hari Lal	Asst. Administrative Officer
Mr. Ganesh Singh	Asst. Administrative Officer
Mr. Taruk Nath Saini	Assistant
Mr. Ramesh Prasad Verma	Assistant
Mr. Shubhash Chandra Jaiswal	Assistant
Mr. Madan Chandra	Assistant
Mr. Arjun	Assistant
Mr. Avdesh Kumar	Assistant
Mr. Pankaj Kumar Arora	Assistant
Mrs. Poonam Manish Mishra	Assistant
Mrs. Shruti Srivastava	Assistant
Mr. Jata Kant	Assistant
Mrs. Kirti Singh	Assistant
Mr. Amit Kumar	Assistant
Mr. Vivek Kumar	Assistant
Mr. Prashant Singh	Assistant
Mr. Dinesh Chandra Mishra	Upper Division Clerk
Mr. Amar Kumar	Upper Division Clerk
Mr. Deepak Kumar	Upper Division Clerk
Mr. Arvind Kumar Yadav	Upper Division Clerk
Mrs. Rupam Rani	Upper Division Clerk
Mrs. Shikha Chuner	Upper Division Clerk
Mr. Bhupendra Kumar Sain	Lower Division Clerk
Mr. Ajay Kumar	Lower Division Clerk
Mr. Manish Singh	Lower Division Clerk
Mr. Shatrughan Verma	Lower Division Clerk
Mr. Anup Kumar Yadav	Lower Division Clerk
Mr. Subhash	Lower Division Clerk

Appointment /New Joining

Name of Official	Designation	Date of joining
Mr. Rahul Kumar	Chief Finance & Account Officer	01-01-2025
Mrs. Shikha Chuner	Upper Division Clerk	20-01-2025
Mr. Shereyansh	Technician(T-1)	13-02-2025
Mr. Syed Furkan Miyan	Technician (T-1)	17-02-2025
Mr. Manish Kr. Sah	Technician (T-1)	18-02-2025
Mr. Gulam Rab	Technician (T-1)	27-02-2025
Mr. Chandan Kumar Tiwari	Finance & Account Officer	17-04-2025
Mr. Avdhesh Kumar	Administrative Officer	05-05-2025
Dr. Kartik Kumar M.	Scientist	07-07-2025

Promotions		
Name	**Promoted to the post of**	***w.e.f.***
Mr. Alok Kumar Singh	T-3 (Level- 05)	01-01-25
Mr. Sudhir Kumar Singh	T-4 (Level- 06)	30-07-23
Mr. Dushyant Mishra	T-5 (Level- 07)	19-11-23
Dr. Mukund Kumar	T-5 (Level- 07)	27-12-22
Mr. Avadhesh Kumar Yadav/ ACTO	Promotion to the grade of CTO	01-04-24
Mr. Abhishek Kumar Singh /STO	Promotion to the grade of ACTO	02-09-22

Joining on Transfer			
Dr. H. S. Pandey	Scientist	Transferred from ICAR-CIAE Bhopal	13.01.2025
Mr. Mukund Narayan	ACTO	Transferred from ICAR-CIAE Bhopal	20.01.2025
Dr. Shyam Nath	Scientist	Transferred from ICAR-VPKAS Almora	27.01.2025
Mr. Amit Srivastava	CTO	Transferred from ICAR-CRIDA Hyderabad	07.02.2025
Mr. Subhash	LDC	Transferred from NEC, Secretariat, Shillong	24.02.2025
Mr. Rishi Kumar	MTS	Transferred from NEC, Secretariat, Shillong	24.02.2025
Mr. Bhupendra Sain	LDC	Transferred from NEC, Secretariat, Shillong	27.02.2025
Mr. Ajay Kumar	LDC	Transferred from NEC, Secretariat, Shillong	03.03.2025
Mr. Sandeep Kumar Maurya	MTS	Transferred from NEC, Secretariat, Shillong	03.03.2025
Mr. Mohit Kumar	MTS	Transferred from NEC, Secretariat, Shillong	03.03.2025
Mr. Ram Narayan Yadav	MTS	Transferred from NEC, Secretariat ,Shillong	11.03.2025
Mr. Neelesh Kumar Tripathi	MTS	Transferred from NEC, Secretariat, Shillong	13.03.2025
Mr. Rahul Kumar	CF&AO	Transferred to DU as Deputy Rgistrar	17.03.2025
Mr. Anoop Kumar Yadav	LDC	Transferred from NEC, Secretariat	21.03.2025
Mr. Manish Singh	LDC	Transferred from NEC, Secretariat, Shillong	07.04.2025
Dr. Sanjay Kumar Pandey	SMS	NEH, RS, Arunanchal Pradesh	16.05.2025
Dr. Vivekanand Singh	SMS	Sargatia, Kushinagar	06.06.2025
Mr. Sunil Kumar Pandey	T-1	Transferred from ICAR-IISWC, RC, Agra	06.06.2025
Mr. Avinash Aman	LDC	Transferred to ICAR HQ as AF&AO	30.06.2025
Dr. Kavita Kumari	Scientist	Transferred from ICAR-CRRI, Cuttak	22.09.2025
Mr. Abhay Singh Pal	T-1	Transferred from ICAR-VPKAS Almora	09.10.2025

Superannuation		
Name of official	**Designation**	**Date of retirement**
Mr. R. B. Verma	AO	31-01-2025
Er. M. H. Ansari	CTO	28-02-2025
Dr. R. Vishwanathan	Director	30-04-2025
Dr. V.P. Jaiswal	Senior Scientist	30-06-2025
Mrs. Asha Gaur	CTO	30-06-2025
Dr. A. K. Singh	Head (Agri. Eng.)	31-08-2025
Mr. Atul Kumar Sachan	CTO	31-08-2025
Dr. Om Prakash	CTO	31-10-2025
Mr. Yogesh Mohan Singh	CTO	31-10-2025
Dr. Radha Jain	Pr. Scientist	30-11-2025
Dr. Chandra Gupta	Pr. Scientist	31-12-2025

CHAPTER 22

Meteorological Data

Important weather parameters during January 2025 to December 2025 at ICAR-Indian Sugarcane Research Institute , Lucknow

Month	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Rainy days (No.)	Bright Sunshine hours (hr/day)	Evaporation (mm)	Wind Speed (km/hr)
	Maximum	Minimum	at 7:18 am	at 2:18 pm					
January	21.3	8.8	93.6	53.4	0.2	0	4.6	1.5	3.1
February	28.2	11.0	88.4	32.6	0.0	0	8.1	3.4	3.9
March	32.9	15.4	75.6	22.1	3.8	1	8.8	6.3	5.0
April	37.2	21.4	57.6	26.8	30.2	1	8.7	6.9	3.0
May	37.9	26.4	64.7	38.0	26.2	2	8.3	7.0	2.3
June	37.8	28.2	72.5	51.7	70.6	5	6.4	5.8	1.7
July	34.1	27.2	89.5	72.8	218.0	16	5.1	3.8	1.5
August	32.4	26.7	94.5	79.6	431.0	15	4.3	2.9	2.1
September	33.6	26.4	93.4	72.1	119.4	8	5.5	3.1	1.8
October	31.9	21.0	92.4	54.9	51.4	6	6.4	2.6	1.4
November	28.6	12.0	94.1	34.0	0.2	0	7.0	2.1	1.2
December	22.4	8.2	95.0	53.4	0.0	0	4.1	1.2	1.0

CHAPTER 23

IARI Lucknow Hub, Lucknow

IARI New Delhi established 16 Educational Hubs as part of IARI Mega-University in order to implement the National Education Policy-2020. The IARI Lucknow Hub has been established to provide quality agricultural education and research and leverages the advanced facilities of the ISRI to support UG, PG and Ph.D students. The hub is located within the campus of the ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow. ISRI, Lucknow is functioning as a nodal institute of IARI, Lucknow Hub with the support of participating institutes i.e. CISH, NBFGR and CSSRI-RRS, Lucknow.

IARI Lucknow Hub Academic Cell Staff

S. No	Staff at IARI Lucknow Hub Academic cell
1	Dr. Dinesh Singh, Nodal Director
2	Dr. A.K. Singh Founder Academic Coordinator
3	Dr. Pushpa Singh, Academic Coordinator
4	Dr. V.K. Singh, Programme Coordinator (PG)
5	Dr. Shyam Nath, Programme Coordinator (UG)
6	Mr. Prem Chandra (PPS)

Current Year Students Strength (2025-2026)

S. No	Degree Programme	Number of students
B.Sc. (Hons.) Agriculture		
1	2023-24	22
2	2024-25	09
M.Sc. (Agriculture)		
1	2023-24	12
2	2024-25	10
Ph. D Programme		
1	2023-24	02
2	2024-25	02

Exams Conducted at IARI Lucknow Hub

Mid-Term and End-Term Examinations were conducted in the Academic Year 2025–26

Educational Tour programs for Students at IARI Lucknow Hub

Visit of Students to Farmers' Field, KVK, Haidergarh and Balarampur Chini Mill; An educational tour was organized for B.Sc. (Hons.) Agriculture 2nd and 3rd year students on 19th December 2025 to the Farmers' Field, KVK, Haidergarh, and Balarampur Chini Mill.

IARI Lucknow Hub - Farewell Party Organised by Students

Notes

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