भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
Annual Report
2024

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ

भाकृअनुप - भारतीय गन्ना अनुसंधान संस्थान
ICAR-Indian Sugarcane Research Institute

लखनऊ - 226 002, उत्तर प्रदेश, भारत
Lucknow - 226 002, Uttar Pradesh, India

टेली. / Tel : +91-522-2480726, 2961318, **फैक्स** / Fax : +91-522-2480738
ईमेल / E-mail : director.sugarcane@icar.gov.in
वेबसाइट / Website : iisr.icar.gov.in

Published by

Dr. R. Viswanathan,
Director
ICAR-Indian Sugarcane Research Institute
Raibareli Road, P.O. Dilkusha, Lucknow-226002

Compiled and Edited by

Dr. R. Viswanathan, Director
Dr. Sangeeta Srivastava, Principal Scientist
Dr. T. K. Srivastava, Principal Scientist
Dr. M. Swapna, Principal Scientist
Dr. R. U. Modi, Scientist
Mr. Amit Srivastava, Chief Technical Officer
Mr. Abhay Kumar Srivastava, Technical Officer

Contribution from

Dr. Dinesh Singh, Project Coordinator (Sugarcane)
Dr. Sanjeev Kumar, Head, Division of Crop Improvement
Dr. V. P. Singh, Head, Division of Crop Production
Dr. Dinesh Singh, Head, Division of Crop Protection
Dr. M. K. Srivastava, Head, Division of Plant Physiology and Biochemistry
Dr. A. K. Singh, Head, Division of Agricultural Engineering
Dr. L. S. Gangwar, Incharge- AKMU
Dr. Sangeeta Srivastava, In-charge, PME Cell
Dr. A. K. Mall, In-charge, ISRI RC, Motipur
Dr. D. N. Borase, In-charge, Biological Control Centre, Pravaranagar
Dr. A. K. Dubey, Head, KVK, Lucknow
Dr. R. K. Singh, Head, KVK, Lakhimpur Kheri
Mr. Abhishek Kumar Srivastava, Chief Administrative Officer
Mr. Ajay Kumar Tondon, Finance and Accounts Officer

Photographs by

Shri Y. M. Singh, Chief Technical Officer
Shri A. K. Yadav, Assistant Chief Technical Officer

Correct citation

Annual Report 2024
ICAR-Indian Sugarcane Research Institute, Lucknow

From the Director's Desk

The Indian sugar industry had a successful season in 2023-24 with great strides not only in the sugar production scenario, but also in the crop production related areas. The sugarcane area was 5.65 million ha with an average sugarcane yield of approximately 79.0 t/ha. The sugar production for the period has been estimated to be 34.0 million tons. The diversification with respect to bio-ethanol has been promising, with the total ethanol production from sugar mills estimated to be more than 400 crore litres. This has enabled us to achieve ethanol blending in petrol of ~13%, with the ethanol blending target set at 20% by 2025. This target will ensure a steady demand for ethanol, benefitting the industry. This has also led to technological advancements in the distillation and fermentation process and also in the infrastructure of the sugar mills. This is apart from the financial security to the sugar mills and to the farmers, energy security, environmental benefits and the savings in the foreign exchange to the nation. All these would not have been possible without a corresponding increase in the cane production and productivity in the field and the application of innovative technological practices for sugarcane production.

With ambitious initiatives like *Viksit Bharat* 2047 in place at the national level, the demand for sugarcane, sugar and ethanol needs to be a major concern for future. Rough estimates from various sources indicate that the average cane yield will have to be 100-110 t/ha with 12% sugar recovery for the nation as a whole, and the country will require around 50 million tons of sugar to meet the domestic and export demands. In 2024-25, the total sugar consumption is estimated to be more than 30.5 million tons considering the domestic consumption, G2G exports, and the permitted quota of 1 million ton sugar export. There will be an increased demand for diversion for ethanol production too.

These targets as well as the challenges in the sugar sector demands improved and sustainable strategies that can result in enhanced productivity and profitability to all the stakeholders. Needless to say, this calls for advancements in the sugarcane and sugar production scenario that can lead to a quantum jump in cane and sugar yield in the coming years. A lot more needs to be done with respect to more efficient utilization of available resources. The recent challenges of depleting natural resources, drastic climatic change resulting in biotic and abiotic stresses, change in disease and pest dynamics etc., necessitate more precise, location-specific approaches, making use of innovative, cutting-edge technologies. The continuing efforts by ICAR-Indian Sugarcane Research Institute in this direction have ensured that we continue to be a significant link in the vast sugarcane research and development network, with effective collaborations and linkages.

The newly released varieties form the Institute *viz*., CoLk 14201, CoLk 16202 and CoLk 16470 are making significant contributions in the major sugarcane growing areas in the country.

The varieties CoLk 16202 (*Ikshu*-16) and CoLk 16470 (*Ikshu*-17) were among the four sugarcane varieties released by our Hon'ble Prime Minister on August 11, 2024. Quality seed supply of the commercial varieties is being carried out through the on-line seed portal. The Accredited Testing Lab developed under NCS-TCP continues to provide its services for testing the quality plantlets developed through micropropagation in sugarcane and in other crops like banana.

The application of nano-fertilizers like nano-urea, integrated weed management practices and development of farmer-friendly apps by the institute for enhanced resource use efficiency are undoubtedly a part of holistic precision agriculture strategies. AI-based weed management is being standardized. Integrated farming system and crop diversification with emphasize on high-value medicinal crops is also being advocated by the institute.

UAV-based crop protection practices have been taken up, with efforts to standardize herbicide, fungicide and insecticide application through drones. This is a significant step towards ensuring timely application of chemicals and efficient utilization of resources. Integrated plant protection measures to manage the major diseases like red rot and pokkah boeng have shown to be highly promising. The institute has taken up studies related to change in disease and pest dynamics in response to the climate change so that, the management measures become more efficient and effective. We have made good progress in

genome editing for resistance to red rot by targeting the susceptibility genes and against sugarcane yellow leaf virus by targeting eLF genes. AI-based techniques with a long-term goal of effective disease and pest management are sure to result in better management of diseases. More than 20 copyrights were granted in the diseases management related areas. Investigating multiple stress responses with respect to physiological and biochemical mechanisms, sugarcane trash as a feed stock for bio-ethanol production etc., have been other significant initiatives of the Institute during the period.

The Patent (No. 526527) entitled "A Tractor Operated Trash Mulcher-Cum-Stubble Shaver Device for Sugarcane Ratoon Crop" was granted by The Patent Office, New Delhi, India in 2024. The cane node planter with modified metering mechanism, design and development of matching accessories for Controlled Traffic Farming (CTF) etc., are some of the new additions in the area of sugarcane mechanization, apart from the several minor and hand held machineries developed and tested. Ergonomic evaluation has also been carried out for many of these machineries. The institute has collaborations with NRM institutes also in the area of farm mechanization.

As the sole research institute under ICAR which is working on sugar beet, the institute is making tremendous efforts to successfully incorporate the crop in the existing sugarcane cropping and processing systems so that, sugar beet can be efficiently utilized as an alternate feedstock for ethanol production. Trials conducted in the tropical and subtropical locations showed a better performance of ISRI clones either as sole crop or intercrop in sugarcane.

The extension activities and other outreach programmes of the institute during the period have ensured the extensive dissemination and large scale adoption of the institute technologies. Entrepreneur development programmes are also an important part of these activities. The *Krishi Vigyan Kendras* (KVKs) at Lucknow and Lakhimpur-II have carried out transfer of technology activities like on-farm trials, front line demonstrations (FLDs), capacity building of farm youth, farmers and other stakeholders, not only in sugarcane but also in other crops.

The IARI Mega University academic programme, initiated by IARI New Delhi, is continuing at ICAR-ISRI, with the institute heading the IARI Lucknow hub, partnering with other ICAR institutions at Lucknow.Undergraduate course in B.Sc. (Hons.) in Agriculture and M.Sc. (Agriculture) and Ph.D are being conducted and the second batch of students were admitted in 2024.

ICAR-ISRI has taken up many collaborative programmes with ICAR-SBI, National Sugar Institute, Vasantdada Sugar Institute, SNSI, Belagavi and many other institutions. The institute is partnering with UP and Bihar governments, DBT, UPCAR, UPCST, industry associations like Indian Sugar Mills Association, Sugar Technologists Association of India, UP Sugar Mills Association and various sugar mills to initiate new areas of research and to disseminate the improved sugarcane production and management technologies and improved varieties. Successful demonstration of integrated management of red rot and top borer and other biotic stresses has been possible to a great extent through our collaborations and outreach activities in the states of UP and Bihar.

The inherent complexities of the crop and the emerging challenges have always ensured the need-based course-corrections and redefining of priorities, as we continue our R&D efforts.The Institute continues to march ahead with innovative profitable and sustainable initiatives with efficient resource utilization, to make the nation an indispensible player in the global sugar scenario, for the holistic development of Indian sugar industry.

This Annual Report is a comprehensive review of the Institute's research, outreach and other activities during the year 2024.We are thankful to the Council for providing adequate funds for research and related activities. We gratefully acknowledge the unstinted and constant support and guidance from Hon'ble Secretary, DARE and Director General, ICAR, Dr. M.L. Jat, Former Hon'ble Secretary, DARE and Director General, ICAR, Dr Himanshu Pathak, DDG (Crop Sciences), Dr. D.K. Yadava, Former DDG (Crop Sciences), Dr. T.R. Sharma, ADG (Commercial Crops), Dr. Prasanta Dash and all other officials at ICAR, New Delhi. The efforts of the Annual Report Committee, all the Heads of the Divisions/In-charge Sections, In-Charge and members of PME Cell and all other staff in providing information, in compiling, editing and bringing out the Annual Report on time is highly appreciated.

(R. Viswanathan)
Director

CONTENT

Executive Summary

Crop Improvement

- Two sugarcane varieties were released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops (*S.O. 4388 (E) dated the Oct. 08, 2024*); two varieties, *viz*., CoLk 16202 (Early) for commercial cultivation in North West Zone of India and CoLk 16470 (Mid-late) for commercial cultivation in North Central and North Eastern Zone of India.
- Two early maturing sugarcane clones, *viz*., CoLk 24201 (LG 20601) and CoLk 24202 (LG 20519) and two mid-late maturing clones, CoLk 24203 (LG 18384) and CoLk 24204 (LG 18071) were accepted for multi-location testing in North West Zone of India during the AICRP(S) Workshop-2024 held at PAU, Ludhiana.
- Two sugarcane varieties, CoLk 11203 and CoLk 11206 have been registered with PPVFRA during 2024. In addition, application for registration under the PPVFRA, has been submitted for three sugarcane varieties, *viz*., CoLk 14201 (*Ikshu*-10), CoLk 15206 (*Ikshu-14*) and CoLk 16466 (*Ikshu*-15).
- Four sugarcane genotypes, *viz*., LG 15566, LG 16527, LG 16579 and LG 16583 showed >20% mean sucrose in juice in January 2024. These clones showed an increase of 5.9-7.9% over the standard check Co 0238 for mean sucrose % in juice.
- Nano-LCMS/MS based investigation of sugarcane proteome revealed that *C. falcatum* infection alters sucrose metabolism and transport. The infection enhances SuSy proteins (irreversible sucrose breakdown) and generally inhibits sucrose transporters (SUTs), suggesting impaired sucrose movement in infected sugarcane. The results were also validated through qRT-PCR analuses.
- In the area of genome editing for reduced lignin content, Caffeic acid/5-hydroxyferulic acid *O*-methyltransferase (*COMT*) gene associated with lignin biosynthesis was analysed for the number of homologues and their respective sequences including exons and introns, and single gRNA sequence from the consensus sequence common in Exon-1 of all the homologues has been designed.
- Virus indexed mother stock cultures were supplied to M/s Balrampur Chini Mills Limited, Haidergarh TC Unit (CoLk 94184, CoLk 14201), M/s UP Cooperative Sugar Mills, Azamgarh Unit (CoLk 14201), and Nasirpur Farms, Patiala (CoLk 16202). Fresh *in vitro* cultures of ISRI sugarcane varieties CoLk 14201, CoLk 15201, CoLk 15466, CoLk 15207 and CoLk 16202 were established.
- Under the DBT, NCS-TCP program, a total of 30042 (as against 14953 samples in 2023) were tested, out of which 2664 samples comprising of 190 samples of sugarcane, 2460 of banana and 14 of potato from DBT recognized TC production facilities were tested for mother stock virus indexing. Of the total samples, 27378 samples comprising of 23966 samples of banana and 3412 of potato were tested for genetic fidelity testing, which equals to quality certification of ~27 million tissue culture plantlets
- DUS Testing Trial of five sugarcane varieties, *viz.* CoLk 11203, CoLk 11206, CoLk 12207, CoLk 12209 and Co 12029 has been completed. The certified DUS data of these five varieties along with the reference varieties for the two crop seasons was submitted to the PPVFRA.
- The 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 was maintained and the required material was supplied to various on-going projects of the Institute.
- Approximately 10150 quintals of seed cane was produced. CoLk 14201 is high 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.

Crop Production

- Integrated herbicide applications, *viz*. sulfentrazone at 1.0 kg/ha as PPI followed by either sulfentrazone at 1.0 kg/ha as PE; 2,4-D at 1.5 kg/ha as PO; or a tank-mixed application of sulfentrazone at 0.75 kg/ha + ametryn at 1.0 kg/ha resulted in significantly higher tillers, NMC, cane length, and cane yield due to effective reduction of *Cyperus rotundus* growth and other grassy weeds, as well as total weed population and weed dry weight. Deep summer ploughing combined with either green manuring *in situ* (*Sesbania sp*.) or post-emergence

applications of glyphosate twice, both supplemented with stale seed bed preparation using herbicide provided season-long control of *C. rotundus*.

- In the second and third ratoon both, higher growth and cane yield were recorded with IW: CPE ratios of 1.0 and 0.8. The water footprint in second and third ratoon ranged from 120.86 L/kg to 139.35 L/kg, with rainfall contributing 50-60% of the crop's total water requirement, and from 124.86 L/kg to 168.64 L/kg, with rainfall contributing 61% of the crop's water needs, respectively.
- Planting of sugarcane in February and March resulted in the highest cane height, thickness, and yield. The February crop produced 2.59% more yield than March and significantly outperformed April and May month initiation. Additionally, the herbicide treatment (Atrazine + Ametryn + 2,4-D) was found most effective in controlling weed growth.
- Sugarcane yield increased by 37.89%, 51.52%, and 55.45% with Natural Farming, Organic Farming and recommended fertilizers over control respectively.
- The use of 100% recommended dose of N through nano-coated urea resulted in a 12.25% increase in plant height, 3.2% in cane diameter, and 23.30% in per cane weight compared to 100% market urea. Reducing the urea dose to 75% using nano-coated urea in three splits produced similar cane weight as 100% *neem*-coated urea.
- Silicate solubilizing bacteria (SSB) at 3 L/ha improved yield attributes and cane yield when combined with different silicon sources and dosages. The best performance was observed with 400 kg/ha silicon through diatomaceous earth with SSB.
- The application of microbial consortia with 75% RDF resulted in a significant increase in cane yield (12.5%) and sugar yield (22%) compared to 100% RDF without microbial consortia. Cane yield in the fourth ratoon decreased by 37.9%, 28.3%, and 14.3% compared to the first (88.6 t/ha), second (76.7 t/ha), and third (64.2 t/ha) ratoons, respectively.
- Nutrient management practices, particularly RDF+FYM, resulted in cane yield increase of up to 24.9% over the control treatment, although juice quality, including brix and purity coefficient, remained unaffected.
- The sugarcane-based integrated farming system, including sugarcane + vegetables + horticulture + poultry + fisheries + vermicompost + dairy, achieved the highest net income of Rs. 780,165/ha in autumn and Rs. 761,276/ha in spring, with B:C ratios of 2.38 and 2.36, respectively.
- Sugarcane-based cropping systems with medicinal plants like *Tulsi*, *Stevia*, and Wild Marigold significantly outperformed traditional rice-wheat-sugarcane systems in both yield and profitability.

Crop Protection

- A total of 2,944 RGB images of insects, healthy and injured symptoms of insects, pests, diseases and physiological disorders were captured are categorized into 29 different classes.
- UAVs-based application of fungicides has been standardized and it was recommended that 65.0 gm of Thiophanate methyl or 50.0 gm of Carbendazim, or 20 ml of Propiconazole fungicide should be mixed with 5 litres of water in the drone tank for spraying of 1250 m^2 area.
- Application of *Trichoderma harzianum* as biocontrol agents through sett treatment recorded significantly reduced disease severity of pokkah boeng disease and improved crop growth and vigour.
- The genome editing of sugarcane for resistance to red rot has been targeted through CRISPR Cas9 system by aiming the susceptibility genes *LHT1, GAD, PP2A* for guided knockout in susceptible varieties like Co 0238.
- A total of 50 sugar beet germplasm were screened under natural condition for foliar disease incidence namely leaf spot due to *Cercospora betae*, *Phoma betae* and *Alternaria alternata*, *Fusarium* yellows and viral disease complex during 2023-2024.
- The production of progeny of pupal parasitoid, *Tetrastichus howardi* per pupa was recorded lowest as 41.17 and increased with increase of weight of pupa (< 0.050 to >0.091g). The female based sex ratio (>90%) was observed in all ranges of weighed pupa.
- The number of progeny (54.1 -76.6) and female emergence (50.7-66.5)/pupa increased with increase of length. The male emergence (%) decreased with increase of length of as well as sex ratio also increased with increase of length.

- A semi-synthetic diet was formulated for sugarcane stalk borer and top borer using sugarcane leaf sheath powder and rajma as base ingredients, supplemented with casein, agar, and antifungal agents.

Plant Physiology & Biochemistry

- Exogenous application of *Ethrel,* NAA @ 50 and 100 ppm & Gibberellic acid (GA_3) stimulated physiological growth, increased initial plant population and caused internodal elongation.
- 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.
- Transcriptome analysis using leaf tissue of control and waterlogged plants of two contrasting varieties CoLk 94184 and CoJ 64 revealed sixty significantly up and down regulated transcripts.
- PAL specific activity increased in silicic acid treated plants during moisture stressed condition.
- High root tissue density, lower CTD (canopy temperature depression), high relative cane internode length (stress/control), high RWC, low leaf electrolyte leakage and high proline accumulation in leaves were identified as tolerant traits for drought.
- High stalk/aerial root ratio, stalk elongation rate, inter nodal length, chlorophyll stability index, high ADH activity and high leaf tissue potassium concentration were identified as important screening indices for waterlogging tolerance in sugarcane.
- The total 64 invertase genes are distributed on 27 different chromosomes representing five out of 10 chromosome types/class in sugarcane genome. Out of 64 invertase sequences, the alkaline neutral invertases were most abundant, represented by 43 genes.

Agricultural Engineering

- A prototype of cane node planter with modified metering mechanism was fabricated and tested in the field. Missing of cane nodes during planting and planting of multiple cane nodes was observed.
- The Patent (No. 526527) entitled "A Tractor Operated Trash Mulcher-Cum-Stubble Shaver Device for Sugarcane Ratoon Crop" has been granted by The Patent Office, New Delhi, India on 14.03.2024. The machine has been commercialised and MoA has been signed with M/s Lohan Agri Equipment, Muzaffarnagar (UP).
- Design developments 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 were conceptualised and fabricated in the divisional workshop and their performance was satisfactory.
- The new design of manual sugarcane *stripper-cum-detopper* improved efficiency by enabling a single-pass operation. This was tested at the Institute farm for more than 30 hours by male and female farm workers. The average 90.1-115.5 kg canes were stripped and detopped per hour by female and male subjects.
- Drone-based chemical spraying was optimized for effective weed and disease management in sugarcane with 86-88% effectiveness in managing binding weeds in sugarcane crops and afternoon drone sprays using Thiophanate Methyl (70WP) at 1.3 g/L (0.1%) were most effective against red rot, showing minimal lesion development and pathogen spread.
- Prototype Feasibility Testing of drone for spraying herbicide at ISRI farm showed resource conservation with 90% reduction in water required per hectare and saving of 90-92% in labour and 93-95% in time.
- Under Inter Institutional collaborative research project on evaluation of multiple auger planting technique for fruit crops in partially reclaimed sodic soil, a tractor-operated, PTO-driven multiple auger system (MAS) was developed and evaluated for digging three circular pits simultaneously. Crop growth parameters were analyzed, showing improved plant height and spread with bioformulation treatment.
- A total of 56 implements were manufactured for conducting field adaptability trials under various agro-climatic and soil conditions. Around 67 prototypes were developed and supplied to various institutes and farmers.
- Prototype feasibility testing of a tractor-operated automatic potato-cum-sugarcane trench planter

was carried out at the ISRI farm. Operated with a 30 kW tractor, the planter achieved an effective field capacity of 0.27 ha/h, completing one hectare in 8 hours. The mechanized planting cost was Rs 3,500/ha, significantly lower than the manual cost of Rs 13,600/ha, resulting in 74.2% cost savings and 90.1% labour savings.

- An electric-powered weeder-cum-seeder for sowing wheat, mustard and companion crops on beds or ridges as intercrops in sugarcane was developed for smallholder farmers practicing sugarcane-based cropping systems and was field-tested at the institute farm, showing satisfactory weeding performance and good germination of urad.

Agricultural Knowledge Management Unit

- India has revealed competitive advantage in export of raw cane sugar, refined cane sugar in solid form and molasses. Other sugar products such as cane syrup, cane confectionary, artificial honey, chewing gums indicate that India does not have competitive advantage in export of these products.
- Indian sugar trade indicators were high as compared to SAC countries. The sugar trade competitiveness reveals, India has comparative advantage in sugar export to SAC countries. The destinations for sugar products were Asian, Gulf and African nations.
- Analysis of trade profile of South Asian countries reveal that sugar is neither a major import nor an export commodity in total trade as well as in aggregate agricultural trade.
- World sugar exports have increased to 68.2 million tons in 2023-24. India's sugar exports registered a significant decline in year 2023-24 over last year due to government sugar exports restriction to maintain sugar price stability.
- Based on criteria of sugarcane intensiveness and growth in area and productivity, cane growing districts were grouped into different categories for four major growing states Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu. The highly intensive sugarcane growing districts in UP have positive growth in area and productivity levels. However, the foremost sugarcane growing districts in three tropical states have experienced decline in area and productivity during past decades.
- The cost of cultivation of sugarcane in U.P. for plant and ratoon crop in year 2024-25 was estimated as ₹3320 and ₹3280 per ton, respectively. The average cost of sugarcane cultivation was ₹ 3310 per ton.
- Images of sugarcane crop were collected at 15 days interval for descriptor classes of plant, leaf, leaf sheath, internode and node of sugarcane and image annotation process has been started using rectangle bounding box and polygon techniques.

Biological Control Center, Pravaranagar

- A Talc-based formulation of highly efficient *Heterorhabditis indica* was developed through slow-drying techniques. These strains were effectively suppressing 63.98% and 72.02% grub population in sugarcane field over control at dose of $2.5x10^7$ and $5x10^7$ IJ/ha and showed tolerance to Chlorpyrifos 20 % EC, Thiamethoxam 75% SG, Imidacloprid 17.8% SL, Clothianidin 50% WDG, Chlorantraniliprole 18.50% SC Fipronil 40% + Imidacloprid 40% WG.
- The bacteria associated with *Heterorhabditis indica* were identified *as Photorhabdus luminescens* and *P. akhurstii* using 16S rRNA partial sequencing.
- *Bacillus thuriengiensis* IISRBCCEB01 and IISRBCCEB02 showed insecticidal activity against *Holotrichia serrata*, caused 67.50 and 60.0% percent mortality with LT_{50} of 12.40 and 16.16 day respectively in first instar grubs, at spore load of $2x10^{10}$ after third week of inoculation.
- Bacteria associated with post-harvest sucrose biodeterioration in sugarcane were identified as *Leuconostoc* sp., *Klebsiella* sp., *Enterobacter* sp., *Pantoea* sp., *Bacillus* sp., *Achromobacter* sp., *Lactococcus sp., Staphylococcus* sp., *Exiguobacterium* sp. *Curtobacterium* sp. *Jejubacter* sp. etc.
- *Cercospora* sp. associated with brown spot disease of sugarcane were sequenced using ITS and 18S rRNA sequencing and sequences were submitted as IISRBCCBP02 (Acc. No. PQ056724) and IISRBCCBP01 (Acc. No. PQ 056713) respectively.
- Mycoparasitic fungi, which showed 72.51% and 74.91% parasitisation of uredospores pustules at the rate of $2x10^6$ and $2x10^8$ spore per ml, was identified as *Cladosporium* sp. by ITS, 18S *rRNA* sequencing and sequences were submitted in NCBI GenBank, as IISRBCCMF02 (Acc. No. PQ056723) and IISRBCCMF01 (Acc. No. PQ 056714) respectively.

ISRI Regional Centre, Motipur

- Five entries for two maturing groups namely CoLk

16201; CoLk 16202; CoLk 19202 (Early) and CoLk 19204 & CoLk 20204 (Mid-late) were accepted in Zonal Varietal Trial (NCZ) during AICRP (S) workshop of October, 2024.

- Four clones; CoLk 20466 & CoLk 20467 (Early) and CoLk 20468 & CoLk 20469 (Mid-late) were promoted from IVT to their respective AVT I in 2023-24. Two mid-late maturing clones *viz*., CoLk 21468 and CoLk 21469 were promoted from IVT to AVT I in 2024-25.
- Three AICRP (S) trials of early group (IVT; AVT Plant AVT Ratoon) and one of mid-late group (IVT) were conducted in 2023-24, and clones developed by ISRI RC, Motipur outperformed in their respective groups. Four AICRP (S) trials were conducted during 2024-25.
- Under Bihar Sugarcane Breeder Seed Production Programme (BSP), 17588 quintals seed of five varieties (CoLk 12207; CoLk 12209; CoLk 94184; CoP 9301 & Co 0118) was produced during 2023-24 at four different centers including ISRI RC, Motipur and sugar mills of Bihar in 30 ha area. During current year, breeder seed is being produced in 29 ha area at four centers.
- An MoU was signed between ICAR-ISRI, Lucknow & Sugarcane Industries Department, Patna, Govt. of Bihar for 5 years to harness the yield potential of the sugarcane crop, and benefits of stakeholders and sugar mills of Bihar. The variety CoLk 14201 has been identified for the state of Bihar.

Sugar beet Outpost, Mukteshwar

- A total of 149 sugar beet germplasm accessions were maintained with seeds sown every alternate year to maintain their viability. Fresh seeds (>24.0 Kg) from 52 sugar beet varieties/germplasm, were harvested in 2024.
- Increased occurrences of *Cercospora* Leaf Spot, *Fusarium*, *Sclerotium* Root Rot and signs of viral infection were observed in most of the germplasm. *Spodoptera* spp. had a high incidence rate (80–95%) in April-May. Minor insect issues (Spider, beetle, *Myzus*, Bihar Hairy Caterpillars) were noted from February to April. The genotypes SYT/06/10, L 33, and LKC 2000 showed resistance to *S. litura*.
- Sugar beet genotypes LKC 11, LKC HB, and LKC 2000 had higher single root weight than checks under drought stress. LKC 2000 also outperformed in root length and diameter compared to LS 6 and IISR Comp 1 whereas, LKC 2006 and LKC 95 had higher sucrose content and Brix than checks.
- ICAR-ISRI initiated collaborations with various public and private sector organizations across India to promote the cultivation of sugar beet and a diverse range of genotypes and varieties were shared for evaluation, along with the comprehensive guidelines on agronomic practices to ensure the cultivation of healthy crop and achieve their full potential.

AICRP on Sugarcane

- During the 92nd meeting of the Central Sub committee on Crop Standards on August 2, 2024, six sugarcane varieties were released and notified by AICRP (S).
- Elite genotypes performed well at wider spacing, with 120 cm in sub-tropical regions and 150 cm in peninsular and east-coast zones. Furthermore, the response to a higher recommended dose of fertilizers (125%) was conspicuous across regions.
- Moisture stress during the pre-monsoon growth phase was found to significantly impact cane yield, with losses ranging from 5% to 35% across different sugarcane-growing zones. Trials in the north-west zone indicated similar cane yields when comparing granular urea to its substitution with liquid nano urea.
- Identification of new pathotypes of the red rot pathogen, with 13 centers involved in testing a total of 109 new isolates against 20 host differential varieties.

कार्यकारी सारांश

फसल सुधार

- 8 अक्टूबर 2024 को कृषि फसलों की किस्मों की अधिसूचना, मानक और विमोचन के लिए केंद्रीय उप-समिति द्वारा जारी अधिसूचना (S.O. 4388(E)) के अंतर्गत दो गन्ना किस्मों को जारी और अधिसूचित किया गया। इनमें कोलख 16202, जो एक अगेती किस्म है, को उत्तर-पश्चिम भारत में वाणिज्यिक खेती के लिए अनुमोदित किया गया है। वहीं कोलख 16470, जो एक मध्य-देरी किस्म है, को उत्तर-मध्य और उत्तर-पूर्वी क्षेत्रों में वाणिज्यिक खेती हेतु स्वीकृति दी गई है।
- पंजाब कृषि विश्वविद्यालय (PAU), लुधियाना में आयोजित अ. भा. स. अनु. परि. कार्यशाला-2024, के दौरान उत्तर-पश्चिम क्षेत्र के लिए बहु-स्थान परीक्षण हेतु कुल चार गन्ना क्लोन स्वीकृत किए गए। इनमें दो अगेती क्लोन—कोलख 24201 (एल जी 20601) और कोलख 24202 (एल जी 20519) शामिल हैं, जबकि दो मध्य-देरी क्लोन—कोलख 24203 (एल जी 18384) और कोलख 24204 (एल जी 18071) को भी बहु-स्थान परीक्षण के लिए चुना गया।
- वर्ष 2024 में, दो गन्ना किस्मों कोलख 11203 और कोलख 11206 को पौधा किस्म और कृषक अधिकार संरक्षण प्राधिकरण (PPVFRA) के अंतर्गत पंजीकृत किया गया। इसके अतिरिक्त, तीन अन्य किस्में कोलख 14201 (इक्षु-10), कोलख 15206 (इक्षु-14) और कोलख 16466 (इक्षु-15)के पंजीकरण हेतु आवेदन प्रस्तुत किया गया है।
- जनवरी 2024 में , चार गन्ना जीनोटाइप एल जी 15566, एल जी 16527, एल जी 16579 और एल जी 16583 में रस में औसतन सुक्रोज की मात्र 20% से अधिक दर्ज की गयी। मानक किस्म को 0238 की तुलना में, इन क्लोनों में औसत सुक्रोज प्रतिशत में 5.9% से 7.9% तक की वृद्धि देखी गई।
- Nano-LCMS/MS तकनीक के माध्यम से किए गए गन्ना प्रोटिओम विश्लेषण में यह स्पष्ट हुआ कि C. falcatum संक्रमण का गहरा प्रभाव सुक्रोज के चयापचय (metabolism) और परिवहन (transport) पर पड़ता है। संक्रमण की स्थिति में SuSy प्रोटीन (जो सुक्रोज के अपरिवर्तनीय विघटन में सक्रिय होता है) की मात्रा में उल्लेखनीय वृद्धि देखी गई, जबकि सामान्य परिस्थितियों में सक्रिय रहने वाले सुक्रोज ट्रांसपोर्टर (SUTs) की अभिव्यक्ति प्रभावित और बाधित पाई गई। इसके परिणामस्वरूप, संक्रमित पौधों में सुक्रोज की संचरण प्रक्रिया बाधित हो जाती है। इन निष्कर्षों को और अधिक मजबूत करने के लिए किए गए qRT-PCR विश्लेषण ने भी SuSy और SUTs के स्तर में आए इन परिवर्तनों की पुष्टि की।
- गन्ने में लिग्निन सामग्री कम करने के उद्देश्य से जीनोम संपादन के क्षेत्र में COMT (कैफिक एसिड/5-हाइड्रॉक्सी फेरुलिक एसिड O-मेथिल ट्रांसफरेज़) जीन का विस्तृत विश्लेषण किया गया। इस अध्ययन के दौरान COMT जीन के विभिन्न समरूपों (homologs) की पहचान की गई, साथ ही उनके एक्सॉन-इंट्रॉन अनुक्रम (exon-intron sequences) का भी विश्लेषण किया गया। विशेष रूप से, सभी समरूपों में पाए जाने वाले सामान्य एक्सॉन-1 अनुक्रम के आधार पर एक एकल mRNA अनुक्रम डिज़ाइन किया गया, जिसे लक्ष्य बनाकर जीनोम संपादन रणनीतियाँ विकसित की जा सकती हैं। यह कार्य आगे चलकर शर्करा उत्पादन में सुधार और प्रोसेसिंग को आसान बनाने हेतु लिग्निन की मात्रा को नियंत्रित करने की दिशा में एक महत्वपूर्ण कदम माना जा रहा है।
- वायरस-अनुक्रमित मातृ स्टॉक कल्चर को विभिन्न इकाइयों को आपूर्ति की गई, ताकि गन्ना उत्पादन में रोगमुक्त और स्वस्थ बीज सामग्री का प्रयोग सुनिश्चित किया जा सके। आपूर्ति की गई इकाइयाँ निम्नलिखित हैं: एम/एस बलरामपुर चीनी मिल्स लिमिटेड, हैदरगढ़ टीसी यूनिट को कोलख 94184 और कोलख 14201 के स्टॉक कल्चर प्रदान किए गए । की गई। एम/एस उत्तर प्रदेश कोऑपरेटिव शुगर मिल्स, आजमगढ़ यूनिट को कोलख 14201 उपलब्ध कराई गई। एवं नसीरपुर फार्म्स, पटियाला को कोलख 16202 का वायरस-मुक्त कल्चर प्रदान किया गया। इसके अतिरिक्त, भारतीय गन्ना अनुसंधान संस्थान (भा.ग.अनु.सं.) द्वारा गन्ने की प्रमुख किस्मों CoLk 14201, CoLk 15201, CoLk 15466, CoLk 15207 और CoLk 16202 के इन विट्रो कल्चर भी सफलतापूर्वक तैयार किए गए । ये कल्चर भविष्य में रोगमुक्त प्लांटिंग मैटेरियल के रूप में उपयोग किए जाएंगे, जिससे गुणवत्तापूर्ण बीज गन्ने की उपलब्धता सुनिश्चित की जा सकेगी और किसानों को उच्च उत्पादकता प्राप्त करने में सहायता मिलेगी।
- DBT के NCS-TCP कार्यक्रम के अंतर्गत वर्ष 2024 में कुल 30,042 नमूनों का परीक्षण किया गया, जो कि वर्ष 2023 में परीक्षण किए गए 14,953 नमूनों की तुलना में लगभग दोगुना है। इसमें से 2,664 नमूनों का वायरस अनुक्रमण परीक्षण किया गया, जिनमें 190 गन्ना, 2,460 केला, और 14 आलू के नमूने शामिल थे। साथ ही, कुल 27,378 नमूनों (जिसमें 23,966 केला और 3,412 आलू) की आनुवंशिक समरूपता (genetic fidelity) का परीक्षण किया गया।
- पाँच गन्ना किस्मों, कोलख 11203, कोलख 11206, कोलख 12207, कोलख 12209 और Co 12029 का DUS ((विशिष्टता, एकरूपता और स्थायित्व) परीक्षण सफलतापूर्वक पूरा किया गया । इन सभी किस्मों का DUS डेटा, उनके संदर्भ किस्मों के साथ दो फसल ऋतुओं का संकलन करते हुए

PPVFRA (पौध किस्म संरक्षण एवं कृषक अधिकार प्राधिकरण) को प्रमाणीकरण हेतु प्रस्तुत कर दिया गया है।

- इसी अवधि में संस्थान द्वारा 365 गन्ना जीनोटाइप का संग्रह संरक्षित रखा गया, जिसमें Saccharum officinarum, S. barberi, S. sinense, ISH क्लोन, इक्षु-ISH क्लोन, एल जी चयन, वाणिज्यिक संकर, तथा 25 सोमाक्लोनल वेरिएंट शामिल हैं । यह संग्रह संस्थान की विभिन्न अनुसंधान परियोजनाओं को आवश्यक आनुवंशिक विविधता और शुद्ध प्रजनन सामग्री उपलब्ध कराने में सहायक सिद्ध हो रहा है।
- इस वर्ष लगभग 10,150 क्विंटल बीज गन्ना का उत्पादन किया गया। इसमें से कोलख 14201 की मांग सबसे अधिक रही, और इसका संपूर्ण बीज उत्पादन गन्ना विकास परिषद तथा उत्तर प्रदेश के लगभग सभी गन्ना उत्पादक जिलों के किसानों को वितरित किया गया, जिससे गुणवत्ता युक्त और रोगमुक्त गन्ना उत्पादन को बढ़ावा मिला।

फसल उत्पादन

- सघन खरपतवार नियंत्रण उपायों के अंतर्गत किए गए अनुसंधान में यह पाया गया कि सल्फेन्ट्राज़ोन (1.0 किग्रा/हे.) का पूर्व रोपण समावेशन अवस्था में छिड़काव करने के बाद, सल्फेन्ट्राज़ोन (1.0 किग्रा/हे.) का अंकुरण पूर्व छिड़काव या 2,4-D (1.5 किग्रा/हे.) अंकुरण पश्चात छिड़काव अथवा सल्फेन्ट्राज़ोन (0.75 किग्रा/हे.) + एमेट्रिन (1.0 किग्रा/हे.) के मिश्रण के उपयोग से गन्ने में अंकुरों की संख्या, प्रभावी गांठों की संख्या, गन्ने की लंबाई, तथा कुल उपज में उल्लेखनीय वृद्धि दर्ज की गई। इन सकारात्मक परिणामों के फलस्वरूप Cyperus rotundus सहित अन्य घास वर्गीय खरपतवारों की बढ़वार में स्पष्ट कमी पायी गयी, जिससे कुल खरपतवार घनत्व और सूखे वजन में भी घटोत्तरी दर्ज की गई। यह रणनीति गन्ने की प्रारंभिक वृद्धि को अनुकूल वातावरण प्रदान कर उच्च उत्पादन की दिशा में सहायक सिद्ध हुई।
- ग्रीष्म ऋतु में गहरी जुताई के साथ हरी खाद (सेसबेनिया प्रजाति) के प्रयोग अथवा ग्लाइफोसेट का दो बार उभारोपरांत छिड़काव, और इसके साथ खरपतवार नियंत्रण हेतु 'स्टेल सीड बेड' विधि अपनाने से C. rotundus पर पूरे मौसम भर प्रभावी नियंत्रण पाया गया।
- दूसरी और तीसरी पेड़ी फसलों में IW:CPE अनुपात 1.0 और 0.8 रखने पर गन्ने की वृद्धि तथा उपज में स्पष्ट वृद्धि दर्ज की गई। दूसरी पेड़ी फसल के दौरान जल पदचिह्न 120.86 से 139.35 लीटर प्रति किलोग्राम रहा, जिसमें वर्षा जल का योगदान कुल जल आवश्यकता का लगभग 50–60 प्रतिशत रहा। वहीं तीसरी पेड़ी फसल में यह जल पदचिह्न 124.86 से 168.64 लीटर प्रति किलोग्राम तक दर्ज किया गया, जिसमें वर्षा का योगदान 61 प्रतिशत तक रहा, जिससे स्पष्ट हुआ कि पेड़ी फसलों में प्राकृतिक वर्षा का उपयोग सिंचाई दक्षता में सहायक सिद्ध होता है।
- गन्ना उपज पर रोपण काल का स्पष्ट प्रभाव देखा गया, जहाँ फरवरी और मार्च में किए गए रोपण से प्राप्त गन्ने की ऊँचाई, मोटाई और कुल उपज अधिकतम रही। मार्च की तुलना में फरवरी में बोई गई फसल की औसत उपज 2.59 प्रतिशत अधिक पाई गई, जबकि अप्रैल और मई में बोई गई फसलों की तुलना में यह अंतर और भी अधिक था, जिससे यह सिद्ध होता है कि समय पर विशेषतः फरवरी माह में रोपण, गन्ने की उत्पादकता को बेहतर बनाने में महत्वपूर्ण भूमिका निभाता है। खरपतवार नियंत्रण के संदर्भ में, एट्राजीन, एमेट्रिन और 2,4-D का संयुक्त खरपतवारनाशी उपचार सबसे प्रभावी सिद्ध हुआ। इस संयोजन ने खेत में मौजूद प्रमुख खरपतवारों पर नियंत्रण स्थापित कर गन्ने की प्रारंभिक वृद्धि को सहयोग प्रदान किया।
- विभिन्न कृषि पद्धतियों के प्रभाव का तुलनात्मक मूल्यांकन करने पर पाया गया कि कंट्रोल की तुलना में प्राकृतिक कृषि, जैविक कृषि तथा अनुशंसित उर्वरक प्रयोग से गन्ने की उपज में क्रमशः 37.89%, 51.52% तथा 55.45% की वृद्धि दर्ज हुई। इससे स्पष्ट होता है कि यद्यपि जैविक विधियाँ भी उल्लेखनीय सुधार दर्शाती हैं गन्ना उत्पादन में उर्वरकों का संतुलित प्रयोग जैविक विकल्पों की अपेक्षा अधिक प्रभावशाली सिद्ध होता है,
- नैनो-कोटेड यूरिया के उपयोग से गन्ने की वृद्धि एवं विकास में सकारात्मक प्रभाव देखा गया। जब 100% अनुशंसित नाइट्रोजन नैनो-कोटेड यूरिया के माध्यम से प्रदान किया गया, तो परंपरागत यूरिया की तुलना में इससे प्राप्त परिणामों में सुधार देखा गया एवं पौधों की ऊँचाई में 12.25%, गन्ने के व्यास में 3.2%, तथा प्रति गन्ना वजन में 23.30% की वृद्धि दर्ज की गई। उल्लेखनीय तथ्य यह भी रहा कि जब नैनो-कोटेड यूरिया को 75% खुराक को तीन भागों में विभाजित कर प्रयोग किया गया, तब भी 100% नीम-कोटेड यूरिया के प्रयोग के समान गन्ना वजन प्राप्त हुआ। इससे यह स्पष्ट होता है कि नैनो-प्रौद्योगिकी आधारित उर्वरक न केवल पोषण दक्षता बढ़ाते हैं, बल्कि कम मात्रा में भी तुलनीय या बेहतर उत्पादकता सुनिश्चित करने की क्षमता रखते हैं, जिससे इनका प्रयोग दीर्घकालिक स्थायित्व की दिशा में एक प्रभावी कदम सिद्ध हो सकता है।
- सिलिकेट घुलनशील बैक्टीरिया (SSB) के 3 लीटर प्रति हेक्टेयर के प्रयोग से गन्ने की उपज एवं इसके घटकों में सकारात्मक सुधार पाया गया, विशेषतः जब इसका उपयोग डायटोमेसियस अर्थ से प्राप्त 400 किग्रा/हेक्टेयर सिलिकॉन के साथ किया गया। यह मिश्रण गन्ने की पोषण दक्षता एवं सहनशक्ति को बढ़ाने में प्रभावी सिद्ध हुआ।
- 75% अनुशंसित उर्वरक मात्रा (RDF) के साथ सूक्ष्मजीव सम्मिश्रण (माइक्रोबियल कंसोर्शिया) का प्रयोग करने पर गन्ने

की उपज में 12.5% तथा चीनी उपज में 22% तक की वृद्धि प्राप्त हुई। यह परिणाम 100% RDF के अकेले प्रयोग की तुलना में बेहतर रहा, जो दर्शाता है कि जैव-इनपुट्स के समन्वय से रासायनिक उर्वरकों की खुराक कम कर भी बेहतर उत्पादन संभव है। चौथी पेड़ी फसल की उपज तुलनात्मक रूप से कम पाई गई। जहाँ पहली पेड़ी में उपज 88.6 टन/हे. थी, वहीं दूसरी और तीसरी पेड़ी में यह क्रमशः 76.7 टन/हे. और 64.2 टन/हे. रही। इसके विपरीत, चौथी पेड़ी की उपज में इन तीनों की तुलना में क्रमशः 37.9%, 28.3% और 14.3% की कमी दर्ज की गई, जो यह इंगित करती है कि पेड़ी की बढ़ती संख्या के साथ उपज में गिरावट एक सामान्य प्रवृत्ति है।

- RDF + FYM आधारित पोषक तत्व प्रबंधन ने गन्ने की उपज में 24.9% तक की वृद्धि प्रदान की, जबकि रस गुणवत्ता से जुड़े मापदंडों जैसे ब्रिक्स तथा पवित्रता गुणांक में कोई उल्लेखनीय अंतर नहीं पाया गया। इससे यह पता चला कि कार्बनिक स्रोतों के साथ पोषण प्रबंधन से उपज में सुधार संभव है, भले ही गुणवत्ता स्थिर बनी रहे।
- गन्ना आधारित एकीकृत कृषि प्रणाली (IFS)—जिसमें गन्ने के साथ सब्ज़ियाँ, बागवानी फसलें, मुर्गीपालन, मत्स्यपालन, वर्मी कम्पोस्ट तथा डेयरी गतिविधियाँ शामिल थीं—ने सर्वाधिक आर्थिक लाभ प्रदान किया। शरद ऋतु में इस प्रणाली से ₹7,80,165/हेक्टेयर तथा वसंत ऋतु में ₹7,61,276/हेक्टेयर की शुद्ध आय अर्जित हुई, जिनका लाभ:लागत अनुपात क्रमशः 2.38 एवं 2.36 रहा। यह दर्शाता है कि गन्ना आधारित समेकित कृषि प्रणाली आर्थिक रूप से अत्यधिक लाभकारी सिद्ध हो सकती है।
- इसी प्रकार, गन्ना आधारित फसल प्रणाली, जिसमें औषधीय पौधों जैसे तुलसी, स्टीविया और जंगली गेंदा को शामिल किया गया, ने पारंपरिक धान-गेहूँ-गन्ना प्रणाली की तुलना में बेहतर उपज व अधिक लाभ प्रदर्शित किया। इससे यह निष्कर्ष निकलता है कि पारंपरिक फसलों के स्थान पर विविधीकृत, उच्च-मूल्य वाली फसलें अपनाना अधिक टिकाऊ और लाभकारी हो सकता है।

फसल सुरक्षा

- गन्ने में पाए जाने वाले कीट, स्वस्थ एवं क्षतिग्रस्त पौध लक्षण, रोग, कीट-व्याधियाँ एवं फिजियोलॉजिकल विकारों की कुल 2,944 RGB छवियाँ एकत्र की गईं । इन छवियों को विश्लेषणात्मक उद्देश्यों के लिए 29 विभिन्न वर्गों में वर्गीकृत किया गया, जिससे डिजिटल पहचान प्रणाली के विकास में सहायक डेटा उपलब्ध कराया जा सका।
- यूएवी (ड्रोन) आधारित कवकनाशी छिड़काव विधि का मानकीकरण किया गया, जिसके तहत थायोफेनेट मिथाइल (65.0 ग्राम), कार्बेन्डाजिम (50.0 ग्राम) अथवा प्रोपिकोनाजोल (20 मि.ली.) को 5 लीटर पानी में मिलाकर ड्रोन द्वारा 1,250 वर्ग मीटर क्षेत्र में छिड़काव करने की सिफारिश की गई है। यह तकनीक श्रम, समय और रसायनों की खपत को कम करने में सहायक है।
- जैव-नियंत्रक एजेंट रूप में Trichoderma harzianum के सेट उपचार (sett treatment) द्वारा पोक्का बोइंग रोग की गंभीरता में उल्लेखनीय कमी दर्ज की गई, साथ ही गन्ने की वृद्धि एवं पौध शक्ति में भी सकारात्मक सुधार देखा गया।
- गन्ने में रेड रॉट रोग प्रतिरोध के लिए CRISPR-Cas9 प्रणाली द्वारा जीन संपादन हेतु संवेदनशील किस्म Co 0238 में एल एच टी 1, जीएडी एवं पी पी २ए जैसे जीनों को लक्षित कर guided knockout की रणनीति अपनाई गई, जिससे भविष्य में रोग प्रतिरोधी किस्मों के विकास की संभावना प्रबल हुई है।
- वर्ष 2023–24 में चुकंदर के 50 जर्मप्लाज्म को प्राकृतिक परिस्थितियों में पर्ण रोगों जैसे कि सर्कोस्पोरा पत्ती धब्बा रोग (Cercospora betae), फोमा पत्ती धब्बा रोग (Phoma betae), अल्टरनेरिया पत्ती धब्बा रोग (Alternaria alternate), फ्यूज़ेरियम येलो रोग (Fusarium yellows) तथा वायरल रोग सम्मिश्रण के विरुद्ध प्रतिक्रिया मूल्यांकन हेतु परीक्षण किया गया, जिससे रोग सहिष्णु जर्मप्लाज्म की पहचान में सहायता मिली।
- Tetrastichus howardi (जो कि एक प्यूपल पैरासिटॉइड है) के संतान उत्पादन को लेकर एक दिलचस्प मूल्यांकन किया गया। देखा गया कि प्रति प्यूपा औसतन 41.17 संततियां उत्पन्न हुईं। दिलचस्प बात ये रही कि जैसे-जैसे प्यूपा का वजन बढ़ा (0.050 ग्राम से ज़्यादा होकर 0.091 ग्राम तक), वैसे-वैसे संतान संख्या में भी बढ़ोतरी हुई तथा सभी वजन वर्गों में मादाओं का प्रतिशत 90% से ऊपर रहा अर्थात ये पैरासिटॉइड मादा उत्पादन के मामले में काफी असरदार साबित हुए। सिर्फ वजन ही नहीं, प्यूपा की लंबाई जितनी ज़्यादा रही, उतनी ही ज़्यादा कुल संततियां (54.1 से लेकर 76.6 तक) और मादा उद्भव (50.7 से 66.5 तक) पाया गया। वहीं, नर संततियों की संख्या घटती गई और लिंग अनुपात मादाओं की ओर झुकता गया।
- गन्ना के चोटी भेदक और तना भेदक का कृत्रिम पालन करने के लिए एक विशेष अर्ध-प्राकृतिक आहार (semi-synthetic diet) तैयार की गयी इस डाइट में मुख्य रूप से गन्ने की पत्तियों के आवरण का चूर्ण और राजमा का उपयोग किया गया । इसे और असरदार बनाने के लिए कैसीन (एक प्रकार का प्रोटीन), अगर (जेल बनाने वाला पदार्थ) और कुछ कवकरोधी एजेंट्स भी मिलाए गए। इस तरह की डाइट इन कीटों के प्रयोगशाला में सफल पालन के लिए काफी उपयोगी साबित हो रही है।

पादप शारीरिकी एवं जैव रसायन

- गन्ने की बढ़वार हेतु एथ्रेल, NAA (50 और 100 पीपीएम) और

जिबरेलिक एसिड (GA_3) का छिड़काव अत्यंत प्रभावी रहा। इन पादप वृद्धि हार्मोन के बाहरी उपयोग से न सिर्फ पौधों की शारीरिक वृद्धि को बढ़ावा मिला, बल्कि शुरुआती पौधा जनसंख्या भी बढ़ी और गांठों के बीच की लंबाई (इंटरनोडल एलॉन्गेशन) में भी अच्छी-खासी बढ़ोतरी देखने को मिली।

- बिना धुले गन्ना ट्रैश (SCT) को कम तीव्रता वाले HPAC से उपचारित करने पर शर्करा और एथेनॉल की मात्रा में जबरदस्त इजाफा वृद्धि हुई तथा एथेनॉल का उत्पादन 93.8% तक पहुंच गया परंतु जैसे-जैसे पूर्व-उपचार की तीव्रता बढ़ी, वैसे-वैसे दो-चरणीय प्रक्रिया का सम्मिलित प्रभाव (synergistic effect) कम होता गया।
- गन्ने की दो किस्मों कोलख 94184 और कोजे 64 पर सामान्य और जलभराव की स्थिति में ट्रांस क्रिप्टोम अध्ययन द्वारा कुल 60 जीन ऐसे पाए गए, जिनकी अभिव्यक्ति जलभराव के प्रभाव से या तो बढ़ी या घट गई अर्थात ये जीन जलभराव के प्रति संवेदनशीलता या सहनशीलता से जुड़े हो सकते हैं।
- सूखे की स्थिति में सिलिसिक एसिड द्वारा इससे उपचारित गन्ना पौधों में PAL (Phenylalanine Ammonia Lyase) एंजाइम की सक्रियता में वृद्धि पाई गई, जो एक तरह से तनाव प्रतिक्रिया में पौधे को मजबूती प्रदान करता है।
- गन्ने में सूखे के प्रति सहनशीलता हेतु जड़ों का घना नेटवर्क, पत्तियों में ज्यादा नमी (RWC), लंबी इंटरनोड लंबाई, कम CTD (canopy temperature depression), कम इलेक्ट्रोलाइट रिसाव और पत्तियों में ज्यादा प्रोलाइन का जमाव आदि कि संकेतक (indicators) के रूप में पहचान कि गयी।
- इसी प्रकार जलभराव सहनशीलता के लिए तने और वायवीय जड़ों का उच्च अनुपात, तेजी से बढ़ने वाले तने, लंबी इंटरनोड लंबाई, पत्तियों में क्लोरोफिल की स्थिरता, ADH एंजाइम की ज़्यादा सक्रियता और पत्तियों में पोटेशियम की ऊंची मात्राआदि की संकेतक के रूप में पहचान की गयी।
- गन्ने के जीनोम में 27 अलग-अलग गुणसूत्रों पर फैले हुए कुल 64 इनवर्टेज जीन पाए गए। ये 10 में से 5 गुणसूत्र वर्गों का प्रतिनिधित्व करते हैं। इन जीनों में से 43 को क्षारीय-न्यूट्रल इनवर्टेज के रूप में पहचाना गया।

कृषि अभियांत्रिकी

- गन्ने की गांठों को रोपने के लिए एक नई संशोधित मीटरिंग प्रणाली के साथ मशीन तैयार की गई और खेत में इसका परीक्षण भी किया गया जिसमे पता चला कि कहीं-कहीं गांठें ठीक से रोपी नहीं गईं और कहीं पर एक ही जगह दो से ज़्यादा गांठें चली गईं। जिसे आगे सुधारा जाएगा।
- गन्ने की पेड़ी फसल के लिए विकसित ट्रैक्टर से चलने वाली ट्रैश मल्चर-सह-स्टबल शेवर मशीन का अधिकारिक तौर 14 मार्च 2024 को पेटेंट (संख्या 526527) प्राप्त हुआ और अब यह मशीन बाजार में उपलब्ध है। इसके निर्माण और वितरण के लिए लोहान एग्री इक्विपमेंट, मुज़फ़्फ़रनगर के साथ समझौता भी हो चुका है।
- CTF (Controlled Traffic Farming) पद्धति को ध्यान में रखते हुए खेतों में काम आने वाले कई यंत्र डिज़ाइन किए गए, जैसे दो कतारों वाली फरुवर-कम-पैकर मशीन, उर्वरक व शाकनाशी छिड़काव यंत्र, और रोटरी वीडर। इन सबका मंडलीय कार्यशाला में निर्माण हुआ और खेत में परीक्षण के बाद इनका प्रदर्शन भी संतोषजनक पाया गया।
- गन्ने की सफाई और ऊपरी हिस्सा काटने (डीटॉपिंग) के लिए डिज़ाइन किए जो मैनुअल स्ट्रिपर-सह-डीटॉपर द्वारा एक ही यंत्र से एक ही बार में दोनों काम हो गए, जिससे काम की रफ्तार बढ़ गई। जब इसे संस्थान के खेत में पुरुष और महिला श्रमिकों ने 30 घंटे तक प्रयोग किया, तो महिला श्रमिकों ने औसतन 90.1 किलो/घंटा और पुरुषों ने 115.5 किलो/घंटा गन्ना स्ट्रिप और डीटॉप किया।
- गन्ने में खरपतवार और बीमारियों को कंट्रोल करने के लिए अब ड्रोन से छिड़काव का तरीका भी बाइंडिंग खरपतवार को रोकने में 86–88% तक असरदार रहा। लाल सड़न रोग के मामले में, दोपहर के समय ड्रोन से थियोफेनेट मिथाइल (70WP) @ 1.3 ग्राम/लीटर की दर से किया गया छिड़काव सबसे प्रभावशाली रहा जिसमे घाव कम हुए और रोग का फैलाव भी रुका।
- संस्थान के अनुसंधान प्रक्षेत्र में खरपतवार नियंत्रण के लिए ड्रोन का प्रोटोटाइप परीक्षण किया गया। जिसमें 90% पानी की बचत, 90–92% श्रम की कमी और 93–95% समय की बचत पाई गयी अतः ड्रोन तकनीक संसाधन संरक्षण के लिहाज़ से एक बेहतरीन विकल्प बनकर उभरी है।
- सोडिक मिट्टी में फलदार पौधों की रोपाई के लिए एक मल्टीपल ऑगर सिस्टम (MAS) नामक नई तकनीक अपनाई गई, जो कि एक एक ट्रैक्टर-संचालित, PTO चालित मशीन है जो एक साथ तीन गोल गड्ढे खोद सकती है। जब इसे बायोफॉर्मुलेशन के साथ प्रयोग किया गया तो पौधों की ऊंचाई और फैलाव में स्पष्ट सुधार देखा गया।
- अलग-अलग मौसम और मिट्टी की परिस्थितियों में परीक्षण के लिए 56 यंत्रों का निर्माण किया गया और करीब 67 प्रोटोटाइप विभिन्न संस्थानों और किसानों को सौंपे गए, ताकि नई तकनीकों का क्षेत्रीय मूल्यांकन हो सके।
- एक विशेष ट्रैक्टर चालित आलू-सह-गन्ना ट्रेंच प्लांटर भी विकसित किया गया, जिसे 30 किलोवाट के ट्रैक्टर से चलाया गया। इसकी कार्य क्षमता 0.27 हेक्टेयर प्रति घंटा रही, जिससे एक हेक्टेयर की रोपाई सिर्फ 8 घंटे में पूरी हो गई। सबसे बड़ी बात, हाथ से रोपण करने में ₹13,600/हेक्टेयर की लागत की

तुलना में यांत्रिक रोपण की लागत ₹3,500/हेक्टेयर रही जिससे 74.2% लागत और 90.1% श्रम की बचत हुई।

- छोटे किसानों के लिए विसकित विद्युत चालित निराई-सह-बुवाई यंत्र, गेहूं, सरसों और उरद जैसी फसलों की मेड़ या बेड पर इंटरक्रॉपिंग के लिए एकदम उपयुक्त है। इसका संस्थान के क्षेत्र में परीक्षण किया गया और इससे निराई भी अच्छी हुई और उरद का अंकुरण भी बेहतरीन रहा।

कृषि ज्ञान प्रबंधन प्रकोष्ठ

- भारत ने कच्ची गन्ना चीनी, ठोस रूप में परिष्कृत गन्ना चीनी तथा मोलासेस के निर्यात में प्रतिस्पर्धात्मक लाभ दर्शाया है जबकि अन्य गन्ना उत्पादों जैसे गन्ना सिरप, गन्ना मिठाई, कृत्रिम शहद, च्युइंग गम आदि के निर्यात में भारत को प्रतिस्पर्धात्मक लाभ प्राप्त नहीं हुआ।
- भारतीय चीनी व्यापार संकेतक दक्षिण एशियाई देशों (SAC) की तुलना में अधिक पाए गए। चीनी व्यापार प्रतिस्पर्धात्मकता के विश्लेषण से स्पष्ट हुआ कि भारत को SAC देशों को चीनी निर्यात में तुलनात्मक लाभ प्राप्त है। चीनी उत्पादों के निर्यात के प्रमुख गंतव्य एशियाई, खाड़ी एवं अफ्रीकी देश रहे हैं। दक्षिण एशियाई देशों के व्यापार प्रोफ़ाइल के विश्लेषण से यह ज्ञात हुआ कि चीनी न तो कुल व्यापार में और न ही कुल कृषि व्यापार में कोई प्रमुख आयात या निर्यात वस्तु है।
- वर्ष 2023–24 में विश्व चीनी निर्यात बढ़कर 68.2 मिलियन टन हो गया जबकि भारत का चीनी निर्यात वर्ष 2023–24 में पिछले वर्ष की तुलना में महत्वपूर्ण रूप से घट गया, जिसका कारण सरकार द्वारा चीनी निर्यात पर लगाया गया प्रतिबंध था, जिससे देश में चीनी मूल्य स्थिरता सुनिश्चित की जा सके।
- गन्ने की सघनता, क्षेत्र विस्तार एवं उत्पादकता वृद्धि के आधार पर उत्तर प्रदेश, महाराष्ट्र, कर्नाटक एवं तमिलनाडु जैसे चार प्रमुख गन्ना उत्पादक राज्यों के जिलों को विभिन्न श्रेणियों में वर्गीकृत किया गया। उत्तर प्रदेश के अत्यधिक गन्ना सघनता वाले जिलों में क्षेत्रफल एवं उत्पादकता में सकारात्मक वृद्धि देखी गई, जबकि महाराष्ट्र, कर्नाटक और तमिलनाडु जैसे उष्ण कटिबंधीय राज्यों के प्रमुख गन्ना उत्पादक जिलों में पिछले दशकों के दौरान क्षेत्रफल एवं उत्पादकता में गिरावट दर्ज की गई।
- वर्ष 2024–25 में उत्तर प्रदेश में गन्ना फसल की अनुमानित लागत पौध फसल के लिए ₹3320 प्रति टन तथा पेड़ी फसल के लिए ₹3280 प्रति टन आंकी गई है जबकि औसत लागत ₹3310 प्रति टन रही।
- गन्ने की फसल के पौधे, पत्तियाँ, पत्ती म्यान, इंटरनोड और नोड जैसे वर्णनात्मक वर्गों के लिए 15-15 दिन के अंतराल पर छवियाँ एकत्रित की गईं और इन पर एनोटेशन की प्रक्रिया प्रारंभ की गई, जिसमें आयताकार बाउंडिंग बॉक्स और पॉलीगॉन तकनीकों का उपयोग किया गया।

जैविक नियंत्रण केंद्र, प्रवरा नगर

- मंद -शुष्कन तकनीक के माध्यम से Heterorhabditis indica का अत्यधिक प्रभावी टैल्क आधारित फॉर्म्युलेशन विकसित किया गया । गन्ने के खेतों में $2.5x10^7$ और $5x10^7$ IJ/हेक्टेयर की खुराक, पर कंट्रोल की तुलना में क्रमशः 63.98% और 72.02% तक भृंग की आबादी को प्रभावी रूप से दबाने में सक्षम पाई गईं तथा Chlorpyrifos 20% EC, Thiamethoxam 75% SG, Imidacloprid 17.8% SL, Clothianidin 50% WDG, Chlorantraniliprole 18.50% SC, Fipronil 40% + Imidacloprid 40% WG जैसी कीटनाशकों के प्रति सहनशीलता दिखाई।
- Heterorhabditis indica से संबद्ध बैक्टीरिया की पहचान 16S rRNA आंशिक अनुक्रमण के माध्यम से Photorhabdus luminescens और P. akhurstii के रूप में की गई।
- Bacillus thuringiensis स्ट्रेन्स IISRBCCEB01 और IISRBCCEB02 ने Holotrichia serrata के विरुद्ध कीटनाशी क्रियाशीलता दिखाई, जिसमें क्रमशः 67.50% और 60.0% मृत्यु दर प्राप्त हुई तथा पहले इंस्टार भृंगों में LT_{50} क्रमशः 12.40 और 16.16 दिन रहा, जब $2x10^{10}$ बीजाणु भार के साथ तीसरे सप्ताह में निषेचन किया गया।
- गन्ने में कटाई के पश्चात सुक्रोज की जैव हानि से संबंधित बैक्टीरिया की पहचान Leuconostoc sp., Klebsiella sp., Enterobacter sp., Pantoea sp., Bacillus sp., Achromobacter sp., Lactococcus sp., Staphylococcus sp., Exiguobacterium sp., Curtobacterium sp., Jejubacter sp. आदि के रूप में की गई।
- गन्ने के ब्राउन स्पॉट रोग से संबंधित Cercospora प्रजातियों का ITS और 18S rRNA अनुक्रमण किया गया और इनके अनुक्रम क्रमशः IISRBCCBP02 (पंजीकरण संख्या PQ056724) और IISRBCCBP01 (पंजीकरण संख्या PQ056713) के रूप में प्रस्तुत किए गए।
- Cladosporium sp की पहचान ऐसे मायकोपैरासिटिक कवकों की पहचान. के रूप में की गई, जिन्होंने $2x10^6$ और $2x10^8$ बीजाणु प्रति मिलीलीटर की दर पर uredospore pustules में क्रमशः 72.51% और 74.91% परजीवन दर्शाया। ITS और 18S rRNA अनुक्रमण द्वारा पहचान की गई इन कवक प्रजातियों के अनुक्रम क्रमशः IISRBCCMF02 (पंजीकरण संख्या PQ056723) और IISRBCCMF01 (पंजीकरण संख्या PQ056714) के रूप में NCBI GenBank में पंजीकृत किए गए।

आईएसआरआई क्षेत्रीय केंद्र, मोतीपुर

- दो परिपक्वता समूहों के लिए पाँच प्रविष्टियाँ कोलख 16201, कोलख 16202, कोलख 19202 (अगेती) तथा कोलख 19204 और कोलख 20204 (मध्य देर) अक्टूबर 2024 में आयोजित अ. भा. स. अनु. परि. (गन्ना) कार्यशाला के दौरान क्षेत्रीय किस्म परीक्षण (एनसीजेड) में स्वीकृत की गईं। चार क्लोन – कोलख 20466 और कोलख 20467 (अगेती), तथा कोलख 20468 और कोलख 20469 (मध्य-देरी) को वर्ष 2023-24 में IVT से उनके संबंधित AVT-I में अग्रसर किया गया। दो मध्य देर परिपक्वता क्लोन – कोलख 21468 और कोलख 21469 – को वर्ष 2024-25 में IVT से AVT-I में अग्रसर किया गया।
- वर्ष 2023-24 में अ. भा. स. अनु. परि. (गन्ना) के अगेती ग्रुप की तीन परीक्षण (IVT, AVT प्लांट एवं AVT रेटून) तथा मध्य-देरी ग्रुप की एक IVT परीक्षण का संचालन किया गया, जिनमें भा. ग. अनु. सं. क्षेत्रीय केंद्र, मोतीपुर द्वारा विकसित क्लोन अपने-अपने समूहों में श्रेष्ठ प्रदर्शन संचालित किया। वर्ष 2024-25 के दौरान चार अ. भा. स. अनु. परि. (गन्ना) (गन्ना) के चार परीक्षण आयोजित किए गए।
- बिहार गन्ना बीज उत्पादक कार्यक्रम (बीएसपी) के अंतर्गत, वर्ष 2023-24 में पाँच गन्ना क़िस्मों कोलख 12207, कोलख 12209, कोलख 94184, कोपी 9301 और को0118 इन पाँच किस्मों का कुल 17588 क्विंटल बीज उत्पादन आईआईएसआर क्षेत्रीय केंद्र, मोतीपुर सहित बिहार के चार विभिन्न केंद्रों और गन्ना मिलों में 30 हेक्टेयर क्षेत्रफल में किया गया। वर्तमान वर्ष में चार केंद्रों पर 29 हेक्टेयर क्षेत्र में पौध संवर्धक उत्पादन किया जा रहा है।
- भारतीय कृषि अनुसंधान परिषद – भारतीय गन्ना अनुसंधान संस्थान, लखनऊ और बिहार सरकार के गन्ना उद्योग विभाग, पटना के बीच पांच वर्षों के लिए एक समझौता ज्ञापन (MoU) पर हस्ताक्षर किए गए, जिसका उद्देश्य गन्ना फसल की उत्पादकता को बढ़ाना तथा बिहार के हितधारकों एवं गन्ना मिलों को लाभ पहुंचाना है। बिहार राज्य के लिए कोलख 14201 किस्म की पहचान की गई है।

चुकंदर उपकेंद्र, मुक्तेश्वर

- इस वर्ष कुल 149 चुकंदर जर्मप्लाज़्म अभिगमों का संरक्षण किया गया, जिनके बीजों को हर वैकल्पिक वर्ष बोया जाता है ताकि उनकी जीवंतता बनी रहे। वर्ष 2024 में 52 चुकंदर किस्मों/जर्मप्लाज़्म से 24.0 किलोग्राम से अधिक ताजे बीज एकत्रित किए गए।
- अधिकांश जर्मप्लाज़्म में सर्कोस्पोरा लीफ स्पॉट, फ्यूजेरियम, स्क्लेरोटियम रूट रॉट और वायरल संक्रमण के लक्षणों की वृद्धि देखी गई। अप्रैल–मई के दौरान स्पोडोप्टेरा प्रजातियों का अत्यधिक प्रकोप (80–95%) दर्ज किया गया। फरवरी से अप्रैल के बीच मकड़ी, बीटल, माइज़स और बिहार हेरी कैटरपिलर जैसे कीटों की हल्की समस्याएं देखी गईं। SYT/06/10, L 33 और LKC 2000 जीनोटाइप्स ने S. litura के प्रति प्रतिरोध दर्शाया।
- चुकंदर जीनोटाइप्स एलकेसी 11, एलकेसी एच बी और एलकेसी 2000 ने सूखे की स्थिति में चेक किस्मों की तुलना में अधिक एकल जड़ वजन प्रदर्शित किया। एलकेसी 2000 ने जड़ की लंबाई और व्यास में भी एल एस 6 और आईआईएसआर 1 की तुलना में बेहतर प्रदर्शन किया, जबकि एलकेसी 2006 और एलकेसी 95 ने चेक किस्मों की तुलना में अधिक सुक्रोज़ और ब्रिक्स प्रतिशत प्रदर्शित किया।
- भा. कृ. अनु. प.- भारतीय गन्ना अनुसंधान संस्थान ने देश के विभिन्न सार्वजनिक और निजी क्षेत्र के संगठनों के साथ सहयोग की पहल की, जिसके तहत चुकंदर की खेती को बढ़ावा देने के लिए विविध जीनोटाइप्स और किस्मों के मूल्यांकन हेतु चुकंदर बीज़ का आदान-प्रदान किया गया तथा स्वस्थ फसल की खेती और उसकी पूर्ण क्षमता प्राप्त करने हेतु समग्र एग्रोनोमिक दिशानिर्देश भी साझा किए गए।

गन्ना पर अखिल भारतीय समन्वित अनुसंधान परियोजना (AICRP)

- 2 अगस्त, 2024 को आयोजित फसल मानकों पर केंद्रीय उप-समिति की 92वीं बैठक के दौरान, अ. भा. स. अनु. परि. (गन्ना) द्वारा छह गन्ना किस्मों को जारी एवं अधिसूचित किया गया।
- उपोष्ण कटिबंधीय क्षेत्रों में 120 सेमी तथा प्रायद्वीपीय एवं पूर्वी तटीय क्षेत्रों में 150 सेमी चौड़ी कतारों पर विशिष्ट जीनोटाइप्स ने बेहतर प्रदर्शन किया। साथ ही, उर्वरकों की अनुशंसित उच्च मात्रा (125%) पर भी सभी क्षेत्रों में फसल की सकारात्मक प्रतिक्रिया स्पष्ट रूप से देखने को मिली।
- मानसून पूर्व की वृद्धि अवस्था के दौरान नमी की कमी का गन्ने की उपज पर गंभीर प्रभाव पाया गया, जिसमें विभिन्न गन्ना उत्पादक क्षेत्रों में 5% से 35% तक की उपज हानि दर्ज की गई। उत्तर-पश्चिम क्षेत्र में किए गए परीक्षणों में ग्रेनुलर यूरिया और उसके स्थान पर प्रयुक्त द्रव्य नैनो यूरिया के बीच गन्ना उपज में कोई विशेष अंतर नहीं पाया गया।
- लाल सड़न रोग कारक के नए रोग रूपों की पहचान की गई, जिसमें 13 केंद्रों द्वारा 109 नए आइसोलेट्स का 20 होस्ट भेदकारी किस्मों के विरुद्ध परीक्षण किया गया।

About the Institute

The ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow was established on February 16, 1952 by the erstwhile 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 is conveniently situated at about 12 km from Chaudhary Charan Singh Airport, Amausi and at 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 36°C to 44°C and minimum temperature during November to February ranges from 7°C to 11.5°C. 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 of sugarcane and recovery of sugar in different agro-ecological zones of the country and to extend appropriate information and technologies to the end users, the following issues and strategies have been identified that need to be pursued at:

Issues

- Low levels of cane yield and sugar recovery
- High cost of cane cultivation
- Decline in total 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

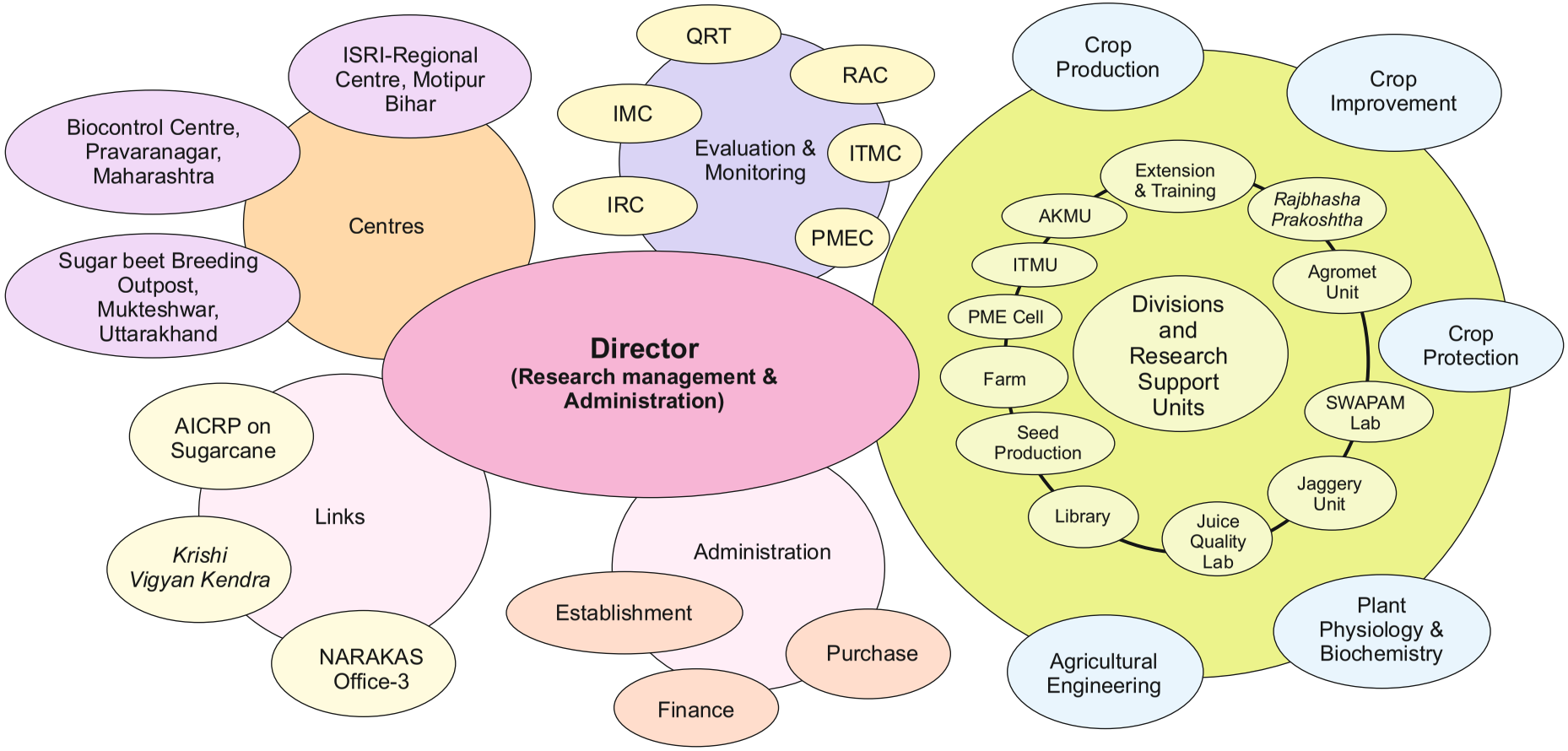
e. Mechanizing sugarcane farming

Arresting decline in total factor productivity

a. Soil biological and nutritional dynamism

b. Carbon sequestering through cropping system

ICAR-Indian Sugarcane Research Institute, Lucknow



Organizational Structure

ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow

Budget 2023-24

Particulars	Plan (Rs. in lakh)	
	Revised Estimate	Expenditure as on December 31, 2023
ICAR-Indian Sugarcane Research Institute, Lucknow	9543.03 including salary & pension	6903.18 including salary & pension
All India Coordinated Research Project on Sugarcane	1545.00 including salary & pension	885.10 including salary & pension

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

Staff Position

(As on December 31, 2024)

Category	Sanctioned	Filled	Vacant
RMP	**1**	**1**	**0**
Scientific			
Principal Scientist	7	07	0
Senior Scientist	14	10	04
Scientist	52	32	20
Total	**73**	**49**	**24**
Technical			
Category-I	77	52	25
Category-II	54	24	30
Category-III	3	1	2
Total	**134**	**77**	**57**
Administrative	**54**	**37**	**17**
Skilled Supporting Staff	**36**	**3**	**33**
Grand Total	**298**	**167**	**121**

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

Release and notification of sugarcane varieties

Sugarcane variety, CoLk 16202 (early) was released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops for commercial cultivation in North West Zone of India (*The Gazette of India notification S.O. 4388 (E) dated the Oct. 08, 2024*). Another mid-late maturing sugarcane variety, CoLk 16470 has also been released and notified by Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops (*The Gazette of India notification S.O. 4388 (E) dated the Oct. 08, 2024*) for commercial cultivation in North Central and North Eastern Zone of India.

Table 1.1 Salient features of sugarcane varieties, CoLk 16202 and CoLk 16470

Variety	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Pol % cane at harvest	Recommended zone
CoLk 16202 (*Ikshu*-16)	LG 95053 × CoLk 94184	Early	93.22	11.43	17.74	13.57	North West Zone
CoLk 16470 (*Ikshu*-17)	CoS 8436 × CoSe 92423	Mid-late	82.50	9.59	17.37	13.20	North Central & North Eastern Zone

Fig. 1.1 *Field view of the plants and buds of CoLk 16202*

Fig. 1.2 *Field view of the plants and buds of CoLk 16470*

Registration of sugarcane varieties

Two sugarcane varieties CoLk 11203 and CoLk 11206 have been registered with PPVFRA and received the Registration Certificates during 2024. Three sugarcane varieties namely, CoLk 14201 (*Ikshu*-10), CoLk 15206 (*Ikshu*-14) and CoLk 16466 (*Ikshu*-15) were applied for registration under the Protection of Plant Variety and Farmers Right Act, 2001 for their protection. The duly filled applications of aforesaid varieties have been submitted to the Protection of Plant Variety and Farmers Right Authority, New Delhi.

Table 1.2 Salient features of sugarcane varieties, CoLk 14201, CoLk 15206 and CoLk 16466

Variety	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Pol % cane at harvest	Recommended Zone
CoLk 14201 (*Ikshu*-10)	Co 0238 GC	Early	91.34	11.39	18.11	13.69	North West Zone
CoLk 15206 (*Ikshu*-14)	LG 95053 GC	Mid-late	89.81	11.64	18.42	14.32	North West Zone
CoLk 16466 (*Ikshu*-15)	BO 91 × Co 86002	Early	85.35	10.19	17.31	13.31	North Central & North Eastern Zone

Fig. 1.3 *Field view of the plants and buds of CoLk 14201*

Fig. 1.4 *Field view of the plants and buds of CoLk 15206*

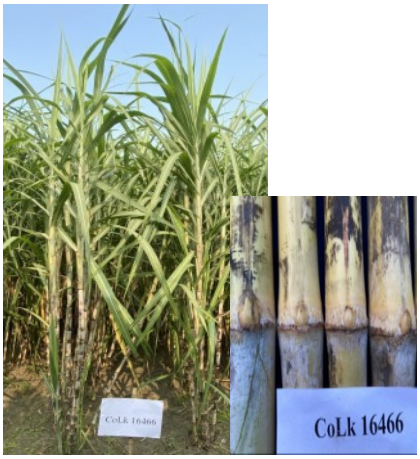


Fig. 1.5 *Field view of the plants and buds of CoLk 16466*

Sugarcane clones accepted for multi-location testing

Two early maturing sugarcane clones, *viz*., CoLk 24201 (LG 20601) and CoLk 24202 (LG 20519) and two mid-late maturing clones, CoLk 24203 (LG 18384) and CoLk 24204 (LG 18071) were accepted for multi-location testing in North West Zone of India during the AICRP(S) Workshop-2024 held at PAU, Ludhiana.

Table 1.3. Salient features of the accepted clones

Clone	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Red rot rating
CoLk 24201 (LG 20601)	CoLk 13201 GC	Early	101.48	12.83	18.22	MR
CoLk 24202 (LG 20519)	Co 0238 GC	Early	99.24	12.21	17.87	MR
CoLk 24203 (LG 18384)	CoSe 95422 PC	Mid-late	101.34	14.36	20.09	MR
CoLk 24204 (LG 18071)	CoLk 94184 × CoPant 84212	Mid-late	97.80	14.01	20.20	MR

Hybridization and seedling raising

A total of 31 bi-parental sugarcane crosses were made during the crossing season 2023. In addition, fluff of 45 GCs was also requested from the ICAR-Sugarcane Breeding Institute, Coimbatore. Fluff of these crosses will be sown in the glass/poly house for raising seedlings. Approximately 12516 seedlings derived from 38 bi-parental crosses, 02 PC, 01 Self and 11 GCs (from the crossing season 2022) were raised and transplanted in the field condition for their evaluation.

Selection in seedling (C_0) population

Based on the HR brix and other growth parameters, a total of 366 clones were selected from the seedling populations. These selected clones have been planted as C_1 clones along with standard varieties for their further evaluation.

Evaluation of clonal generations

A total of 94 sugarcane clones were selected from C_1 population and promoted to the C_2 generation for their further evaluation. About 47 promising sugarcane clones were selected from C_2 population and promoted to the C_3 generation and also given for the red rot testing. Among these clones, the best promising ones were planted in replicated trials for their yield and quality evaluation. Based on the yield, quality and red rot ratings, best twelve promising clones, *viz.*, 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 were included in the Station Trial (2024-25) for their evaluation.

Station Trial (2023-24)

Ten elite sugarcane genotypes, *viz.*, LG 16471, LG 18016, LG 18032, LG 18071, LG 18078, LG 18085, LG 18384, LG 20519, LG 20579 and LG 20601 along with six standard varieties (Co 0238, CoJ 64, CoLk 14201, CoS 767, CoPant 97222, CoLk 15207) were evaluated in Station Trial (2023-24) for their growth, yield and quality parameters.

Table 1.4 Performance of elite sugarcane genotypes under Station Trial (2023-24)

Genotype	Cane yield (t/ha)	CCS yield (300 days)	CCS yield (360 days)	Sucrose % (300 days)	Sucrose % (360 days)
LG 16471	69.97	8.82	9.82	17.90	19.92
LG 18016	67.54	8.36	9.73	17.77	20.43
LG 18032	79.07	10.51	11.26	18.82	20.20
LG 18071	97.80	12.34	14.01	17.93	20.20
LG 18078	104.75	13.08	14.41	17.74	19.49
LG 18085	99.24	12.21	14.68	17.87	20.90
LG 18384	101.34	12.71	14.36	18.05	20.09
LG 20519	98.60	12.39	13.08	18.13	18.99
LG 20579	87.84	11.51	11.99	18.74	19.32
LG 20601	101.48	12.83	14.46	18.22	20.18
Co 0238	85.79	10.83	11.82	17.87	19.74
CoJ 64	75.64	9.46	11.12	17.98	20.86
CoLk 14201	87.50	11.09	12.05	18.30	19.81
CoS 767	84.88	9.61	11.72	16.79	19.70
CoPant 97222	84.31	10.38	12.04	17.61	20.26
CoLk 15207	88.49	11.87	12.37	19.01	19.94
CV (%)	6.34	8.19	8.56	4.64	4.93
CD (0.05)	9.34	1.52	1.77	1.39	1.64

Evaluation of early sugarcane clones for North West Zone

Initial Varietal Trial (Early)

A trial comprising of six sugarcane genotypes, *viz.*, Co 20016, CoLk 20201, CoLk 20202, CoLk 20203, CoPb 20211, and CoH 20261 and three standards (CoJ 64, Co 0238, Co 05009) was conducted and observations were recorded on various yield and quality parameters. The genotype, CoLk 20201 recorded the highest cane yield (117.82 t/ha) followed by CoLk 20202 (113.64 t/ha) and CoPb 20211(108.56 t/ha). Similarly, a higher CCS yield was recorded in CoLk 20201 (16.23 t/ha) followed by CoLk 20202 (14.28 t/ha) and CoPb 20211 (13.78 t/ha). The highest sucrose content at harvest was recorded in CoLk 20201 (19.72%) followed by CoPb 20211 (18.20%). Among the standards, Co 0238 was found the best standard for both cane yield (111.11 t/ha) and CCS yield (14.41 t/ha).

Advanced Varietal Trial I Plant (Early)

Four sugarcane clones, *viz.*, CoLk 19201, CoLk 19202, CoPb 19211 and CoS 19231 along with three standards, CoJ 64, Co 0238 and Co 05009 were evaluated for yield and quality parameters. Among the test genotypes, CoLk 19201 recorded the highest cane yield (106.97 t/ha) and CCS yield (13.67 t/ha). The genotype CoLk 19202 showed the highest sucrose content at harvest (18.96%) followed by CoS 19231 (18.82%). Among the standards, Co 0238 was the best check for cane yield (101.60 t/ha) and CCS yield (14.01 t/ha).

Advanced Varietal Trial-II Plant (*Early*)

Four sugarcane clones, *viz.*, CoS 17231, CoS 17232,

CoPb 18181 and CoLk 18202 along with three standard varieties, CoJ 64, Co 0238 and Co 05009 were evaluated for yield and quality characters. The genotype, CoLk 18202 recorded the highest cane yield and CCS yield (102.20 and 13.01 t/ha, respectively) among the test entries, followed by CoS 17231 (83.66 and 11.04 t/ha, respectively). Among the test entries, CoS 17231 recorded the highest sucrose percentage at harvest (18.77%) followed by CoS 17232 (18.67%) and CoPb 18181 (18.30%). Among the standard varieties, Co 0238 was the best for cane yield (97.42 t/ha) and CCS yield (12.92 t/ha).

***Advanced Varietal Trial- Ratoon* (*Early*)**

Four sugarcane genotypes, *viz*., CoS 17231, CoS 17232, CoPb 18181 and CoLk 18202 along with three standards, CoJ 64, Co 0238 and Co 05009 were evaluated for their ratooning ability. The genotype, CoLk 18202 recorded the highest cane yield (89.29 t/ha) and CCS yield (11.39 t/ha). Among the standard varieties, Co 0238 was found to be the best for cane yield (86.96 t/ha) and CCS yield (11.50 t/ha).

***Seed multiplication* (*Early*)**

The seed of 10 sugarcane genotypes, *viz*., Co 21012, Co 21013, Co 21014, CoPb 21181, CoPb 21182, CoLk 21201, CoLk 21202, CoLk 21203, CoPb 21211 and CoH 21261 has been multiplied for next year's IVT.

Evaluation of mid-late sugarcane clones for North West Zone

***Initial Varietal Trial* (*Mid-late*)**

Nine sugarcane clones, *viz*., Co 20017, Co 20018, CoPb 20181, CoLk 20204, CoLk 20205 CoPb 20212, CoS 20231, CoS 20232 and CoS 20234 along with three standards, *viz*., CoS 767, CoPant 97222 and Co 05011 were evaluated for yield and quality parameters. The genotype CoPb 20212 recorded the highest cane yield (124.12 t/ha) followed by CoS 20234 (108.79 t/ha) and CoLk 20204 (106.87 t/ha). The genotype CoPb 20212 showed the highest CCS yield (18.22 t/ha) followed by CoLk 20204 (15.78 t/ha) and CoS 20234 (15.74 t/ha). Among the test genotypes, CoLk 20204 recorded highest sucrose percentage at harvest (20.93%) followed by CoPb 20212 (20.74%) and CoS 20234 (20.46%). Among the standard varieties, Co 05011 recorded the highest CCS yield (13.60 t/ha) followed CoPant 97222 and CoS 767.

***Advanced Varietal Trial I Plant* (*Mid-late*)**

Seven sugarcane genotypes, *viz*., Co 19017, CoPb 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. CoLk 19204 recorded the highest cane yield (120.86 t/ha) followed by CoPb 19213 (118.76 t/ha) and CoS 19235 (117.85 t/ha). Similarly, Co 19017 exhibited the highest sucrose % at harvest (20.14%) followed by CoLk 19204 (19.17 %) and CoPb 19182 (19.13 %). Among the standard varieties, CoPant 97222 was found to be the best for cane yield (98.68 t/ha) and CCS yield (13.58 t/ha).

***Advanced Varietal Trial II Plant* (*Mid-late*)**

Six sugarcane genotypes, *viz*., Co 18022, CoPb 18213, CoPb 18214, CoS 18231, CoS 18232 and CoS 18233 along with three standards, CoS 767, CoPant 97222 and Co 05011 were evaluated for yield and quality parameters. The genotype, CoS 18231 recorded the highest cane yield (105.37 t/ha) followed by Co 18022 (100.30 t/ha). CoS 18231 exhibited the highest sucrose content (%) at harvest (19.84%) followed by CoS 18232 (19.53%) and CoS 18233 (19.03%). Among the standard varieties, CoPant 97222 was found to be the best for cane yield (94.86 t/ha) and CCS yield (13.24 t/ha).

***Advanced Varietal Trial Ratoon* (*Mid-late*)**

Six sugarcane genotypes, *viz*., Co 18022, CoPb 18213, CoPb 18214, CoS 18231, CoS 18232 and CoS 18233 along with three standards, CoS 767, CoPant 97222 and Co 05011 were evaluated for their ratooning ability. The genotype, CoS 18231 recorded the highest cane yield (82.19 t/ha) and CCS yield (10.79 t/ha). Among the standard varieties, CoS 767 was found to be the best for cane yield (79.62 t/ha) and Co 05011 for CCS yield (10.18 t/ha).

***Seed multiplication* (*Mid-late*)**

The seed of ten sugarcane genotypes, *viz*., CoPb 21183, CoPb 21184, CoLk 21204, CoLk 21205, CoLk 21206, CoS 21231, CoS 21232, CoS 21233, CoH 21262, CoH 21263 has been multiplied for next year's IVT.

Evaluation of mid-late sugarcane clones for North Central-North East Zone

***Initial Varietal Trial* (*Early*)**

A total of nine clones were tested including three checks for high sugar and cane yield. Out of six tested clones, *viz*., CoBln 19501, CoP 20436, CoP 20437, CoP 20438, CoLk 20466 & CoLk 20467 three were from PUSA; two from Motipur and one from Buralikson. Among these six, CoLk 20467 maintained its superiority for cane yield (113.28 t ha^{-1}), while, CoLk 20466 was the best performer for Brix and Sucrose (20.15, 17.58, respectively). However, on an overall basis, check variety, CoSe 01421, maintained its superiority for juice quality.

***Advanced Varietal Trial-II Plant* (*Early*)**

Five clones, *viz.* CoSe 18451; CoSe 18452, CoP 18436, CoP 18437 and CoP 18438 were subjected to evaluation for sugar and yield quality attributes in comparison to three reference checks, *viz.*, CoLk 94184, CoSe 95422, and CoSe 01421. Among the tested clones, CoSe 18451 exhibited the highest cane yield at 107.47 t/ha and commercial cane sugars (CCS %) at 12.83%. Conversely, the check variety CoSe 01421 displayed high sucrose content at 17.44%, accompanied by a Brix value of 19.21 at harvest.

***Advanced Varietal Trial-Ratoon* (*Early*)**

Five clones, namely CoSe 18451, CoSe 18452, CoP 18436, CoP 18437 and CoP 18438 underwent evaluation to assess their sugar and yield quality attributes in comparison to three reference checks: CoLk 94184, CoSe 95422, and CoSe 01421. Among the five tested clones, CoSe 18452 and CoP 18438 displayed notable sucrose content levels at 17.37%, and 17.04%, respectively. Furthermore, CoLk 94184 demonstrated the highest cane yield of 71.92 t/ha and commercial cane sugars (CCS %) at 12.02%.

***Initial varietal Trial* (*Mid-late*)**

Seven clones namely CoSe 18453; CoBln 19502; CoP 20439; CoP 20440; CoLk 20468; CoLk 20469; CoBln 20501, with three standard varieties, *viz.*, BO 91, CoP 9301, CoP 06436 were investigated for high yield and sucrose content. Among all, CoLk 20468 exhibited the highest CCS (11.97%), sucrose (17.48%), and Brix value (19.94). Following closely, CoLk 20469 displayed the second highest CCS (11.43%), sucrose (16.71%), and Brix value (18.80) at the time of harvest. Conversely, the highest cane yield was recorded in CoLk 20468 (112.35 t/ha), trailed by CoLk 20469 (108.18 t/ha) and CoP 20439 (103.09 t/ha).

Development of Sugarcane Clones/Varieties for North Central Zone

Crosses were made at National Hybridization Garden, ICAR-SBI, Coimbatore to develop varieties/clones that would be acceptable for the North Central Zone. In this respect, 51 different cross combinations (BP, GC & PC) were attempted, comprising of 29 BP and 22 crosses involving GC and PC during 2023. Fluff of a total 51 crosses was sown. The primary objective of these crosses was to generate healthy seedlings, resulting in the production of approximately 7300 seedlings through the aforementioned crosses. The seedlings successfully raised from crosses attempted in 2022 were in the C_1 stage this year. About 7450 seedlings were produced, and out of these, 520 clones were selected based on juice quality. The segregating population of the subsequent generation is being handled. Juice analyses and morphological observations were also recorded for further assessment and selection. Furthermore, a preliminary varietal trial was established to assess yield, juice quality, and resistance to red rot disease with 14 progenies of bi-parental, self, and general crosses of *Saccharum* hybrid, including four checks. Based on observations from the previous year's trial, three clones were selected for proposal in the Zonal Varietal Trial (ZVT) for NCZ and all three clones, *viz.*, CoLk 16201 (CoSe 92423 × CoH 70); CoLk 16202 (Co 2000-10 × CoSe 92423) and CoLk 19202 (CoJ 99192 × CoS 8436) in the early group and two clones CoLk 19204 (CoS 8436 × CoSe 92423) and CoLk 20204 (CoH 104 GC) in the mid-late maturing group, were accepted for Zonal Varietal Trial in during AICRP (S) Workshop in October, 2024 (Table 1.5).

The following entries were advanced to Advance Varietal Trial I in different maturity groups for further assessment based on their overall performance in the IVT, their response to red rot, and the juice qualities during 2023-24.

Maturity Group	Entries Accepted for AVT 1
Early Maturing	CoLk 20466 and CoLk 20467
Mid Late	CoLk 20468 and CoLk 20469

Table 1.5 Station Trial Performance of Accepted Clones for ZVT Trials for NCZ

Entry	CCS (t ha^{-1})	Cane yield (t ha^{-1})	Sucrose (%)	CCS (%)	Red rot reaction	
					Plug	Nodal
Early						
CoLk 16201	11.01	90.42	17.68	12.18	MR	MR
CoLk 16202	11.68	95.55	17.74	12.22		
CoLk 19202	11.08	91.23	17.64	12.15		
Mid-late						
CoLk 19204	11.27	91.87	17.78	12.27	MR	MR
CoLk 20204	10.70	87.53	17.72	12.23		

While, this year 2024-25 out of four clones two clones, *viz*., CoLk 21468 and CoLk 21469 were promoted from Initial Varietal Trial (Mid-late) to Advance Varietal Trial I (Mid-late).

Station Trial

Thirteen newly developed clones form different cross combinations (BP, GC & PC) were selected based on previous year juice analysis and station trial was established including four checks in RBD with three replications at RC, Motipur. The observations are being recorded for further selection. Based on performance, the best clones will be proposed for AICRP(S) trials during the upcoming workshop.

Identification of location-specific sugarcane genotypes (ICAR-ISMA Collaborative Project)

With reference to the letter No. PME/ISMA/2024-1 dated 20-05-2024 from the Director, ICAR-SBI, Coimbatore, ICAR-ISRI, Lucknow has been added as a partner in the 'ICAR-ISMA Collaborative Project' and an amount of Rs. 100.00 Lakh was approved for five years, 2023-24 to 2027-28 (Rs 20.00 Lakh per year). This collaborative project was initiated to identify location-specific sugarcane genotypes. During the current year (2024-25), TRIAL-I is being conducted at 16 sugar mills farms of sub-tropical India and entries of TRIAL-II are being multiplied at respective sugar mills for next year's trial.

TRIAL-I

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

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

TRIAL-II (Multiplication)

Entries: Co 12027, Co 14034, Co 17015, Co17016, Co 17017, Co18019, Co18020, Co 19016, Co 20015, Co 20018, Co 21013, Co 21014, Co 21015, Co 21016, Co 22020, Co 22021, Co 22022, Co 22023, CoLk 18202, CoLk 19201, CoLk 19202, CoLk 20201, CoLk 20202, CoLk 20204.

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

Germplasm maintenance and pre-breeding for improved genetic stocks.

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

The 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., was maintained and the required material was supplied to various on-going projects of the Institute. It includes 183 commercial hybrids, 51 ISH and *Ikshu* ISH lines, 71 LG clones and 30 species level genotypes. A 'Varietal Cafeteria' comprising of 20 early and mid-late maturing varieties was planted in March 2023 to provide an opportunity for farmer to select varieties of their choice. DUS character-based characterization is being carried out for the LG clones in the collection.

Defining ideotypes in sugarcane for moisture deficit conditions

The project aimed to screen sugarcane genotypes (varieties, clones, and IGH/ISH) under moisture deficit conditions. A total of 34 sugarcane genotypes were tested against four check varieties (BO 91, CoLk 94184, CoSe 01421, and CoLk 15466) for tolerance toward moisture deficit conditions. Under irrigated conditions, the single cane weight of 20 genotypes showed promising results against all checks. The best six genotypes having high single cane weight were LG 20983 (1.20 kg), LG 20986 (1.15 kg), LG 20974 (1.36 kg), LG 20985 (1.25 kg), LG 20972 (1.09 kg), LG 20984 (1.03 kg). None of the genotypes had the highier HR Brix against checks, however, LG 20990 with a 20.09% Brix value was closest to the highest check, CoLk 94184 with a 21.42% under the same conditions. Three genotypes, *viz*., LG 20992, LG 20990 and LG 20982 showed high sucrose content of 19.22, 18.94, 18.52%, respectively, while one genotype, LG 20969 (18.1%) was at par with the checks, *viz*., CoLk 15466 (18.41%), CoSe 01421 (17.62%), CoLk 94184 (18.84%), BO 91 (16.42%). For cane height, 12 genotypes outperformed against the best check (CoLk 15466 (217 cm), however, LG 20983 (330 cm), LG 20976 (249.4 cm), LG 20974 (245 cm), LG 20965 (244 cm) and LG 20973 (236 cm) were the top five genotypes. For cane diameter, 29 genotypes showed superior results against the best check BO 91 (1.96 cm). Of 34 genotypes, the best five genotypes were LG 20983 (3.20 cm), LG 20986 (3.02 cm), LG 20977 (2.86 cm), LG 20987 (2.82 cm) and LG 20984 (2.78 cm). Ten genotypes showed the highest leaf weight against the best check BO 91 (0.051 kg). Of these, the best four were LG 20972 (0.09 kg), LG 20965 (0.08 kg), LG 20974 (0.08 kg), LG 20985 (0.07 kg). In addition, three genotypes, LG 20991, LG 20992 and LG 20982 showed promising results for single cane weight, sucrose content (%), cane height, and cane diameter under both irrigated and drought stress conditions against checks. Under drought stress conditions, 11 genotypes

showed superior results in single cane weight against the highest check value of 0.75 kg in CoLk 94184. Of these, the best five were LG 20984 (1.18 kg), LG 20985 (1.09 kg), LG 20986 (1.08 kg), LG 20974 (1.05 kg) and LG 20992 (1.02 kg). Sucrose content was higher in four genotypes, *viz*., LG 20990 (18.53%), LG 20982 (18.45%), LG 20991 (18.38%) and LG 20963 (18.32%), LG 20968 (18.25%) against all checks, *viz*., CoLk 15466 (17.77%), CoSe 01421 (14.49%), CoLk 94184 (18.26%) and BO 91 (16.42%). Besides, three genotypes, LG 20990 (20.63%), LG 20965 (20.56%) and LG 20982 (20.40%) recorded higher sucrose Brix value against the check variety CoLk 94184 (20.45%). Besides, all the tested genotypes showed increased cane diameter ranging from 2.04 cm (LG 20962 and LG 20971) to 2.96 cm (LG 20984) except LG 20982 with 1.94 cm against best check, CoSe 01421 (1.92 cm) under drought stress conditions. For cane height, 17 genotypes outperformed against best check, CoLk 15466 (179 cm); the best eight genotypes were LG 20991 (231 cm), LG 20973 (225 cm), LG 20985 (223 cm), LG 20976 (215 cm), LG 20992 (213 cm), LG 20970 (208 cm), LG 20965 (206 cm), LG 20979 (204 cm).

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 being evaluated in the clonal stages exhibited variation with respect to the sucrose content and other morphological traits. The juice analysis carried out in the month of January-February 2024 showed four sugarcane genotypes, *viz*., LG 15566, LG 16527, LG 16579 and LG 16583 with more than 20% mean sucrose in juice in January 2024. These clones showed an increase of 5.9-7.9% over the standard check Co 0238 for mean sucrose % in juice. An increase of 7-8% over Co 0238 was exhibited for CCS%. 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 2023 showed satisfactory germination in the different crosses. The crosses involving the clones LG 14564, LG 08422, LG 01200, LG 01118 and LG 01030 exhibited good germination (>50%). These were transplanted to the field and were ratooned for synchronous growth and tillering. The HR Brix readings recorded in the seedlings transplanted to field in 2023 indicated that approximately 10 % of the seedlings had a mean HR brix values more than 20 (°Brix) in January. The seedlings from crosses involving LG 14564 exhibited a higher proportion of stools having mean HR brix values > 20% in January.

Three promising clones CoLk 19201, CoLk 20203 (all early maturing) and CoLk 20205 (mid-late maturing) are being tested in the multi-location trials of AICRP (Sugarcane). One promising clone CoLk 21203 has been advanced to Advanced Varietal Trial under the AICRP multi-locational trials. Two promising genotypes LG 15482 and LG 16558 are being evaluated in the divisional station trial.

Characterization of genetically diverse sugarcane genotypes for winter sprouting potential and their association with yield and quality traits

A total of 280 genetically diverse sugarcane genotypes comprising released subtropical varieties, ISH and IGH clones, advanced clones and somaclonal variants along with 8 checks randomly distributed in each blocks were planted in spring 2024. The data on percentage of alive and sprouted clumps per plot and number of sprouted tiller per clump to calculate winter sprouting potential would be taken 45 days after ratooning of clones.

Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority

Maintenance of reference collection of sugarcane varieties

One hundred and eighty sugarcane clones were maintained as reference collection for the sugarcane DUS Testing during the crop season 2023-24. 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 organizations 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 already been submitted to the Authority. The DUS Testing Trial (2024-25/First year) comprising of 04 newly released sugarcane varieties i.e. 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 intervention for accelerated genetic gains

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

NanoLCMS/MS based investigation of sugarcane proteome revealed the involvement of *C. falcatum* infection on sucrose metabolism in stalk tissues. It was found that *C. falcatum* promotes sucrose biosynthesis in CoJ 64 cultivar by enhancing the abundance of SPS-1, 4, 12, 14, and SPP-1, 2, 3, 5. In case of invertases, implicated in sucrose degradation, *C. falcatum* infection induced the abundance of AI proteins (SAI-1, 2, 3, 8, 9, 12, 14, CWI-2, VI-1), whereas the abundance of ANI proteins was reduced (ANI-1, 4, 6, 10, 11) in BO 91 cultivar. Similarly, fungal infection also reduced the peptide abundance of ANIs (ANI-6, 10) in CoJ 64 cultivar. Peptide abundance of SuSy proteins, involved in irreversible catalysis of sucrose, was also enhanced by fungal infection in both the cultivars of sugarcane. It was found that SuSy-1 and 4 in BO 91 cultivar, and SuSy-1 and 6 in CoJ 64 cultivar were significantly induced by *C. falcatum* infection.

Sugarcane proteome was further investigated for the effect of *C. falcatum* infection on sucrose transport. Whole proteome analysis of moderately red rot resistant (BO 91) and susceptible (CoJ 64) cultivars of sugarcane revealed the presence of eight SUT proteins in stalk tissues, named as SUT-1 to SUT-8. Differential peptide abundance analysis revealed that majority of SUT proteins were considerably inhibited by *C. falcatum* infection in sugarcane (Fig. 1.6 & 1.7). In stalk tissues of moderately red rot resistant cultivar (BO 91), the peptide abundance of five SUT proteins (SUT-1, 5, 6, 7, and 8) was suppressed, whereas the abundance of only one SUT protein (SUT-2) was induced by *C. falcatum* infection. Among the SUT proteins of red rot susceptible cultivar (CoJ 64), the peptide abundance of SUT-5 was hampered by *C. falcatum* infection. Further, it was observed the peptide abundance of SUT-3 and 4 remained unaffected after *C. falcatum* infection in both the cultivars of sugarcane. Our results indicate that sucrose transport is hampered in sugarcane stalks after *C. falcatum* infection.

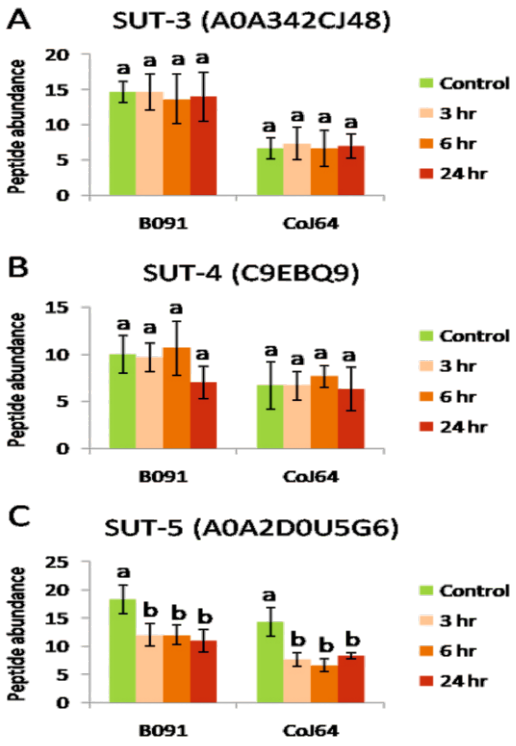


Fig. 1.6 (A-C). *Peptide abundance of sucrose transporter (SUT) proteins (A. SUT-3, B. SUT-4, C. SUT-5, D. SUT-1, SUT-2, SUT-6 SUT-7, and SUT-8) in moderately red rot resistant (BO 91) and red rot susceptible (CoJ 64) cultivars of sugarcane after C. falcatum inoculation.*

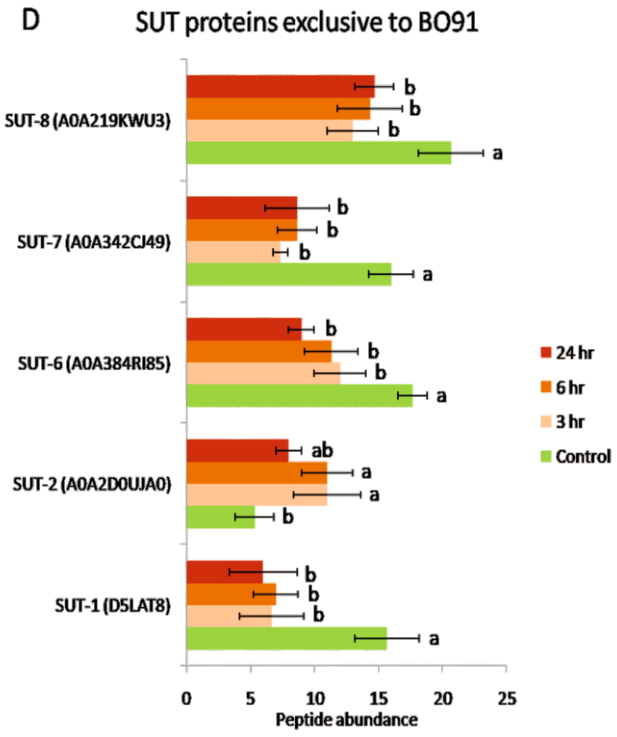


Fig. 1.7 (D) *represents the SUT proteins exclusively present in BO 91 cultivar. Samples for LCMS/MS-based proteome analysis were collected in biological triplicates at 3, 6, and 24 hr after fungal inoculation.*

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

Real time qRT-PCR was performed to investigate the relative expression of selected genes involved in sucrose metabolism including SPS-1, SPS-2, SPP-3, SAI-1, SAI-3, CWI-2, ANI-6, ANI-10, SuSy-1, and SuSy-3 (Fig. 1.8 a & b). To a large extent, the change in expression of selected genes was in agreement with the change in peptide abundance of corresponding proteins. In case of genes implicated in irreversible sucrose biosynthesis, the expression of SPS-1 was significantly reduced, whereas that of SPS-2, and SPP-3 remained statistically unaffected in moderately red rot resistant cultivar (BO 91) of sugarcane after *C. falcatum* infection. However, in red rot susceptible (CoJ 64) cultivar, we observed enhanced expression of SPS-1, and SPP-3, whereas the expression of SPS-2 was reduced after *C. falcatum* infection. Among SuSy genes, the expression of both the genes (SuSy-1, and 3) remained unchanged in BO 91 cultivar of sugarcane, while in CoJ 64 cultivar, the expression of SuSy-1 was considerably reduced after *C. falcatum* inoculation. Interesting results were noticed in case of invertase genes of sugarcane after *C. falcatum* infection. All the AI genes (SAI-1, 3, and CWI-2), excluding CWI-2 in CoJ64 cultivar, were significantly induced in both the cultivars (BO 91, and CoJ 64) of sugarcane by *C. falcatum* infection. Contrarily, the expression of both the ANI genes (ANI-6, and 10) was reasonably inhibited by *C. falcatum* infection in both the cultivars of sugarcane. The results of qRT-PCR expression analysis signify a significant correlation with the findings of LC-MS/MS-based proteomics data.

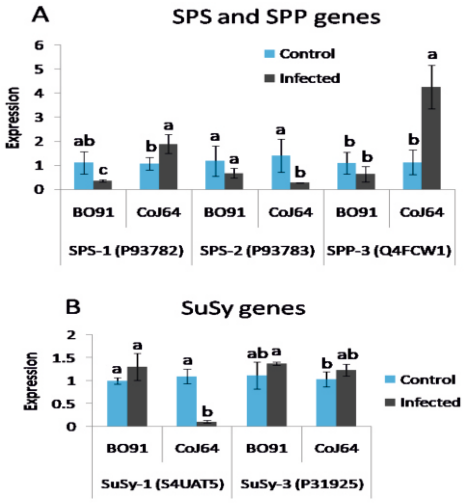


Fig. 1.8a *Influence of Colletotrichum falcatum infection on the expression (Log_2 fold change) of genes associated with sucrose metabolism (A. SPS and SPP genes; B. SuSy genes;*

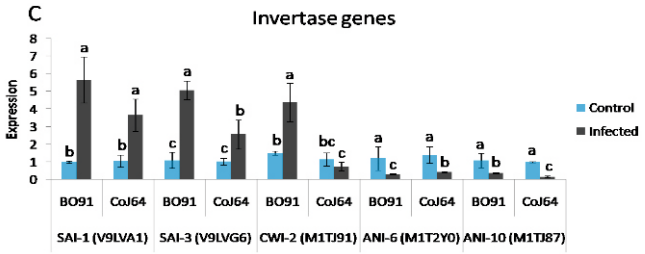


Fig 1.8b *Investase genes in moderately red rot resistant (BO 91), and susceptible (CoJ 64) cultivars of sugarcane. Stalk samples were taken after 24 hr of fungal inoculation in biological triplicates.*

Enhancing climate resilience and ensuring food security with genome editing tool (ICAR, New Delhi)

Lignin content modification: Caffeic acid/5-hydroxyferulic acid *O*-methyltransferase (*COMT*) is a crucial gene associated with lignin biosynthesis, its product 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. The sugarcane genome database (https://sugarcane-genome.cirad.fr/) was searched to obtain the information about the number of COMT gene homologues and their respective sequences including exons and introns. Seven homologues of *COMT* gene were found, each having two exons (Exon-1 and Exon-2). Discrete primers for each homologue were designed to get the respective gene sequences of homologues in sugarcane variety Co 0238. A single gRNA sequence from the consensus sequence common in Exon-1 of all the homologues and by using PAM motif (NGG) of Cas9 endonuclease has been designed.

Sucrose content modification: Novel genes related to sucrose accumulation, specifically members of the bZIP and AP2/ERF transcription factor (TF) families, were identified. These TF genes are known to be closely linked to sucrose metabolism in higher plants. To locate bZIP and AP2/ERF family genes in sugarcane, *Sorghum bicolor* protein sequences along with few closely related grass members were used as queries in a BLASTp search against the R570 genome. The identified genes were then analyzed for phylogenetic relationships and chromosomal distribution. Ten conserved motifs of the selected genes were identified. In the case of bZIP-TF gene(s), conserved uORF enables translational control of mORF region. So, uORF analyses were performed with the help of Atkinson's lab server portal. Non-canonical and canonical

initiation codons were identified to target CRISPR-mediated knockouts (KO). However, conserved allelic region of mRNA were targeted in the case of *Sc*RAV gene. The targeted KO mutants of the uORF and mORF of the bZIP and RAV gene(s), respectively, could potentially enhance sugar productivity in sugarcane cultivars. Further, the protocols for caulogenesis and somatic embryogenesis is being developed to utilize them for efficient gene delivery in sugarcane through particle bombardment.

Red rot and Yellow Leaf Disease

The *LHT1* gene is existing the form of 17 transcripts on chromosome 5 and 8, *GAD* gene is present as 8 transcripts on chromosomes 1 and 9 and *PP2A* gene has 7 transcripts on chromosomes 6 and 9. The different homologs of the three genes were validated in the varieties Co 0238 and CoJ 64 by designing specific primers for each of these individually. The PCR amplicons were sanger sequenced and the conserved regions were identified through multiple sequence alignment. The conserved regions of all the

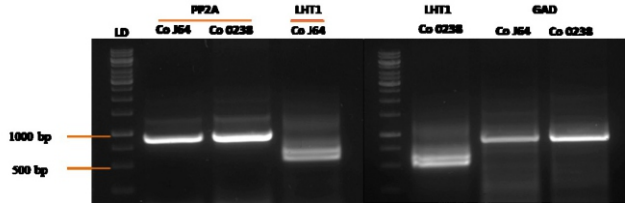


Fig. 1.9. *Amplicon size of common region for all transcripts of three amplified genes (PP2A, LHT and GAD) in CoJ 64 and Co 0238; LD represents 100 bp ladder; Expected band sizes: PP6T = 860 bp; LHT1 = 510 bp; GAD_8T = 890 bp.*

three genes were also validated on both varieties.

Production of Disease free and genetically pure cane seed through tissue culture techniques

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 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 2024, a total of 30042 (as against 14953 samples in 2023) were tested, out of which 2664 samples comprising of 190 samples of sugarcane, 2460 of banana and 14 of potato from DBT recognized tissue culture production facilities were tested for mother stock virus indexing. Of the total samples, 27378 samples comprising of 23966 samples of banana and 3412 of potato were tested for genetic fidelity testing, which equals to quality certification of ~27 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)].

Quality Seed production and clean seed program.

Online Seed Indent Portal

An online seed indent system was started for sale of sugarcane seed to farmers. Seed indents from 1000+ farmers were received during Oct-Nov, 2024 issued by respective division / section.

Seed production in agricultural crops (ICAR Seed Project)

During the year 2023-24, approximately 10430 quintals of seed cane was produced. CoLk 14201 is high 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 sugar mill, farmers and farmers engaged in Jaggery making. More than 12 lakhs single buds of newly released sugarcane varieties (CoLk 15466, CoLk 16202, CoLk 15201) were supplied during 2023-24.

Table 1.6 Seed cane availability during the crop season 2024-25

Sl. No.	Variety	Total expected quantity available (Q)
Early		
1	CoLk 16202	2650
2	CoLk 14201	2500
3	CoLk 15466	1600
4	CoLk 11203	1600
5.	CoLk 9709	250
6.	CoLk 12207	100
7.	CoLk 94184	100
8.	CoLk 16466	50
Mid-Late		
9.	CoLk 16470	50
10	CoLk 15207	400
11.	CoLk 14204	400
12.	CoLk 15206	250
13.	CoLk 11206	100
14.	CoLk 12209	100
	Total	**10150**

Under Seed Cane Awareness, seed of newly released varieties CoLk 16202, CoLk 15206, CoLk 15201, 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 organized at the Institute.

During the year 2024-25, ~12.0 ha area was planted with newly released varieties for seed cane production during autumn season 2023 and spring season of 2024. New varieties like CoLk 16202 and CoLk 15206 were included in the seed production program. More than 10 lakh buds of CoLk 16202 were supplied to the Cane Development Councils of the cane growing districts of Central and Western Uttar Pradesh through the allotment by the Cane Commissioner, Government of Uttar Pradesh during the current autumn season (Oct 2024). Similarly, 05 lakh buds of CoLk 15466 were supplied to the Cane development Councils of the cane growing districts of Eastern Uttar Pradesh through the allotment by the Cane Commissioner, Government of Uttar Pradesh during the current autumn season (Oct 2024). More than 1600 q seed cane of the variety CoLk 14201 was supplied to the different Cane Development Council of Sitapur and Lakhimpur districts during Oct, 2024. In addition, 1003 sugarcane farmers booked their seed requirement of CoLk 16202 and CoLk 15466 through ONLINE PORTAL on Institute website. Each farmer was given 300 single buds of the variety of their choice during the Oct-Nov, 2024.

Sugarcane Seed Distribution to SC/ST farmers

Approximately 639 quintals of seed cane of the variety CoLk 14201 was distributed among SC/ST farmers of Ayodhya and Barabanki districts under SCSP program being undertaken at ICAR-ISRI, Lucknow.

Bihar Sugarcane Breeder Seed Production Program

ISRI RC, Motipur is handling the BSP project which is funded by SID, Patna. Under this program, 17588 quintals of seed of five varieties (CoLk 12207; CoLk 12209; CoLk 94184; CoP 9301 & Co 0118) was produced at four different centers including ISRI RC, Motipur and sugar mills of Bihar in 30 ha during 2023-24. During the current year breeder seed is being produced in 29 ha area at four different centers, namely ISRI RC, Motipur; New Swadeshi Sugar Mills, Narkatiyaganj; Harinagar Sugar Mills, Harinagar; and Tirupati Sugars Ltd., Bagaha. To continue this programme, a Memorandum of Understanding (MoU) has been signed between ICAR-ISRI, Lucknow & Sugarcane Industries Department(SID), Patna, Govt. of Bihar (Bihar) on 2nd September, 2024 for harnessing the yield potential of the sugarcane crop, and benefits of stakeholders and sugar mills of Bihar. Breeder seed of recently developed sugarcane varieties of ISRI, such as CoLk 12207 and CoLk 12209, is being produced under this initiative. In the upcoming season, CoLk 15466, CoLk 16466, and CoLk 16470 will be added to the seed chain for breeder seed production. Further the sugarcane variery CoLk 14201 has been released for the state of Bihar also.

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

This year, demand for providing, virus indexed mother stock cultures was received from M/s Balrampur Chini Mills Limited, Haidergarh TC Unit (CoLk 94184, CoLk 14201), M/s UP Cooperative Sugar Mills, Azamgarh Unit (CoLk 14201), and Nasirpur Farms, Patiala (CoLk 16202). The requested mother stock cultures were supplied to tissue culture units. A total of 110 nos. of fresh *in vitro* cultures of new sugarcane varieties, CoLk 14201 (early: 27 stocks), CoLk 15201 (early: 08 stocks), CoLk 15466 (early: 20 stocks), CoLk 15207 (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 different cycles of multiplication. The *in vitro* cultures of varieties CoLk 09204, CoLk 94184, CoLk 11203, CoLk 11206, CoLk 12207 and CoLk 12209 are also being maintained.

In vitro cultures of sugarcane variety CoLk 14201 (*Ikshu*-10) and CoLk 15201 (*Ikshu*-11), and CoLk 94184 were multiplied through enhanced axillary shoot proliferation using apical shoot explants, and ~20000 PTC-raised plantlets were transferred to field conditions after acclimatization and hardening.

Revenue generation

During the F.Y. 2023-24, a total of Rs. 45.30 lakhs revenue was generated through sale of sugarcane planting material (Seed cane). The sugarcane seed was supplied to different *Ganna Vikas Parishad* located in different districts of Uttar Pradesh and sugarcane seeds of different varieties were provided to different farmers.

CHAPTER 2

Natural Resource Management

Development of smart agronomic techniques for enhanced sugarcane productivity and climate resilience

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

Cyperus rotundus L. (purple nut-sedge) has become a dominant weed in sugarcane fields in India, comprising 60-80% of the weed flora. Herbicides like atrazine, metribuzin, and 2, 4-D have reduced other weed species but promoted *C. rotundus* growth, leading to significant competition with the crop and yield losses. Frequent irrigation and fertilizer use further worsen the weed problem. No single control method is effective long-term, prompting the need for an integrated approach. A project launched in 2023-24 aims to develop sustainable strategies for managing *C. rotundus* in sugarcane through ecological insights and cultural practices. To enhance the research and provide comprehensive insights, the project consists of two key experiments, as detailed below:

a). Effect of herbicide combinations on population and dry weight of *C. rotundus* and other weeds in sugarcane

An experiment was conducted to evaluate the efficacy of new herbicide molecules, either alone or in combination as tank-mix formulations, against *Cyperus rotundus* in sugarcane using a Randomized Block Design (RBD) with three replications. All herbicide treatments, whether applied alone, sequentially, or as tank mixes, were significantly more effective in controlling *C. rotundus* and other weeds compared to the weedy check. Treatments comprising sequential application of sulfentrazone as a pre-plant incorporation (PPI) followed by sulfentrazone as a post-emergence (PE), or 2, 4-D as a post-emergence (PO) treatment, or a tank-mix application with ametryn at 1.0 kg/ha were found significantly less effective against *C. rotundus* as compared to other herbicides. However, these treatments were most effective in controlling other weeds such as *Dactyloctenium aegyptium* and *Paspalum distichum*. Post-emergence applications of halosulfuron at 70 g ha^{-1}, flaxasulfuron at 37.5 g ha^{-1}, and ethoxysulfuron at 60 g ha^{-1}, either alone or in combination with 2, 4-D at 1000 g ha^{-1}, significantly reduced the *C. rotundus* population but were less effective against grasses. Similarly, the application of sulfentrazone at 1.0 kg ha^{-1} as PPI followed by either sulfentrazone at 1.0 kg ha^{-1} as PE, 2, 4-D at 1.5 kg ha^{-1} as PO, or a tank-mixed application of sulfentrazone at 0.75 kg ha^{-1}+ ametryn at 1.0 kg ha^{-1} resulted in significantly higher tillers, NMC, cane length, and cane yield due to effective reduction of *C. rotundus* growth and other grassy weeds, as well as total weed population and weed dry weight. However, halosulfuron, flaxasulfuron, and ethoxysulfuron did not improve tillers, NMC, or cane yield due to insufficient control of dominant grassy weeds. For broad-spectrum weed management, both sedge and grass-killer herbicides should be used in combination.

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

Treatment	Weed population Nos. m^{-2} at 120 DAP				Weed dry matter (g m^{-2}) at 120 DAP			
	Cyperus rotundus	*Dactyloctenium aegyptium*	*Paspalum distichum*	*Total*	*Cyperus rotundus*	*Dactyloctenium aegyptium*	*Paspalum distichum*	*Total*
Sulfentrazone 0.75-1.0 kg/ha PPI & PE	5.4* (28.2)	1.5 (1.3)	1.0 (0.0)	5.67 (31.2)	4.1 (15.8)	2.6 (5.8)	1.0 (0.0)	5.3 (27.1)
Sulfentrazone 0.75-1.0 kg/ha PE + Ametryn @ 1.0 kg/ha PE	5.1 (25.0)	1.0 (0.0)	1.2 (0.4)	5.2 (26.0)	3.9 (14.2)	1.0 (0.0)	1.7 (1.9)	4.1 (15.8)
Sulfentrazone 0.75-1.0 kg/ha PE+2,4-D @ 1.5 kg/ha PO	4.5 (19.3)	1.4 (1.0)	1.0 (0.0)	4.5 (19.3)	3.8 (13.4)	2.3 (4.3)	1.0 (0.0)	4.6 (20.2)

Halosulfuron 0.067 kg/ha PO	3.7 (12.7)	4.0 (15.0)	1.0 (0.0)	5.3 27.1)	3.4 (10.6)	11.6 (133.6)	1.0 (0.0)	12.1 (145.4)
Flaxasulfuron 0.0375 kg/ha PO	3.7 (12.7)	3.7 (12.7)	1.5 (1.3)	5.3 (27.1)	3.6 (12.0)	10.7 (113.5)	2.6 (5.8)	11.6 (133.6)
Ethoxysulfuron 0.06 kg/ha PO	4.5 (19.3)	4.5 (19.3)	1.6 (1.6)	6.5 (41.3)	3.8 (13.4)	12.3 (150.3)	2.5 (5.3)	13.1 (170.6)
Halosulfuron 0.067 kg/ha + 2,4-D @ 1.0 kg/ha PO	3.2 (9.2)	4.5 (19.3)	1.2 (0.4)	5.5 (2.3)	3.1 (8.6)	12.2 (14.8)	2.1 (3.4)	12.7 (160.0)
Flaxasulfuron 0.0375 kg/ha + 2,4-D @ 1.0 kg/ha PO	3.3 (9.9)	4.3 (17.5)	1.6 (1.6)	5.5 (29.3)	3.4 (10.6)	11.4 (129.0)	2.6 (5.8)	12.2 (147.8)
Ethoxysulfuron 0.06 kg/ha + 2,4-D 1.0 kg/ha PO	3.5 (11.3)	4.8 (22.0)	1.9 (2.6)	6.1 (36.2)	3.6 (12.0)	13.3 (176.0)	3.2 (9.2)	14.1 (197.8)
Weedy check (Control)	6.5 (41.3)	4.8 (22.0)	2.1 (3.4)	8.3 (67.9)	5.7 (31.5)	15.6 (242.4)	3.1 (8.6)	17.5 (305.3)
SE(m)	0.3	0.3	0.4	0.3	0.4	1.5	1.0	1.4
LSD (p=0.05)	0.8	1.0	NS	0.9	1.3	4.6	NS	4.2

*Data is subjected to square root transformation using √X+1. Values in parentheses are original.

Table 2.2 : Effect of herbicide combinations on growth parameters and cane yield of sugarcane

Treatment	Germination (%)	Tillers 120 DAP	NMC (000 ha^{-1})	Cane length (m)	Cane weight (kg)	Cane girth (mm)	Cane yield (t ha^{-1})
Sulfentrazone 0.75-1.0 kg/ha PPI & PE	38.446	154.700	108.900	1.790	0.827	23.697	96.533
Sulfentrazone 0.75-1.0 kg/ha PE+Ametryn 1.0 kg/ha PE	38.783	167.300	112.833	1.867	0.740	24.180	97.767
Sulfentrazone 0.75-1.0 kg/ha PE+2,4-D @ 1.5 kg/ha Po	38.180	152.967	101.833	1.757	0.753	24.427	93.400
Halosulfuron 0.067 kg/ha PO	36.755	145.567	91.367	1.480	0.747	23.273	89.700
Flaxasulfuron 0.0375 kg/ha PO	37.567	143.333	85.700	1.530	0.740	23.477	86.600
Ethoxysulfuron 0.06 kg/ha PO	36.393	142.967	85.067	1.493	0.727	24.130	82.500
Halosulfuron 0.067 kg/ha + 2,4-D 1.0 kg/ha PO	36.055	138.033	83.000	1.450	0.727	21.841	80.800
Flaxasulfuron 0.0375 kg/ha + 2,4-D @ 1.0 kg/ha PO	34.663	134.700	81.733	1.430	0.713	20.805	80.567
Ethoxysulfuron 0.06 kg/ha + 2,4-D 1.0 kg/ha PO	34.558	133.833	73.300	1.410	0.653	21.783	77.967
Weedy check (Control)	34.656	128.533	73.300	1.303	0.620	21.350	71.200
SE(m)	0.962	16.342	3.471	0.094	0.042	0.931	4.527
LSD (p=0.05)	2.880	NS	10.393	0.283	NS	NS	13.556

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

A field experiment was conducted with 10 treatments, including deep summer ploughing combined with either green manuring *in situ* (*Sesbania* sp.) or two post-emergence application of glyphosate, both supplemented with stale seed bed preparation using herbicide. These treatments were further superimposed with a pre-emergence application of sulfentrazone at 0.75 kg ha^{-1}, followed by mulching with previous crop residues and post-emergence applications of halosulfuron at 0.07 kg ha^{-1} + 2, 4-D at 1.5 kg ha^{-1}. Additionally, a pre-emergence application of atrazine at 2.0 kg $ha^{-1}$and a post-emergence application of 2,4-D at 1.0 kg ha^{-1} at 60 days after planting (DAP), followed by one inter-culture operation at 90 DAP, were used as standard check, along with a farmers practice control (deep summer ploughing only). The experiment was laid out in a Randomized Block Design (RBD) with three replications.

The density, number of tubers per unit area and dry matter production of *Cyperus rotundus* were recorded at 60 and 90 DAP. Results showed that all treatments significantly reduced the population and number of tubers of *C. rotundus* compared to the control (farmers practice). The trend was similar for the dry weight of both *C. rotundus* plants and tubers. Superimposing halosulfuron at 0.07 kg/ha post-emergence over deep summer ploughing, followed by two glyphosate applications at 1.5%, stale seed bed preparation, and retention of previous crop residues reduced the density of *C. rotundus* by 75% and 91%, the number of tubers by 53.0% and 55.3%, the dry weight of *C. rotundus* by 68.6% and 72%, and the dry weight of tubers by 77.2% and 78.7% at 60 and 90 DAP, respectively. The highest population of *C. rotundus* (304 and 302/m^2), number of tubers (193.3 and 180.7/m^2), dry weight of *C. rotundus* (156.6 and 100.3 g), and dry weight of tubers (78.9 and 60.8 g) were recorded under the farmers practice. Germination (%) at 45, and number of tillers at 90 DAP were not significantly affected by various weed control measures.

Table 2.3 : Effect of integrated weed control practices on the number of *C. rotundus* plants and tubers

	Treatment	Number of *C. rotundus* plants m^{-2}		Number of tubers m^{-2}	
		60 DAP	90 DAP	60 DAP	90 DAP
T_1	Deep summer ploughing (May-June) + Green manuring (July-August) + oilseed (September-February) fb sugarcane planting	163.0	233.3	145.3	140.7
T_2	Deep summer ploughing (May-June) fb Glyphosate application twice (July-August) + oilseed crops fb sugarcane planting	148.7	153.3	130.7	134.7
T_3	T1 + Stale seed bed (March through herbicide) before planting of Sugarcane	157.0	141.3	131.3	126.7
T_4	T2 + Stale seed bed (March through herbicide) before planting of Sugarcane	140.3	127.0	117.3	120.0
T_5	T3 + pre-emergence application of sulfentrazone @ 0.75 kg/ha PE *fb* mulching with previous crop residues	109.3	107.3	115.3	106.0
T_6	T4 + pre-emergence application of sulfentrazone @ 0.75 kg/ha PE *fb* mulching with previous crop residues	119.0	91.0	96.7	111.7
T_7	T5 + post-emergence application of halosulfuron @ 0.07 kg/ha + 2,4-D @ 1.5 kg/ha (PO)	112.7	74.0	94.7	84.7
T_8	T6 + post-emergence application of halosulfuron @ 0.07 kg/ha+ 2,4-D @ 1.5 kg/ha (PO)	99.0	43.3	83.3	80.7
T_9	Atrazine 2.0 kg PE + 2,4 -D 1.0 kg/ha at 60 DAP fb interculture at 90 DAP (ISRI Recommended practice)	131.3	107.3	99.3	118.7
T_{10}	Control (Farmers practice) *ie* early rice fb mustard - sugarcane	304.0	302.0	193.3	180.7
	SE (m)	33.3	26.5	20.2	22.4
	LSD (p=0.05)	99.6	79.2	60.4	66.7

**fb* = followed by

Table 2.4 : Dry weight of C *rotundus* plants and tubers as influenced by integrated weed control practices

	Treatment	Dry weight of C *rotundus* Plants(gm^{-2})		Dry weight of tubers (g m^{-2})	
		60 DAP	**90 DAP**	**60 DAP**	**90 DAP**
T_1	Deep summer ploughing (May -June) + Green manuring (July-August) + oilseed (September - February) fb sugarcane planting	120.53	83.45	68.307	34.97
T_2	Deep summer ploughing (May - June) fb Glyphosate application twice (July - August) + oilseed crops fb sugarcane planting	91.17	62.64	53.040	33.78
T_3	T1 + Stale seed bed (March through herbicide) before planting of sugarcane	80.84	61.70	36.227	32.93
T_4	T2 + Stale seed bed (March through herbicide) before planting of sugarcane	78.45	54.26	34.680	32.84
T_5	T3 + pre -emergence application of sulfentrazone 0.75 kg/ha PE *fb* mulching with previous crop residues	69.19	60.25	32.867	23.55
T_6	T4 + pre -emergence application of sulfentrazone 0.75 kg/ha PE *fb* mulching with previous crop residues	57.77	49.63	24.000	22.14
T_7	T5 + post -emergence application of halosulfuron 0.07 kg/ha + 2,4-D 1.5 kg/ha (PO)	60.29	44.57	23.860	16.75
T_8	T6 + post -emergence app lication of halosulfuron 0.07 kg/ha+ 2,4-D 1.5 kg/ha (PO)	50.05	27.84	17.973	12.44
T_9	Atrazine 2.0 kg PE + 2,4 - D 1.0 kg/ha at 60 DAP fb interculture at 90 DAP (ISRI Recommended practice)	63.25	57.78	44.053	32.73
T_{10}	Control (Farmers practice) ie early rice fb mustard - sugarcane	156.46	100.31	78.893	60.78
	SE (m)	45.78	N/A	23.364	16.81
	LSD (p=0.05)	15.29	16.66	7.80	5.61

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

A field experiment to assess the influence of IW/ CPE based irrigation regime and field moisture management practices on sugarcane growth and yield, water productivity and water footprint was initiated in February 2021. During the year (2024-25), performance of second ratoon of the system planted in 2022 and third ratoon of the system planted in 2021 as influenced under various treatments was assessed. The second ratoon crop was initiated on 20th February 2024 and was harvested in January first week of 2025. The third ratoon crop was initiated on 15.02.2024 and harvesting was done on 30.12.2024. Both the experimental fields consisted of plots (7x6 m) with four paired rows of sugarcane in 150:30 configuration and trenches so formed remained intact for applying irrigation treatments till the onset of monsoon. Earthing up, during rainy season, resulted in trench formation in the inter-row spaces that were used for post-monsoon irrigation treatments. The crop was given a general irrigation 30 DARI and thereafter irrigation scheduling was adopted as per the technical programme. The experiment consisted of maintaining irrigation regimes (03) based on IW/ CPE ratio 1.0, 0.8 and 0.6 with irrigation depth of 75 mm. Six moisture management practices *viz.,* 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) were taken. Quantity of water applied to every plot for each irrigation was measured with the help of a water meter. Irrigation regimes were laid to main plots and moisture management practices to sub-plots. Strip plot design with 03 replications was adopted. Data recorded and analysed during the year indicate:

Second ratoon crop

1. Irrigation regimes exerted significant influence over growth and yield of sugarcane. The number of tillers (140 DAP), number of millable canes, and cane yield were recorded significantly higher with IW: CPE ratio being 1.0 and 0.8 over those recorded with IW: CPE ratio being 0.6.
2. Sugarcane juice quality was not influenced by irrigation regimes or the methods of irrigation.

3. As far total water productivity under different irrigation regimes, the best (194.84 L kg^{-1}) was recorded with IW: CPE ratio 0.6 against 186.83 L kg^{-1} under IW: CPE ration 0.8. However, the water productivity of the applied irrigation water was found best under IW: CPE ratio 0.6 (82.21 L kg^{-1}) followed by the ratio 0.8 (89.13 L kg^{-1}).
4. The water footprint of sugarcane second ratoon cultivation ranged between 120.86 L kg^{-1} and 139.35 L kg^{-1} for different irrigation regimes wherein IW: CPE ratio 0.8 recorded the minimum water footprint. Among methods of irrigation, the flood irrigation with mulching generated the lowest water footprint (117.35 L kg^{-1}).
5. Partitioning of water footprint among green, blue and grey components revealed that rains contribute about 50 – 60 % to total water footprint and the crop depends on irrigation water only for 40 – 50 % of its water requirement.

Third Ratoon Crop

1. 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.
2. The highest ratoon yield was harvested under the irrigation regime with IW: CPE ratio 1.0 statistically similar to that recorded with IW: CPE ration 0.8.
3. Irrigation by skipping alternate trenches in ratoon crop caused significant reduction in the cane yield as compared to flood irrigation or trench irrigation.
4. The best irrigation water productivity in ratoon cultivation was found under the irrigation regime having IW: CPE ratio 0.8 (97.56 L kg^{-1}) followed by IW: CPE ratio 0.6 (99.50 L kg^{-1}).
5. Among irrigation methods the skip trench irrigation with mulching recorded the best water productivity (59.41 L kg^{-1}) followed by irrigating alternate trenches (59.62 L kg^{-1}).
6. Water footprint of sugarcane third ratoon crop ranged between 124.86 and 168.64 L kg^{-1}.
7. Partitioning among green, blue and grey components revealed that ratoon gets about 61% contribution from the rains and depends on irrigation only for 25% of its crop water needs.

Third ratoon (First cycle)

Table 2.5 : Effect of irrigation regime and water application methods on sugarcane third ratoon crop growth.

Treatment	Initial tiller count ('000 ha^{-1})	Tiller count 140 DARI ('000 ha^{-1})	NMC ('000 ha^{-1})	Average cane length (cm)
Irrigation regime (IW:CPE ratio)				
1.0	88.23	114.58	81.72	192.77
0.8	83.25	109.14	85.31	188.33
0.6	81.63	101.85	74.11	174.27
CD (P=0.05)	NS	07.23	6.35	12.37
Irrigation method				
Flooding	88.77	116.47	86.92	196.88
Flooding with mulch	83.99	118.49	84.09	192.44
Trench irrigation	86.55	115.95	83.80	188.33
Trench irrigation with mulch	82.42	113.54	84.40	186.66
Skip trench irrigation	79.39	99.82	70.82	177.77
Skip trench with mulch	74.6	95.89	74.25	168.66
CD (P=0.05)	NS	12.52	10.58	13.37

Table 2.6 : Effect of irrigation regime and water application methods on sugarcane third ratoon yield and quality

Treatment	Average cane weight (kg)	Average cane girth (mm)	Cane yield (t ha^{-1})	Sucrose (%)
Irrigation regime (IW:CPE ratio)				
1.0	0.932	25.30	81.44	16.62
0.8	0.903	24.32	76.87	16.57
0.6	0.907	23.62	60.30	15.95

CD (P=0.05)	0.047	NS	5.29	NS
Irrigation method				
Flooding	0.919	23.70	81.10	16.71
Flooding with mulch	0.907	24.04	77.97	16.67
Trench irrigation	0.901	24.85	76.77	16.04
Trench irrigation with mulch	0.891	24.23	71.64	16.82
Skip trench irrigation	0.889	24.35	64.51	16.25
Skip trench with mulch	0.878	25.27	65.30	16.81
CD (P=0.05)	0.092	NS	7.32	NS

Table 2.7 : 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 ($m^3 t^{-1}$)	Irrigation water productivity ($m^3 t^{-1}$)	Irr. Water productivity (? m^{-3})
Irrigation regime (IW:CPE ratio)						
1.0	900	822	1722	211.44	110.51	32.57
0.8	750	822	1572	204.50	97.56	36.89
0.6	600	822	1422	236.00	99.50	36.18
CD (P=0.05)	-	-	-	-	-	-
Irrigation method						
Flooding	720.66	822	1542.66	190.21	88.86	40.51
Flooding with mulch	705.66	822	1527.66	195.92	90.50	39.77
Trench irrigation	539.33	822	1361.33	177.32	70.52	51.24
Trench irrigation with mulch	514.33	822	1336.33	186.53	71.79	50.14
Skip trench irrigation	384.66	822	1206.66	187.05	59.62	60.37
Skip trench with mulch	388	822	1210.00	185.29	59.41	60.58
CD (P=0.05)	-	-	-	-	-	-

Table 2.8 : Water footprint of sugarcane first ratoon as influenced by irrigation regime and water application method

Treatment	Green water footprint ($m^3 t^{-1}$)	Blue water footprint ($m^3 t^{-1}$)	Grey water footprint ($m^3 t^{-1}$)	Total water footprint ($m^3 t^{-1}$)
Irrigation regime (IW:CPE ratio)				
1.0	64.46	35.85	24.55	124.86
0.8	68.29	37.98	26.01	132.28
0.6	87.06	48.42	33.16	168.64
CD (P=0.05)	-	-	-	-
Irrigation method				
Flooding	64.73	36.00	24.66	125.99
Flooding with mulch	67.33	37.45	25.65	130.43
Trench irrigation	68.38	38.03	26.05	132.46
Trench irrigation with mulch	73.28	40.75	27.91	141.94
Skip trench irrigation	81.38	45.26	31.00	157.64
Skip trench with mulch	80.39	44.71	30.62	155.72
CD (P=0.05)	-	-		-

Second Ratoon (Second Cycle)

Table 2.9 : Effect of irrigation regime and water application methods on sugarcane Second ratoon crop (second cycle) growth

Treatment	Initial tillers ('000 ha^{-1}) 45 DARI	Tiller count 140 DARI ('000 ha^{-1})	NMC ('000 ha^{-1})	Average cane length (cm)
Irrigation regime (IW:CPE ratio)				
1.0	92.62	180.55	109.57	207.27
0.8	97.31	167.88	99.94	202.38
0.6	90.52	164.10	91.49	205.73
CD (P=0.05)	NS	8.52	8.52	NS
Irrigation method				
Flooding	97.16	181.16	108.15	215.84
Flooding with mulch	96.89	167.51	106.25	208.35
Trench irrigation	96.13	175.39	118.57	204.17
Trench irrigation with mulch	96.12	156.42	111.23	201.97
Skip trench irrigation	92.24	177.24	114.73	202.84
Skip trench with mulch	98.37	167.35	111.06	207.60
CD (P=0.05)	NS	18.32	NS	9.32

Table 2.10 : Effect of irrigation regime and water application methods on sugarcane second ratoon crop (second cycle) yield and quality

Treatment	Average cane weight (kg)	Average cane girth (mm)	Cane yield (t ha^{-1})	Sucrose (%)
Irrigation regime (IW:CPE ratio)				
1.0	0.878	23.88	81.16	17.98
0.8	0.887	23.98	84.14	17.99
0.6	0.994	23.65	72.98	17.68
CD (P=0.05)	NS	NS	7.36	NS
Irrigation method				
Flooding	0.948	23.41	82.84	17.71
Flooding with mulch	0.939	24.56	86.66	17.67
Trench irrigation	0.960	23.69	84.15	18.04
Trench irrigation with mulch	0.962	23.59	81.24	17.82
Skip trench irrigation	0.942	24.30	78.04	18.25
Skip trench with mulch	1.040	23.47	70.63	17.81
CD (P=0.05)	NS	NS	6.9	NS

Table 2.11 : Effect of irrigation regime and water application methods on quantity of water used and water productivity of sugarcane Second ratoon crop (Second cycle)

Treatment	Irrigation water (mm)	Rain (mm)	Total water (mm)	Total Water productivity (m^3 t^{-1})	Irrigation water productivity (m^3 t^{-1})	Irr. Water productivity (? m^{-3})
Irrigation regime (IW:CPE ratio)						
1.0	900	822	1722	212.17	110.89	32.46
0.8	750	822	1572	186.83	89.13	40.38
0.6	600	822	1422	194.84	82.21	43.78
CD (P=0.05)	-	-	-	-	-	-
Irrigation method						
Flooding	720	822	1542	186.14	86.91	41.42
Flooding with mulch	705	822	1527	176.20	81.35	44.25
Trench irrigation	539	822	1361	161.73	64.05	56.20
Trench irrigation with mulch	514	822	1336	164.45	63.26	56.89
Skip trench irrigation	384	822	1206	154.53	49.20	73.16
Skip trench with mulch	388	822	1210	171.31	54.93	65.53
CD (P=0.05)	-	-	-	-	-	-

Table 2.12 : Water footprint of sugarcane plant crop (second) as influenced by irrigation regime and water application method

Treatment	Green water footprint ($m^3 t^{-1}$)	Blue water footprint ($m^3 t^{-1}$)	Grey water footprint ($m^3 t^{-1}$)	Total water footprint ($m^3 t^{-1}$)
Irrigation regime (IW:CPE ratio)				
1.0	64.68	35.97	24.64	125.30
0.8	62.39	34.70	23.76	120.86
0.6	71.93	40.01	27.40	139.35
CD (P=0.05)	-	-	-	-
Irrigation method				
Flooding	63.37	35.24	24.14	122.76
Flooding with mulch	60.58	33.69	23.07	117.35
Trench irrigation	62.38	34.69	23.76	120.85
Trench irrigation with mulch	64.62	35.94	24.61	125.18
Skip trench irrigation	67.27	37.41	25.62	130.31
Skip trench with mulch	74.33	41.34	28.31	143.98
CD (P=0.05)	-	-	-	-

Improved agronomic interventions for enhancing productivity of sugarcane ratoon crop

A project on the management of late-initiated sugarcane ratoon crop was planted in the month of February and harvesting/ ratoon initiation was done next year on fifteenth of each of February, March, April and May months. CoLk 09204 was used for experimentation. The ratoon crops were initiated as per the technical programme and data were recorded during the year.

Assessment and standardization of natural farming techniques for sugarcane production system

An experiment was conducted with the objectives i) developing and standardizing cow-based fermented liquid formulations for natural farming practices; ii) creating feasible technologies to improve soil environment and enhance sugarcane profitability and sustainability under natural farming; and iii) studying the effect of natural farming techniques on soil health and biotic stress in sugarcane-based production systems. The study included 8 treatments; four nutrient management treatments- RDF 0 (Absolute Control, 0 kg of NPK), RDF 1 (Recommended dose of fertilizer), NF1 (Natural Farming), and NF2 (Organic Farming plus NF1) along with two intercropping systems: Intercropping System 1 (S1) with sugarcane + vegetable pea and ratoon + berseem, and Intercropping System 2 (S2) with sugarcane + (vegetable pea- *navdhanya - dhaincha*) and ratoon + (berseem - *navdhanya- dhaincha*). Natural farming utilized cow-based formulations like *beejamrutha, drava-jeevamrutha, ghan-jeevamrutha*, and *neemastra*, along with organic farming methods including bio-agents and organic manures.

Table 2.13 : Effect of nutrient management and intercropping system on sugarcane growth & yield parameters and cane and vegetable pea yield

Treatment	Germination %	Tillers (120DAP) '000 ha^{-1}	NMC '000 ha^{-1}	Cane length (cm)	Cane diameter (mm)	Cane yield (t ha^{-1})	CCS (t ha^{-1})
RDF_0S_1	34.87	116.06	69.55	255.33	24.57	59.07	5.54
RDF_0S_2	34.80	119.08	70.48	259.33	24.90	59.97	5.32
$RDFS_1$	35.10	154.91	91.52	283.00	25.90	91.94	8.37
$RDFS_2$	35.37	159.31	91.78	285.33	26.37	93.11	8.58
NF_1S_1	35.63	133.92	83.93	268.00	25.40	81.35	7.02
NF_1S_2	35.27	134.41	84.56	269.67	25.63	82.80	6.91
NF_2S_1	35.90	137.05	86.81	272.00	26.10	89.44	7.50
NF_2S_2	35.70	139.07	88.15	273.00	26.50	90.60	7.47
CD (P=0.05)	NS	10.62	5.56	12.85	0.89	7.12	1.71

The data revealed that all treatments (S1 & S2 systems) with RDF1, NF2, and NF1 significantly outperformed RDF0 (both S1 & S2 systems) in terms of growth, yield parameters, and sugarcane yield, as well as Commercial Cane Sugar (CCS). The highest tiller production, number of millable canes, cane length, cane yield, and CCS were recorded under RDF1, followed by NF2 and NF1 (both S1 & S2 systems). Maximum cane diameter was observed with organic farming, followed by RDF1 and natural farming. The highest sugarcane yield of 92.72 t ha^{-1} was recorded with RDF1 (RDF 1 S1: 91.94 t ha^{-1}, RDF1S2: 93.11 t ha^{-1}), which was comparable to NF2 at 90.02 t ha^{-1} (NF2S1: 89.44 t ha^{-1}, NF2S2: 90.60 t ha^{-1}), followed by NF1 at 82.08 t ha-1 (NF1S1: 81.35 t ha^{-1}, NF1S2: 82.80 t ha^{-1}).

Nano-assisted urea coating for improving nitrogen use efficiency of sugarcane

The nano-material coated urea was used for testing its performance on sugarcane crop. The sugarcane crop was grown in pots in which total 10 treatments were applied. The coated urea was applied to sugarcane crop with 100, 75 and 50 % of the recommended doses of N either in 2 or 3 splits and one check treatment was kept where 100 % RDN was given in 3 splits. The results showed that cane height, girth and cane weight were significantly affected by different treatments. Higher plant height (12.25 %), cane diameter (3.2 %) and per cane weight (23.30%) were recorded with the use of 100 % RDN through nano -coated urea over 100 % RDN of market urea. These parameters were significantly at par in 75 % coated urea over 100 % neem-coated urea.

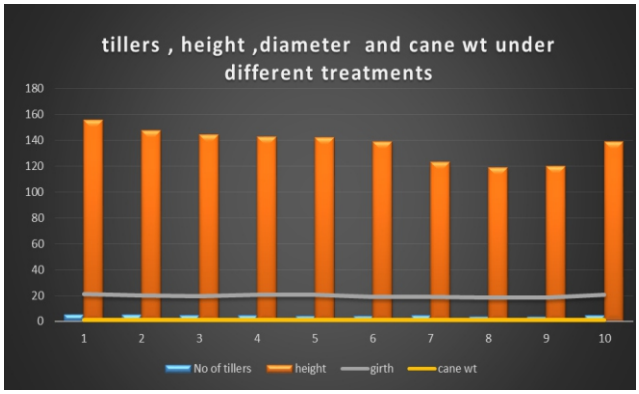


***Fig 2.1**: Tillers, height, cane diameter and cane weight as affected by different treatments*

Nutrient content measured at 120 DAP showed that nitrogen content was 5 % higher in nano urea treated plants with 100 % RDF (T1) over same doses of neem urea (T10). While P and K content was almost similar in each treatment (Figure 2.1). Juice quality parameters (brix, Sucrose (%) and purity coefficient) were not affected significantly in different treatments. The non-significant differences in height, diameter and per cane weight in 75 % RDF of coated urea over 100 % RDF of neem coated urea revealed that with the use of 75 % reduced doses of coated urea in three splits can give equal cane weight over use of 100 % recommended doses of N with neem coated urea .

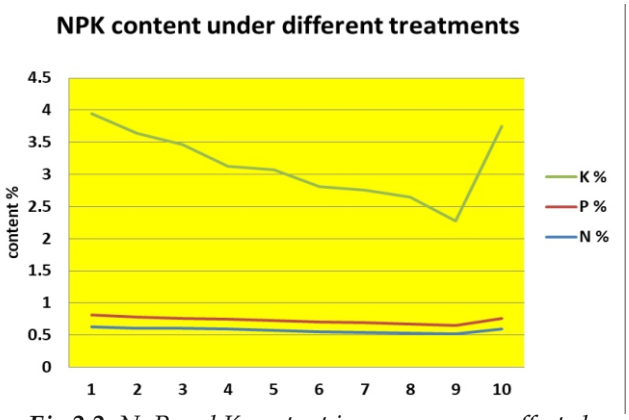


***Fig 2.2:** N, P and K content in sugarcane as affected by different treatments*

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^{-1}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_4 + brown manuring of *Sesbania* at ratooning; and in sub-plot two treatment as dates of sugarcane ratoon (2^{nd} ratoon) initiation *viz.* D_1: 15 December & D_2: 15 February.

The data revealed that, maximum sprouting, tillers production, number of millable canes, cane length, cane diameter, cane yield and commercial cane sugar was recorded in sugarcane ratoon initiated on 15^{th} February. Ratoon initiated on 15^{th} February was significant superior over ratoon initiated on 15^{th} December of previous year in all the growth and yield parameters. Among the sub plot treatments all the treatments recorded significant superior over control for NMC, cane yield and CCS t ha^{-1}.

Table 2.14 : Effect of date of sugarcane ratoon initiation and nutritional management approach on tiller production, NMC, height of plant, cane diameter, cane yield and CCS (2nd ratoon)

Treatment	Sprouting %	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							
D_1	83.28	170.59	78.99	218.66	2.28	63.68	7.88
D_2	92.18	208.62	89.22	230.45	2.34	79.86	10.09
CD (P=0.05)	4.83	17.42	4.01	8.36	0.02	7.50	NS
Nutrient management approach							
N_1	83.61	185.67	79.71	220.46	2.28	67.05	8.50
N_2	86.14	187.59	81.96	222.99	2.29	69.43	8.64
N_3	87.64	188.87	84.16	224.36	2.31	71.49	8.78
N4	89.54	192.30	86.48	226.39	2.32	74.33	9.48
N_5	91.73	193.59	88.21	228.58	2.34	76.56	9.51
CD (P=0.05)	2.11	5.64	3.11	2.47	0.03	1.12	0.43

Diversification of sugarcane based cropping system with medicinal and aromatic plants in sub-tropical India

A fixed field experiment was initiated in June 2019 aiming to identify the most remunerative sugarcane-based cropping system. The experiment included ten treatments with three replications. Results showed that the highest productivity of plant and ratoon sugarcane (87.8 t ha^{-1}) was recorded under the *Tulsi-Stevia-* Sugarcane (Spring)- Sugarcane Ratoon- Mint cropping sequence, outperforming the Rice- Wheat-Sugarcane (Spring)- Sugarcane Ratoon- Wheat sequence. The highest profitability (₹7.73 Lakh) was achieved under the *Tulsi-* Wild Marigold- Sugarcane (spring) - Sugarcane Ratoon- Mint cropping sequence. The performance of *tulsi,* wild marigold, and *stevia* proved more profitable than other crops like rice, *kalmegh*, wheat, and marigold in the sugarcane-based cropping system. The study concluded that replacing the traditional rice-wheat system with medicinal crops under sugarcane-based cropping systems is more beneficial for the sub-tropical region of India.

Soil health and quality management for sugarcane eco-system resilience through resource optimization

Effect of silicon nutrition on growth, yield, juice and soil quality of sugarcane in subtropics

A field experiment was carried out with the objective to study the integrated effect of silicon sources and silicate solubilizing bacteria (SSB) on growth, yield, and juice and soil quality of sugarcane. The experiment consisted of 10 treatments *viz*. T1 - control (no SSB), T2 – control with SSB, T3 - silicon 300 kg ha^{-1} through bagasse ash without SSB, T4 - silicon 300 kg ha^{-1} through bagasse ash with SSB, T5 - silicon 400 kg ha^{-1} through bagasse ash without SSB, T6 - silicon 400 kg ha^{-1} through bagasse ash with SSB, T7 - Silicon 300 kg ha^{-1} through diatomaceous earth without SSB, T8 - silicon 300 kg ha^{-1}through diatomaceous earth with SSB, T9 -silicon 400 kg ha^{-1} through diatomaceous earth without SSB and T10 - silicon 400 kg ha^{-1} through diatomaceous earth with SSB. The experimental crop was planted on 08.02.2023 with a row to row spacing of 75 cm using sugarcane mid late variety CoLk 09204 in RBD replicated thrice. The data recorded on tillering, NMC, cane length and cane yield indicated significant variations among the treatments. Application of silicate solubilizing bacteria 3 L ha^{-1} showed positive response on yield attributes and yield of sugarcane either applied alone or in combination with different dosage and sources of silicon.

Improving soil health and sugarcane ratoon productivity

Field experiment was initiated during 2019-20 to assess the effectiveness of various microbial cultures in increasing ratoon cane productivity and the effect of microbial cultures on soil quality parameters in multi-ratooning systems. The experiment comprising of fourteen treatments in combination with three nutrient management levels (RDF 75% (N_1), RDF 50% (N_2) and Organic FYM @15t ha^{-1} (N_3) and four levels of microbial consortia (**M_1:** Microbial culture of N + P + K + Zn + S + Fe; **M_2:**Microbial culture of N + P + K + Zn + S; **M_3:** Microbial culture of N + P + K + Zn; **M_4:** Microbial culture of N + P + K) along with one absolute control (0 kg/ha) and one 100% RDF (only chemical fertilizer) was laid out in RBD with three replications using sugarcane variety cv. CoLk 09204. The fourth ratoon crop was initiated on 22th February 2023, and

treatments were allocated per technical programme. Nutrient at 75% RDF recorded the highest cane (58.4 t ha^{-1}) and sugar yield (6.98 t ha^{-1}) significantly compared to 50% RDF (54.2 t ha^{-1}) and FYM application @ 15 t ha^{-1} (52.3 t ha^{-1}). However, difference between 50% RDF and FYM application were found to be non-significant. The 75% RDF combined with microbial consortia superseded the cane yield and sugar yield compared to 100% RDF (51.9 t ha^{-1}) and followed a similar pattern as in preceding ratoon crops. Microbial consortia M_1 (57.1 t ha^{-1}) recorded higher cane yield being at par with M_2 (55.8 t ha^{-1}) , M_3 (54.1 t ha^{-1}) and M_4 (52.8 t ha^{-1}).RDF at 100% significantly improved the cane yield by 25 % over absolute control (41.5 t ha^{-1}). The higher mean value of total soil bacteria counts, soil respiration, SMBC and soil enzymatic activity of dehydrogenase and amylase were recorded at all growth stages with FYM application 15 t ha^{-1} (N_3) closely followed by 75% RDF and 50% RDF in combination with microbial consortia treatments. On average, the fourth ratoon cane yield decreased by 37.9, 28.3 and 14.3 % compared to first (88.6 t ha^{-1}), second (76.7 t ha^{-1}) and third (64.2 t ha^{-1}) ratoon, respectively. Results revealed that application of microbial consortia with 75% RDF improved cane and sugar yield by 12.5 and 22 % compared to the recommended dose of fertilizer (100%) without microbial consortia (51.9 and 5.72 t ha^{-1}).

Table 2.15 : Number of tillers, NMC, cane length and cane yield as influenced by silicate solubilizing bacteria and different sources and dosage of silicon

Treatment	Tiller no. (000 ha^{-1})	NMC (000 ha^{-1})	Cane length (cm)	Yield (t ha^{-1})
Control (No SSB)	103.36	94.15	246.12	91.36
Control with SSB	106.15	96.85	249.25	94.23
Silicon @ 300 kg/ha through bagasse ash without SSB	112.82	102.81	257.63	100.85
Silicon @ 300 kg/ha through bagasse ash with SSB	114.26	104.66	259.85	103.02
Silicon @ 400 kg/ha through bagasse ash without SSB	116.32	105.66	263.95	104.25
Silicon @ 400 kg/ha through bagasse ash with SSB	119.65	108.42	266.82	107.52
Silicon @ 300 kg/ha through diatomaceous earth without SSB	112.95	103.02	258.24	101.15
Silicon @ 300 kg/ha through diatomaceous earth with SSB	115.12	105.22	260.46	103.65
Silicon @ 400 kg/ha through diatomaceous earth without SSB	117.06	106.15	264.75	105.12
Silicon @ 400 kg/ha through diatomaceous earth with SSB	119.84	108.45	267.13	107.68
SEm ±	2.22	1.77	2.75	2.09
CD (P=0.05)	6.64	5.30	8.24	6.27

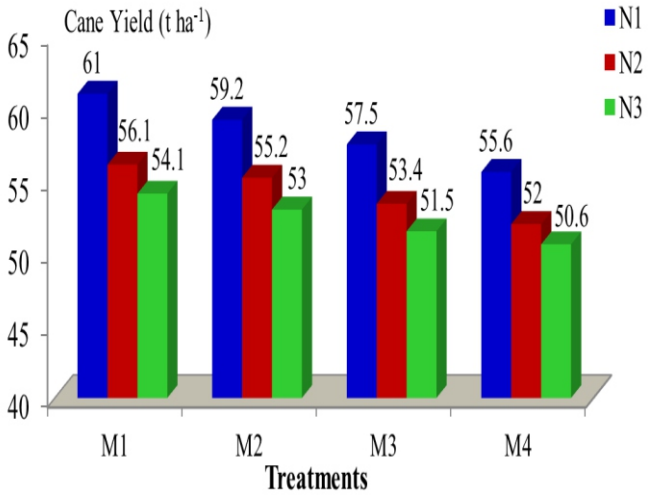


Fig 2.3. Fourth ratoon cane yield as influenced by nitrogen management and microbial treatments during 2023-24

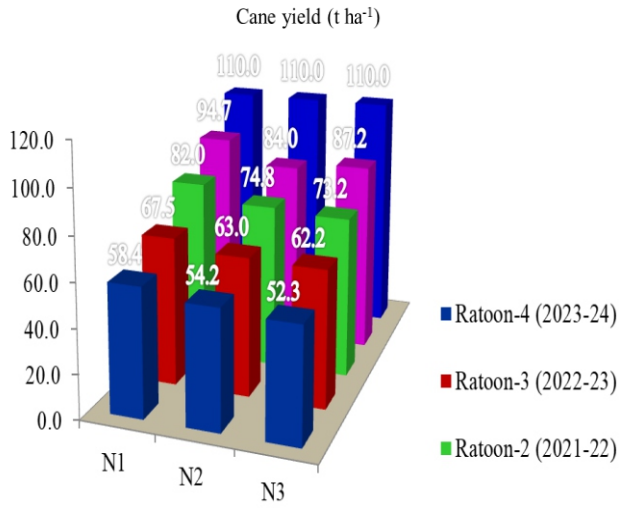


Fig 2.4. Comparative yield performance of ratoon crop

Table 2.16 : Growth, yield, and quality attributes of third ratoon crop as influenced by nitrogen management and microbial treatments (2023-2024)

Treatment	Cane height (cm)	Cane diameter (cm)	Single cane Wt. (kg)	Yield (t ha^{-1})	NMC ('000 ha^{-1})	Sugar yield (t ha^{-1})	Sucrose %	LAI			Photosynthetic rate (µmol m^{-2} s^{-1})		
								Tillering stage	Grand growth stage	Harvesting stage	Tillering stage	Grand growth stage	Harvesting stage
Nutrient Management													
N_1(RDF - 75% 150kg N+ 45kg P_2O_5 +45kg K_2O + 18.75 kg $ZnSO_4$ +30 kg S +7.5kg $FeSO_4$)	184	2.11	0.79	58.4	83.6	6.98	19.16	3.00	2.60	2.16	18.61	10.47	9.74
N_2 (RDF -50% 100kg N + 30kg P2O5 + 30kg K2O + 12.25 kg ZnSO4 +20 kg S +5kg FeSO4)	163	1.91	0.69	54.2	82.4	5.94	18.14	2.37	2.24	1.86	16.34	8.41	7.95
N_3 (Organic (FYM @ 15 t ha^{-1}**)**	162	1.89	0.71	52.3	80.9	5.80	18.17	2.29	2.31	1.99	14.43	7.16	5.95
CD	**7.76**	**0.09**	**0.03**	**3.84**	**NS**	**0.53**	**0.84**	**0.38**	**NS**	**NS**	**NS**	**NS**	**2.01**
SE(m)	**2.63**	0.03	**0.011**	**1.30**	**1.43**	**0.18**	**0.29**	**0.06**	**0.13**	**0.14**	**1.17**	**1.16**	**0.68**
Microbial Consortia													
M_1(Microbial culture of P+ K+ Zn+ S+ Fe)	183	2.11	0.81	57.1	81.4	6.83	19.13	2.88	2.55	2.15	17.92	10.37	8.78
M_2-(Microbial culture of P+ K+ Zn+ S)	175	2.07	0.76	55.8	81.4	6.54	18.83	2.69	2.23	1.91	17.08	9.00	8.47
M_3-(Microbial culture of +P+ K+ Zn)	166	1.91	0.70	54.1	83.0	6.01	18.32	2.60	2.54	2.06	15.77	8.07	7.83
M_4 (Microbial culture of P+ K)	154	1.80	0.64	52.8	83.3	5.58	17.69	2.03	2.22	1.89	15.07	7.28	6.44
CD	**8.96**	**0.10**	**0.04**	**NS**	**NS**	**0.61**	**0.97**	**0.22**	**NS**	**NS**	**NS**	**NS**	**NS**
SE(m)	**3.03**	0.04	**0.013**	**1.50**	**1.65**	**0.21**	**0.33**	**0.07**	**0.15**	**0.156**	**1.36**	**1.34**	**0.79**
Contro-1 (no Nutrients)	143	1.72	0.5	41.5	80.4	4.18	16.4	1.78	1.87	1.62	11.27	4.89	5.15
Contro-2 (100% RDF)	164	1.88	0.59	51.9	83.4	5.72	18.09	2.3	2.26	2.02	14.13	7.08	7.31
CD	**15.19**	**0.18**	**0.06**	**7.09**	**NS**	**0.98**	**1.65**	**0.35**	**NS**	**NS**	**NS**	**NS**	**3.80**
SE(m)	**5.20**	**0.06**	**0.02**	**2.43**	**2.86**	**0.34**	**0.57**	**0.12**	**0.25**	**0.25**	**2.48**	**2.23**	**1.30**

Assessing nutrient depletion/addition pattern by weeds in sugarcane grown alluvial soils

A field experiment was initiated during 2023–24 to assess the nutrient depletion/addition pattern by weeds in sugarcane growing alluvial soils in a strip-plot design with two weedy treatments, like weedy and weed free, and five nutrient management treatments, including T_1-Control, T_2-farmyard manure (FYM) 10 t ha^{-1}, T_3-farmer practices, T_4-recommended dose of fertilizers, and T_5-RDF+FYM 10 t ha^{-1} with three replications. The data revealed that fresh and dry weight of weeds were not affected significantly during February to June, but were affected significantly during July to September, and October to January due to different nutrient management treatments. The highest fresh and dry weight of weed was recorded with RDF treatment followed by fallow and RDF+FYM treatment during July to September. However, the highest fresh and dry weight of weed was recorded with RDF (T_4) followed by RDF+FYM and Fallow treatments. The treatment T_2 (FYM10) observed lowest fresh and dry weed across the growth period of sugarcane (Table 2.17). The tillers, shoot counts, cane length, cane diameter, single cane weight, and NMC were significantly higher in the noon-weedy treatment as compared to the weedy treatment. The cane yield was also significantly higher in non-weedy treatments than in weedy treatments, which increased by 21.1% over weedy treatments. Among the nutrient management treatments, RDF+FYM recorded significantly greater count of tillers, shoot, cane length, single cane weight, NMC and cane yield over rest of the treatments. However, control treatment observed significantly lower counts of tillers, shoot, cane length, single cane weight, NMC and cane yield over rest of the treatments. The cane yield increased by 5.08, 10.6, 18.4 and 24.9% over control (84.7 t ha^{-1}) treatment in FYM, FP, RDF and RDF+FYM treatments, respectively. The juice quality namely brix, sucrose content and purity coefficient was not affected significantly under weedy and non-weedy treatments. However, the application of different levels of nutrients also did not affected the brix and purity coefficient but sucrose content was affected significantly and lowest was recorded in RDF+FYM treatments (Table 2.18).

Table 2.17 : Effect of different treatments on fresh and dry weight of weed at different growth stages

Treatment	Fresh weight (t ha^{-1})	Dry weight (t ha^{-1})	Fresh weight (t ha^{-1})	Dry weight (t ha^{-1})	Fresh weight (t ha^{-1})	Dry weight (t ha^{-1})
	Ist stage (Feb-June)		II stage (July-September)		III stage (October-January)	
T_1-Control	2.52 (5.41)	1.49(1.23)	4.65 (20.7)	2.12 (3.50)	2.26 (4.15)	1.33(0.77)
T_2-FYM@10 t ha^{-1}	2.73 (6.62)	1.62(1.23)	3.76 (13.2)	2.05 (3.20)	1.92(2.69)	1.29(0.65)
T_3-Farmers Practice	3.10 (8.87)	1.71(1.23)	4.87 (23.6)	2.18 (3.73)	2.69(6.28)	1.42(1.01)
T_4-RDF	2.91 (7.48)	1.72(1.23)	5.96 (34.9)	2.74 (6.61)	2.91(7.51)	1.67(1.79)
T_5- RDF+FYM	2.41 (4.80)	1.49(1.23)	5.38 (29.2)	2.48 (5.14)	2.84(7.10)	1.49(1.23)
T_6-Fellow	3.24 (9.53)	1.77(1.23)	5.58 (30.3)	2.65 (6.01)	2.66(6.10)	1.49(1.21)
CD (P<0.05)	NS	NS	1.15	0.41	0.40	0.22

Note: Data were transformed by using square root. Original values are given in parentheses.

Table 2.18 : Effect of weeds and nutrient management on growth, cane yield attributes and cane yield

Treatment	Tillers counts ('000 ha^{-1})	Shoot counts ('000 ha^{-1})	Cane length (cm)	Cane diameter (mm)	Single cane weight (g)	NMC ('000 ha^{-1})	Cane yield (t ha^{-1})	Brix	Sucrose content (%)	Purity coefficient
Weed Effect										
W1-Weedy	150.6	116.6	190.4	24.0	0.957	100.5	85.8	18.92	17.35	91.29
W2- Non-weedy	249.1	159.2	200.4	23.9	1.033	126.7	103.5	19.35	17.46	90.34
CD (P<0.05)	10.2	15.2	6.04	NS	0.062	3.08	8.68	NS	NS	NS
Nutrient management										
T_1-Control	182.8	124.7	186.8	23.7	0.919	104.1	84.7	19.31	17.52	90.36
T_2-FYM@10t ha-1	188.2	133.6	194.3	22.7	1.009	109.1	89.0	19.11	17.58	91.45
T_3-Farmers Practice	201.3	137.7	195.0	24.3	0.995	113.7	93.7	19.24	17.56	90.92
T_4-RDF	209.6	143.9	198.8	24.6	1.022	117.4	100.3	19.10	17.48	91.08
T_5- RDF+FYM	217.3	149.5	202.0	24.5	1.030	123.8	105.8	18.93	16.89	90.27
CD (P<0.05)	5.72	4.08	8.06	NS	0.032	4.83	8.09	NS	0.481	NS
W×N	NS	NS	NS	NS	0.052	NS	NS	NS	NS	NS

Soil test and resource based integrated plant nutrient supply system for sustainable sugarcane production

An experiment was initiated to develop targeted yield equations for spring season early maturing high sugar ratoon crop (var. CoLk 94184) under sugarcane-ratoon- wheat system during 2024, which is useful for the recommendation of mineral fertilizers based on soil test values and fixed targeted yield in the alluvial soils of sub-tropical conditions. The basic data and targeted yield equations for the plant crop is given in Table 2.19. The nutrient requirement of N, P and K were 1.53, 0.49 and 1.91 kg for the production of per tonne ratoon yield (var. CoLk 94184), respectively. The soil efficiency was 42.6, 128.9 and 52.3% N, P and K whereas fertilizers efficiency was 25.3, 73.6 and 103.9%, respectively. The organic efficiency was 12.6, 21.9 and 11.3% N, P and K, respectively.

Production system diversification and technology dissemination for enhancing stake-holder livelihood

Developing sugarcane based integrated farming system models for small farm holders of sub-tropical India

A field experiment was carried out under sugarcane based integrated farming system model for small farm holders of sub-tropical India. The objective of study was to assess the effect of different sugarcane based integrated farming systems on system productivity, sustainability, economic profitability and hence, four integrated production systems were designed at the farm level and compared with the conventional production system. The enterprise in each production system was allocated in a complementary fashion. All the crops were managed as per the recommended package of the practices. The opportunities of productivity, food, nutritional security with environmental sustainability of four sets of sugarcane-based integrated farming system (SIFS) *(viz* FS-I mono-cropping of sugarcane, FS-II Cropping of sugarcane + vegetables, FS-III Cropping of sugarcane+ vegetables+ horticulture + backyard poultry; FS-IV Cropping of sugarcane + vegetables + horticulture + backyard poultry+ fisheries +vermicompost +dairy(cow) was taken for study. The results indicated that autumn sugarcane based integrated farming system as sugarcane + vegetables + horticulture + backyard poultry + fisheries + vermicompost + dairy (cow) fetched net income of ₹780165 ha^{-1} and additional income of ₹453040 ha^{-1} with B:C ratio of 2.38. Similarly spring sugarcane based integrated farming system as sugarcane + vegetables + horticulture + backyard poultry+ fisheries + vermicompost + dairy (cow) fetched net income of ₹ 761276 ha^{-1} and additional income of ₹450981 ha^{-1} with and B: C ratio was 2.36.

Table 2.19 : Basic data and targeted yield equations during 2024.

Basic data	N	P	K	Targeted yield equations
Nutrient requirement (kg/tonne)	1.53	0.49	1.91	FN = 6.07 T– 1.69 STVN – 0.50 ON
Soil efficiency (%)	42.6	128.9	52.3	FP_2O_5= 0.67 T– 1.75 STVP – 0.30 OP
Fertilizer efficiency (%)	25.3	73.6	103.9	FK_2O = 1.84 T –0.52 STVK – 0.11 OK
Organic efficiency (%)	12.6	21.9	11.3	Response yardsticks (kg kg^{-1}) = 11.7

Table 2.20 : Productivity and profitability (₹ha-1) of different components of the cropping/farming system integrated with sugarcane (autumn planted sugarcane)

Farming System	Cost of Production	Gross Income	Net Income	Income From component crop/enterprise or enterprises/unit	B:C Ratio
FS-I	268000	595125	327125	0	2.22
FS-II	395500	925145	529645	202520	2.34
FS-III	445950	1145925	699975	372850	2.57
FS-IV	565350	1345515	780165	453040	2.38

Table 2.21 : Productivity and profitability (₹ha-1) of different components of the cropping/farming system integrated with sugarcane (autumn planted sugarcane)

Farming System	Cost of Production	Gross Income	Net Income	Income From component crop/enterprise or enterprises/unit	B:C Ratio
FS-I	265000	575295	310295	---	2.17
FS-II	385500	900236	514736	204441	2.34
FS-III	428950	1125122	696172	385877	2.62
FS-IV	560350	1321626	761276	450981	2.36

CHAPTER 3

Management of Insect Pets & 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 sub tropical India

Survey of disease and insect pests in sugarcane crop was done in the farm area of ICAR-ISRI, Lucknow and in the command areas of different sugar mills *viz.*, mills of Hasanpur in western Uttar Pradesh, Kushinagar in eastern Uttar Pradesh, areas in central Uttar Pradesh and Bihar, Betuadhari in West Bengal and Buralikson in Assam. Natural incidence of red rot varied from trace incidence to 70%. Co 0118 showed red rot infection (1-5%) in Bihar and Uttar Pradesh. CoLk 11203 and CoLk 15207 exhibited red rot incidence in one clump each at ICAR-ISRI, Lucknow campus. Leaf scald was prominent in many clones in the first clonal stage and in the variety Co 0238. Red rot infected plots in Co 0238 ranged from 3-8 % in the surveyed areas of the sugar mills in DCM Ajbapur & Balrampur sugar mills and at Kumbhi in Lakhimpur, U. P., with an expected yield loss of 3- 8% at farmer's field. However, three fields of Co 0238 were badly affected with red rot incidence (approximate 60-80%). 25-90% red rot incidence was recorded in the variety Co 0238, with losses of about 25-30% in Dwarikeshpuram Sugar Mill, Afzalpur, Bijnour,Uttar Pradesh. Severe incidence of red rot in Co 0238 (8-35%) was observed in the command area of Cooperative Sugar Mill, Snehroad, Bijnour, Uttar Pradesh. The red rot incidence was 30-40% near river areas in Uttam Sugar Mill Ltd, Barkatpur, Bijnor, Uttar Pradesh. Smut and leaf scald symptoms in the range of 7-10% were also noticed in this variety in different sugar mills in this area. Minor occurrence of pokkah boeing disease was also found in some farmers' fields, particularly in the variety Co 0238. Foot rot was observed in the varieties CoLk 14201, CoLk 94184 and Co 15023 under command areas of Babhnan unit, Balrampur Chini Mills Ltd, (BCM), Babhnan, Gonda, Uttar Pradesh. Bacterial rot caused by red stripe disease was observed in CoLk 13204 and CoLk 14201. Wilt was observed in Co 15023, Co 11015 and Co 0118 in the command areas of different sugar mills of western Uttar Pradesh. Besides, ratoon stunting disease, pokkah boeng disease was also found in the range of 10-15% and 25-30% respectively in different varieties. Moreover, viral diseases like SCMV and SCBV were common in almost all sugarcane varieties. Foliar diseases like ring spot, brown spot, leaf scorching and eye spot were found in traces (1-10%) (Fig. 3.1 & 3.2).

Survey in farmers' fields for pest incidence reported incidence of root borer, along with top borer in different sugar mills of Uttar Pradesh, viz., Dhanura Sugar Mill, Amroha, Deoband, Khaikheri, Rohana, and Titawi Sugar mill areas, Saharanpur and Muzaffarnagar districts. The attack of second brood of root borer was observed that may have happened during first week or second week of July. The incidence of root borer was observed in both wilt affected and healthy clumps of canes. The incidence of top borer V brood (10-30%) was reported in the variety Co 0238 in the command areas of Dhampur Sugar Mill, Dhampur, Dwarikeshpuram Sugar Mill, Afzalpur, Cooperative Sugar Mill, Snehroad, and Uttam Sugar Mill Ltd., Barkatpur.

Fig. 3.1 *Interaction with the farmers and sugar mill officials during survey of sugarcane crop in states of UP and Bihar.*

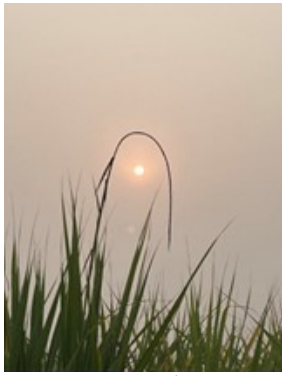
Red rot infection on CoLk 15207

Bacterial rot on CoLk 13204

Foot rot on CoLk 14201 & CoLk 15023

GSD on cv Co 0238

LSD on cv Co 0238 including C1 seedlings



Smut in CoLk 14201

Wilt disease on Co 15023 in command areas of different sugar mills of Western Uttar Pradesh

Banded leaf and sheath blight

Sereh like disease in C1 seedling

Zonate leaf spot on VSI 08005

***Fig 3.2** Symptoms of different diseases of sugarcane*

Artificial intelligence-based detection of insect, pests and diseases

A total of 2,944 RGB images of disease incidence for red rot, wilt, smut, pokkah boeng, YLD, red stripe, red leaf spot, ring spot, leaf scald, leaf scorching, RSD, foot rot, GSD, mosaic, leaf fleck, zonate leaf spot, sereh disease, banded leaf and sheath blight, and symptoms of pest incidence like scale insect, mealy bug, Plassey borer, white fly, blister mite, red mite, web mite, root borer, early shoot borer and rat damage were captured manually through different cameras. All RGB images were categorized into 29 different classes. The symptoms of incidence of Plassey borer, zonate leaf spot, foot rot, banded leaf and sheath blight, early shoot borer, scale insect and sereh diseases were added as new classes to the repository. The symptoms on canes and leaves were captured under different light conditions (e.g., illumination), seasons (varying temperature and humidity), various growing phases of the crop, different noises, and at different locations (North Central and North West Zone). The images were collected from susceptible varieties such as Co 0238, CoLk 11203, CoLk 15207, BO 91, Co 419, Co 975, Co 997, Co 1148, CoS 8436, Co 7717, Co 62399, CoC 671, CoJ 64, CoS 767, Co 7805, Co 86002, Co 86032, CoSe 95422, CoV 92102, Co 0238 and accessions like *Khakai*. The collected dataset was labelled properly and annotated to a specific folder. In total, the image repositories of 18, 690 RGB images of insects, healthy and injured symptoms of insects, pests, diseases, and physiological disorders are maintained in the Division of Crop Protection, ICAR-ISRI, Lucknow.

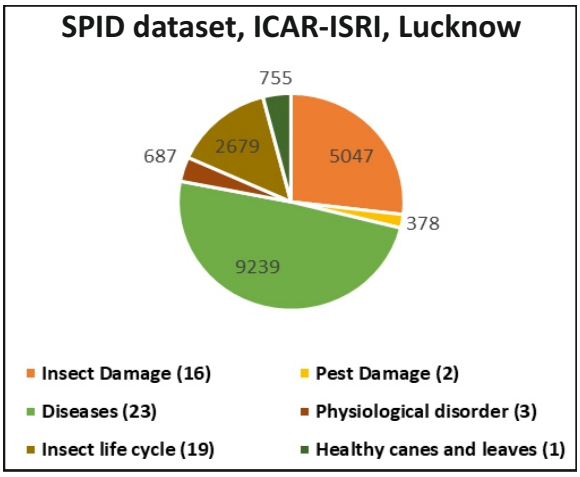


Fig. 3.3 Artificial intelligence –based detection of insect pests and diseases.

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

A total of 65 isolates of *Colletotrichum falcatum* infected samples were collected from the different areas of Uttar Pradesh and Bihar through roving surveys. The incidence of red rot ranged from 5-70%.These were isolated, sub-cultured and purified for pathogenic and molecular studies. In the first phase, 36 isolates and standard pathotypes CF08 and CF13 were inoculated on Co 0238 and CoJ 64 to study the phenotypic reaction. The CF13 and all isolates showed virulent reactions on Co 0238 and avirulent reaction on CoJ 64, suggesting CF 13 behaviour across the region. In the second phase, the 31 *C. falcatum* isolates were phenotyped on 21 differentials *viz*., BO 91, Co 419, Co 975, Co 997, Co 1148, CoS 8436, Co 7717, Co 62399, CoC 671, CoJ 64, CoS 767, Co 7805, Co 86002, Co 86032, CoSe 95422, CoV 92102, Co 0238, *Khakai* (*S. sinese*), SES 594 (*S. spontaneum*) and Baragua (*S. officinarum*) by plug method of inoculation. All isolates including the standard pathotypes CF08 and CF13 showed avirulent reactions on the following differentials *viz,* CoS 8436, CoSe 95422, BO 91, Baragua and SES 594. The 28 isolates and CF13 showed virulent reactions on Co 975 except three, *viz*., CF 0238 isolates from Mumtazpur, Narayanpur and Mohammadpur, which exhibited avirulent reactions on Co 975.One isolate from Daulatpur showed MS reaction on CoJ 64, which was different, from CF 13 behaviour. All the remaining isolates exhibited avirulent reaction on the host differentials - Co 419, Co 997, Co 1148, CoS 8436, Co 7717, CoJ 64, CoS 767, Co 7805, Co 86002, CoSe 95422, SES 594 (*S. spontaneum*) and *Baragua* (*S. officinarum*) and virulent reactions on CoLk 8102, Co 975, Co 62399, CoC#671, Co 86032, CoV 92102, Co 0238 and *Khakai* (*S. sinese*). This is similar to the expected nature of CF 13 on the host differentials (Fig. 3.4).

Fig. 3.4 The representative isolates of C. falcatum exhibited avirulent reaction of Co 0238 and virulent reaction on CoJ 64.

Characterization of *Sporisorium scitamineum* causing sugarcane smut disease

A total of 24 isolates of *S. scitamineum* were collected from Shahjahanpur, Kushinagar, Lucknow (ISRI fields and Kharika farm), Masodha, Ayodhaya , Hariawan from prominent varieties *viz.*, Co 419, CoS 19235, CoS 13231, Co 453, CoLk 15201, CoS 13235, CoP 06436, CoBln 19501, CoS 13231, CoS 13235. Interestingly, at ISRI farm, smut disease was observed on a weed of the genera *Chenopodium* growing in the vicinity of the sugarcane crop (variety CoLk 11203) heavily infected with smut disease (Fig. 3.5). Two isolates were collected for subsequent cross-infectivity analysis. A schematic representation of the establishment of haploid sporidial culture is depicted in Fig. 3.6. Among the sugarcane smut isolates, a highly significant difference ($p<0.05$) was observed in teliospore morphology and colony characteristics. Teliospores were observed as globose to sub-globose, reddish-brown to dark brown, echinulate, and measuring 4.80–8.60 µm in diameter. The isolates exhibited radial colony growth ranging from 1.52–3.24 cm after seven days at 28 °C, averaging 2.1 cm across 24 isolates; growth rates include 12 slow-growing, 9 medium-growing, and 3 fast-growing isolates. Colony morphology was diverse, with 20 isolates forming cottony colonies with aerial mycelia, while 2 displayed yeast-like growth. The teliospore and colony morphology of the two isolates collected from weed was variable as compared to the smut isolates from the sugarcane varieties. Teliospores were small and ranged from 3.1-3.9 µm. A highly significant difference was observed in the germination percentage of teliospores on different culture media, with maximum germination in 5% sucrose, followed by that in YePSA , 1% water agar & distilled water. These results provide a strong foundation for studying the genetic diversity, pathogenicity, and evolutionary relationships of the isolates.

Fig 3.5 *Smut isolates collected from sugarcane and weed hosts in diverse sugarcane growing regions of Uttar Pradesh*

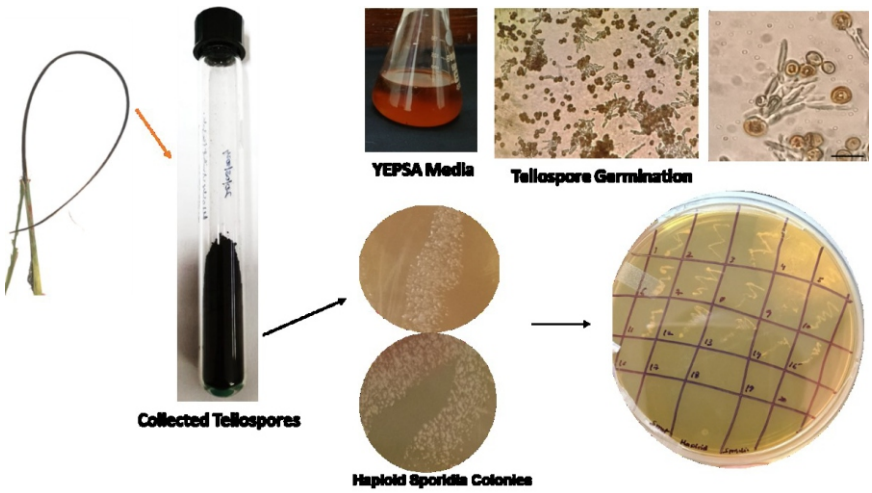


Fig. 3.6 *Schematic representation of smut teliospores collection, germination test, and establishment of sporidial culture*

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

The NGS results revealed prevalence of sugarcane streak mosaic virus (SCSMV) and sugarcane bacilliform virus (SCBV). The SCSMV isolates were identified and the complete genome sequences retrieved were of SCSMV isolate INDR-71, YN-YZ211, HN-YZ49, IR Khuz6, CIVFE07. The complete genome sequence from sugarcane bacilliform IM virus isolate BR-RB68, MH2, ROC22, SCBV-CHN2, SCBV-YG40 were recovered. A representation of the different viruses identified is depicted below along with the phylogenetic tree (Fig. 3.7 & 3.8). The sorghum plants growing in the vicinity of the sugarcane fields were found to be exhibiting symptoms typical of mosaic disease. These infected sorghum samples were positive for the sorghum streak mosaic virus and the sequences have been submitted in the NCBI database with accession numbers PP723015, PP747388, PP747387, PP735905, PP735907, PP747390, PP747391, PP747385, PP747386, PP735906, PP747384 and PP747389 from both sorghum and sugarcane.

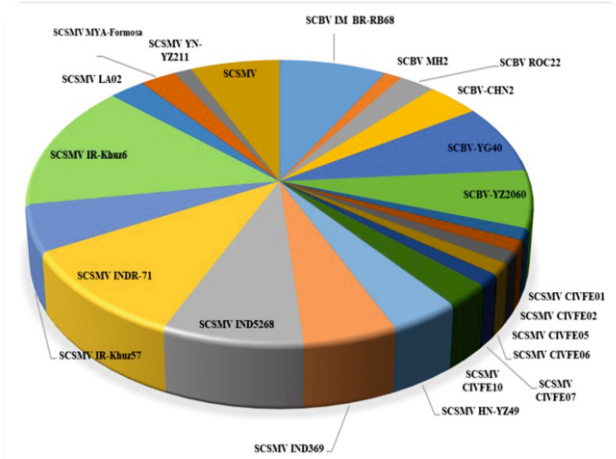


Fig. 3.7 Summary of complete/near complete genomes of known sugarcane viruses recovered from all sugarcane samples

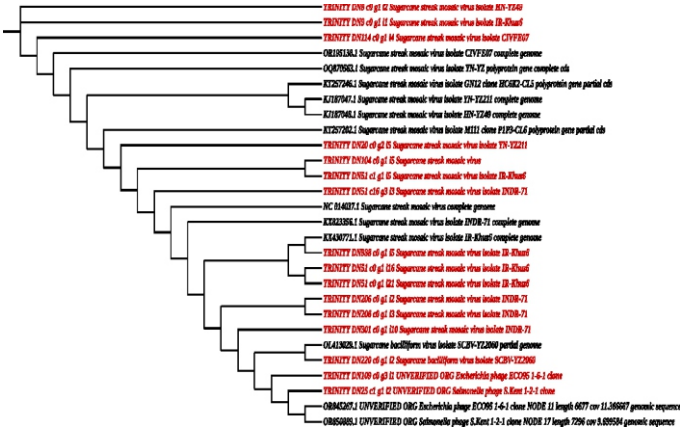


Fig. 3.8 Genetic relationship of recovered consensus genomes of viruses/viroids from sugarcane samples with their respective genomes available in NCBI database

Evaluation/screening of sugarcane germplasm/ genotypes against major sugarcane diseases

During 2023-24, out of the ninety-two genotypes tested against the red rot pathogen *Colletotrichum falcatum* pathotypes CF 08 and CF 13 by using plug and nodal methods of inoculation under field conditions, the genotype LG 16465 was rated as resistant (R) against both the pathotypes (CF 08 and CF 13) after 60 days of inoculation. Forty-seven genotypes were rated as moderately resistant (MR) against both the red rot pathotypes (CF 08 and CF 13). Three genotypes LG 16674, LG 16554 and LG 16583 were rated as moderately susceptible (MS) against both the red rot pathotypes (CF 08 and CF 13 and four genotypes LG 20519, LG 20252, LG 20488 and LG 16452 were rated as MR against pathotype CF 08 and MS against pathotype CF 13. Five genotypes LG 20188, LG 20155, LG 20392, LG 0280 and A-2 were rated as MR against pathotype CF 08 and susceptible (S) against pathotype CF 13. Eleven genotypes *viz.*, LG 20321, LG 15563, LG 16547, LG 16581, LG 20053, LG 20469, LG 20257, LG 20130, LG 20186, LG 15533 and LG 16568 were rated as MR against pathotype CF 08 and highly susceptible (HS) against pathotype CF 13. Eight genotypes *viz.*, LG 20037, LG 15449, LG 20131, LG 20287, LG 20183, LG 20410, LG 16618 and LG 16556 were rated as MS against pathotype CF 08 and MR against pathotype CF 13. Seven genotypes *viz.*, LG 15531, LG 20351, LG 20259, LG 15578, LG 20408, LG 16665 and LG 16685 were rated as S against pathotype CF 08 and MR against pathotype CF 13. Three genotypes LG 20527, LG 16620 and LG 20231 were rated as S against pathotype CF 08 and MS against pathotype CF 13.

The same genotypes were evaluated for smut by artificially inoculated smut pathogen *Sporisorium scitamineum* under field conditions during 2023-24. Out of 92, nine genotypes i.e. LG 20212, LG 20256, LG 15563, LG 15449, LG 16538, LG 15578, LG 15455, A-1 and A-2 were found MR against smut pathogen while five genotypes viz., LG 20243, LG 20425, LG 20579, LG 15531 and LG 20616 were rated as MS against smut disease of sugarcane under full inoculum load. Remaining genotypes showed resistance against the disease.

Evaluation against wilt disease during 2023-24 under natural conditions indicated that 26 genotypes *viz.*, LG 20601, LG 20243, LG 20344, LG 20212, LG 20321, LG 20037, LG 20155, LG 15466, LG 20351, LG

20287, LG 20539, LG 20456, LG 16554, LG 15482, LG 20527, LG 20053, LG 20479, LG 20130, LG 15414, LG 16452, LG 20597, LG 20304, LG 20235, LG 20183, LG 20410 and 12 were susceptible (S) and remaining genotypes were resistant (R) against wilt disease under wilt sick soil condition.

Out of 92 genotypes, 10 genotypes *viz*., LG 20321, LG 20037, LG 15449, LG 16538, LG 20459, LG 20322, LG 16554 , LG16452, LG 20379 and 12 were found susceptible to yellow leaf disease (YLD) and the remaining genotypes showed resistance against YLD under natural condition.

Evaluation of zonal varieties for red rot, smut, wilt and YLD at ISRI, Lucknow center (North–West Zone) during 2023-24

A total of 36 genotypes i.e. 06 in Initial Varietal Trial (Early) *viz*., Co 20016, CoLk 20201, CoLk 20202, CoLk 20203, CoPb 20211 and CoH 20261; 4 in Advanced Varietal Trial (Early)-I Plant *viz*., CoLk 19201, CoLk 19202, CoPb 19212 and CoS 19231; 4 in Advanced Varietal Trial (Early)-II Plant *viz*., CoS 17231, CoS 17232, CoPb 18181 and CoLk 18202; nine Initial Varietal Trial (Mid Late) *viz*., Co 20017, Co 20018, CoPb 20181, CoLk 20204, CoLk 20205, CoPb 20212, CoS 20231, CoS 20232 and CoS 20234; 7 in Advanced Varietal Trial (Mid late)-I Plant *viz*., Co 19017, CoPb 19182, CoLk 19204, CoPb 19213, CoPb 19214, CoS 19232 and CoS 19235 and 6 genotypes of Varietal Trial (Mid late)-II Plant *viz*., Co 18022, CoPb 18213, CoPb 18214, CoS 18231, CoS 18232 and CoS 18233 were screened against red rot, smut and natural infection of wilt and yellow leaf disease along with susceptible checks *viz*., CoJ 64 (CF 08) and Co 0238 (CF 13) for red rot and CoLk 7701 and C0 1158 for smut at ICAR- ISRI, Lucknow. The results are shown in Table 3.1.

Table 3.1 Reaction of sugarcane genotypes against red rot, smut and wilt at ISRI, Lucknow during 2023-24

Sr. No.	Genotypes	Disease Reaction						
		Red Rot				Smut	Wilt	YLD
		Plug Method		Nodal Method				
		CF 08	CF 13	CF 08	CF 13			
Initial Varietal Trial (Early)								
1.	Co 20016	MR	MR	R	R	R	S	S
2.	CoLk 20201	MR	MR	R	R	R	R	R
3.	CoLk 20202	MR	MR	R	R	R	R	R
4.	CoLk 20203	MR	MR	R	R	R	R	R
5.	CoPb 20211	MR	MR	R	R	R	S	R
6.	CoH 20261	MR	MR	R	R	R	R	R
Advanced Varietal Trial (Early) – I Plant								
1.	CoLk 19201	MR	MR	R	R	R	S	S
2.	CoLk 19202	MR	MR	R	R	R	R	R
3.	CoPb 19212	Not Tested						
4.	CoS 19231	MR	S	R	R	R	R	R
Advanced Varietal Trial (Early) – II Plant								
1.	CoS 17231	MR	MR	R	R	R	R	R
2.	CoS 17232	MR	MR	R	R	S	R	R
3.	CoPb 18181	MR	MR	R	R	MR	R	R
4.	CoLk 18202	MR	MR	R	R	MS	R	S
Initial Varietal Trial (Mid Late)								
1.	Co 20017	MR	MS	R	R	R	S	R
2.	Co 20018	MR	S	R	S	R	S	R
3.	CoPb 20181	MR	MR	R	R	S	R	R
4.	CoLk 20204	MR	MR	R	R	R	R	R
5.	CoLk 20205	MR	MR	R	R	R	R	R
6.	CoPb 20212	MR	MR	R	R	R	S	S
7.	CoS 20231	MR	MS	R	R	HS	R	R
8.	CoS 20232	MS	MS	R	R	R	S	R
9.	CoS 20234	MR	HS	R	S	R	S	R

Advanced Varietal Trial (Midlate) –I Plant								
1.	Co 19017	MR	MR	R	R	R	R	R
2.	CoPb 19182	MR	MS	R	R	R	S	S
3.	CoLk 19204	MR	MR	R	R	MR	R	S
4.	CoPb 19213	MR	MS	R	R	R	S	S
5.	CoPb 19214	MR	MR	R	R	R	S	R
6.	CoS 19232	MR	MS	R	R	R	R	S
7.	CoS 19235	MS	MS	R	R	R	R	S
Advance Varietal Trial (II-Plant Mid Late)								
1.	Co 18022	MS	MR	S	R	S	S	S
2.	CoPb 18213	MR	MR	R	R	R	R	R
3.	CoPb 18214	MR	MS	R	R	R	S	R
4.	CoS 18231	MS	MS	R	R	R	R	S
5.	CoS 18232	MR	MR	R	R	R	R	R
6.	CoS 18233	MR	MR	R	R	MS	R	R
Check	Co 0238*	R	HS	-	-	-	-	-
Check	CoJ 64*	HS	R	-	-	-	-	-
Check	Co 1158**	-	-	-	-	HS	-	-
Check	CoLk 7701**	-	-	-	-	HS	-	-

*: Check for red rot ; **: Check for smut

Evaluation of zonal varieties for red rot, smut, wilt and YLD at ISRI Regional Station, Motipur (North Central and North Eastern Zone) during 2023-24.

In North central and North eastern zone, 18 genotypes *viz.*, six in Initial Varietal Trial (Early)-I Plant *viz.*, CoBln 19501, CoP 20436, CoP 20437, CoP 20438, CoLk 20466 and CoLk 20467; 5 in Advance Varietal Trial (Early) *viz.*, CoP18436, CoP18437, CoP18438, CoSe 18451and CoSe18452 and 7 in Initial Varietal Trial (Mid late) *viz.*, CoSe18453, CoBln 19502, CoP 20439, CoP 20440, CoLk 20468, CoLk 20469 and CoBln 20501 along with two standard checks were screened against the prevalent red rot pathotypes (CF 08 and CF 13) by plug and nodal method of inoculation and against smut, wilt and YLD, at ISRI RC, Motipur. The results are shown in Table 3.2.

Table 3.2 Reaction of sugarcane genotypes against red rot, smut, wilt and YLD at ISRI Regional Centre, Motipur during 2023-24.

Sr. No.	Genotypes	Disease Reaction						
		Red rot				Smut	Wilt	YLD
		Plug Method		Nodal Method				
		CF 08	CF 13	CF 08	CF 13			
Initial Varietal Trial (Early)								
1.	CoBln 19501	MR	MR	R	R	MR	S	R
2.	CoP 20436	MR	MR	R	R	R	R	R
3.	CoP 20437	R	R	R	R	R	R	R
4.	CoP 20438	HS	HS	S	S	MR	S	R
5.	CoLk 20466	MR	MR	R	R	R	S	R
6.	CoLk 20467	MR	MR	R	R	MR	R	R
Initial Varietal Trial (Mid Late)								
1.	CoSe 18453	MR	MR	R	R	MR	S	R
2.	CoBln 19502	MR	MR	R	R	R	S	R
3.	CoP 20439	MR	MR	R	R	MS		
4.	CoP 20440	S	S	S	S	R	S	R
5.	CoLk 20468	MR	MR	R	R	R	R	R
6.	CoLk 20469	MR	MR	R	R	R	R	S
7.	CoBln 20501	MR	S	R	R	R	R	R

Advance Varietal Trial (Early) II-Plant								
1.	CoP 18436	MS	MS	R	R	R	R	R
2.	CoP 18437	MR	MR	R	R	R	S	S
3.	CoP 18438	MR	MR	R	R	MS	R	R
4.	CoSe 18451	MR	MR	R	R	R	R	R
5.	CoSe 18452	MR	MR	R	R	R	R	S
Check	CoJ 64*	HS	MR	-	-	MR	-	-
Check	Co 0238*	MR	HS	-	-	R	-	-
Check	Co 1158**	-	-	-	-	S	-	-
Check	CoLk 7701**	-	-	-	-	S	-	-

*: Check for red rot
**: Check for smut

Assessment of Elite and ISH genotypes for resistance to red rot during 2023-24

Twenty four ISH genotypes namely ISH 501, ISH 548, ISH 536, ISH 524, ISH 542, ISH 526, ISH 594, ISH 585, ISH 519, IGH 823, ISH 558, ISH 545, IGH 834, IGH 833, ISH 590, ISH 562, ISH 584, ISH 587, ISH 502, ISH 528, IGH 829, ISH 554, ISH 567 and ISH 516 along with two susceptible checks CoJ 64 (for CF 08) and Co 0238 (for CF 13) were evaluated against red rot disease of sugarcane against the pathotypes CF 08 and CF 13 at ICAR- ISRI, Lucknow during 2023-24. Fourteen genotypes *viz*., ISH 548, ISH 524, ISH 526, ISH 519, ISH 585, ISH 558, IGH 833, ISH 590, ISH 584, ISH 502, ISH 528, IGH 829, ISH 554 and ISH 567 were rated as moderately resistant (MR) to both the pathotypes (CF 08 and CF 13) of *Colletotrichum falcatum* by plug method and resistant (R) by nodal method. Three ISH genotypes *viz*., ISH 501, ISH 536 and ISH 516 were rated as moderately resistant (MR) against pathotype CF 08 and susceptible (S) against pathotype CF 13 by plug method and resistant (R) against pathotype CF 08 and susceptible (S) against pathotype CF 13 by nodal method of inoculation.

Management of pokkah boeng disease of sugarcane

Different treatment combinations viz., T1 – sugarcane sett treatment with *Trichoderma harzianum* strain T6 @ $1x10^7$ fungal units using mechanized sett treatment device, T2: soil treatment with *Trichoderma harzianum* strain T6 @ $1x10^7$ fungal units, T3: foliar spraying of *Trichoderma harzianum* strain T6 @ $1x10^7$ fungal units, T4; sett treatment with Carbendazim @ 0.1% using mechanized sett treatment device, T5: Negative control without pathogenic inoculum application T6: Standard control, T7: Foliar application of Copper oxychloride @ 0.2% and T8: Foliar application of Carbendazim @ 0.1% were tried to find out their effect on pokkah boeng disease management and conversion of the pokkah boeng infected cane plants from the top rot symptom to wilt disease. The susceptible sugarcane variety - Co 0238, was planted and managed with the standard agronomic practices. After 45 days of the planting, suspension of *Fusarium verticilloides* strain F2 (@ $1x10^6$) was sprayed over the foliage in all the treatments except T5 in the evening, for disease development. The initial chlorotictic symptoms were recorded 15 days after pathogenic inoculum spray in all the treatments except T1, and further, in all the treatments after 15th May, 2024. The initial chlorotic symptoms became severe in the form of twisting and curling in the plants, except in T1. Minimum disease severity (4.44%) was recorded with foliar spray of copper oxychloride @ 0.2% (T7) followed by foliar spray of bavistin @ 0.1% (T8) (4.64%), which was closely followed by sett treatment with *Trichoderma* culture (T1)(11.24%). Maximum disease severity (44.92%) was recorded in foliar applied *Trichoderma* culture (T3) followed by T6 – Standard control (44.67%) in the month of September. In the negative control (T5), the natural disease severity was 19.89%. A decline in the disease severity was recorded in all the treatments after the month of September (Fig. 9). No significant effect of *Trichoderma* culture through soil application (35.34%) was recorded for pokkah boeng disease management. The histopathological study of the top rot plant did not show presence of any fungal mycelium in the middle and base of the cane, indicating absence of systemic infection of pathogen fungal mycelium from the top portion to the base of the cane.

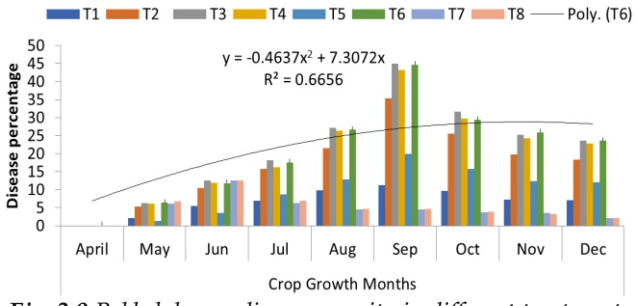


Fig. 3.9 *Pokkah boeng disease severity in different treatments during different months of the crop season*

Management of wilt disease of sugarcane using biocontrol agent *Chaetomium globosum*

A total of 35 endophyte isolates of *Chaetomium globosum* were isolated and evaluated for testing their antifungal potential against sugarcane wilt caused by *F. sachhari*. The most promising strain CGSR13 inhibited colony diameter, spore germination and sporulation by 66.39%, 55.17% and 75.00% respectively. The collective sett and soil treatment with CGSR13 showed 60.09% and 46.37% inhibition in wilt (*F. sacchari*) under greenhouse and field conditions during 2022-2023 and 2023-2024 crop seasons. Besides, soil application and spraying also reduced the disease incidence. There was an increase in sett germination (14.49%), fresh shoot weight (6.47%), dry shoot weight (3.09%), FSW/DSW (3.44%), cane diameter (5.77%), fresh root weight (23.62%), dry root weight (44.44%), FRW/DRW (27.09%), internode length (20.83%), number of internodes (35.52%), cane length (48.90%) and cane weight (68.79%) in CGSR13 treated *F. sacchari* infected plants compared to the untreated control under field conditions. The liquid chromatography-mass spectrometry (LC-MS) results showed that the methanolic extract of *C. globosum* CGSR13 contains plant growth regulator melatonin, cysteine, formononetin and antagonistic scoulerine and sarsasapogenin (Table 3.3).

Table 3.3 Plant growth regulator and antagonist compounds found in the extract of *Chaetomium globosum* CGSR13 using LCMS

Sr. no.	Chemical compound	Chemical formula	Exact mass	Function
1.	Melatonin	C13H16N2O2	232.121	Plant growth regulator during stress
2.	Scoulerine	C19H21NO4	327.147	Antagonist
3.	Sarsasapogenin	C27H44O3	416.329	Protect the plant against microbes and fungi
4.	Cysteine	C6H12N2O4S2	240.023	Plays a central role in fixing inorganic sulfur from the environment
5.	Formononetin	C16H12O4	268.073	Accelerates mycorrhization and increases crop production at low phosphorus application rates

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

Screening of 26 *Trichoderma* isolates was done against *F. sacchari* to identify the potent, promising and potential biocontrol strains of *Trichoderma* (Fig. 3.10) against wilt. Liquid culture filtrate assay showed that 15 *T. harzianum* isolates inhibited colony diameter of *F. Sacchari* in the range 10.85—77.56%. In the year 2024 (autumn season). The susceptible sugarcane varieties Co 419 and Co 7717 setts were treated with the most potent and promising *T. harzianum* (Conc. 2 x 10^6/ml) for 10 h and were planted in pots containing compost and soil (1:5). After 48 h the pots were soil inoculated with *F. sachhari* (1.5x10^6/ml) (Fig. 3.11).

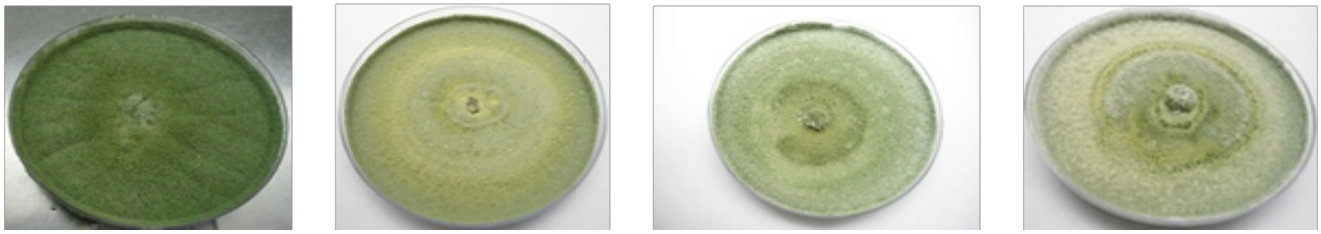


Fig. 3.10 *Different strains of Trichoderma spp.*

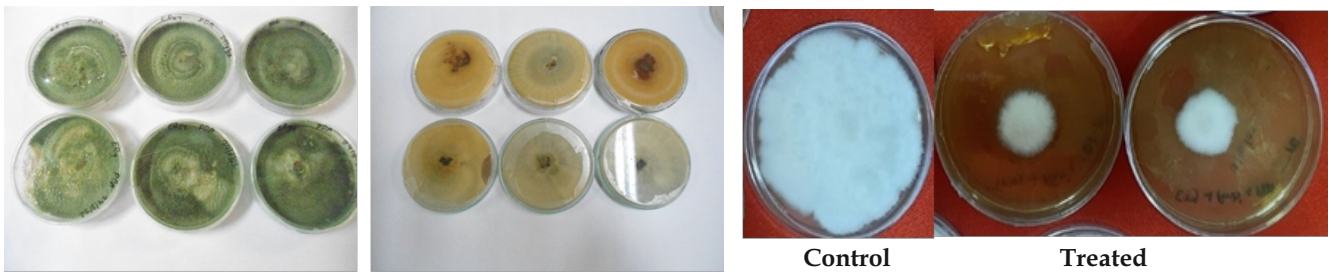


Fig. 3.11 *Effect of Trichoderma harzianum on Fusarium sacchari using liquid culture filtrate method*

Seven phyllospheric bacteria isolated from cauliflower viz., *Bacillus subtilis* CFLB 11, *B. amyloliquefaciens* CFLB 31, *B. velezensis* CFLB 24, Microbacterium sp. CFLB 28, Glutamicibacter, nicotinae CFLB 18, *Pseudoarthrobacter* sp. CFLB 36 and *Stenotophomonas rhizophila* CFLB 26 were tested against three sugarcane fungal pathogens *Colletotrichum falcatum* (red rot disease), *Fusarium sacchari* by using dual culture technique under *in vitro* conditions. Maximum growth inhibition of wilt pathogen *Fusarium sacchari* (77.83 %) was recorded in *Bacillus subtilis* CFLB 11 treatment followed by *B. amyloliquefaciens* CFLB 31(75.36%), *Pseudoarthrobacter* sp. CFLB 36 (70.44%), and *B. velezensis* CFLB 24 (70.44%) after 7 days of inoculation. A maximum growth inhibition of 94.11% of the red rot pathogen *Colletotrichum falcatum* was recorded in *Pseudoarthrobacter* sp. CFLB 36 treatment followed by *B. velezensis* CFLB 24 (91.5%), *Glutamicibacter nicotinae* CFLB 18 (90.19%) and *B. amyloliquefaciens* CFLB 31(89.86%) after 7 days of inoculation. A total of 56 isolates of rhizospheric bacteria were isolated from sugarcane varieties Co 0238 and CoLk 14201 on nutrient agar and King's B media.

Integrated insect pest and disease management for subtropical sugarcane

An integrated management strategy was taken in six sugar mill command areas namely (i) Hargaon, (ii) Loni, (iii) Babhnan, (iv) Haidergarh in Uttar Pradesh and (v) Harinagar and (vi) Narkatiaganj in Bihar to manage the major diseases and insect pests of sugarcane *viz.*, red rot and top borer. Large plot trials of the variety Co 0238 were laid out in ~1.0 ha area in each of above sugar mills in areas endemic to red rot. The following treatments *viz.*, i. Selection of clean seed and mechanized sett treatment with systemic fungicide (Thiophanate methyl 70%WP@ 0.1%) in STD, ii. Soil application of effective strain(s) of *Trichoderma* with FYM @ 200kg/ha at the time of planting, iii. Furrow treatment – Bifenthrin @ 100g ai/ha at planting, iv. Cultural Practices – Rouging & removal of red rot affected shoots at 45 DAP, v. Chemical management – Chlorantraniliprole (75a.i.) 18.5% SC @ 375g in 1000 l of water/ha & Thiophanate methy l70%WP @ 0.1% at 45 DAP, vi. Chemical management – need based pesticide application at 180 DAP, vii. Biocontrol – Release of parasitoides from July to October, viii. *Trichogramma* - eight releases at 15 days interval @ 50,000 adults/ha and ix. *Trichoderma* – soil application during July were applied. Observations on disease and pest occurrences suggested that ScSMV, Leaf fleck and YLD virus load is high in all cultivated varieties. The study indicated that a yield gain of 5-9 t/ha could be achieved through the integrated strategy with the application of ISRI, technologies (Table 3.4).

Table 3.4 Effect of integrated management practices on incidence of diseases of sugarcane in sugar mills area in Uttar Pradesh

Varieties of Sugarcane	Disease	Disease incidence (%)			
		DCM, Hariawan		DCM, Loni	
		Treated plot	Control Plot	Treated plot	Control Plot
CoLk 14201	Pokkah boeng	1.5%	4.0 %	7.5%	15.0%
	Leaf fleck and YLD	27.5%	50.0%	45.0%	45.0%
Co 0238	Pokkah boeng	7.5%	15.0%	7.5%	15.0%
	RSD	12.5%	35.0%	-	-
	Red rot	7.5%	15.0%	-	-
	Wilt	-	-	-	1.5%
	ScMV	-	-	15.0%	15.0%
Co 0118	Pokkah boeng	1.5%	3.5%	3.0%	7.5%
	RSD	7.5%	15.0%	7.5%	15.0%
	ScMV	-	-	12.5%	15.0%
	Leaf fleck	-	-	12.5%	16.0%
Yield (t/ha)		67.5 t/ha	62.3 t/ha	63.4 t/ha	52.6 t/ha

Drone-based fungicide application in sugarcane crop

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. The application was from a flying height of 1.5–2m and speed of below 4 m/s, 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 (Fig. 3.13).

Fig. 3.13 *Application of fungicides in sugarcane crop using drone.*

Characterization, identification and management of insect pests of sugarcane

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

The developmental period of *Tetrastichus howardi* on stalk borer pupa varied from 17.33 to 17.83 days and was not influenced by the weight of pupae. The lowest was 41.17 and increased with increase of weight of pupa (< 0.050 to >0.091g). The maximum number of progeny per pupa (82.83) was obtained from pupa of weight >0.091g (Fig. 3.14). It may be associated with nutritional availability, size, immune response or pupae stage period of the host. The number of females per pupa also increased (37.67 to 77.50) with the weight of pupa. Female-biased sex ratio (>90%) was observed in all the cases, which can aid in improving mass rearing programme. The smaller host pupae gave rise to small number of parasitoids whereas larger ones supported development of more parasitoids, may be, due to the limitation of space and deficiency of food material in smaller pupa, thereby, lowering the fecundity of females or increasing mortality among immature stages, or both.

Potential difference of length of stalk borer pupa on reproductive potential of *T. howardi*

The developmental period varied from 15.7 to 16.2 days and significantly differed with the length of pupa (Table 3.5). The number of progeny and female emergence/pupa increased with increase in length. There was also significant difference in the percentage female emergence. The male emergence (%) decreased with increase in length while the sex ratio increased with increase in length. A larger host size contributed to maximization of progeny. The mean number of exit holes increased with length and number of adults emerged.

Table 3.5 Effect of length of stalk borer pupa on the reproductive potential of *T. howardi*

Length (cm.)	Development period (Days)	No. of Adults/pupa	Female (%)	Male (%)
1.10 - 1.20	15.7 a*	54.1 a	93.7 b	6.3 b
1.20 - 1.30	16.2 b	59.7 b	93.8 b	6.2 b
1.30 - 1.40	16.1 b	76.6 c	86.8 a	13.2 c
1.40 - 1.50	16.2 b	111.7 d	95.2 c	4.9 a

*Means followed by different letters in the same column are significantly different ($P<0.05$)

Incidence of top borer, *Scirpophaga excerptalis* under natural conditions

The incidence of first brood of top borer was significantly high (20.8-33.7%) in CoLk 11203, CoLk 8102,Co 7717 and Co 1148, with the varieties 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 the accession *Khakai* being less susceptible. The second brood infestation was lower than that of the first brood and ranged from 0.6 to 6.5% in varieties/accession tested. 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% (Fig. 3.14). In general, attack of fourth brood has serious consequence on a sugarcane crop because at this stage, the plant is not in a position to compensate the loss of canes through tillering.

Fig. 3.14 *Top borer infested sugarcane plants with adult, egg and moth*

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

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 and during the fag end of monsoon period, stalk borer larvae infest the water shoots giving rise to peculiar symptoms on the leaf, due to high sheath mining activity of the initial instars. The population of stalk borer larvae dwindles during summer months (Fig.3.15). Internode borer incidence was higher than stalk borer incidence in different varieties. It ranged from 6.3 to 17.6% in the 18 varieties/accession studied.

Fig. 3.15 *Sugarcane plants infested with internode borer*

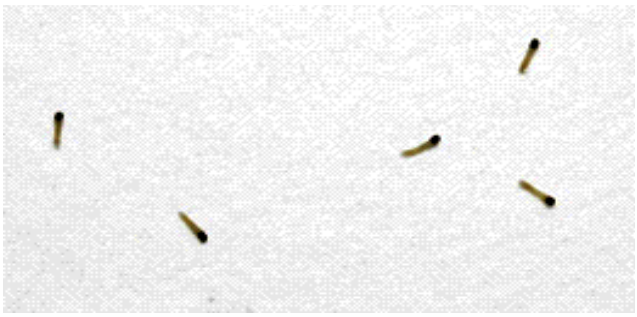
Mealy bug, *Saccharicoccus sacchari* (Ckll.) (Homoptera: Pseudococcidae)

The incidence of mealy bug, *Saccharicoccus sacchari* was observed in standing cane in the months of June and August 2024 (Fig 3.16).The incidence in eighteen varieties of sugarcane ranged from 12.7 to 29.5% during June. However, incidence was maximum in Co1148 (70.1%) followed by CoLk 13204, CoLk 8102, CoLk 11203, CoLk 11204, CoLk 16203, Co 0238 and it varied from 48.8-62.4% in the rest of the varieties, in the month of August. The sheath moisture content, basal width of the sheath, water stress conditions and small dry spells influenced incidence of mealy bug. The main source of carry-over of *S. sacchari* is through seed cane and ants.

Fig. 3.16 *Pink Mealy bug infested canes of sugarcane.*

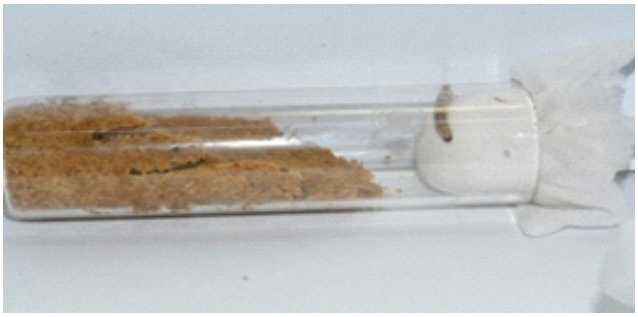
Advancing sugarcane borer rearing and insecticidal impact on the pest and bioagents

A preliminary semi-synthetic diet was formulated for sugarcane stalk borer and top borer using sugarcane leaf sheath powder and rajma as base ingredients, supplemented with casein, agar, and antifungal agents (Fig 3.17). The stalk borer successfully developed to the pupal stage on this diet, with a low survival rate of 10%, whereas the top borer failed to progress beyond the first instar stage and did not survive. In the light of these findings, we aimed to develop a refined semi-synthetic diet. The biochemical composition of third-instar larvae from three sugarcane borer species *viz.*, top borer, stalk borer, and internode borer (additional) was analyzed for carbohydrate, lipid, and protein content. This biochemical profiling provides the basis for estimating their dietary needs and formulating an optimized diet (Table 3.6).



a) First instar larvae

b) Semisynthetic diet for stalk borer



c) Third instar larvae on diet

d) Pupae collected from the diet

Fig. 3.17 *Effect of semi-synthetic diet on survival of larvae of borers.*

Table 3.6 Biochemical composition of third-instar larvae of three sugarcane borer species viz., top borer, stalk borer, and internode borer

Insect	Carbohydrates (µg/3rd instar larva)	Lipids (µg/3rd instar larva)
Top borer	3655.556	7063.041
Internode borer	1933.333	3855.526
Stalk borer	6155.556	3479.817

Effect of insecticides on pupal parasitoid *Tetrastichus howardi* under *in vitro* conditions

The toxicological effect of five commonly used insecticides in sugarcane ecosystems *viz.*, Monocrotophos 36% SL (800g a.i./ha), Chlorpyriphos 20% EC (300g a.i./ha), Thiomethoxam 25% WG (120g a.i./ha), Fipronil 5% SC (100g a.i./ha), and Chlorantraniliprole 18.5% W/W (75g a.i./ha) on the pupal parasitoid *Tetrastichus howardi* (reared on silkworm pupae) was evaluated under laboratory conditions (25±1 °C) using the leaf dip method at recommended doses, with distilled water as the control. Mortality of *T. howardi* was assessed at 16 and 24 hours post-exposure. High mortality rates were observed across treatments at both time points, with no statistically significant difference between exposure durations, except for chlorantraniliprole (Fig 3.18). This insecticide exhibited lower mortality at 16 hours ($Z = 1.6$, $p = 0.11$), but a significant increase in mortality was recorded at 24 hours ($Z = 2.72$, $p = 0.006$).

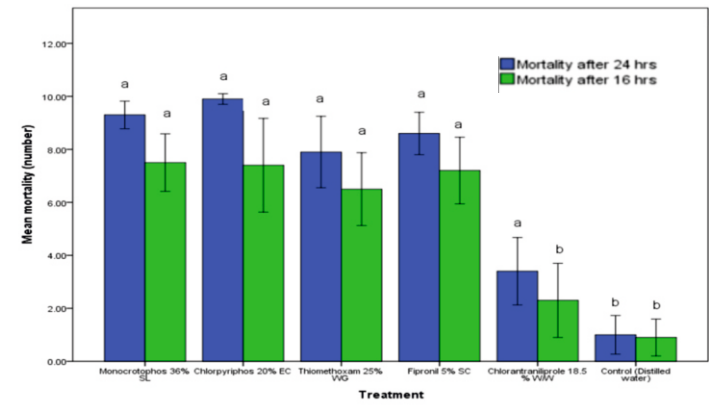


Fig. 3.18 *Effect of insecticides on mortality of pupal parasitoid Tetrastichus howardi under in vitro conditions*

Biological Control Centre, Pravaranagar, Maharashtra

Utilization of entomopathogenic nematodes against white grubs infesting sugarcane

Pathogenicity of three native strains of *Heterorhabditis* sp. against second and third grub instars of *Holotrichia serrata*: The second and third instar grub of *Holotrichia serrata* were challenged with three different native strains of *H. indica* (strain IISRBCC8005, IISRBCC86032, and IISRBCC10001) with a different dosage of infective juveniles per grub, separately. The grub mortality of each instar was monitored (DAI: days after EPN inoculation). The per cent mortality of the second instar grub was observed between 26.66% to 86.66% after 7 to 11 DAI (Figure 3.19a), however, per cent mortality of the third instar grub was between 33.33% to 80% after 15 to 20 DAI (Figure 3.19b). A positive correlation was observed between the increasing dose of IJs with grub mortality. The pupae of *Holotrichia* are also highly susceptible to EPN infection. Exposing the freshly emerged IJs of three native strains of *H. indica* (at a dose of 500 IJs per pupae) was found to cause pupal mortality in 4 to 11 days of EPN infection.

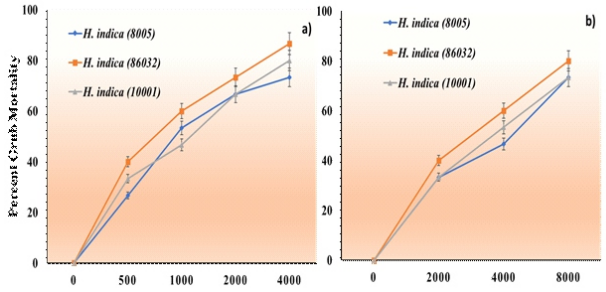


Figure 3.19 *Per cent grub mortality in the second (a) and third instar (b) of Holotrichia serrata due to H. indica infection*

Field-evaluation of *Heterorhabditis indica* against white grubs in sugarcane: The experiment on field bioefficacy was conducted in a suru-planted sugarcane plot, which was naturally-infested by white grub (area: 25 sq. m variety: CoM 0265) at Pravaranagar (MS). The plots were irrigated two days before the EPN application. The required quantity of EPN with water-drenched nearer to clump in evening hours. The control plant received water only. Observation of white grub mortality recorded after 30 days of application. An application of *H. indica* (2.510^7 IJ/ha and 5 10^7 IJ/ha) was observed to suppress the white grub population (63.98% and 72.02%) over the control (Figure 3.20a).

Assessing the survivability and compatibility of *H. indica* with insecticides: *In vitro* studies on compatibility of EPN with agrochemicals such as Chlorpyrifos 20 % EC, Thiamethoxam 75% SG,

Figure 3.20 *H. indica formulation drenching at root zone (a), dead grubs recovered from H. indica treated sugarcane plot (b).*

Imidacloprid 17.8% SL, Clothianidin 50% WDG, Chlorantraniliprole 18.50% SC, Monocrotophos 36% SL, Fipronil 40% + Imidacloprid 40% WG, used for white grub control. The three strains of *H. indica* at the rate of 100 IJ/ml were exposed to the recommended dosage of insecticides and water as control in a 24-well culture plate separately and nematode viability was observed under a stereomicroscope after 24, 48 and 72 hours of exposure. It was observed that all tested insecticides caused less than 15% of EPN mortality after 72 hours of exposure except monocrotophos where maximum EPN mortality occurred (59.14% IJs mortality) (Figure 3.20b).

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

Bioassays were carried out to assess the insecticidal activity of *Bacillus thuriengiensis* isolates (IISRBCCEB01 and IISRBCCEB02) against first instar grubs produced from an F1 population of lab-reared *H. serrata*. Sterilized rearing mixture of decomposed FYM and soil (1:1) were inoculated with spore talc formulation containing $2x10^6$, $2x10^7$, $2x10^8$, $2x10^9$ and $2x10^{10}$ spores/gm of mixture. Treated rearing mixture 100g were transferred in sterilized insect breeding box and one healthy first instar grub was inoculated per box for rearing and incubated at 28°C for 12/12 hrs light and dark cycle. Disease symptoms in treated larvae were monitored every week up to 70 days by evaluating feeding status, mortality and body weight. The highest percent mortality of 67.50 was observed within third week and lowest LT_{50} of 12.40 days reported at 10^{10} spore load in *Bacillus thuriengiensis* IISRBCCEB01 (Table 3.7). First instar grubs treated with *Bacillus thuriengiensis* IISRBCCEB02 at 10^{10} spore per gm of rearing mixture had highest percent mortality of 24.0, 40.0, 60.0 and 71.43 at the third, and fourth weeks after inoculation, respectively, and an LT_{50} of 16.16 days (Table 3.8). The *Bacillus thuriengiensis* IISRBCCEB01 exhibits highest insecticidal activity compared to *Bacillus thuriengiensis* IISRBCCEB02 against first instar grub of *H. serrata*

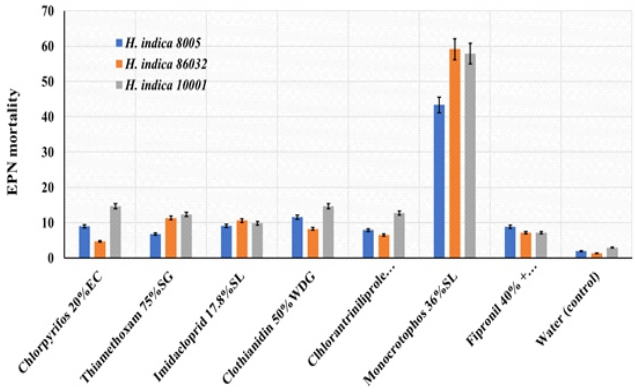


Table 3.7 Insecticidal activity of *Bacillus thuriengiensis* IISRBCCEB01 isolate against the first instar grub of *H. serrata*.

Spore load/gm rearing mix.	Percent mortality (weeks after Inoculation)				LT_{50} (Days)
	I	II	III	IV	
10^6	0.0	0.0	32.85	48.33	28.98
10^7	0.0	25.0	37.50	57.14	24.79
10^8	18.89	25.33	51.43	63.33	21.29
10^9	30.00	44.44	62.50	75.0	14.15
10^{10}	34.0	47.50	67.50	80.0	12.40

Table 3.8 Insecticidal activity of *Bacillus thuriengiensis* IISRBCCEB02 isolate against the first instar larvae of *H. serrata*

Spore load/gm rearing mix.	Percent mortality (weeks after Inoculation)				LT_{50} (days)
	I	II	III	IV	
10^6	0.0	0.0	25.0	42.33	32.77
10^7	0.0	12.50	30.0	51.66	28.46
10^8	16.67	20.0	44.29	58.33	25.17
10^9	20.0	33.33	50.0	62.50	20.64
10^{10}	24.00	40.00	60.00	71.43	16.16

Diversity profiling and management strategies of bacteria associated with post-harvest sucrose biodeterioration in sugarcane A total of 14 sucrose utilizing and 24 gum-producing bacterial isolates were isolated following the enrichment culture method using raw sugar medium and dextransucrase-inducing agar medium from stale cane juice of CoM 0265, Co 86032 and CoLk 140201. Based on 16S rRNA gene partial sequence these bacterial isolates were identified as *Leuconostoc* sp., *Klebsiella* sp., *Enterobacter* sp., *Pantoea* sp., *Bacillus* sp., *Achromobacter* sp., *Lactococcus sp.*, *Staphylococcus* sp., *Exiguobacterium* sp. *Curtobacterium* sp. *Jejubacter* sp. etc. of *Klebsiella* sp., *Leuconostoc* sp., *Enterobacter* sp., *Pantoea* sp., were the dominant genera, which were present throughout the storage period of 10 days of manually and mechanically harvested canes. The details of the bacteria associated with post-harvest sucrose biodeterioration along with their NCBI GenBank accession depicted in Table 3.9 and 3.10. The sucrose biodeterioration/degradation potential of bacteria was determined by measuring sucrose % (Pol% juice) after 12hrs incubation of filtered sterilized (by 0.22µ membrane) fresh cane juice inoculated with bacterial isolates and incubated at 28°C. The % sucrose degradation was estimated by calculating percent decrease in pol% from the initial value in control. The gum-producing *Jejubacter* sp. IISRBCCSB36 (26.61%), *Achromobacter* sp. IISRBCCSB34 (23.69%) and *Priesta* sp. IISRBCCSB29 (22.70%) showed the highest sucrose degradation potential after 12 hours of incubation (Figure 3.21). Sucrose utilizing *Leuconostoc* sp. IISRBCCSB08 (24.39%), *Pantoea* sp IISRBCCSB11 (21.06) and *Klebsiella* sp. IISRBCCSB12 (21.67%) showed the highest sucrose degradation ability after 12 hours of inoculation.

Table 3.9 Gum producing bacteria associated with post-harvest sucrose deterioration and their NCBI GenBank details.

S. No.	Bacterial Genera	GenBank Submission	Accession Number
1.	*Leuconostoc sp.*	IISRBCCSB13	PQ056979
2.	*Bacillus sp.*	IISRBCCSB14	PQ056980
3.	*Pantoea sp.*	IISRBCCSB15	PQ056981
4.	*Enterobacter sp.*	IISRBCCSB06	PP748835
5.	*Klebsiella sp.*	IISRBCCSB07	PP748836
6.	*Bacillus sp.*	IISRBCCSB16	PQ056982
7.	*Enterobacter sp.*	IISRBCCSB17	PQ056983
8.	*Bacillus sp.*	IISRBCCSB30	PQ872864
9.	*Lactococcus sp.*	IISRBCCSB22	PQ269186
10.	*Mesobacillus sp.*	IISRBCCSB05	PP738382
11.	*Leuconostoc sp.*	IISRBCCSB31	PQ872865
12.	*Leuconostoc sp.*	IISRBCCSB23	PQ269187
13.	*Klebsiella sp.*	IISRBCCSB18	PQ056984
14.	*Enterobacter sp.*	IISRBCCSB24	PQ269188
15.	*Staphylococcus sp.*	IISRBCCSB25	PQ269189
16.	*Exiguobacterium sp.*	IISRBCCSB32	PQ872866
17.	*Pantoe sp.*	IISRBCCSB26	PQ269190
18.	*Staphylococcus sp.*	IISRBCCSB27	PQ269191
19.	*Curtobacterium sp.*	IISRBCCSB33	PQ872867
20.	*Achromobacter sp.*	IISRBCCSB34	PQ872868
21.	*Jejubacter sp.*	IISRBCCSB35	PQ872869
22.	*Klebsiella sp.*	IISRBCCSB28	PQ269192
23.	*Jejubacter sp.*	IISRBCCSB36	PQ872870
24.	*Priesta sp.*	IISRBCCSB29	PQ269193

Table 3.10 sucrose utilizing bacteria associated with post-harvest sucrose deterioration and their NCBI GenBank details.

Sr. No.	Bacterial Genera	GenBank submission	Accession number
1	*Leuconostoc* sp.	IISRBCCSB19	PQ269183
2	*Klebsiella* sp.	IISRBCCSB03	PP738147
3	*Pantoea* sp.	IISRBCCSB04	PP738148
4	*Enterobacter* sp.	IISRBCCSB02	OQ504353
5	*Leuconostoc* sp.	IISRBCCSB20	PQ269184
6	*Enterobacter* sp.	IISRBCCSB21	PQ269185
7	*Leuconostoc* sp.	IISRBCCSB08	PQ056974
8	*Klebsiella* sp.	IISRBCCSB09	PQ056975
9	*Achromobacter* sp.	IISRBCCSB10	PQ056976
10	*Klebsiella* sp.	IISRBCCSB01	OQ504350
11	*Pantoea* sp.	IISRBCCSB11	PQ056977
12	*Klebsiella* sp.	IISRBCCSB12	PQ056978
13	*Leuconostoc* sp.	IISRBCCSB37	PQ872871
14	*Jejubacter* sp.	IISRBCCSB38	PQ872872

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

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

Incidence of diseases: The major incidences of disease *viz.*, brown spot, rust and pokkah boeng were observed in the range of 89 to 97%, 40 to 80%, and 35 to 45%, respectively in the surveyed sugarcane fields. The incidence of yellow leaf disease (YLD) was monitored from 25 to 50% in ratoon crop of CoM 0265 and plant crop of Co 86032 and a minor incidence of sugarcane leaf scorch (10% to 15%) was also reported in both varieties. The smut incidence of 5-10% was observed on ratoon as well as plant crop of CoM 0265 and VSI 8005 (Figure 6). Minor incidence of wilt was also reported in MS 10001 and CoM 0265. The variety CoM 0265, which has second highest area of sugarcane cultivation is succumbed to many foliar diseases as compared to Co 86032. There is a need to follow the well-established three seed tire program for seed cane production of CoM 0265 as well as replacement of existing old seed cane in production chain with good quality seed cane to explore the highest yield potential of this cultivar.

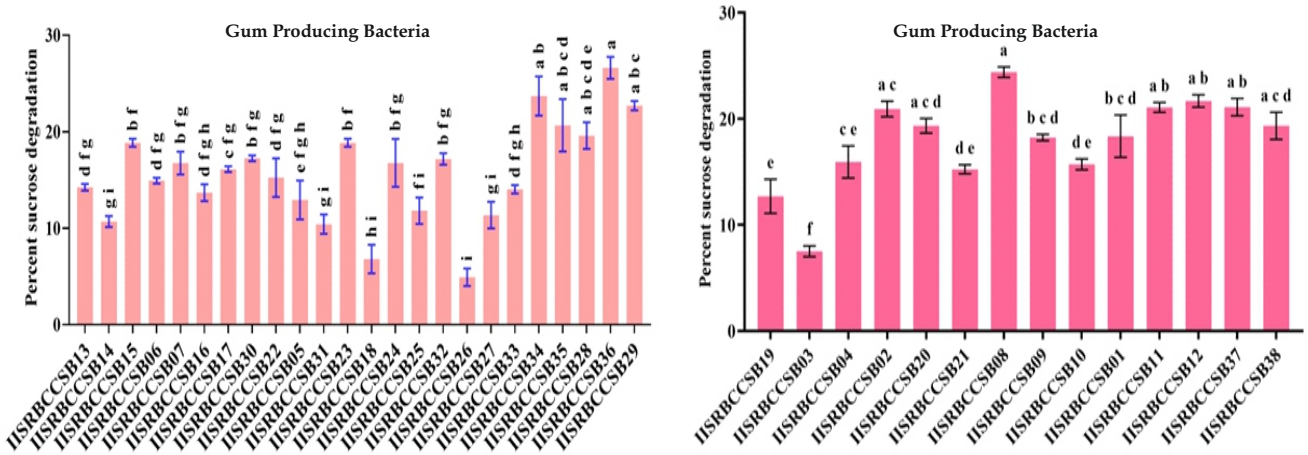


Figure 3.21 *Percent sucrose degradation potential of sucrose utilizing bacteria*

Figure 3.22 *Incidence of diseases a: Brown spot-reddish brown to dark brown oval shape spot; b-Brown rust- mass of uredospore on subepidermal uredinia; c-Smut- whip tail symptoms, d-Pokkah boeng, top rot with necrosis symptoms.*

Identification and pathogenicity of *Fusarium* species associated with pokkah boeng of sugarcane in Maharashtra

Twenty-two isolates of *Fusarium* sp. associated with sugarcane pokkah boeng disease from CoM 18121, PDN 9057, CoM 11082, Phule 15012, CoVSI 8005, MS 10001and Co 86032, maize and guinea grass were isolated, purified, and maintained at IISR-BCC, Pravaranagar (Figure 3.23). Pathogenicity test indicated that all the isolates produced disease symptoms in CoM 0265 cultivar with disease severity index ranging from 9.99 to 13.33 in leaf axil inoculated plants respectively (Table 3.11). The colony colour, growth pattern, and pigmentation were also recorded and the growth rate of these isolates varied from 1.57 to 3.01mm per day. Symptoms reported during the pathogenicity test are chlorosis and necrosis of leaves, punctured lesions, twisted leaves, reduction of the total leaf area, death of the plan top, and stalk rot.

Table 3.11 The growth rate and disease severity index of *Fusarium* sp. isolates

Isolates	Source	Location	Growth rate (mm/day)
F1	CoM18121	Pravaranagar	2.76
F2	PDN9057	Pravaranagar	1.57
F3	CoM18121(3)	Pravaranagar	2.85
F4	CoM18121	Pravaranagar	2.75
F5	CoM11082	Pravaranagar	2.47
F6	PDN9057	Pravaranagar	2.99
F7	CoM18121	Pravaranagar	2.71
F8	PDN 9057	Pravaranagar	1.65
F9	Phule 15012	Pravaranagar	2.43
F10	Phule 15012	Pravaranagar	2.42
G1	Guinea grass	Nirmal pimpri	2.91
G2	Guinea grass	Nirmal pimpri	2.66
G3	Guinea grass	Nirmal pimpri	2.57
G4	Guinea grass	Nirmal pimpri	2.62
A1	CoVSI 8005	Ashwi	3.01
A2	CoVSI 8005	Ashwi	2.82
A3	Maize	Ashwi	2.82
A4	CoVSI 8005	Dadh	2.21
A5	CoVSI 8005	Dadh	2.97
A6	CoM18121	Dadh	2.13
A7	Co86032	Dadh	2.94
A8	CoM10001	Dadh	2.81

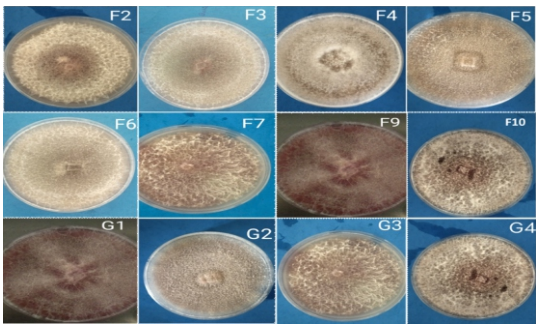


Figure 3.23 *Axenic cultures of Fusarium sp. associated with pokkah boeng isolated from different locations and cultivars*

Isolation and pathogenicity of *Cercospora* sp associated with brown spot disease of sugarcane

The *Cercospora* sp. associated with the brown spot was isolated from the conidia collected from the symptomatic leaves of cultivar CoM0265 and Co86032 using single spore isolation techniques. Artificial media was developed using different combinations of culture media and sugarcane leaf extract and also sporulation at the different levels of pH, standardized for maximum growth temperature, and light hours. The culture media containing 25% green leaf extract supplemented with 20% V8 showed highest conidia production at 14 days and growth at 21 days after inoculation compard to PDA, V8 alone, and fresh and dry leaf extract in combination with V8 media (Figure 3.24). Highest spore count and colony growth was observed at pH 4.5 and 25^{0}C. However, the there was no significant difference for colony growth among the temperature level 20^{0}C, 25^{0}C, 28^{0}C and 30^{0}C and light hours whole dark (WD), light (WL) and 12hr light/dark (12D/12L) (Figure 3.25). Pathogenicity of conidia produced from 25%LE+20%V8 media was established by inoculation and reisolation of *Cercospora* sp. from artificially inoculated sugarcane plant. Pathogenicity test of *Cercospora* sp. was conducted by brush method of inoculation under *in vitro* and in field condition. The lower leaves of 60 days old seedling of Co M026 were washed with four changes of sterile

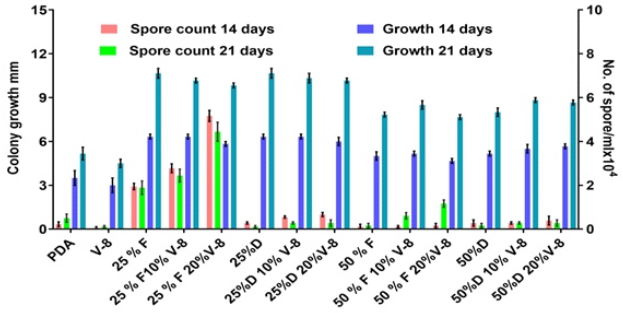


Figure 3.24 *spore count and vegetative growth of Cercospora sp. in different culture media at 14 and 21 days after inoculation*

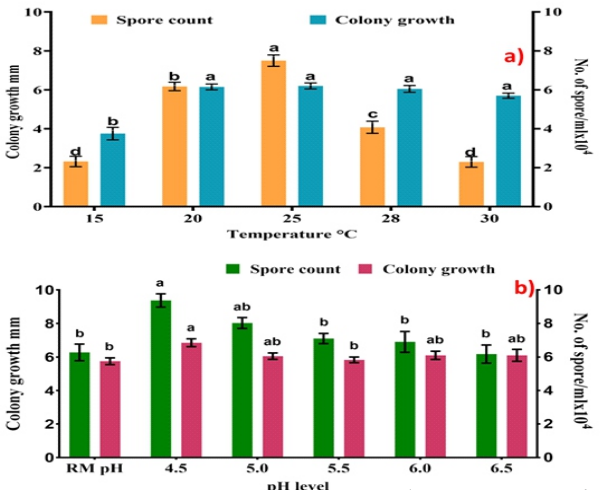


Figure 3.25 *Cercospora sp. spore count and vegetative growth at different level of temperature (a) and pH*

water, blotted dry, and then inoculated with spore concentration of $2x10^6$/mL by spreading the conidia on lower surface by hair brush. Brown spot symptoms with well-developed fascicles and conidiophores with conidia appeared 10-14 days after inoculation. (Figure 3.26). The fungal isolates associated with brown leaf spot in sugarcane were identified as *Cercospora* sp. Based on partial sequencing of ITS and 18S rRNA sequences of this genes were submitted as IISRBCCBP02 (Acc. No. PQ056724) and IISRBCCBP01 (Acc. No. PQ 056713) respectively.

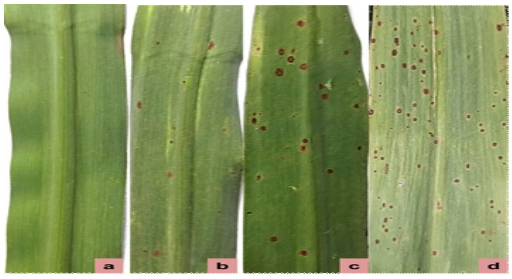


Figure 3.26 *Cercospora pathogenicity test a- healthy leave, b-severity of disease after b-7 DAI, c- 14 DAI and d- 21 DAI*

Isolation and *in vitro* bioassay of mycoparasitic fungi of brown rust of sugarcane

The natural incidence of mycoparasitic fungi was observed on rust pustules in the range of 50-80% per leaves in CoM0265, Co86032. Mycoparasitic fungi which parasitized brown rust uredospores was identified as *Cladosporium* sp. based on ITS, 18S *rRNA* sequencing and sequences were submitted in NCBI GenBank, as IISRBCCMF02 (Acc. No. PQ056723) and IISRBCCMF01 (Acc. No. PQ 056714) respectively. In *vitro*, bioassay showed a 91.85 ± 2.41 % reduction in germination percentage of brown rust spore due to parasitization of mycoparasitic *Cladosporium* sp. The field bioassay studies indicated 72.51 ± 5.55% and 74.91±4.64% parasitization of uredospores by *Cladosporium* sp. at the rate of $2x10^6$ and $2x10^8$ spore per ml.

Infestation of insect pest: White grub infestation was sporadic in the range of 40% to 80%, with beetle emergence during May- July. In endemic spot of white grub infestation, 1000- 2500 beetles per neem tree/day were observed. The infestations of woolly aphid, pyrilla, internode and early shoot borer was reported in the range of 20% to 40% and minor infestations of top borer, root borer and termite damage of 10-15% were also reported in the surveyed sugarcane fields. White fly *Aleurolobus barodensis* infestation (40-90%) in the sugarcane-grown area of north Maharashtra from June to October 2024 was observed however, an increasing level of infestation of whitefly *Neomaskellia andropogonis* was also reported in Ahmednagar sugar mill command areas (Figure 3.27). Infestation of scale insect in the range of 10-20 nymphs/leaf was observed on the lower surface.

Parasites and Predators reported:

The predator of sugarcane pyrilla *Epiricania melanoleuca* was observed in the range of 2-3 cocoons

Figure 3.27 *Infestation of pest a-Woolly aphid adult and nymphal stages on lower leaf surface b- white fly Aleurolobus barodensis nymph and pupae at the lower leaf surface, c-Neomaskellia andropogonis nymph and pupae at the lower leaf surface; d- Internode borer, exit hole with excreta and cane damage; e-Top borer damage.*

per clump during July – January. Pyrilla egg mass were also parasitized by parasitoids *Tetrastichus pyrilli*. The woolly aphid predator *Micromus igoratus* and cetrid fly larvae were observed in the range of 7-9 per leaf wherever a high density of nymphs is present. The infestation of the nymphal and pupal parasitoids was observed in the *Aleurolobus barodensis* and the coccinellidae predator incidence was also observed in white fly *Neomaskellia andropogonis*. Nymphal and pupal parasitoids of *Aleurolobus barodensis* was identified as *Habrobacon* sp. based on 28SD subunit partial sequencing. The coccinellidae predators were observed on whitefly *Neomaskellia andropogonis* eggs and nymph stages (Figure 3.28).

Figure 3.28 *Predators reported during survey and surveillance a- parasitoids emerged from nymph and pupae of whitefly; b- Coccinellid predator feeding on eggs, nymph of whitefly Neomaskellia andropogonis; c&d- Micromus igorotus larval predators and cetrid fly maggots respectively feeds on feeding on adult and nymph of woolly aphid, f & g- unparasitized eggs and Tetrastichus pyrilli parasitized egg of Pyrilla; h- Epiricania melanoleuca cocoon and eggs.*

Isolation and *In vitro* bioassay of entomopathogenic fungi of sugarcane whitefly *Aleurolobus barodensis*: A total thirteen isolates of entomopathogenic fungi (EPF) of white fly *Aleurolobus barodensis* were isolated from different parasitisation pattern in nymphs and pupae using potato dextrose agar and axenic cultures were obtained by single spore isolation technique from

the spore suspension of initial culture plates (Figure 3.29 and 3.30). The pattern of parasitisation of entomopathogenic fungi, which has high pathogenicity which really contribute to the biocontrol of white fly was ascertained.

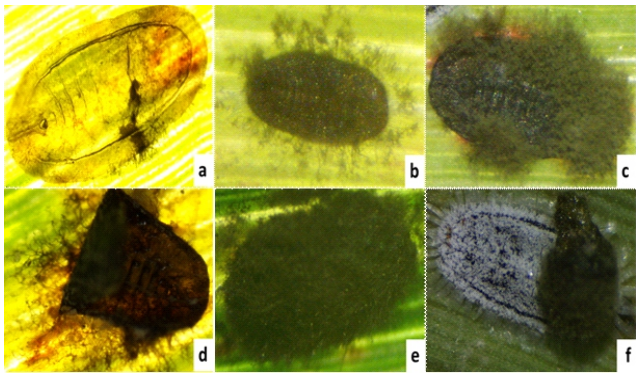


Figure 3.29 *Entomopathogenic fungi parasitisation pattern observed during survey and surveillance. a-c - parasitisation on early nymphal stage; d - second instar nymphal stage; e- pupal stage, f- saprophytic fungal growth on honey dew secretion of nymphal stage.*

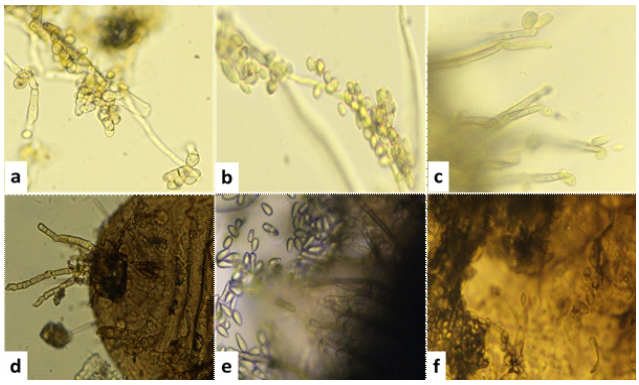


Figure 3.30 *Microphotograph of saprophytic fungi grew on honey dew (a), EPF parasitized on adult fly (b), parasitized pupal stage but adult fly alive (c), parasitized nymphal stage (d), parasitized pupal stage and adult fly dead (e), inside pupae mummified by EPF (f)*

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 Govt. of Maharashtra approved and sanctioned the project during the 23rd State Level Sanctioning Committee (SLSC) meeting under the chairmanship of the Chief Secretary of Govt. of Maharashtra at ISRI-Biological Control Centre, Pravaranagar. The RKVY unit sanctioned the 1.28 Cr as 100% funding as per the norm of the Government of India, of this total funding, 80 Lakhs were sanctioned for Construction work of the biocontrol laboratory and 48.81 Lakhs for the purchase of instruments. Recently institute received funds of Rs. 80.0 Lakhs for the construction of a Biocontrol Laboratory at the Biological Control Center, Pravaranagar, Maharashtra. Now has been submitted a revised project for release of remaining funds.

Talc-based formulation of *Heterorhabditis indica*

To enhance the EPN survival and make it readily available, the infective juveniles (IJs) of *Heterorhabditis indica* were brought under anhydrobiotic conditions by slow drying technique and impregnated with talc powder or fine clay or soil to retain sufficient moisture. Approx. 1.5 Lakhs IJs per gram of talc powder would be the initial inoculum. The survivability of IJs in this formulation was found up to 3 to 4 months. The native strains of EPNs are being stored live under optimum temperature in a liquid culture (@1000 IJs/ml) in the water and stored in a tissue culture flask. (Figure 3.31)

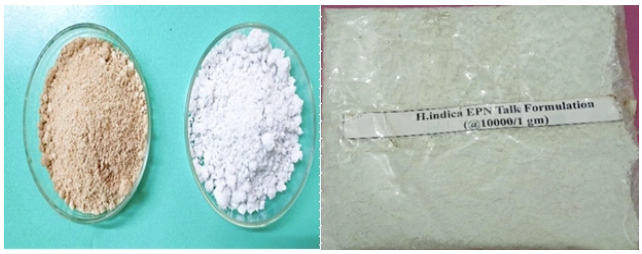


Figure 3.31 *Photograph of talc-based powder formulation of H. indica*

Transfer of Technology

A. Mass multiplication and field release of egg parasitoid, *Trichogramma chilonis* against borer complex of sugarcane: An egg parasitoid *T. chilonis* is employed for the efficient management of sugarcane borers (early shoot, internode, and top shoot borer). The egg parasitoid was reared on its natural insect host (rice mealworm, *Corcyra cephalonica*) in the laboratory. A total of 266 trichocard were distributed to the 108 farmers. This intervention of the center brings a 106.4 ha sugarcane growing area under the biological control of a borer complex.

B. Mass multiplication and maintenance of host insect rice mealworm (*Corcyra cephalonica*)

In the insectary unit, we are rearing the rice mealworm as a host insect on the broken rice grains for the continuous supply of eggs for the mass production of trichocards. We are also maintaining the pure culture of *C. cephalonica* and supplying it to academicians, researchers, and entrepreneurs.

C. Mass multiplication and maintenance of greater wax moth (*Galleria mellonella*): For the mass production, preservation, and maintenance of entomopathogenic nematodes and pupal parasitoids, we are rearing the *G. mellonella* on an artificial semisolid diet in the insectary unit, however, we are also supplying the pure culture of *G. mellonella* to researchers, academicians and entrepreneurs.

CHAPTER 4

Research in Plant Physiology & Biochemistry

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

Physiological and molecular bases of multiple abiotic stress tolerance in sugarcane

Experiments were conducted in field and pots to identify physiological and molecular traits conferring tolerance to single stress as well as multiple abiotc stress. The stress tolerant traits identified in the pot experiment were validated in a field experiment consisting 11 genotypes. High root tissue density, lower canopy temperature depression (CTD), high relative cane internode length (stress/control), high RWC, low leaf electrolyte leakage and high proline accumulation in leaves were identified as tolerant trait for drought. High stalk/aerial root ratio, stalk elongation rate, intermodal length, chlorophyll stability index, high ADH activity and high leaf tissue potassium concentration were identified important screening indices for waterlogging tolerance in sugarcane. Waterlogging induced severe deficiencies of N, K and S and excess of Fe, Al and Mn. However, the major cause for reduction in cane weight of sugarcane genotypes was recognized as deficiencies of N, K and S rather than excess of elements. The genotypes tolerant to N, K and S deficiencies under waterlogging can be utilized in breeding program for developing sugarcane varieties with improved waterlogging tolerance. The low leaf tissue Na/K ratio and Na/Ca ratio in LTM leaf, high membrane integrity measured in terms of electrolyte leakage, high proline concentration was identified as screening indices for salinity tolerance in sugarcane. High leaf tissue K concentration during stress, high cholorophyll stability index, low leaf electrolyte leakage and high root membrane integrity were identified as important screening indices for multiple abiotic stress tolerance. Transcriptomic analysis was conducted using total RNA as starting material from leaf samples of A-27-12 (tolerant) and CoJ 64 (susceptible) at the end of stress treatment. Differential expression of genes associated with carbon and energy function, nitrogen metabolism, hormone/signaling genes, antioxidant enzymes, various transcription factors and different transmembrane transporters of potassium, copper, sulphur and phosphorus were found to be modulated under waterlogging stress. The ethylene responsive transcription factor (ERF); ERF060, ERF RAP2-13-like; which play a major role in controlling waterlogging responsive genes were significantly upregulated under waterlogging. Highest decrease in expression of photosynthetic gene was observed under treatment salinity; a total of 9 photosynthetic genes showed more than log 2 fold decrease in expression under salinity. The changes in photosynthetic gene expression was closely associated with measured photosynthetic rate and stomatal conductance under different stresses. Under drought treatment; a total of 34 genes in 5 KEGG pathways (Xenobiotics biodegradation and metabolism- 11, signal transduction-5, plant hormone signalling- 13, Energy metabolism- 2, Nucleotide metabolism- 3) were upregulated only in tolerant genotype A-27-12; these genes were not upregulated in sensitive genotype CoJ 64. These genes which are exclusively upregulated in tolerant genotype A-27-12 are being validated for their presence in other drought tolerant genotypes by qRT-PCR.

Evaluation of silica in relation to moisture stress and productivity of sugarcane

In order to study the impact of silicon application on biochemical traits under moisture stress, a pot culture experiment was conducted during 2024, using sugarcane variety CoLk 11206. Phenol metabolism enzyme phenylalanine ammonia lyase (PAL), phenolic acid content, flavonoids, antioxidant activity (DPPH and FRAP assay) and total thiol were assayed. PAL specific activity increased in silicic acid 1.66 (µmol t- cinnamic acid produced h^{-1} mg^{-1} of protein) treated plant during stressed condition whereas, 0.72 (µmol t-cinnamic acid produced h^{-1} mg^{-1} of protein) in non-stressed plants. However, in control it was 0.29 and 0.31 (µmol t- cinnamic acid produced h^{-1} mg^{-1} of protein) in both conditions respectively. The results indicated that, stress brought upon due to water shortage at cellular level was minimized through silica application by metabolic shift. Further, Phenolic acid (0.225 and 0.195 mg phenolic acid g^{-1} FW) and flavonoids (0.328 and 0.275 mg flavonoid g^{-1} FW) content in both stressed and non-stressed plant increased in silicic acid applied plant. The enhanced

level of both phenolic acid and flavonoids in stressed plants confirms the metabolic diversion towards secondary metabolism. However, in control both phenolic acid and flavonoids displayed lowest presence (0.136 and 0.138) (0.198 and 0.202) of these metabolites in both stressed and non-stressed plants. Antioxidant activity (AOA) under DPPH (4.01 and 5.28 TE/g FW) found maximum with silicic acid in both stressed and non-stressed plant. Further, it was noticed that control (3.17 and 3.23 TE/g FW) plants exhibited least AOA under DPPH assay. Moreover, AOA under FRAP assay found to be highly influenced in silicic acid (2.59 and 4.47 mg TE/g FW) treated plants, whereas, control plants displayed the (1.64 and 1.88 mg TE/g FW) lesser activity relative to all the doses of silicon applied in both stressed and non-stressed condition. The results revealed that influence of silicon in enhancing phenolic acid and flavonoids contents, contributing the antioxidant potential to protect the plants under drought scenario. The total thiol content in silicic acid treated plant displayed higher value (3.90 and 7.09 µmol GSH/g FW), over control (2.78 and 2.57 µmol GSH/g FW). Besides this silicon content in different plant parts (leaf, leaf sheath, stalk and root) during crop growth phase was studied. It was observed that silicon concentration in different plant parts increased in stressed plant relative to their non-stressed counterpart.

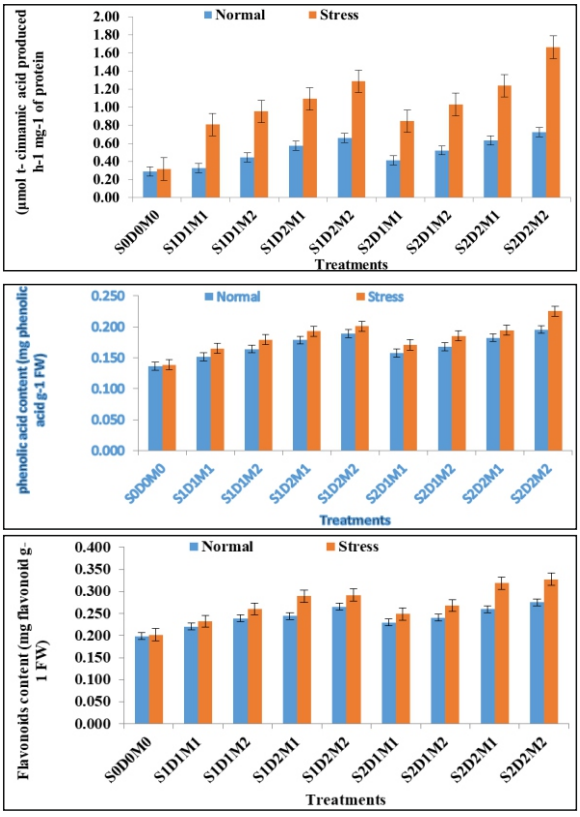


Fig. 4.1 (A - C) *Silicon induced PAL activity, phenolic acid, and flavonoids content in sugarcane during moisture stress*

Process development for enhancing ethanol recovery from sugarcane trash and "β-heavy" molasses.

HPAC pre-treatment of SCT 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.

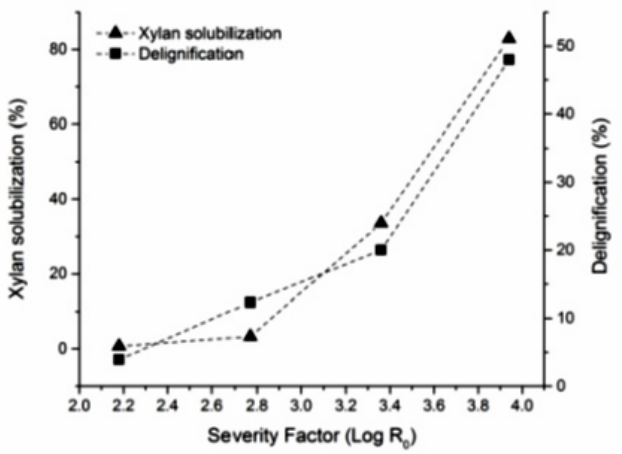


Fig 4.2 *Xylan solubilisation and SCT delignification extend after four severity HPAC pre-treatments.*

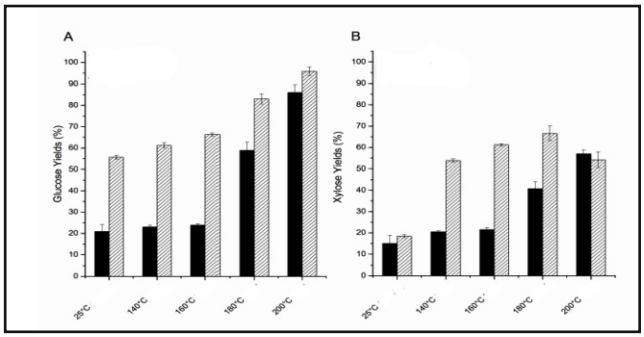


Fig 4.3 *Overall sugar recovery yields (A: glucose; B: xylose) from two stage pre-treatment and 72 h enzymatic hydrolysis*

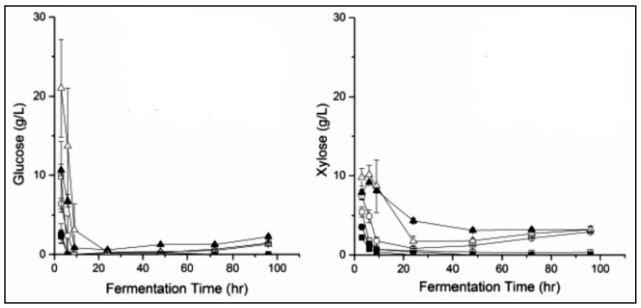


Fig 4.4 *Sugar concentration (A: glucose; B: xylose) profiles of pre-treated SCT samples during 96 hour simultaneously saccharification and fermentation*

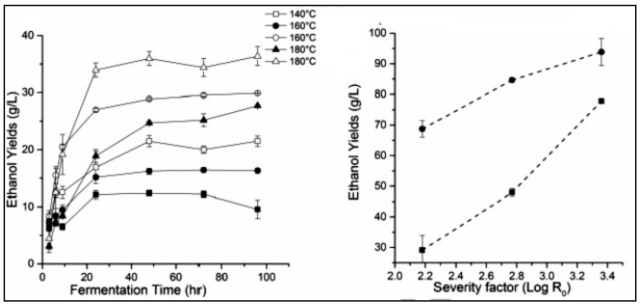


Fig 4.5 *Ethanol profile and final ethanol yield of two stage pre-treated samples*

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

Five experiments were conducted to assess the impact of PGRs in sugarcane plant and ratoon I and II crops. While in the first experiment, impact of PGRs on biomass dynamics was assessed in Oct 2023; 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 2023 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 (GA_3) 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 GA_3. Field demonstrations of PGR Technology were conducted with plant crop of sugarcane varieties CoLk 16202, CoLk 15201, CoLk 14201, CoLk 15466, and CoLk 15206. The application of *Ethrel* externally on cane prompted physiological 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 (I) 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 and 1, 45,106, with CoLk 94184 and CoLk 14201, respectively 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 and 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.

Fig 4.6 *PGR Technology demonstration with ratoon crop by exogenous application of Etrhel+ GA_3*

Biochemical and molecular characterization of soluble invertases of sugarcane

Invertases are essential in sugarcane since it act as an energy source to growing tissues by breaking down sucrose into glucose and fructose. They help create a sucrose concentration gradient, which aids in the transport and distribution of sucrose between source and sink tissues. Additionally, invertases regulate metabolic processes, control sucrose allocation, and influence overall plant growth and productivity. They also play a role in cell expansion by regulating cell turgor and in controlling the sugar composition in storage organs

Four different types of invertases were found in sugarcane genome.

(i) Alkaline neutral invertases

(ii) Acid soluble invertases

(iii) Cytosolic invertases

(iv) Cell wall invertases

The total 64 invertase genes are distributed on 27 different chromosomes representing five out of 10 chromosome types/ class in sugarcane genome. Out of 64 invertase sequences, the alkaline neutral invertases were most abundant, represented by 43 genes. These were distributed in all 5 classes of invertase containing chromosomes viz. Chr 1, Chr 2, Chr 3, Chr 5 and Chr 10. The other types of invertases, were mainly found on chromosome class 3. Thus, Chromosome class 3 contained a total of 42 invertase genes. The sequence alignment was done using online Multialin (http://multalin.toulouse.inra.fr/) program. All the sequences of different classes were aligned as subgroup to get better understanding of their similarity. The results obtained for 5 cell wall invertases which are located on chromosome 3A-3E, are presented here. The sequence alignment indicate that these are derived from duplication of chromosome 3 during the evolution of present genome. There are minor differences of specific addition, deletion and substitution of DNA fragments in all five sequences.

The sequence alignment indicated that these are derived from duplication of chromosome 3 during the evolution of present genome. There are minor differences of specific addition, deletion and substitution of DNA fragments in all five sequences.

Activity of invertase enzyme in six Sugarcane varieties

The activity of acidic and neutral invertase enzymes was measured across six different sugarcane varieties. The results (Table 4.1) suggest that the varieties differ significantly in their capacity for sucrose metabolism, as reflected by the variation in invertase activity. The relatively high acidic invertase activities in some varieties may indicate a greater potential for sucrose breakdown, while the neutral invertase activity patterns suggest differences in sucrose utilization and storage efficiency.

Table 4.1 *Activity of invertase enzyme in six Sugarcane varieties*

S.N.	Variety	Activity (µg glucose/g fr wt/min)	
		Acidic invertase	Neutral invertase
1	CoLk 15206	1312.746	386.3545
2	CoLk 15466	907.553	330.5
3	CoLk 15201	972.992	508.97
4	CoLk 16202	1343.152	152.03
5	CoLk 14201	1366.287	265.061
6	CoLk 94184	778.658	245.892

Effect of various modulators on invertase

The study explored the impact of various chemical effectors on neutral and 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 $Bi(NO_3)_3$, H_2MoO_4, and $FeSO_4$ significantly reduced the activity, with H_2MoO_4 causing the highest inhibition at 97%. This finding is consistent with previous reports where $FeCl_2$ was shown to reduce neutral invertase activity by 80% in sugarcane stalks. Similarly, acidic invertase was notably activated by $LaCl_3$, and strongly inhibited by $Pb(NO_3)_2$ and $AgNO_3$, These findings illustrate how different chemicals can either enhance or suppress invertase enzyme activities, crucial for sugar metabolism in plants (Table 4.1)

Table 4.2 : Effect of various modulators on invertase enzyme

	Effectors used	NEUTRAL INVERTASE		ACIDIC INVERTASE	
		% of Activating	% of Inhibiting	% of Activating	% of Inhibiting
1	$BaCl_2$	**10**	-	**8.1**	-
2	$Bi(NO_3)_3$	-	**68**	-	**58.8**
3	$MgSO_4$	-	21	5.8	-
4	$MnCl_2$	-	18	37.4	-
5	$Pb(NO_3)_2$			-	**93**
6	Na_3AsO_4	-	36.6	-	8.5
7	EDTA	-	2.3	-	15.2
8	$ZnSO_4$	-	**31.3**	-	22.65
9	Na_2MoO_4	-	12	-	21.5
10	$LaCl_3$	**25**	-	**149.8**	-
11	$C_3H_7NO_2S \cdot HCl$	**108.3**	-	-	**97.8**
12	H_2MoO_4	-	**97**	-	**34.31**
13	$AgNO_3$	-	**20.61**	-	**96.53**
14	$FeSO_4$	-	52.07	-	39.3
15	$C_5H_{11}NO_2S$	**9**	-	**11.3**	-

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

Comparative Transcriptome analysis in response to waterlogging using leaf tissues

Transcriptome analysis using leaf tissue of control and waterlogged plant of two contrasting varieties CoLk 94184 and CoJ 64 revealed a total of 295618 Unigenes which 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. 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 were "Protein kinase domain" followed by "Protein tyrosine kinase", "Cytochrome P450" and RNA recognition motif. The most abundant transcription factor families were bHLH followed by WRKY, NAC and among differentially expressed genes, sixty significantly up and down regulated transcripts were identified based on log2 fold change in four sets of samples. S1- CoLk 94184 (C), S2- CoLk 94184 (WL), S3- CoJ 64 (C), S4-CoJ 64 (WL). Primers designed and validated using RNA samples isolated from both the varieties. Results obtained indicated higher expression of Zinc type ADH, HSP 70, Ethylene responsive factor RAP2-3, NAC domain containing 83, Pyruvate decarboxylase partial genes in waterlogged plants.

Transcriptome analysis in response to waterlogging using root tissue

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.

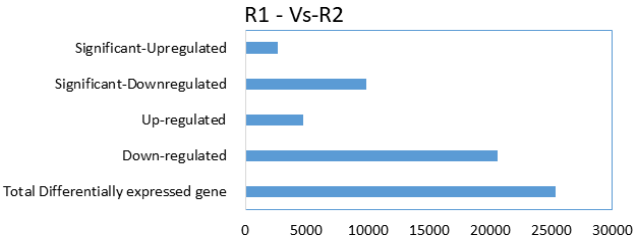


***Fig 4.7** Differentially expressed genes (DEGs), R1 and R2: control vs Waterlogged root*

Ethephon Technology developed and refined

Setts priming with ethephon using STD unit - Setts priming with graded doses of ethephon (ET) @ 50, 100 , 200 and 400ppm along with water treated control causes early and higher initial shoot population at all doses of ethephon; highest (>80% over control) was at 400 ppm ethephon in sugarcane.

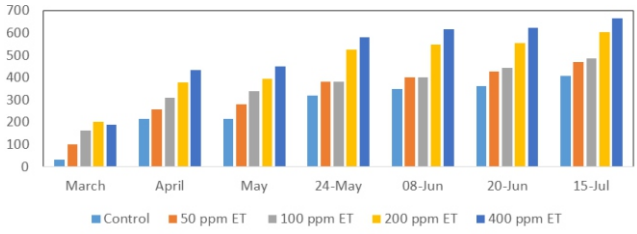


***Fig 4.8** Effect of sett priming with ethaphon on shoot population*

CHAPTER 5

Mechanization of Sugarcane Farming

Mechanization of sugarcane based cropping system

Development of cane node planter

Prototype of cane node planter with modified metering mechanism was fabricated (Fig. 5.1). The fabricated equipment was tested in the field. Missing of cane nodes during planting was observed in actual field conditions. Planting of multiple cane nodes was also observed. The metering mechanism has been modified for improved performance of cane node planting. Field testing will be conducted during the next season of cane planting.

Fig. 5.1 *Cane node planter working in field*

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. 5.2). 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.

The Patent (No. 526527) entitled "A Tractor Operated Trash Mulcher-Cum-Stubble Shaver Device for Sugarcane Ratoon Crop" has been granted by The Patent Office, New Delhi, India on 14.03.2024. The machine has been commercialised and MoA has been signed with M/s Lohan Agri Equipment, Muzaffarnagar (UP).

Fig. 5.2 *Before and after (30 days) effect of operation of IISR 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. 5.3). 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. 5.3 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. 5.4). 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 (Fig. 5.5). 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 (Fig 5.6). The average 90.1-115.5 kg canes stripped and detopped per hour by female and male subjects.

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.

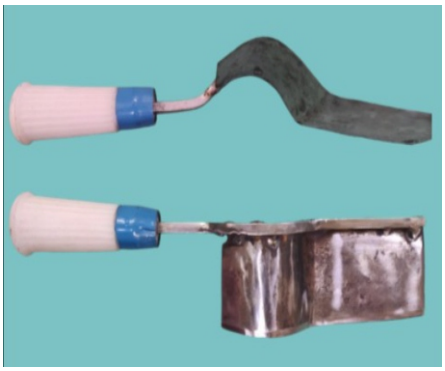


Fig. 5.4 Modified manual sugarcane stripper-cum-detopper

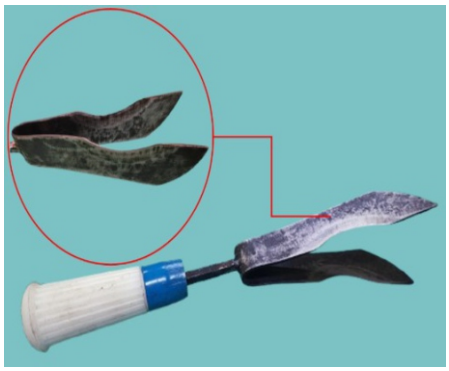


Fig. 5.5 Newly developed manual sugarcane stripper-cum-detopper

Fig. 5.6 Testing of newly developed manual sugarcane stripper-cum-detopper

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. In terms of droplet density, traditional knapsack sprayer achieves a higher density of 56.2 droplets/cm² compared to 46.4 droplets/cm² with drone leading to better surface coverage, which was also reflected in the spray coverage percentage (57.3 % for traditional methods against 17.1 % for drone). However, spraying drone generate a smaller volume mean diameter (VMD) of 276.0 µm compared to 672.6 µm, further emphasizing their suitability for precision spraying. Weed control efficiency with drone was 80.3% and found non-significant ($p>0.05$) with the 80-81% efficiency of traditional knapsack spraying (Fig. 5.8). 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 and insecticides.

Fig. 5.7 *Agricultural spray drones for chemical application in sugarcane*

Fig. 5.8 *View of the effect of drone spraying on control of weed*

Inter Institutional collaborative research project on evaluation of multiple auger planting technique for fruit crops in partially reclaimed sodic soil

A prototype of multiple auger was developed and evaluated for fruit crops in partially reclaimed sodic soil (Fig. 5.9). Five auger holes (30 cm diameter mid-hole and four peripheral holes of 10 cm diameter) were dug out in six rows. After augering three hole at a place the direction of the tractor was changed to right angle three more holes were made in two goes superimposing the central hole. Crop growth parameters were analyzed, showing improved plant heights and spread with bioformulation treatment. By December 2023, bioformulation-treated plants had average heights of 1.84 m compared to 1.18 m for untreated plants. The average plant spread (N-S) was 2.17 m with bioformulation and 1.76 m without, while (E-W) spread was 2.17 m and 1.73 m, respectively. Bioformulation-treated plants yielded 197.89 fruits per plant, significantly higher than 73.67 fruits per plant without treatment. Soil analysis before planting apple ber showed high pH below 15 cm depth, ranging from 8.14 to 9.73, with electrical conductivity varying between 0.947 and 2.885 dS/m. Organic carbon content was low, between 0.019% and 0.732%. To manage insect attacks, Chlorocil-20 was sprayed, and staking was done to support tilting plants due to fruiting.

Fig. 5.9 *Developed multiple auger for fruit crops in partially reclaimed sodic soil and its performance*

AICRP on Farm Implements and Machinery (FIM)

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

Prototype fabricated

Machine/Implement	Source of Power	Achievement
Deep furrow sugarcane cutter planter	Tractor	5
Trench opener	Tractor	2
Deep furrower	Tractor	2
Disc type sugarcane management device	Tractor	2
Manual cane detrasher	Manual	5
Manual cane stripper-cum-detopper	Manual	20
Manual cane node cutter-cum-bud scooper	Manual	20
Total		**56** (Manual-45)

Prototype Supplied

Name of prototype	Supplied to	Number
IISR Manual cane stripper-cum-detopper	KVK Moradabad	15
IISR Manual cane stripper-cum-detopper	KVK Amroha	10
IISR Manual cane stripper-cum-detopper	KVK Hapur	15
Manual cane node cutter-cum-bud scooper	Farmers	3
Manual sugarcane cutter	Farmers	5
Total		**48**

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 IISR farm (Fig. 5.10). Planter performance parameters like sett length, number of setts cut and dropped per unit length of furrow, depth of furrow, depth of soil cover, height of ridge, number of seed potatoes dropped per unit length of ridge, wheel slippage of tractor, etc. were recorded. The performance of the planter was compared with manual planting as intercrop and manual planting as relay crop. The planter was operated by a 30-kW tractor. The effective field capacity of the planter was 0.27 ha/h, thus to plant one-hectare area would take approximately 8 hours. The cost of planting operation with the planter was Rs 3500 per ha whereas it was Rs 13600 per ha when planting was done manually. Thus, there was 74.20 % cost saving in planting with this machine. Saving in labour by planting with developed machine was 90.1 %.

Fig. 5.10 *Automatic potato-cum-sugarcane trench planter under field operation*

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. 5.11). One

Fig. 5.11 *Drone for spraying of agro-chemicals under field operation*

of the key advantages of drone spraying was resource conservation. Drones require only 50-55 liters of water per hectare, a staggering 90% reduction compared to the 450-500 liters needed for traditional methods. Additionally, drone spraying saves 90-92% in labor and 93-95% in time, making it highly efficient for large-scale operations. Operational costs are also reduced by 15-20%, providing a cost-effective alternative in resource-limited settings.

Centre of Excellence in Farm Machinery

Development of mini harvesting system for sugarcane

A mini harvesting system for sugarcane was developed for cutting standing sugarcane stalks (Fig. 5.12). This system consists of rotating cutting blade perpendicular to the direction of travel, 52 cc petrol engine, main frame, accelerator and operator handle. It is powered 2-stroke engine with fuel tank capacity of 1000 ml and is equipped with four towed wheels. The front two wheels and the frame are constructed from mild steel, while the two rear wheels are made of solid rubber. The distance between the axis front and rear wheels axis is 50 cm. The engine is mounted on the main frame, with power transmitted to the cutting blade via a universal shaft with an inbuilt clutch. The cutting blade is positioned 50 mm above the ground surface. A push button located on the machine's handle allows the operator to control the speed of cutting blade. The system incorporates a modified brush cutter, including adjustments to the main frame, blade selection, and cutting angle. This machine is designed for operation by a single individual. During the testing it was found that this system can harvest single cane at single time easily while bunch of cane creates problem as torque require is higher.

Fig. 5.12 *Development of small harvesting system for sugarcane*

Sugarcane peeling tool

A small-scale sugarcane peeling tool has been developed and is currently undergoing testing with various diameters of sugarcane (Fig 5.13). This tool utilizes a scraping system with a diameter of 30 mm and features a spring-loaded mechanism. The spring's flexibility allows it to adjust according to the diameter of the sugarcane. The scraper is mounted on a square pipe with dimensions of 310 mm (length) x 60 mm (width) x 60 mm (height). In operation, a single operator inserts a sugarcane stalk into the system and moves it back and forth, allowing the scrapers to effectively remove the outer layer of the sugarcane. The scrapping capacity of this tool is 70-75 kg/h for the average size of cane.

Fig. 5.13 *Sugarcane peeling tool*

Development of weeder cum seeder

E-powered weeder cum seeder is developed for the small land holding sugarcane-based cropping system farmers (Fig. 5.14). It is intended to sow wheat, mustard and companion crops on bed/ridge in sugarcane as intercrop. It consists of main frame, ergonomically designed adjustable handle, two row sowing shoe type furrow openers, rotary weeding unit for weeding, power transmission unit including battery, chain sprocket and four wheels. This system has two rear wheel drive powered by 24-volt battery. Total capacity of seed box is 4.0 kg, each with 2.0 kg. The frame constructed of mild steel. Two front wheels are lightweight spoke wheels of diameter 48.0 cm the rear wheels are spike tooth MS wheels for better traction. The distance between the front and rear wheels is 56.0 cm. The battery and motor are mounted on the main frame. Power transmitted to the front wheel from motor by chain sprocket system. Powered weeding system

Fig. 5.14 *Development of weeder-cum-seeder*

having 30 cm operating width is attached at the rear end. The furrow opener is positioned at back side of main frame that opens the furrow and places the seeds on soil. An accelerator located on the machine's handle with holding fist allows the operator to control the machine. This machine is designed for operation by single individual.

RKVY funded 'Agri Drone Project'

Agricultural Spray Drone was demonstrated to 110 farmers from various states for agrochemical spraying in sugarcane crop at ICAR-ISRI, Lucknow from May 2024 to Dec 2024 (Fig. 5.15).

Fig. 5.15 *Agricultural Spray Drone demonstration to the farmers*

Frontline Demonstrations

Frontline Demonstrations of IISR Tractor operated modified sugarcane cutter planter

IISR tractor-operated modified sugarcane planter was demonstrated at farmers field of Hardoi and Lakhimpur Khiri in 8.2 ha area covering 12 farmers (Fig. 5.16). 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 63% in cost of operation and 91% in labour requirement while using this planter as compared to conventional method.

Fig. 5.16 *IISR tractor operated modified deep furrow sugarcane planter in field operation*

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

IISR two row disc type ratoon management device (Disc RMD) demonstrated at Sitapur and Lakimpur Khiri districts (Fig. 5.17). A total of approximately 4.5 ha area was covered in 08 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. 5.17 *IISR tractor operated two row disc type ratoon management device in field operation*

Frontline Demonstrations of IISR Tractor operated deep furrow sugarcane cutter planter-cum- raised bed multi-crop seeder

Demonstration of IISR tractor operated raised bed seeder-cum-sugarcane planter was conducted at farmers field of Biswa sugar mill area of Sitapur district in 5.2 ha area covering 14 farmers (Fig. 5.18). 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%.

Frontline Demonstrations of IISR Tractor operated multipurpose interculturing equipment

Demonstration of IISR tractor operated multipurpose interculturing equipment was conducted at farmers field at farmers field of Sitapur district in 5.5 ha area for 14 farmers (Fig. 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%.

Frontline Demonstrations of Manual multicrop planter for sowing intercrop in sugarcane

Field demonstrations of IISR manual multicrop planter for sowing of intercrops in sugarcane were conducted at Biswa sugar mill area in different villages. The sugar mill purchased and distributed IISR manual multicrop planters to the farmers for sowing of intercrop in sugarcane. A total of 37.13 ha area was covered at 109 farmers' field for sowing of intercrop in sugarcane in different blocks of Biswa sugar mill area of Sitapur district.

Frontline Demonstrations of manual sugarcane stripper-cum-detopper

Field demonstrations and multi-location testing of IISR manual sugarcane *stripper-cum-detopper* were conducted at various villages including Fatehpur Shumali, Raipur Shumali, Neelikhedi, Basti and Aehraula Tejwan. The trails covered 4.9 ha of sugarcane harvesting with the participation of 10

Fig. 5.18 *IISR Tractor Operated Deep Furrow Sugarcane Cutter Planter –Cum- Multicrop Raised Bed Seeder in field operation*

Fig. 5.19 *IISR Tractor operated multipurpose interculturing equipment in field operation*

farmers. KVK, Amroha procured and distributed ISRI manual sugarcane stripper-cum-detopper to these farmers for efficient harvesting and detopping of sugarcane. The test results of this tool showed that the highest number of cane were stripped and de-topped in a given time by both male and female farm workers. One person can clean nearly 142 to 150 kg of the cane in one hour with this new tool whereas it was 15-20% less with conventional tools. However, the physiological workload with this tool and conventional tool was observed in "Very Light" category by both male and female workers.

CHAPTER 6

Diversification and Value-addition in Sugarcane

Post-harvest processing of sugarcane and value addition

Refinement of sugarcane cleaner cum washer for jaggery

A protective/safety cover on sugarcane cleaner-cum-washer was designed, fabricated and installed (Fig. 6.1). A frame made up of MS flats was fabricated on which fibre sheet was fixed with the help of screws. Openings for feeding and exit of canes were provided. Machine was tested with protective cover. It was observed that sometimes canes go sideways and are obstructed by the cover towards exit side. A guide is therefore, was felt needed. Scratching of canes was also observed, which is due to hardness of thick wire bristles on scrapping rollers. Due to bristle hardness, load on motor and movement of canes was observed. Slight modification in sprayers of washing system was made. It helped in regular and more uniform water spraying over the canes.

Development of ISRI model Jaggery unit for enhanced capacity

During jaggery production, inadequate vapor removal led to the installation of three 450 mm, 1400 RPM exhaust fans and two 24-inch aluminum turbo air ventilators. The furnace had a water evaporation rate of 1.81 kg water/kg bagasse, with flue gas containing 0.035% CO_2 and 0.013% CO, indicating efficient combustion at 280-290°C. Each batch used 230 kg of bagasse to produce 95 kg of jaggery from 600 kg of juice, consuming 2.42 kg of bagasse per kg of jaggery. The total processing time per batch was 2 hours and 21 minutes. The furnace's thermal efficiency was 28.82%, with an overall jaggery production efficiency of 16%.

Development of small powder Jaggery cubes

A manually operated machine for making jaggery cubes using jaggery powder was developed. Experiments were conducted using graded jaggery powder of fineness (less than 0.300 mm), having a moisture content of 7.0 ± 0.3%. The capacity of the machine was 6.0 kg/h, producing jaggery cubes weighing 5-6 g each. The size of each cube was 15 mm. The average compression ratio of jaggery cubes was 3.0, and the average density was 1.60 g/cm^3. The average moisture content of the cubes was 2% (db).

Fig. 6.1 *Sugarcane cleaner-cum-washer with protective /safety cover*

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

About 4.5 to 5.0 litre of water is evaporated per kilogram of jaggery made from sugarcane. Therefore, even a small unit producing 1.0 quintal jaggery per day evaporates 450 to 500 litre of water. This evaporated water goes to waste in the atmosphere. A conceptual 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 was made. A miniature unit for verification of concept has been fabricated. Unit consists of a small masonry stove with a M.S. pan of 304 mm diameter and 152 mm height for boiling water. Bagasse and/or twigs are used as fuel. This unit is to see the extent of water collection by the matching water vapour collection hood.

AICRP on Post Harvest Engineering and Technology

Development of home scale portable jaggery manufacturing unit

A home scale portable jaggery making unit has been developed. It is compact and user-friendly, fitting seamlessly into any household. The major components of the home scale portable jaggery manufacturing machine are (i) main frame (ii) sub-main frame (iii) sugarcane crusher (iv) 1.0 hp electric motor and a gearbox to power the unit(v) wire strainer (vi) controlling unit (vii) induction cook top (viii) silicon moulds (ix) boiling pan (x) power supply system (xi) bagasse dispenser (xii) storage area.

Development of Jaggery Coating Machine for Value Added Products

The machine was modified to accommodate different capacity coating vessels and made portable by incorporating wheels. Fresh jaggery, sourced from the Jaggery Unit at ICAR-ISRI, Lucknow (Sugarcane variety: CoLk94184), along with other required materials, was procured from the local market. The prototype demonstrated a coating capacity ranging from 1.37 to 3.61 kg/h, achieving a maximum coating efficiency of 97% with a coating time of 4.63 minutes. The total cost of the machine was ₹35,000 with an operational cost of ₹129.4 per hour. The cost of coating varied for different products: ₹65.03/kg for almonds, ₹47.06/kg for foxnuts, and ₹57.77/kg for peanuts. Sensory evaluation revealed that jaggery-coated foxnuts were the most acceptable among the coated.

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

The Agri-Business Incubation (ABI) Center has actively fostered entrepreneurship and innovation, supporting a diverse range of startups in the agribusiness sector. Over the past year, the center has incubated eight entrepreneurs, facilitating the development of five innovative technologies, including jaggery moulding frame technology using silicon, advanced sugarcane crushers, and value-added jaggery products. Through strategic mentorship, training programs, and awareness sessions, the ABI Center has empowered agripreneurs with technical expertise in jaggery production, storage, and value addition. Additionally, the center has successfully generated revenue through registration and incubation fees while expanding its network of technology and business mentors. With a focus on financial sustainability and capacity-building, the ABI Center continues to play a crucial role in bridging the gap between agricultural innovation and market-ready solutions, fostering economic growth and rural development.

Technology Developed

Name of the Machine: Jaggery Coating Machine for Value Added Products

Capacity of Machine: 3.61 kg/h

Use of Machine: Jaggery coating

Details of the Machine: The jaggery coating machine has a maximum coating capacity of 3.61 kg per hour and an impressive coating efficiency of 97.2%. It can coat up to 131.25 grams of product in a maximum time of 4.63 minutes. The total cost of development amounted to ₹34,454, while the operational cost stands at ₹129.4 per hour. The cost of coating varies by product, with almonds at ₹65.03 per kg, foxnuts at ₹47.06 per kg, and peanuts at ₹57.77 per kg. Sensory evaluation results indicate that jaggery-coated foxnuts were the most acceptable among the tested products (Fig. 6.2).

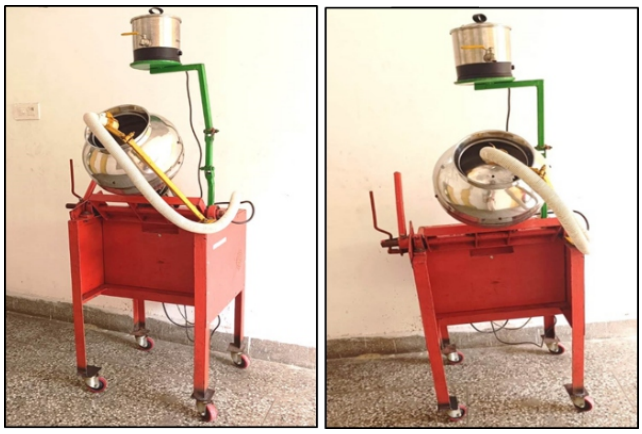


Fig. 6.2 *Developed Jaggery coating Machine*

Details of Product Developed

Name of Product: Jaggery Based Flax Seeds Laddu

- Cost of Products: Approx. Rs. 800/- Kg
- Use of Products: Supplementary food for improvement of nutritional status (Fig 6.3)

Fig. 6.3 *Jaggery Based Flax Seeds Laddu*

CHAPTER 7

Agricultural Knowledge Management Unit

Database management, socio-economic studies and decision support system for sugar sector

International sugar trade and export opportunities for Indian sweeteners:

Revealed Comparative Advantage Index (RCA) for the Indian sugar and processed value added products export was analyzed by applying standard tools. The sugar export increased during the last decade due to favorable trade environment, sustained export growth momentum. The Export Performance Ratio (EPR) was applied to measure the comparative advantage. The Export Performance Ratio (EPR) of the i^{th} sweetener's product is expressed as

EPRi = (Ei/CE)/(Wi/WE)

Where,

Ei = Export of i^{th} sugar product from India

CE = Aggregate export of sugar and allied products from India in a triennium

Wi = Total world's export of i^{th} sugar and allied products

WE = Total world's export of all sugar value added products in a triennium.

If value of EPR >1, it means India has revealed comparative advantage for export of sugar products and vice-versa. Nominal Protection Coefficient (NPC) is used to measure the export competitiveness of sugar and allied products. If NPC < 1, India has comparative advantage in sugar export. The Simpson's Diversity was Index applied to measure the diversity of India's sugar exports. In order to make it comparable, Revealed Symmetric Comparative Advantage was also worked out. The RSCA ranged from –1 to +1. The positive value of RSCA indicates a comparative advantage and negative value no comparative advantage in export of that product. The results are presented in Table 7.1 to 7.3. This reveals that India has competitive advantage in exports of the raw cane sugar, refined cane sugar in solid form and molasses (HS 170111, 170191,170310) as revealed by the values of RCA (>1) or the positive RSCA value. However, for the other sugar products such as cane syrup, cane confectionary, artificial honey, chewing gums, RCA value (<1) and (RSCA negative values), indicate that India does not have competitive advantage in exporting these products in international market.

Table 7.1: Sugar and allied product and HS code for international trade

International sugar sub code under (HS 1701)	Description of sugar product
HS170111	Raw cane sugar in solid form
HS170191	Cane or beet sugar containing added flavors
HS170199	Cane/ beet sugar in solid form
HS170230	Glucose/syrup contain <20% fructose
HS 170240	Glucose/syrup, containing >=20% Fructose
HS 170260	Other fructose and fructose syrup
HS170290	Artificial honey, caramel and other sugars
HS170310	Molasses from sugarcane from sugar refining
HS 170390	Molasses from the extraction or refining
HS170410	Chewing gum
HS170490	Sugar confectionery (incl. white chocolate)
HS170112	Raw beet sugar in solid form

Table 7.2. Analysis of Revealed Comparative Advantage for sugar products export during TE 2020

Product Code/Year	2018			2019			2020		
	EPRi	RCA	RSCA	EPRi	RCA	RSCA	EPRi	RCA	RSCA
HS170111	0.12	0.12	-0.79	0.95	0.95	-0.02	0.99	0.99	0.00
HS170191	0.33	0.33	-0.51	1.93	1.93	0.32	8.27	8.27	0.78
HS170199	1.41	1.41	0.17	2.52	2.52	0.43	3.25	3.25	0.53
HS170230	0.87	0.87	-0.07	0.46	0.46	-0.37	0.60	0.60	-0.25
HS 170240	0.05	0.05	-0.90	0.06	0.06	-0.89	0.05	0.05	-0.91
HS 170260	0.00	0.00	-1.00	0.00	0.00	-1.00	0.00	0.00	-1.00
HS170290	0.11	0.11	-0.80	0.12	0.12	-0.78	0.11	0.11	-0.80
HS170310	2.33	2.33	0.40	3.74	3.74	0.58	3.44	3.44	0.55
HS 170390	0.03	0.03	-0.94	0.03	0.03	-0.93	0.10	0.10	-0.82
HS170410	0.33	0.33	-0.50	0.25	0.25	-0.60	0.26	0.26	-0.59
HS170490	0.18	0.18	-0.70	0.18	0.18	-0.70	0.17	0.17	-0.71
HS170112	0.01	0.01	-0.97	0.01	0.01	-0.98	0.17	0.17	-0.72
% Share in World			2.78			5.02			6.46
TE Average	4.76	1959.31	41190.9						
NPC	1.345			1.399			1.206		
Simpson DI	0.436			0.541			0.520		

Table 7.3 Analysis of Revealed Comparative Advantage for sugar products export during TE 2023

Product Code/Year	2021			2022			2023		
	EPRi	RCA	RSCA	EPRi	RCA	RSCA	EPRi	RCA	RSCA
HS170111	1.19	1.19	0.09	1.90	1.90	0.31	0.67	0.67	-0.20
HS170191	3.97	3.97	0.60	4.51	4.51	0.64	3.34	3.34	0.54
HS170199	1.99	1.99	0.33	2.15	2.15	0.36	1.99	1.99	0.33
HS170230	0.43	0.43	-0.40	0.40	0.40	-0.43	0.31	0.31	-0.53
HS 170240	0.11	0.11	-0.81	0.02	0.02	-0.97	0.01	0.01	-0.98
HS 170260	0.00	0.00	-1.00	0.00	0.00	-1.00	0.00	0.00	-1.00
HS170290	0.07	0.07	-0.88	0.11	0.11	-0.80	0.19	0.19	-0.68
HS170310	3.11	3.11	0.51	3.55	3.55	0.56	3.40	3.40	0.55
HS 170390	0.10	0.10	-0.82	0.04	0.04	-0.92	0.58	0.58	-0.27
HS170410	0.15	0.15	-0.74	0.16	0.16	-0.73	0.17	0.17	-0.70
HS170490	0.11	0.11	-0.80	0.11	0.11	-0.80	0.12	0.12	-0.78
HS170112	0.12	0.12	-0.79	0.08	0.08	-0.86	0.06	0.06	-0.89
%Share in World			8.89			11.29			7.32
TE Average	4960.00	54182.19	9.15						
NPC	0.965			0.832			0.659		
Simpson DI	0.595			0.598			0.554		

The Nominal Protection Coefficient (NPC >1) reveals that India have not comparative advantage for sugar export during TE 2020 without government support. However, India has comparative advantage for sugar products as NPC(<1) during TE 2023. The Simpson's diversity index (SDI) reveals that the Indian sugar and allied product export basket was diversified during TE 2020 and TE 2023. India's sugar export and trade indicators was high as compared to SAC countries. India's position with respect to ease of doing business, trading across borders, LPI score, LPI rank and CPIA rating was high. Analysis of sugar export composition indicates that more than 96% sugar and jaggery was under HS Code 1701, sugarcane chemically pure sucrose in solid form. The analysis of sugar trade competitiveness also reveal that India has comparative advantage in sugar export to SAC countries (RCA>1 and RSCA positive value). The major destinations for sugar products were Asian, Gulf and African nations as depicted in Fig 7.1, 7.2 and 7.3.

The sugar exports have enhanced from 63.9 million tons in 2020-21 to 64.3 million tons during year 2022-23. India's sugar exports has registered a decline over last year (2023- 24) due to government restrictions on sugar exports to maintain domestic sugar price. Brazil faced adverse weather conditions, however it recovered with 8.7% gain in sugar exports. The share of major sugar exporting nations TE 2023, reflects that Brazil remains largest exporter with share of 44.7% followed by India (14.4%), Thailand (10.5%) and Australia (5.1%). The international sugar exports were highly concentrated as top four exporters, Brazil, India, Thailand and Australia account for 75 percent of world sugar exports. However, sugar imports are more diversified as compared to sugar exports. Indonesia was largest sugar importer, accounting for 10.1% of aggregate sugar import TE2023, followed by China, 8.8%, USA (5.4%), Bangladesh (4.2%) and EU (3.9%). The sugar market forecast says that the sector would witness a high concentration in coming decade. Brazil will remain leader in world sugar market, while India's prospects for growth and export stability in sugar exports could restrain primarily due to the ambitious Ethanol Blended Petrol (EBP) Programme to achieve 20% ethanol blending in petrol (E20) by year 2025-26. This policy initiative likely to divert substantial sugarcane production towards ethanol production for blending purposes, thereby limiting the surplus sugar availability for export as domestic sugar demand could also increase. Sugar trade statistics analysts predict a decline in sugar imports by the EU, USA, Russia, Japan and Mexico. The prospects of Indian sugar and other sweetener exports in future could be better on account of higher international prices than domestic sugar prices. The favorable price advantage in the international market has also obviated export subsidy to mills to offload surplus sugar stocks. The Government of India has to adopt Revenue Sharing Formula (RSF) to determine sugarcane price from revenue realized by the sugar mills from sale of sugar, bioethanol, electricity and Co-products to minimize the need for sugar export subsidy. It would help in making sugarcane pricing policy effective which would be WTO compatible and acceptable to all stakeholders.

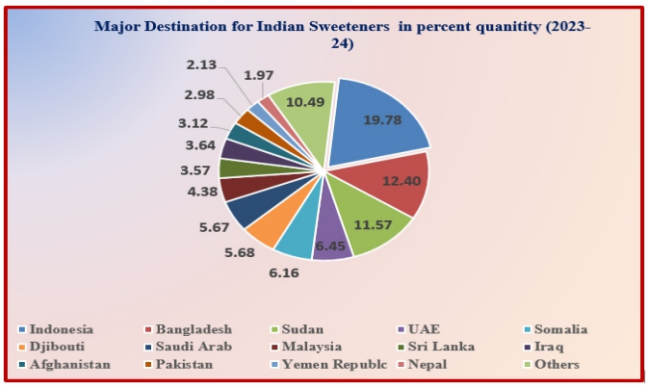


Fig 7.1 *Major sugar and allied products trade destination during year 2023-24*

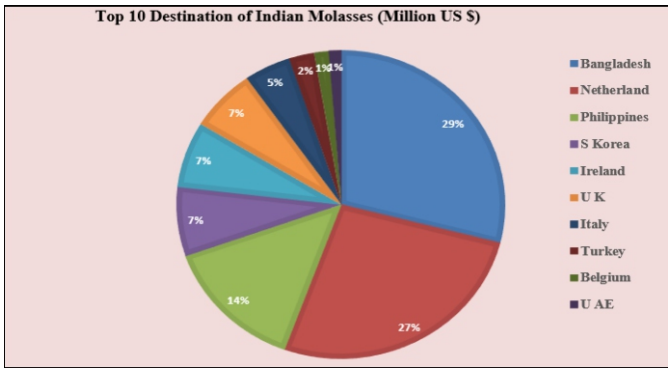


Fig 7.2 *Top 10 destinations for Molasses and Indian sugar products*

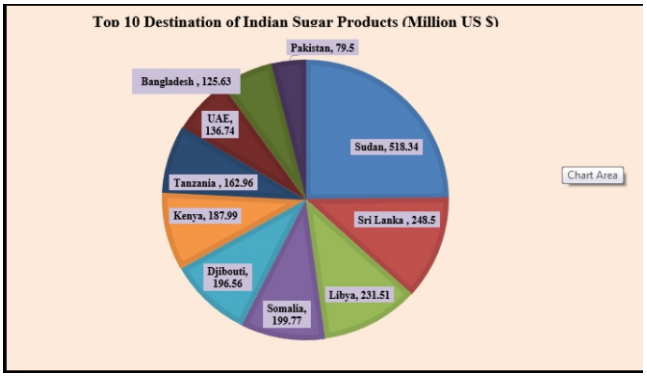


Fig 7.3 *Top 10 destinations for Indian sugar products in terms of monetary value*

Analysis of cost of cultivation of sugarcane in Uttar Pradesh during 2024-25

The cost of sugarcane cultivation in Uttar Pradesh for the crop season 2024-25 was estimated on the basis of primary data collected from 86 farmers from 6 district (Three district each from Western, and Central Region) on the basis of PRA techniques during July-Dec. 2024. The estimates of 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 meeting for the fixation of State Advised Price (SAP) for sugarcane in UP during December 2024. The cost of cultivation for plant and ratoon crop was ₹ 3320 and ₹ 3280 per ton, respectively. The average cost of sugarcane cultivation was ₹ 3310 per ton. The average sugarcane productivity has declined due to wide spread of red rot diseases in leading cane variety Co 0238 in the state. The area under this variety has also declined from 72.9 to 44.5 % during past two crop season year. The sugarcane cost of production on Cost A_2 +FL and Cost C_2 was ₹ 239615 and ₹ 278586/ha and average productivity 84.1/ha. These estimates was submitted to UP Sugarcane Department for State Advised Price Fixation Recommending Committee under the chairmanship of Chief Secretary, Govt. of UP.

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

Traditional practices such as Rishi krishi, Natueco farming, homa farming, panchagavya krishi and bio-dynamic farming are related to organic farming. It minimize energy consumption by 30.7 % per unit land through elimination of energy for chemical fertilizers, pesticides production, applying agro-crop residues or in-house inputs. The challenges in organic farming adoption iclude yield reduction in initial years due to sudden switch from inorganic to organic inputs, gaps in input availability, requirement of FYM for nutrients and limited pest and disease management options. The farmers stated that lack of premium price for organic crop products and marketing infrastructure as major constraint in its promotion. The results of Network Project on Organic Farming (NPOF) reported that net return was 17-20% higher (at 20-25 % premium product price) for organic products as compare to inorganic product (Table 7.4). The cost of cultivation was 13-20 % higher in organic farming because of bulky nature of organic manures. Benefit: Cost ratio (BCR) for number of cropping systems under NPOF ranges from 1.14 to 4.34.The expenses on organic nutrients sources varies from 28 to 85% of operational cost for the crops, whereas, in non-organic cultivation, cost of inorganic nutrient ranges from 16 to 68 %. The reviewed studies reveal a substantial rise in consumption of organic products. It brings extra income with organic products export. India has supplied organic products such as oilseeds, dry fruits, organic jaggery, raw sugar, cereals, coffee and tea to number of countries viz., Australia, USA, Canada, Switzerland, EU, and UAE. It has exported organic food products worth $1 billion (₹ 7,078 crores) in 2020-21(Ministry of Commerce & Industry).The share of organic products in export value realization was oilseeds (9%), soya meal (8%), cereals and millets (7%) and tea and coffee (6%)

Table 7.4 Export of Organic Products from India during year 2023-24

Nations	Export Quantity (MT)	Value (In ₹ Crores)	Value (USD Million)
U.S.A.	1,02,463	1,954	241.1
European Union	75,098	1,312	162.0
Canada	14,251	163	20.2
Great Britain	13,718	161	19.91
Sri Lanka	12,348	66	8.16
Switzerland	3,226	64	7.87
Vietnam	11,075	53	6.5
Australia	1,016	45	5.6
Thailand	9,390	39	4.8
New Zealand	1,931	20	2.4
Total	**2,61,029**	**4,008**	**494.8**

Development and evaluation of sugarcane crop image dataset for varietal identification

The project has been initiated with objectives - to develop image data set of sugarcane crop varieties and to evaluate image data set using computer vision techniques for varietal identification. Field trial of 24 early and mid-late sugarcane varieties recommended for subtropical India has been initiated in two replications. Varieties undertaken in early group are CoLk 14201, CoLk 15466, CoLk 11203, CoS 17231, CoLk 9709, CoLk 16202, CoLk 15201, CoS 13235, Co 0118, CoLk 94184, CoLk 12207, and Co 0238 while in mid-late group are CoS 767, CoS 08279, CoLk 09204, CoLk11206, CoLk15207, Co05011, CoPant97222, CoLk12209, CoLk14204, ColLk15206, CoLk16030, and CoPb14185. Collected 45,000+ images of sugarcane at 15 days interval (approx.) for descriptor classes of plant, leaf, leaf sheath, internode and node of sugarcane. Further, measurable characters viz. internode diameter, bud size, and root band size were also recorded for varieties undertaken. Image annotation performed for labelling of images using rectangle bounding box and polygon techniques. Online free annotation tools has been used to annotate images and record coordinates in JSON, XML and CSV formats. 7000+ annotations has been made and images labelled for object detection.

Development of Trait-Specific Genomic Database for Sugarcane

This project aims to create a centralized and accessible repository of sugarcane genomic data specific to these important traits. The goal is to leverage the extensive sugarcane genomic data available from NCBI (National Center for Biotechnology Information) and other public sources. This project seeks to bridge knowledge and technology gaps by developing a trait-specific database that consolidates SNP and CNV data related to sugarcane from NCBI and other public domains. Work done so far includes: data retrieval from public domain, data curation and classification by trait and assembly of raw reads for each experiment.

Rhizospheric Metagenomic Study to Identify Beneficial Microbes for Sustainable Management of Sugarcane Smut in Uttar Pradesh

The project aims to investigate the rhizospheric microbial community associated with sugarcane plants in Uttar Pradesh with the objective of identifying beneficial microbes that can contribute to the sustainable management of sugarcane smut, a prevalent disease affecting sugarcane cultivation in Uttar Pradesh. Through meta-genomic analysis, it is intended to elucidate the diversity and functional potential of these microbial communities and identify potential bio-control agents that can mitigate sugarcane smut incidence.

CHAPTER 8

Harnessing the potential of sugar beet for Indian Agro-Climate

Developing sugar beet varieties suitable for Indian agro-climates

Seed Production at Sugar beet Breeding Outpost, Mukteshwar

One hundred forty nine germplasm accessions of sugar beet are being preserved in cold storage facilities at ISRI, Lucknow. To ensure the viability of the seeds, seeds are sown every alternative year at Mukteshwar. One-third of the sugar beet germplasm was sown this year at Sugar beet Breeding Outpost, Mukteshwar by transplanting / direct sowing methods.

Seeds of LS 6, LKC 2020, and IISR Comp 1, are being produced for need-based supply to sugar beet cultivators nationwide. Fresh seeds of 52 sugar beet varieties/germplasm was produced in October 2024 with a combined seed weight of >24.0 Kg. Besides, the seed yield of IISR Comp 1 was 1.474 Kg, and LS 6 was 16.7 Kg.

Table 8.1: List of Sugar beet Germplasm used for production during October, 2024

LS 06	IISR Comp I	DRFB 2	PAC 60008
L 33	SV 891	SYT/06/10	LKC 2007
LKC 2010	SYT/06/25	SR 96	USK-39-33
LKC 11	SYT/06/23	SBEB 621	USK-PS-24
LKC 2000	IN 07	LK 7	BTS 604
SV 889	R 06	PAC 60006	SYT/06/12
FC 712	LKC 95	Indus Prasda	LK 4
SV 887	DRFB 4	IISR Comp I HBS	LKC LB
LKC HB	LKC 2006	SYT/06/04	7112 x BTS 605
LKC 2020	7112	LKC 11	IN 13 x LK 4
SYT 06-13	Shubhra	SR 97	LK 0503 x LK 27
PAC 60002	Mangolia	SYT/06/11	Shubhra x LS 6
LKS 10	436	LK 8	IN 13 x LK 4

Screening of sugar beet genotypes against insect pests and diseases

A comprehensive screening of 50 sugar beet genotypes was conducted to assess their susceptibility to insect pests and diseases. Foliar infections were observed in all the genotypes, with a notable prevalence of *Cercospora* leaf spot disease. *Alternaria* leaf spot was also seen in few of the genotypes. Additionally, *Fusarium* and *Sclerotium* root rots were identified as significant concerns in many of the genotypes. Viral infection was also found to affect most of the sugar beet germplasm, further exacerbating the health challenges faced by these plants. These findings align closely with the results observed in the previous year (2022-23), indicating consistent disease pressure across the genotypes.

In terms of insect pests screening, a mild presence of leaf miners, spiders, beetles, and aphids (*Myzus*) was noted from February to April. The incidence of Bihar hairy caterpillar and grasshoppers became more prominent during March. However, among the major insect pests, the infestation of *Spodoptera* spp. was first noticed around two months after germination, and its population peaked between April and May, with an alarming incidence up to 94 per cent. During the peak incidence period, *Spodoptera* spp. caused complete defoliation, with the leaves being entirely consumed. When evaluating the resistance of the 50 sugar beet genotypes, several genotypes displayed varying levels of susceptibility to *Spodoptera litura*. The genotypes SYT/06/10, L 33, and LKC 2000 demonstrated considerable resistance to this pest, with minimal damage observed. In contrast, the genotypes LKC 2020, LK 4, LK 7, LKC HB, LKS 10 and LKC 11 were found to be highly susceptible to *Spodoptera* litura, exhibiting significant damage during the peak infestation period. These findings are consistent with those observed in the previous year, suggesting a persistent level of insect problem across the genotypes.

Identification of sugar beet varieties/germplasm for water-limiting conditions

To identify sugar beet germplasm with superior drought tolerance and high yield potential under water-limited conditions, an experiment was conducted with 16 different treatments and two check varieties, LS 6 and IISR Comp 1 in randomized block design with three replications. Drought stress was applied by withholding irrigation, while the irrigated plots received optimal water supply. Regular monitoring ensured that the drought conditions were accurately implemented.

Among the genotypes tested, LKC 11, LKC HB, and LKC 2000 showed remarkable resilience to drought, with single root weight of 1.23 kg, 1.09 kg, and 1.08 kg, respectively, surpassing the root weight of the check varieties, LS 6 (1.02 kg) and IISR Comp 1 (1.0 kg). LKC 2000 particularly stood out, not only for its high root weight but also for its superior root length (31.8 cm) and root diameter (12.38 cm) compared to the checks, LS 6 (30.12 cm and 9.28 cm) and IISR Comp 1 (28.98 cm and 9.1 cm). However, in terms of root length and diameter, the check varieties LS 6 and IISR Comp 1 maintained their usual high performance. Proline content, which is a critical indicator of drought stress response, showed a significant increase in all genotypes under water deficit conditions, further reinforcing their tolerance to drought. This heightened accumulation of proline suggests enhanced stress resistance mechanisms in these genotypes, making them more suited for water-limited environments. Additionally, sucrose content and Brix values, which are key quality parameters in sugar beet, were also influenced by drought stress. The genotypes LKC 2006 and LKC 95 emerged as the best performers for both sucrose content and Brix value, recording 16.37% and 16.29% for sucrose, and 17.90 and 17.66 for Brix, respectively. These findings align with the observations from the previous year, emphasizing the stability and resilience of these genotypes under water-limiting conditions. These figures were significantly higher than those of the check varieties, with LS 6 recording a sucrose content of 16.05% and a Brix value of 18.50, and IISR Comp 1 with a sucrose content of 15.03% and a Brix value of 15.75. Overall, the results from this study indicate that the genotypes LKC 11, LKC HB, and LKC 2000 exhibit excellent drought tolerance, high yield potential, and superior quality traits.

Performance of sugar beet at different locations/ conditions

High temperature and hot conditions (ARS, Basanthpur)

Twelve sugar beet genotypes were evaluated for their performance under low temperature conditions. Tuber formation gradually started at two months, accelerating significantly by three months. The individual yield across genotypes ranged from 26.77 to 60.22 tons per hectare. LKC 2000 produced the largest root weight (1.69 Kg), closely followed by LKC 2020 (1.58 Kg). LS 6 recorded the highest tuber yield (60.22 t ha^{-1}), with LKC 2000 ranking second (59.29 t ha^{-1}).

Saline stress conditions (CSSRI RRS, Lucknow)

An experiment was conducted to evaluate the performance of sugar beet in saline soils using 14 genotypes. Among these, LKC 2006 achieved the highest tuber weight (1072.2 g), followed by LK 4 (847.2 g), LKC 2000 (841.7 g), and LS 6 (791.7 g). Root length was also highest in LKC 2006 (28.9 cm), with notable lengths recorded for LK 7 (27.8 cm), LKC 2000 (27.3 cm), LKC LB (27.7 cm), LKC 11 (26.9 cm), and L 33 (25.2 cm), compared to IISR Comp 1 (24.2 cm) and LS 6 (25.0 cm). In terms of root diameter, LS 6 excelled with 9.3 cm, while L 33 (8.4 cm), LK 4 (8.3 cm), LKC 2000 and LKC 2006 (both 8.7 cm), and LKC 2020 (8.8 cm) were close contenders. LS 6 demonstrated clear superiority in root diameter.

Tropical conditions (VSI, Pune)

An experiment involving 14 sugar beet genotypes, in RBD with three replications, was conducted to evaluate their agronomic performance under the soil and agro-climatic conditions of central Maharashtra. The findings revealed significant differences in germination percentages at 20 and 30 days after sowing (DAS). LKS 10 exhibited the highest germination at 20 DAS (74.0%), while LK 4 led at 30 DAS (77.3%). At 60, 90, and 120 DAS, genotype L 33 consistently recorded the highest plant population (59.00, 57.33, and 55.67 t ha^{-1}), whereas LKC 95 had the lowest (42.0, 40.0 and 36.3 t ha^{-1}). Plant counts at harvest were not significantly different across genotypes. The largest beet girth was observed in LK 7 (40.4 cm), comparable to LKC 2000 (38.6 cm), LKC 95 (37.3 cm), and LS 6 (35.8 cm). LKC 95 produced the heaviest beet (1.6 Kg), followed by LK 7 (1.6 Kg), LS 6 (1.4 Kg), and LKS 10 (1.3 Kg). LK 7 achieved the highest beet yield (72.8 t ha^{-1}), closely matched by LS 6 (71.7 t ha^{-1}), LKC 2000 (69.7 t ha^{-1}), LKS 10 (68.1 t ha^{-1}), and LK 4 (63.9 t ha^{-1}). Brix, sucrose, and purity percentages showed no significant differences among genotypes, though L 33 recorded the highest brix (20.1 %) and sucrose (16.9%), while LKC 2000 exhibited the highest purity (85.5%).

Another experiment was carried out to evaluate the susceptibility of different sugar beet genotypes to key pests and diseases under the agro-climatic conditions of central Maharashtra. No insect pest infestations were detected throughout the cropping period. Likewise, *Sclerotium* rot, *Fusarium* rot, and *Erwinia* rot were not observed in any of the genotypes. However, all tested cultivars exhibited the presence of powdery mildew.

Testing in East Coast Zone (Research centres of ANGRAU)

Seeds of sugar beet varieties (LS 6 & IISR Comp. I) were supplied to different research centres of ANGRAU, Guntur during this year. According to trials conducted on various sowing dates The first fortnight of October was the most productive period of year for sugar beet sowing in the ECZ.

Drought stress conditions (SOA University, Bhubaneshwar)

An experiment was carried out to evaluate performance of sugar beet genotype LS 6 under different level of drought stress. Under 10 days of drought stress yield of LS 6 was lower (85.2 t ha^{-1}) compared to the irrigated conditions (94.5 t ha^{-1}). When drought stress was extended to 15 days, the yield further deteriorated decreased by 25-30 t ha^{-1}.

Assessment of sugar beet genotypes for ethanol recovery (NSI, Kanpur)

The ethanol content of five elite sugar beet genotypes namely LS 6, IISR Comp 1, LKC 2020, LKC 2006 and LKC 2010, was estimated at National Sugar Institute, Kanpur. The highest ethanol content was observed in LKC 2020 (8.5%) followed by LKC 2010 (8.2%).

Transfer of Technology:

Different sugar beet germplasm, namely L 33, LK 7, LK 4, LKS 10, LKC 11, LKC 95, LKC 2000, LKC 2006, LKC 2007, LKC 2010, LKC 2020, LKC LB, LKC HB, LS 6, and IISR Comp 1, were supplied to ARS, Basanthpur; ICAR-CSSRI RRS, Lucknow; S. Nijalingappa Sugar Institute, Belgavi; K.J. Somaiya Institute of Applied Agricultural Research (KIAAR), Sameerwadi (Karnataka); Vasantdada Sugar Institute, Pune while, six germplasm were supplied to National Sugar Institute, Kanpur, and two sugar beet varieties, *viz*., LS 6 and IISR Comp 1 were supplied to Siksha O Anusandhan University, Odisha; Regional Agricultural Research Station, Anakapalle; Sugarcane Research Station, Vuyyuru; Agricultural Research Station, Perumalapalle; Agricultural College, Naira (ANGRAU, Guntur) for research purposes. Package of practices were also shared with public and private organizations to grow healthy sugar beet crop and achieve the best potential results.

Linkages

ICAR-ISRI, Lucknow established relationships and collaborations with the sugar beet research institutes/centres *viz.* : ARS, Basanthpur; CSSRI RRS, Lucknow; SNSI, Belgavi; KJ SIAAR, Sameerwadi (Karnataka); VSI, Pune; NSI, Kanpur; SOA University, Odisha; RARS, Anakapalle; SRS, Vuyyuru; ARS, Perumalapalle; Agricultural College, Naira (ANGRAU, Guntur).

Sugar beet & autumn sugarcane intercropping (A collaborative project between ICAR-ISRI, Lucknow & NSI, Kanpur)

Intercropping sugarcane with sugar beet offers distinct advantages, particularly for sugar millers. Incorporating sugar beet into the crop rotation extends the processing period of sugar mills by an additional two months. With sugar beet capable of yielding between 5000-6000 liters per hectare, significantly surpassing other grains such as wheat, it presents a compelling option for ethanol production. Therefore a collaborative project on sugar beet and autumn sugarcane intercropping has been initiated at following sugar mills in Uttar Pradesh by ICAR-ISRI, Lucknow, and NSI, Kanpur:

- DCM Shriram Ltd., Rupapur (Hardoi)
- The Seksaria Biswan Sugar Factory Limited, Biswan (Sitapur)
- Dalmia Bharat Sugar and Industries Limited, Ramgarh (Sitapur)
- Balrampur Chini Mills Ltd., Haidergarh (Barabanki)
- KM Sugar Mills Ltd., Motinagar (Ayodhya)

CHAPTER 9

AICRP on Sugarcane

Research Achievements

Under AICRP on Sugarcane, for the development of location specific high yielding sugarcane varieties with high sugar, zonal varietal trials of early and mid-late maturing varieties were conducted to screen the promising genotypes. In view of developing abiotic stress tolerant varieties, ISH & IGH programmes are being executed at certain centers for both drought as well as water-logging conditions. During the 92nd meeting of the Central Subcommittee on Crop Standards on August 2, 2024, six sugarcane varieties has been released and notified by AICRP (S).

During the year 2024, a total of 24 Zonal Varietal Trials were conducted, comprising 11 early maturing, 9 mid-late maturing and 4 combining both early and mid-late entries. A total of 41 entries were evaluated in both the early and mid-late groups, with 40 entries in the combined trials. From these evaluations, 20 promising genotypes were identified in the early group, 21 in the mid-late group and 12 from the combined trials. These advancements are pivotal in addressing the varying climatic and agro-ecological conditions across the country.

The crop production research conducted during the year revealed significant findings regarding optimal agronomic practices. It was observed that elite genotypes performed exceptionally well at wider spacing, with 120 cm in sub-tropical regions and 150 cm in peninsular and east-coast zones. Furthermore, the response to a higher recommended dose of fertilizers (125%) was conspicuous across various regions, contributing to enhanced sugarcane growth, yield, and quality. Moisture stress during the pre-monsoon growth phase was found to significantly impact cane yield, with losses ranging from 5% to 35% across different sugarcane-growing zones. However, areas that experienced adequate rainfall did not report a significant effect of drought treatment on yield, highlighting the crop's compensatory abilities during critical growth stages. Additionally, trials in the north-west zone indicated similar cane yields when comparing granular urea to its substitution with liquid nano urea, emphasizing the potential for improved nutrient management practices. Noteworthy was the integration of soil health-promoting microbial consortia, which, when applied alongside the recommended dose of fertilizers, enhanced cane yields at most centers. This approach not only improves productivity but also promotes sustainable agricultural practices.

In Plant Pathology a crucial focus was on the identification of new pathotypes of the red rot pathogen, with 13 centers involved in testing a total of 109 new isolates against 20 host differential varieties. This research is vital for developing resistant varieties and mitigating the impact of red rot, a major disease affecting sugarcane production. Furthermore, extensive screening for major diseases such as red rot, smut, wilt, and Pokkah boeng was conducted across multiple centers. The evaluation of tissue culture-raised plantlets for yellow leaf disease management proved effective, with several genotypes showing robust vigor and resistance to virus diseases. The assessment of disease incidence across various regions highlighted that red rot was prevalent, particularly in the Co 0238 variety. Continuous surveillance and research efforts are essential to combat these diseases and maintain the health of sugarcane crops.

The Entomology program involved six projects conducted at 13 centers during 2023-24, focusing on pest management across different sugarcane-producing zones. A comprehensive survey of pest populations revealed that pests like Pyrilla, armyworm, and white grub were generally at manageable levels, although isolated instances of severe damage were reported, particularly from top borers. A significant aspect of the research involved testing various genotypes for resistance to key pests. In the north-west and peninsular zones, several entries exhibited moderate to high resistance to early shoot borer and mealy bug. Additionally, bio-control agents such as *Cotesia flavipes* and *Dipha aphidivora* were found to significantly reduce pest populations, showcasing the potential for integrated pest management strategies. The development of cost-effective techniques for mass multiplication of beneficial bio-agents has further strengthened the capacity for sustainable pest management.

Technology Developed:

Six new varieties were developed with traits as mentioned in details hereunder:

(i) Co 17018 (*Karan*-17), Parentage : Co 0327 GC

This variety has been released and notified by CVRC in 2024 for North West Zone comprising of Uttar Pradesh (central and western parts), Punjab, Haryana, Uttarakhand and Rajasthan. It is a mid-late maturing variety having cane yield (90.32 t/ha), sucrose (%) in juice (18.37), CCS (11.60 t/ha) and Pol (%) in cane (13.68). Reaction against red-rot was resistant (R) and in response against major insect-pests it was found less susceptible (LS). This variety is tolerant to salinity conditions.

(ii) CoPb 17215, Parentage : CoJ 88216 GC

This variety has been released and notified by CVRC in 2024 for North West Zone. It is a mid-late maturing variety having cane yield (90.14 t/ha), CCS (11.27 t/ha), sucrose (%) in juice (18.01) and Pol (%) in cane (13.50). For reaction against red-rot it was found Resistant (R) and its reaction against major insect-pests was found Less Susceptible (LS). This variety was recommended for cultivation under irrigated conditions.

(iii) CoLk 16202 (*Ikshu*-16), Parentage: LG 95053 X CoLk 94184

This variety has been released and notified by CVRC in 2024 for North West Zone. It is an early maturing variety having cane yield (93.22 t/ha), sucrose (%) in juice (17.74), CCS (11.43 t/ha) and Pol (%) in cane (13.57). The variety is resistant (R) to red rot disease and its reaction against major insect-pests was found Less Susceptible (LS). This variety is non-lodging, non-flowering, good ratooner and nutrient responsive. This variety has been recommended for irrigated condition.

(iv) CoS 16233 (*Roshan*), Parentage: Co 89003 X CoSe 92423

It has been released and notified by CVRC in 2024 for North West Zone. It is a mid-late maturing variety having cane yield (92.38 t/ha), sucrose (%) in juice (18.73), CCS (12.01 t/ha) and Pol (%) in cane (14.29). Reaction against red rot was resistant (R). The variety showed Less Susceptible (LS) reaction against major insect-pests. This variety is non-lodging and tolerant to salinity conditions.

(v) CoLk 16470 (*Ikshu*-17), Parentage: CoS 8436 X CoSe 92423

This has been released and notified by CVRC in 2024 for North Central & North Eastern Zones comprising eastern Uttar Pradesh, Bihar, West Bengal and Assam. It is a mid-late maturing variety having 82.50 t/ha cane yield, 17.37% sucrose in Juice, CCS (9.59 t/ha) and reaction against red rot was resistant (R). The clone showed Less Susceptible (LS) reaction for major insect-pests. This variety is non-lodging, non-flowering, better ratooning and suitable under waterlogged conditions.

(vi) CoP 16437 (*Rajendra Ganna*-1), Parentage: CoSe 92423 X Co 1148

Released and notified by CVRC in 2024 for North Central & North Eastern Zones this sugarcane variety is an early maturing variety having cane yield (86.43 t/ha), CCS (10.70 t/ha), sucrose (%) in juice (17.88) & Pol (%) in cane (13.85). Reaction against red rot was resistant (R). The clone is also Less Susceptible (LS) for major insect-pests. This variety is non-lodging and cultivable under irrigation condition.

CHAPTER 10

Krishi Vigyan Kendra, ICAR-ISRI, Lucknow

On Farm Testing/Trials (OFTs)

OFTs are most important mandatory component of KVK under which evaluation of recently developed technologies or varieties in specific agro climatic condition are conducted for future recommendations or popularization. Six 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

The orchrds of Lucknow district do not follow the canopy management practices, so they get unsatisfactory production. So, KVK, ICAR-ISRI, Lucknow conducted an OFT for assessment of different canopy management systems 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.

Frontline demonstrations

A total of 378 FLDs were conducted in 57.63 ha area, with oil seeds in 40 ha and pulses covered 5.0 ha. area under national food security mission (NFSM); 1.13 ha were under horticultural crops and 11.5 ha under fodder crops.

Enterprise	No. of Farmers	Area (ha)
Oilseeds	119	40.0
Pulses	40	5.0
Vegetables	45	1.13
Other crops	174	11.5
Total	**378**	**57.63**

Extension Activities

Livetelecast of PM Kisan Samman Nidhi Programme

Celebration of World Soil Day

Celebration of *Kisan Diwas*

Frontline Demonstration Conducted

Frontline demonstrations on oilseed and pulses crops

Crop	Thematic Area	Technology demonstrated	Variety	No. of Ffrmers	Area (ha)	Yield (q/ha)				% Increase in yield	Economics of demonstration (Rs./ha)				Economics of check (Rs./ha)			
						Demo												
						High	Low	Average	Check		Gross Cost	Gross Return	Net Return	BCR (R/C)	Gross Cost	Gross Return	Net Return	BCR (R/C)
Mustard	ICM	Improved variety	Giriraj	50	20	21	16.5	18.9	16.2	16.6	30100	106785	76685	3.54:1	29000	91530	62530	3.15:1
Sesamum	ICM	Improved variety	GT-6	69	20	5.8	5.0	5.5	4.8	14.58	22000	50968	28968	2.31:1	21500	44482	22982	2.06:1
Pigeon pea	ICM	Improved variety	IPA-203	40	5	16.2	13.4	14.2	9.5	49.5	29230	77390	48160	2.6:1	31580	51775	20195	1.6:1

FLD on other 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												
						High	Low	Average	Check		Gross Cost	Gross Return	Net Return	BCR (R/C)	Gross Cost	Gross Return	Net Return	BCR (R/C)
Vegetables																		
Cow pea	ICM	Improved variety seed treatment with Rhizobium and NPK@20:60:60 kg/ha.	Kashi Nidhi	09	0.5	133	121	130	108..5	19.8	89500	195000	105500	2.18:1	95800	162750	66950	1.7:1
Potato	ICM	Improved variety	Kufri Chipsona-3	18	0.315	370	345	356	295	20.7	125350	356000	230650	2.8:1	131550	295000	163450	2.2:1
Potato	ICM	Improved variety	Kufari Bahar	18	0.315	423	375	385	295	30.5	125350	385000	259650	3.1:1	131550	295000	163450	2.2:1
Fodder Crops																		
Perennial grasses	ICM	Improved variety	Napier-3108	103	4	860	795	843	--	--	29410	29730	63320	3.2:1	--	--	--	--
Forage Sorghum	ICM	Improved variety	CSH24MF	55	6.5													
Cow pea	ICM	Improved variety	BL-4	16	1													

Training Pogrammes

Krishsi Vigyan Kendra has conducted 07 training programmes for participating farmers and farm women, rural youth and extension funtioneries on various topics with an objective to improve skill and upgrade their knowledge about developed and potent products. All training programmes were fully skill-oriented and conducted following the principles of "Learning by doing".

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	05	121	3	124
Rural youths	0	0	0	0
Extension functionaries	0	0	0	0
Sponsored Training	2	42	6	48
Vocational Training	0	0	0	0
Total	**07**	**163**	**9**	**172**

Other Extension activities conducted by KVK:

Activity	No. of programmes	No. of farmers	No. of extension personnel	TOTAL
Advisory Services (Mobile)	1330	6295	0	6295
Diagnostic visits	2	10	2	12
Field Day	0	0	0	0
Group discussions	3	74	0	74
Kisan Ghosthi	8	1516	12	1528
Film Show	8	163	15	178
Self -help groups	0	0	0	0
Kisan Mela	0	0	0	0
Farmers visited to KVK	12	827	0	827
Scientists' visit to farmers field	39	722	0	722
Plant/animal health camps	0	0	0	0
Farm Science Club	0	0	0	0
Ex-trainees sammelan	0	0	0	0
Farmers' seminar/workshop	0	0	0	0
Method demonstrations	5	63	0	63
Celebration of important days	2	100	11	111
Special day celebration	4	32	415	447
Exposure visits	0	0	0	0
Lecture delivered	17	454	0	454
Other activities	9	1295	0	1295
Total	**1439**	**11551**	**455**	**12006**

Seed and planting material production:

Particulars	Quintal/Number	Value Rs.
Seed (q)	328	122000/-
Planting material (No.)	1950	--
Bio-Products (kg)	500	2500
Livestock Production Cow milk (lit.)	3128	156400

On Farm Trials

Centre opening of mango tree

Control

Artificial Insemination by Sex-sorted semen in cows under OFT

CFLD on Sesamum

CFLD on Blackgram

FLD on Potato

FLD on Fodder sorghum and Barseem

CHAPTER 11

ICAR-Krishi Vigyan Kendra-II, Lakhimpur Kheri

A brief overview of achievements and progress

SL No	Detail of events	Number of training		Beneficiary	
		Target	Achievements	Target	Achievements
1	Training	47	53	1290	1703
2	Trainings under SCSP	-	4	-	535
3	Natural Farming Training	-	2	-	60
4	FLD	8	8	165	165
5	OFT	8	8	57	57
6	Vegetable & flower seedlings	30000 nos	34975 nos	300	565
7	Animal health Camp	2	4	100	123
8	Farmer's visit to KVK	-	12	500	554
9	Scientists visit to Farmers field	180	186	510	1982
10	Group meeting	2	2	70	95
11	Celebration of important day	7	7	364	364
12	*Kisan Gosthi*	2	13	100	1412
13	Film Show	5	5	125	136
14	Method demonstration	12	12	74	416
15	Other extension activities (Lecture delivered, Advisory, *Mahila Mandal* meet etc.)	50	105	825	5679
	Total			**4467**	**13833**

Achievements under SCSP scheme

- Successfully conducted FLDs on 440 qlt. of wheat seed variety DBW-187, DBW-303, DBW-1270 and 04 Qtl Oat Seed (Variety-kent) to 1335 SC farmers under SCSP.
- Conducted FLDs on Potato and distributed 20 qtl Potato seed (Variety- K. Ganga, K. Mohan) among 25 SC farmers.
- Successfully distributed, 200 nos. Power sprayers, 1000 nos. Grow Bag, 100 nos. Tarpaulin, 1200 Kg. Irrigation pipe, 100 nos. Water Harvesting drum (500 Ltr) among 954 SC farmers under SCSP for uplifting their livelihoods.
- Successfully introduced new varieties of 25 qtl Green Gram (Zaid), 30 qtl Black Gram (Zaid), 04 qtl Maize (Zaid), 10 qtl Lentil (Rabi) (Variety- L-4717), 02 qtl Mustard (Rabi) (Variety – Giriraj RH-725), 01 qtl Mustard (Rabi) (Variety – Yellow pant sweta), 30 qtl Field Pea (Rabi) (Variety – IPFP-12-2), 03 qtl Gram (Rabi) (Variety – RVG-204) among 2120 SC Farmers for increasing the yield and doubling farmer's income under FLD programme.
- Distributed Poultry & Veterinary medicine among 300 SC Farmers for their upliftment.

Distribution of Lentil variety L.4717 & mustard seed Giriraj (RH-725) / Yellow Pant Sweta Among 540 SC farmer

Distribution of Poultry Medicine & Veterinary Medicine 300 SC Farmers

Achievements under TSP scheme

Distributed 3000 nos of chicks to ST farmers at Village Belaparsua, Shastri Purwa Block Nighasan for Livelihood security of Tribal Farmers under TSP Plan 2023-24

SL. No	Name of Input	Quantity	No. of Farmers Benefited	No. of Village Covered
Poultry Chicks				
1	CARI Shyama	500 Nos	50	2 Belaparsua & Shastri Purwa Village, Block Nighasan
2	CARI Nirbheek	500 Nos		
3	CARI Priya	1000 Nos		
4	Kadaknaath	1000 Nos		
	Total	3000 Nos		

Animal Health Camp

- To diagnose and treat the problems of the animals and make aware the farmers for vaccination and deworming of the animals, During the animal health camp organised in Village dt 20-02-2024 Belaparsua, 178 animals were diagnosed and treated for different kinds of ailments such as mastitis, diarrhea, deworming, infertility and pneumonia etc. Total 41 farmers benefitted in this animal health camp.
- Animal health camps were organized in collaboration with SSB 70th Vahini, Lakhimpur Kheri in the remote Villages on 27-03-2024 and on 21-06-2024 at Kartaniya ghat and Bhartapur.

During the Animal Health camp total 232 animals of different species were treated for different ailments such as mastitis, diarrhea, deworming, infertility and pneumonia etc. Total 82 farmers benefited in this Animal Health Camp.

Research Achievements

Evaluation of high yielding variety of cowpea (Var- *Kashi Kanchan*)

To increase cowpea production of the district an OFT was to make available quality seeds and to make them aware of scientific cultivation practices. Farmers were given advices regarding use of HYVs, trainings and method demonstration. The BC ratio of trial was observed 2.18:1 in comparison to that for local practices (1.82:1).

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. The OFT aimed to make the farmers aware of scientific cultivation practices. Farmers were given advice's regarding used of HYVs, trainingsand method demonstration. The BC ratio of trial was observed 2.07:1 in comparison to local practices (1.69:1).

Assessment of feeding of balance ration and mineral mixture to buffalo heifers for early onset of heat

On farm testing on Assessment of Feeding of balance ration 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 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. The final results of the trial are still awaited.

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 identified in the field that the buffaloes are not conceiving after repeat breeding. This increases the inter-calving period ultimately imposing 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 1:1.20 in comparison to that in control 1:0.83.

Sustainable Management of *Sclerotinia* stem rot in mustard

The On Farm Trail (OFT) was conducted for the field evaluation of Bioagents *viz. Tricoderma viride* and *T. harzianum* through seed treatment and soil application while Carbendanzim was applied as seed treatment and foliar application for sustainable management of Sclerotinia stem rot in mustard caused by *Sclerotinia sclerotiorum*. Four treatments along with control as farmers practices were conducted in randomized block design with five multi location trails at five farmer fields. The result from the trial revealed that lowest stem rot incidence 18.78 % along with highest yield 18.83 q./ha was recorded in seed treatment with *Trichoderma viride* and *T. harzianum* @ 10 gm/kg seed + carbendazim @ 2 gm/kg seed at the time of sowing + Soil application of *Trichoderma viride* and *T. harzianum* 2.5 kg/ha pre-incubated in 300 kg FYM/ha in 10 days prior to sowing + spray of carbendazim @ 2g/lt of water in standing crop. 21.57% was recorded disease incidence and 16.98 q./ha yield in in soil application of *Trichoderma viride* and *T. harzianum* 2.5 kg/ha pre-incubated in 300 kg FYM/ha in 10 days prior to sowing over farmer practices (Use of different fungicide at standing crop) no which maximum disease incidence 38.75% and lowest yield 14.43 q./ha were recorded.

Evaluation of different combination of casing materials for growth and yield of button musrhroom (*Agaricus bisporus*)

Five different combinations of casing materials were evaluated through On Farm Trails to improve growth and yield of button mushroom and data are presented. Pinhead initiation differed with respect to different casing materials and yield attributing characters like stalk length, stalk diameter, pileus diameter and yield also were recorded. Pinhead initiation was fastest (12.53 days) in bag TO III which had Vermicompost + rice husk

ash + Cocopeat (2:1:1:1) casing material followed by FYM + Cocopeat + rice husk ash (2:1:1) (13.82 days) TO II, FYM + Cocopeat + soil (2:1:1) (14.89 days), whereas it was delayed (17.31 days) in only cow dung as farmer practice. Stalk length, stalk diameter and pileus diameter varied from 2.67 - 3.54cm, 1.52 – 1.71 cm and 3.84 – 4.86 cm respectively. The maximum (19.85 kg/q compost) fresh yield was obtained from technical option III (Vermicompost + rice husk ash + Cocopeat) (I: I:I) with highest (3.63) BC ratio.

Transfer of Technology through FLDs

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. It's a beneficial crop for Lakhimpur Kheri farmers. Ten farmers were directly benefited. Under FLD, a BC ratio was recorded 1.65:1 in demonstration plot.

Transfer of technology on Popularization of Pointed Gourd Var. Kranti" was done to demonstrate the high yielding varieties of Pointed Gourd at farmers field with recommended spacing. Usually farmers cultivate local cultivars and do not maintain the proper spacing in th field. The variety was grown successfully and farmers are showing big interest to adopt the technology. Six of farmers were direct by benefited.

100 demonstrations were conducted on deworming of buffalo calves under Transfer of technology on production potential of animal husbandry.

Animal/Crop	Thematic Area	Name of the technology	No. of Animals	Weight gain after 3 months (Kg)	% change in major parameter	Other parameter (%Mortality)	Gross Cost (Rs.)	Gross Return (Rs.)	Net Return (Rs.)	BCR
Buffalo Calf at Village Saidapur Bhau, Pipra Maroda, Saidapur Deokali etc,	Health Management	Farmer practices: Vs No Deworming	100	67.34	-	16	2500	3500	1000	1:1.40
		Deworming with Albendazole @ 2 ml/5 Kg body weight		75.67	12.37	7	2535	5000	2465	1:1.97

Transfer of technology on Pest management in Maize crop for increasing the yield was successful in the filed and yield was increased 16.57%. Ten farmers were benefited from this technology. B:C ratio, when farmer uses only chemical is 1.35 and it was 1.55 when the technology was used. Farmer's are happy with this technology.

Name of the technology	No. of Demo	Pest infestation (%)	Yield (q/ha)	% increase	Cost of cultivation (Rs./ha)	Gross return (Rs/ha)	Net return (Rs./ha)	BC ratio
Farmer practices: Chemical only	**10**	**49.32**	**22.10**	**-**	**33429.21**	**45305**	**1187.79**	**1.35**
Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed + Installation of pheromone traps @ 5/acre + 5% NSKE / Azadirachti n 1500ppm @ 5ml/l of water+ Installation of pheromone traps @ 5/acre + Chlorantraniliprole 18.5% SC + *Bacillus thuringiensis* v. *kurstaki* formulations @ 2g/l		**18.53**	**26.49**	**16.57**	**34986.78**	**54304.5**	**19317.72**	**1.55**

Technology Option	Number of Demo	Pest infestation			Yield q/ha	Percent increase	Gross cost of cultivation In Rs.	Gross income	Net income	BC ratio
		Pod Boreers (%)	Plume Moth	Control (%)						
Farmer practices:	10	42.59	37.52		14.50		16220	71700	55480	3.40
Technical Option –I: Carbendazim 25%+ Mencozeb 50% WS (3g/kg seed) + Imidacloprid 48 FS@ 1.25 ml/kg seed+ *Trichoderma viride* @ 8-10g/kg + *Rhizobium* and PSB @ 10g/kg seed + spraying of Emamectin benzoate @ 0.4g/lit at flowering times.		13.37	10.87	68.60 & 71.02	17.05	16.18	16220	85550	69330	4.21

Transfer of technology on Pest management (Pod boreers, Plume moth) in Pigeon pea crop for increasing in yield regarded success in this filed and yield increased by 16.18% with pest control (Pod Boreers is 68.60% & Plume Moth 71.02%) Ten farmers were benefited from this technology. B:C ratio when farmer uses only chemical is 3.40 and it was 4.21 with the use.

FLD under SCSP

Transfer of Technology under SCSP scheme. Demonstration of new variety of wheat seed DBW-187 was carried out in Farmers field. The BC ratio was 1.5 when farmer used local variety of wheat seed and 2.1 when the new variety was used. Yield Increase is 61.27 %. Farmers are happy with this technology

Crop	Thematic Area	Name of the technology	No. of Farmers	Total Quantity of input	Area in ha.	Yield (q/ha)	% increase	Cost of cultivation (Rs./ha)	Gross return (Rs/ha)	Net return (Rs./ha)	BC ratio
Wheat	ICM	Farmer practices: Local Seed	1545		300	45	-	41000	103500	62500	1.5
		Technology Demonstration: DBW-187		360Qt.		62	61.27	46000	142600	96600	2.1

Trainings organized

Capacity building of farmers, farm women, rural youth, extension functionaries and other stake holders:

To improve the knowledge of farm and farm women and rural youth, KVK organized 53 trainings programs total 1299 farmers including farm women and rural youth were benefited farm these trainings on plant protection, horticultural and animal science aspects.

Discipline	Trainings	Male	Female	Total
Agronomy	16	415	119	534
Horticulture	14	368	133	501
Animal Science	12	238	93	331
Plant Protection	11	290	47	337
Grand Total	**53**	**1311**	**392**	**1703**

Training under SCSP :-

Seed Distribution cum Training programme for SC farmers

Discipline	Training	Male	Female	Total
Agronomy	2	101	17	405
Plant Protection	0	0	0	0
Horticulture	2	112	18	130
Animal Science	0	0	0	0
Grand Total	**4**	**213**	**35**	**535**

Training under Natural Farming

05 days training under Natural farming for upgrading the knowledge of *Krishi Sakhi*.

Discipline	Training	Male	Female	Total
Agronomy	0	0	0	0
Plant Protection	1	0	25	25
Horticulture	0	0	0	0
Animal Science	1	0	35	35
Grand Total	**2**	**0**	**60**	**60**

Glimpses of Training programme

CHAPTER 12

Patent, Copyright & Technologies

Management of IP portfolio and commercialization of technologies was done under National Agricultural Innovation Fund (NAIF) Component -1. The details of IP granted and commercialization of technologies is as follows:

Table 12.1 : Summary of IP Portfolio of institute during year 2024

IPRs	Total IPRs application filled	Application Granted/ Registered**
Patent	1	1
Copyright	31	20
Design	2	-
Plant Variety submitted to PPV&FRA, New Delhi	CoLk 14201 (*Ikshu*-10) CoLk 15206 (*Ikshu*-14) CoLk 16466 (*Ikshu*-15)	Under Process
	CoLk 11206 (*Ikshu*-4) REG/2019/182	Registered (Aug 23 2024)
	CoLk 11203 (*Ikshu*-5 REG/2019/181)	Registered (Aug 23 2024)

Patent filed

IPRs	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Plant Variety	Date of application Filed/ submitted	Date of Application Granted / Registered
Patent	TEMP/E-1/76657/2023-DEL	An Inventive Pre-treatment method for the development of freeze-dried sugarcane juice powder	24/09/2024	Complete Application filled
	526527	A tractor operated Trash Mulcher-cum- Stubble Shaver Device for Sugarcane Ratoon management	14/02/2022	Hranbet (14-03-2024)


पेटेंट कार्यालय,भारत सरकार
The Patent Office, Government Of India
पेटेंट प्रमाण पत्र । Patent Certificate
(Rule 74 of The Patents Rules)
पेटेंट सं. / Patent No. : 526527
आवेदन सं. / Application No. : 202211007706
फाइल करने की तारीख / Date of Filing : 14/02/2022
पेटेंटी / Patentee : ICAR- Indian Institute of Sugarcane Research
It is hereby certified that a patent has been granted to the patentee for an invention entitled "A TRACTOR OPERATED TRASH MULCHER-CUM-STUBBLE SHAVER DEVICE FOR SUGARCANE RATOON CROP" as disclosed in the above mentioned application for the term of 20 years from the 14th day of February 2022 in accordance with the provisions of the Patents Act,1970.
Date of Grant : 14/03/2024
Controller of Patents

Copy Rights Filed and Granted

Diary Number	Work Title	Class of Work	Submitted on	Status
23424/2024-CO/L	Leaf Symptoms of Red Stripe Disease in Sugarcane	Literary/ Dramatic	25/07/2024	Re-Scrutiny
21619/2024-CO/L	Shortening of Internodes in Sugarcane due to Twisted Top (Pokkah Boeng) Disease	Literary/ Dramatic	08/07/2024	Re-Scrutiny
21050/2024-CO/L	Top Rot Symptoms of Red Stripe Disease in Sugarcane	Literary/ Dramatic	02/07/2024	Re-Scrutiny
21009/2024-CO/L	Complete Nodal Discolouration (Internal) due to RSD in Sugarcane Stalks	Literary/ Dramatic	01/07/2024	Re-Scrutiny
20658/2024-CO/L	Internal Symptoms of Wilt in Sugarcane Roots	Literary/ Dramatic	26/06/2024	Re-Scrutiny
10893/2024-CO/L	Systemic wilt development from twisted top (Pokkah boeng) phase in sugarcane	Literary/ Dramatic	08/04/2024	Re-Scrutiny
10873/2024-CO/L	Red rot induced rind discolouration in sugarcane	Literary/ Dramatic	08/04/2024	Re-Scrutiny
293/2024-CO/L	Typical yellow leaf disease symptoms of midrib yellowing and necrosis in sugarcane	Literary/ Dramatic	03/01/2024	Re-Scrutiny
20521/2024-CO/L	Internal stalk symptoms leaf scald disease in sugarcane	Literary/ Dramatic	20/11/2024	Registered
10881/2024-CO/L	Stalk symptoms of combined of red rot and wilt pathogens in sugarcane stalks	Literary/ Dramatic	12/11/2024	Registered
10959/2024-CO/L	Intellectual Property Rights: Transforming Knowledge to Prosperity	Literary/ Dramatic	12/11/2024	Registered
10946/2024-CO/L	Rind discolouration in sugarcane due to systemic wilt	Literary/ Dramatic	12/11/2024	Registered
303/2024-CO/L	Typical bunchy top symptoms of yellow leaf disease in sugarcane	Literary/ Dramatic	22/10/2024	Registered
10617/2024-CO/L	Varietal Degeneration in Sugarcane due to Non -Fungal Diseases	Literary/ Dramatic	03/10/2024	Registered
10851/2024-CO/L	Combined infection of red rot and wilt pathogens in sugarcane stalks	Literary/ Dramatic	20/09/2024	Registered
21288/2024-CO/L	Brown Spot Symptoms in Sugarcane Leaves	Literary/ Dramatic	18/09/2024	Registered
21620/2024-CO/L	Top Rot in Sugarcane Due to Twisted Top (Pokkah Boeng) Disease	Literary/ Dramatic	12/09/2024	Registered

21536/2024-CO/L	Various Forms of Leaf Twisting in Sugarcane Stalks due to Twisted Top (Pokkah Boeng) Disease	Literary/ Dramatic	12/09/2024	Registered
21287/2024-CO/L	Axillary Bud Sprouting in Sugarcane due to Leaf Scald Disease	Literary/ Dramatic	12/09/2024	Registered
21179/2024-CO/L	Knife Cut Symptoms on Sugarcane Stalks due to Twisted Top (Pokkah Boeng) Disease	Literary/ Dramatic	12/09/2024	Registered
21051/2024-CO/L	Leaf Blight Symptoms of Leaf Scald Disease in Sugarcane	Literary/ Dramatic	11/09/2024	Registered
21008/2024-CO/L	Nodal Symptoms (Internal) of RSD in Sugarcane Stalks	Literary/ Dramatic	11/09/2024	Registered
20659/2024-CO/L	Internal Symptoms of Wilt in Sugarcane Stalks	Literary/ Dramatic	05/09/2024	Registered
20621/2024-CO/L	Rust Symptoms in Sugarcane Leaves	Literary/ Dramatic	28/08/2024	Registered
21617/2024-CO/L	Shortening of Internodes in Sugarcane due to Yellow Leaf Disease	Literary/ Dramatic	14/08/2024	Registered
21418/2024-CO/L	Reddish to Purplish Discoloration of Mid Rib And Leaf Lamina in Sugarcane due to Yellow Leaf Disease	Literary/ Dramatic	14/08/2024	Registered
10952/2024-CO/L	Sporulation of Red Rot Pathogen in Salmon Color on Nodal and Rind on Sugarcane Stalks	Literary/ Dramatic	18/07/2024	Registered
10843/2024-CO/L	Characteristics Red Rot Disease Symptoms of Reddish Tissue Discoloration of Stalk Tissues with White Spots	Literary/ Dramatic	24/06/2024	Registered

MOUs signed for Research Collaboration with Universities & Institutions during 2024

Sl. No.	University/ Institutions	Date
1.	Uttar Pradesh Skill Development Society (UPSDS)	April 8, 2024
2.	ERA University, Lucknow	May 10, 2024
3.	Vellore Institute of Technology (VIT), Vellore	May 25, 2024
4.	Manav Rachna International Institute of Research & Studies, Faridabad-121004	July 01, 2024
5.	Indian Institute of Pulses Research , Kanpur	July 02 , 2024
6.	Motherhood University, Roorkee, Haridwar	August 28, 2024
7.	Tirupati Sugars Ltd., Bagaha (Bihar)	August 29, 2024
8.	Harinagar Sugar Mills Harinagar	August 30, 2024
9.	NSSM, Narkatiyaganj (Bihar)	August 31, 2024
10.	Sugarcane Industries Department, Patna, Govt. of Bihar (Bihar)	September 02, 2024
11.	DCM Shriram Sugar mills, New Delhi	September 26, 2024

CHAPTER 13

Services to the Industry

Table: 13.1 Memorandum of Understanding (MoU) for Contract Research

Contracting party	Contract research
FMC India Pvt Ltd , Bandra East Mumbai_51	Evaluation of FIN2204 against Top borer and Termites in Sugarcane (K Srinivas, Arun Baitha, Dinesh Singh and R. Viswanathan; 2024_2026, Budget: Rs. 15.00 Lakh)
Bayer Crop Science Ltd., Mumbai	Bio efficacy and Phytotoxicity evaluation of Tetranilipore 200 G/L SC (VAYEGO) Early shoot borer and Top shoot borer infestation in sugarcane crop and its effects on natural enemies. (PI: Y. E. Thorat, Co -PI: D. N. Borase, Arun Baitha and Dinesh, 01/24 -12/26, Budget: Rs. 20 Lakh).
UPL SAS Ltd., Mumbai	Bio efficacy and phytotoxicity evaluation of Acetamiprid 25% + Bifenithrin 25 % WG against insect pest of sugarcane and effect on natural enemies (PI: D. N. Borase, Co -PI: Arun Baitha, Y. E. Thorat,01/24-08/26 Budget: Rs. 15 Lakh)
UPL SAS Ltd., Mumbai	Bio-efficacy and phytotoxicity evaluation of GPH 3021 against complex weeds and flora of sugarcane and its effect on succeeding crops (PI: D. N. Borase, Co -PI: S. K. Yadav, Dileep Kumar, Y.E. Thorat, 01/24-08/26 Budget: ₹ 15 Lakh)
Microplex India Pvt. Ltd. Wardha	Evaluation of Trapping performance of improved IISR -Combo insect traps against sugarcane insect pest (PI: Dr. Y. E. Thorat, Co-PIs: Dr. D. N. Borase, Dr. Arun Baitha and Dr. Arun Baitha; Project Cost- ₹ 5.0 Lakh, Duration 2024-2025)

Table: 13.2 MOUs signed for Research Collaboration with Universities & Institutions during 2024

Sl. No.	University/ Institutions	Date
1.	Uttar Pradesh Skill Development Society (UPSDS)	April 8, 2024
2.	ERA University, Lucknow	May 10, 2024
3.	Vellore Institute of Technology (VIT), Vellore	May 25, 2024
4.	Manav Rachna International Institute of Research & Studies, Faridabad-121004	July 01, 2024
5.	Indian Institute of Pulses Research , Kanpur	July 02 , 2024
6.	Motherhood University, Roorkee, Haridwar	August 28, 2024
7.	Tirupati Sugars Ltd., Bagaha (Bihar)	August 29, 2024
8.	Harinagar_Sugar_Mills_Harinagar	August 30, 2024
9.	NSSM, Narkatiyaganj (Bihar)	August 31, 2024
10.	Sugarcane Industries Department, Patna, Govt. of Bihar (Bihar)	September 02, 2024
11.	DCM Shriram Sugar mills, New Delhi	September 26, 2024

Memorandum of Understanding Signed

A Memorandum of Understanding was signed on 29th August, 2024 between ICAR-ISRI, Lucknow & Tirupati Sugars Ltd., Bagaha (Bihar)for harnessing the yield potential of the sugarcane crop and for benefit of stakeholders and sugar mills. The MoU will facilitate the testing of sugarcane clones identified by institute for the zone at mill area and, transfer of ISRI developed technologies related to production, protection, mechanization, tissue culture and post-harvest management among the farmers of mill area & Disease free seed production through three tier system.

A Memorandum of Understanding was signed on 30th August, 2024 between ICAR-ISRI, Lucknow & HSM, Harinagar (Bihar) for harnessing the yield potential of the sugarcane crop and for benefit of stakeholders and sugar mills.

A Memorandum of Understanding was signed on 31st August, 2024 between ICAR-ISRI, Lucknow & NSSM, Narkatiyaganj (Bihar) for harnessing the yield potential of the sugarcane crop and for benefit of stakeholders and sugar mills.

A Memorandum of Understanding was signed on 2nd Sept. 2024 between ICAR-ISRI, Lucknow & Sugarcane Industries Department, Patna, Govt. of Bihar (Bihar) for the production of breeder seed of sugarcane under the Chief Minister Sugarcane Development Programme, and to harness its benefits to stakeholders and sugar mills. The MoU will facilitate the production of quality breeder seed of mega varieties, varietal development and the nucleus seed/genetic material for further breeder seed production.

A Memorandum of Understanding was signed on 26th September 2024 between Dr. R. Viswanathan, Director, ICAR-Indian Institute of Sugarcane Research (ISRI), Lucknow, and Sri Roshan Lal Tamak, CEO and Executive Director of the Sugar Business, DCM Shriram Limited, New Delhi. Under this MoU, ISRI will provide the support to DCM Shriram's four plants in Uttar Pradesh on analyzing the impact of various good agricultural practices on water efficiency, soil health improvement, seed cane provision of new varieties, varietal evaluation, plant protection measures and mechanization. Additionally, ISRI experts would conduct field visits to DCM Shriram's High Yield Project plots.

CHAPTER 14

Human Resource Development

SERB-DST sponsored two months *Vritika* Internship programme on "Artificial Intelligence based Sugarcane Crop Monitoring" organized at the institute during 15th April – 13th June, 2024

Institute has organized two month internship programme on the topic "AI based sugarcane crop monitoring" sponsored by Science and Engineering Research Board (a statutory body of the Department of Science & Technology, Government of India), New Delhi. It was successfully conducted at the institute in physical mode during 15th April – 13th June, 2024 to extend latest ICT tools and techniques information for AI based sugarcane crop monitoring. In the training programme, theoretical and field level exposure of agricultural and sugarcane farming activities were given to students in order to understand importance of crop monitoring and environment monitoring for sustainable production. Lectures were delivered about advance Information and Communication Technologies applicable in agriculture domain for an efficient monitoring of the resources and crop management for precision agriculture. Field visits were made to showcase practical exposure of sugarcane farming and its important monitoring aspects. Data collection and management activities were also taught for computer vision based sugarcane crop monitoring.

Capacity building of ICAR-ISRI Officials

Name	Training programme	Venue	Date
Dr. Sangeeta Srivastava Dr. L S Gangwar	AgrIP: A online Short Course on Patents	IP&TM, New Delhi and ZTM-ABI, ICAR-CIFT, Cochin	15th January - 05th February 2024
Dr. Sangeeta Srivastava	E-governance tools and applications in ICAR	ICAR-IASRI, New Delhi	8th-14th February, 2024.
Dr. L S Gangwar	Developing Winning Research Proposals under NAHEP	NASC Complex, New Delhi	13th -15th February, 2024
Dr. L S Gangwar	Price Policy for Sugarcane 2025 - 26 Sugar Season	Krishi Bhawan, New Delhi	25th October, 2024
Dr. S S Hasan	ITU/FAO Workshop on Cultivating Tomorrow: Advancing digital agriculture through IoT and AI and 9th Meeting of Focus Group AI and IoT for Digital Agriculture	ICAR at NASC Complex, New Delhi	18th -19th March, 2024
Dr. S S Hasan	Precision Agriculture Conclave for Public Private Partnership	NASC Complex, ICAR, New Delhi	20th March, 2024

Dr. Y E Thorat	One-day training programme on 'mechanical, biological, and chemical control of sugarcane insect pests'	VSI, Pune	23rd March 2024.
Dr. Sayanti G Majumdar, Dr. K. Srinivas	Enhancing Pedagogical Competencies for Agricultural Education	ICAR-NAAS, New Delhi	29th April – 03rd May 2024
Dr. Sangeeta Srivastava	IPR awareness/ training program under the special initiative, "National Intellectual Property Awareness Mission (NIPAM)"	Office of Controller General of Patents, Designs and Trade Marks (CGPDTM), Mumbai	9th August, 2024
Dr. Y E Thorat	Online training programme on 'Agri entrepreneurship development in plant protection'	Jointly organized by ICAR-NCIPM, New Delhi and MANAGE, Hyderabad	20th-23rd August, 2024
Dr. Y E Thorat	Training program on Adsali sugarcane yield 110 t/acre planation	RAMETI, Nasik (Govt. of Maharashtra)	27th-28th June, 2024
Shri R N Bharti	Regional Training -cum-awareness program for Northern Region	J-Gate@ CeRA, on SKUAST, Kashmir	02nd September, 2024
Dr. Sangeeta Srivastava	Second Master Trainer Training on Academic Management System (AMS)	The Graduate School of ICAR-IARI, New Delhi	04th September, 2024
Dr. Sangeeta Srivastava	Uploading of employees' details on iGoT Karmayogi platform during 2024-25 (for HRD Nodal Officers by iGoT Karmayogi Bharat team)	HRM Unit, ICAR, New Delhi	26th September, 2024
Dr. Ranjit Singh Gujjar	Hands on training on " Genome editing Technologies in crops" being organized by	ICAR-IIRR, Hyderabad	14th -23rd October 2024
Dr. Sangeeta Srivastava	Understanding IP: Encouraging creativity and Innovation, IP awareness programme under National Intellectual Property Festival on the theme, "Nurturing ideas to innovation"	Central Arid Zone Research Institute, Jodhpur organized with IPG of CSIR-NCL, Pune under NIPAM 2.0	18th October, 2024
Dr. Chandramani Raj	Genome Editing -Basic Principles and Practices	Division of Plant Physiology, ICAR - IARI, New Delhi	02nd-06th December 2024

Sponsored Sugarcane extension trainings organized for Farmers / Students/ Officials

Date	Sponsored by	No. of trainees
3rd-6th Jan., 2024	ARIAS Society, Khanapara, Guwahgati, Assam	15 Farmers
08th-10th Jan., 2024	True Vision Welfare Society, Badaun, CAT, (NABARD, Scheme)	25 Farmers
17th-25th Jan, 2024	Deputy Director, Cane Development, Patna, Bihar	21 Farmers
19th–20th Feb, 2024	ATMA, (Pune) Maharashtra	16 Farmers
19th–27th Feb, 2024	Deputy Director, Cane Development, Patna, Bihar	20 Farmers
4th-7th March, 2024	"Agronomical practices for cultivation of sugarcane production"	10 officers of Sugar Industry, Govt. of Bihar and sugar mills.
11th-15th March, 2024.	Deputy Director, Sugarcane, Development, Samastipur, Bihar	20 Farmers
18th-22nd March, 2024	Deputy Director, Sugarcane Development, Motihari, Bihar	20 Farmers
19th March, 2024	GKS Moradabad, UP	24 farmers
24th-28th June, 2024	Importance of mechanization in sugarcane - based cropping system sponsored by UPCAR, Lucknow	20 farmers
16th-20th Oct., 2024	Project Coordinator ATMA (Bhagalpur), Bihar	22Farmers + 03Officers

21st-25th Oct., 2024	Deputy Director Department of Sugarcane Industry, Cane Division, (Motihari), Bihar	20Farmers + 02Officers
25th Oct., 2024	SCSP project	100 farmers
11th-18th Nov., 2024	Deputy Director Sugarcane Development, Department of Sugarcane Industry, (Patna), Bihar	18Farmers + 01Officers
11th-18th Nov., 2024	Deputy Director Sugarcane Development, Department of Sugarcane Industry, Gaya, Bihar	17Farmers + 01Officers
25th Nov.-2nd Dec., 2024	Deputy Director Sugarcane Development, Department of Sugarcane Industry, (Patna), Bihar	40 farmers (2 group) + 04 official
16th Dec., 2024	Deputy Director Sugarcane Development, Department of Sugarcane Industry, (Patna), Bihar	20 farmers + 01 official
20th Dec., 2024	Deputy Director Sugarcane Development, Department of Sugarcane Industry, (Patna), Bihar	20 farmers + 01 official
05th July, 2024	Innovative Technology for Sugarcane Cultivation	10 students
02nd Sept.- 01st Oct., 2024	RAWE training" for B.Sc. (Ag.) Students of Narayan Institute of Agricultural Science, GNSU, Sasaram, Rohtas, Bihar	45 students
07th-11th Oct., 2024	"Utilization of farm machinery for marginal and small-scale farmers in sugarcane cultivation sponsored by UPCAR, Lucknow	22 farmers
25th Oct., 2024	"Cane Production techniques" Sponsored by Department of sugarcane industry, Cane division, (Motihari), Bihar and organized by ICAR-ISRI, Lucknow	20 Farmers + 02Officers
18th Nov., 2024	"Cane Production techniques" Sponsored byDeputy directorate of *Inkh Vikas Ganna Udhog department* (Patna) district- Ara, Bihar and organized by ICAR-IISR, Lucknow	18Farmers + 01Officers
25th Nov. to 02nd Dec., 2024	"Cane Production techniques" Sponsored byDeputy directorate of *Inkh Vikas Ganna Udhog department* (Patna) District- Bhagalpur, Bihar and organized by ICAR-IISR, Lucknow	13 Farmers + 02 Officers
25th Nov. to 02nd Dec., 2024	"Cane Production techniques" Sponsored by Deputy directorate of *Inkh Vikas Ganna Udhog department* (Patna) District- Jamui, Bihar and organized by ICAR-IISR, Lucknow	18 Farmers + 02 Officers
04th - 08th Dec., 2024	"Training cum Visit Interaction with Scientists" Sponsored by Department of Agriculture and Farmers Empowerment, Govt. of Odisha and organized by ICAR-IISR, Lucknow	5 Officers/Officials of Agriculture Department
09th - 16th Dec., 2024	"Cane Production techniques" Sponsored by Deputy directorate of *Inkh Vikas Ganna Udhog department* (Patna) Bihar and organized by ICAR-IISR, Lucknow	20 Farmers + 01 Officers
16th - 20th Dec., 2024	"Cane Production techniques" Sponsored by Deputy directorate of *Inkh Vikas Ganna Udhog department* (Patna) Bihar and organized by ICAR-IISR, Lucknow	10 Officers

Capacity building program

Programme Organized	Number of Participants	Date &Venue of Event	Remarks
One-day sensitizing workshop with the collaboration of CSTUP, Lucknow on Innovation, Access, and Benefit Sharing in Intellectual Property Rights and Technology Commercialization	120	February 19, 2024, Auditorium ICAR-ISRI, Lucknow	For Scientific/ Research Scholars & Farmers
One week Advanced Entrepreneurship and Skill Development Program (A-ESDP) on Sugarcane Propagation through Tissue Culture Techniques	50	March 12-18, 2024.	For scientific/technical staff and research scholars
Celebrated World Intellectual Property Day	100	April 28, 2024, Director Conf. Hall, ICAR-ISRI, Lucknow	For scientific/technical staff and research scholars
Sensitizing lecture delivered on Role of Intellectual Property in Agriculture	35	September 25, 2024, Ext. Hall, ICAR-ISRI, Lucknow	For farmers and UG students

Trainings organized at ICAR-ISRI, Biological Control Centre, Pravaranagar, Maharashtra

Dr. D. N. Borase	One-week unit attachment training programme on sugarcane research and management under the RAWE AIA programme for students	College of Agriculture, Loni	30th September to 6th October 2024
Dr. Y. E. Thorat	45-day training program of Ms. Deokar Mrunal Sandip	PVP, College, Pravaranagar (MS)	6th March to 20th April 2024
	One-week unit attachment training programme on sugarcane research under the RAWE AIA programme	College of Agriculture, Loni	15th to 21st April 2024
	One-day training programme on IPM in sugarcane'	National-level training program on Climate Resilient Agriculture organized by Watershed Organization Trust (WOTR) Pune	14th March 2024 and on 5th December 2024
	One-day training programme for the organic farming, certification and marketing	RAMETI, Nasik (Govt. of Maharashtra)	26th November 2024

Details of the students undergone UG/PG training at ICAR-ISRI, Lucknow

UG Training

Name	Subject	University/College	Duration	Supervisor
Ms. Anshika Singh	B. Tech. (Biotechnology)	Graphic Rea, Dehradun	January 04 – February 05, 2024	Dr. Sanjeev Kumar (Biotech)
Mr. Abhishek Kumar	B. Tech. (Biotechnology)	S V B Patel University & Technology, Meerut	February 13 – May 12, 2024	Dr. Sangeeta Srivastava
Mr. Vaibhav Singh	B.Sc. (Hons.) Biotechnology	Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidhyalaya Evam Go-anusandhan Sansthan, Mathura	March 07 – June 04, 2024	Dr. Chandramani Raj
Ms. Shreya Mishra	B.Sc. (Biotechnology)	Banasthali Vidyapith, Rajasthan	May 16 – June 16, 2024	Dr. Sangeeta Srivastava
Ms. Khushi Singh	B.Sc. (Biotechnology)	Banasthali Vidyapith, Rajasthan	May 21 – June 20, 2024	Dr. Swapna M.
Ms. Mansi Pandey	B.Sc. (Biotechnology)	Banasthali Vidyapith, Rajasthan	May 27 – June 25, 2024	Dr. RS Gujjar
Ms. Naina Mishra	B.Sc. (Biotechnology)	Banasthali Vidyapith, Rajasthan	June 03 – July 02, 2024	Dr. Sanjay Goswami
Ms. Jyotsana	B. Tech. (Biotechnology)	SHUATS, Prayagraj	June 04 – July 03, 2024	Dr. Sanjeev Kumar (Biotech.)
Ms. Akanksha Singh	B. Tech. (Biotechnology)	SHUATS, Prayagraj	June 04 – July 03, 2024	Dr. RS Gujjar

Ms. Prekshi Sharma	B. Tech. (Biotechnology)	Shoolini University	July 01 – August 01, 2024	Dr. Chandramani Raj
Mr. M. Mahesh Bandu	B. Sc. (Ag. Biotechnology)	Aditya Agr. Biotechnology College, Beed, VNMKV, Maharashtra	December 08, 2024 – March 08, 2025	Dr. DN Borase, BCC, Pravaranagar, Maharashtra
Mr. Yadav R. Balasaheb	B. Sc. (Ag. Biotechnology)	Aditya Agr. Biotechnology College, Beed, VNMKV, Maharashtra	December 08, 2024 – March 08, 2025	Dr. YE Thorat, BCC, Pravaranagar, Maharashtra
Mr. Abhishek Bhanudas	B. Sc. (Ag. Biotechnology)	Aditya Agr. Biotechnology College, Beed, VNMKV, Maharashtra	December 08, 2024 – March 08, 2025	Dr. DN Borase, BCC, Pravaranagar, Maharashtra

PG Training

Name	Subject	University/College	Duration	Supervisor
Ms. Agrima Singh	M.Sc. (Biotechnology)	Shri Ramswaroop Memorial University, Lucknow	January 08– July 05, 2024	Dr. Shweta Singh
Ms. Sitanshi Mishra	M.Sc. (Bioscience & Technology)	Shri Ramswaroop Memorial University, Lucknow.	January 10 – July 07, 2024	Dr. Shweta Singh
Ms. Kumari Rupa	M.Sc. (Biotechnology)	Shri Ramswaroop Memorial University, Lucknow	January 24 – July 21, 2024	Dr. Lalan Sharma
Ms. Deokar Mrunal Sandip	M.Sc. (Biotechnology)	SavitribaiPhule University, Pune	March 06 – April 20, 2024	Dr. YE Thorat, BCC, Pravaranagar, Maharashtra
Mr. Yuvraj Singh	M. Sc. (FP & FT)	University of Lucknow, Lucknow, U.P.	April 15 –July13, 2024	Dr. Dilip Kumar
Ms. Mrinalinee Singh	M.Sc. (Biotechnology)	BanasthaliVidyapith, Rajasthan	June 06 – 05 July, 2024	Dr. Sanjeev Kumar (Biotech.)
Ms. Guriya Kumari	M.Sc. (Agronomy)	CSJMU, Kanpur	July 01 – 31 August, 2024	Dr. Pushpwa Singh
Mr. Vivek Kumar Vishwakarma	M.Sc. (Plant Pathology)	SHUAT&S, Prayagraj	July 02 – 01 August, 2024	Dr. Dinesh Singh (HoD)
Mr. Palash Kumar Kaurav	M. Sc (Agronomy)	Barkatullah University, Bhopal	November 26, 2024 – May 23, 2025	Dr. SK Yadav
Mr. Anmol Gour	M. Sc. (Agronomy)	Barkatullah University, Bhopal	November 26, 2024 – May 23, 2025	Dr. Dilip Kumar
Mr. Sayan Hazra	M. Sc. (Ag.) Plant Pathology	SAS, Nagaland University, Nagaland	December 17, 2024 – January 15, 2024	Dr. R.K. Tiwari

CHAPTER 15

Awards / Honours / Recognitions

Professional Society Awards

- ICAR-Indian Sugarcane Research Institute, Lucknow was conferred with the prestigious "Agriculture Leadership Award 2024" for its outstanding research work in sugarcane, which has positively touched the lives of millions of the farmers and rural people, at the 15th Agriculture Leadership Conclave-2024 organised by the Agriculture Today Group at New Delhi on 10th July 2024.

- Dr. R Viswanathan received the prestigious 21st Prof S.R. Bose Memorial Award of the Indian Mycological Society, Kolkata.
- Dr. R Viswanathan received Kameshwar Sahai Bhargava Oration Award of the Indian Virological Society, New Delhi
- Dr. R Viswanathan received Mundkur Memorial Award 2024, Indian Phytopathological Society, New Delhi.
- Dr. R Viswanathan was awarded with prestigious K.C. Mehta Memorial Award 2023-24 for outstanding contribution in Plant Protection from the National Academy of Agricultural Sciences, New Delhi
- Dr. Dinesh Singh received Prof. M. S. Pavgi Award conferred by Indian Phytopathological Society, New Delhi.
- Dr. Rahul Kumar Tiwari received NAAS Young Scientist Award 2024 for outstanding contribution to the field of plant protection.

- Dr. Lalan Sharma received Excellence in Research Award during International Conference on Ecological impact on Agriculture, Business and Technology (EIABT-2024), at Agriculture and Forestry University, Rampur, Chitwan, Nepal.
- Dr. Lalan Sharma received Global Outstanding Scientist Award during 7th International Conference on Global approaches in agricultural, biological, environment and life sciences for sustainable future (GABELS– 2024), Budda Hall, DAV College, Tribhuvan University, Lalitpur, Kathmandu, Nepal.
- Sanjeev Kumar (HoD) received Sir T.S. Venkataraman Award for outstanding research in sugarcane agriculture for the biennium 2022-23 on the occasion of 113th Foundation Day Celebrations of ICAR-Sugarcane Breeding Institute, Coimbatore on 25th October, 2024.

- Dr. Indu received Young Scientist Award in International Conference on Current Innovations

and Technological Advances in Agriculture and Allied Sciences- (CITAAS-2024) Jointly organized by Department of Agriculture and Farmers Welfare, Horticulture Department, Govt. of Punjab, ISASTR-Noida and Just Agriculture Edu. Group in collaboration with Guru Kashi University, Talwandi Sabo (Punjab). 29th-31st Aug, 2024.

- Dr. Kamta Prasad received Best Sugarcane Agriculture paper Award National Level on 10th Feb, 2024 in the Bhartiya Sugar Annual Symposium in award night 2023 at Sayaji Hotel Kolhapur, Maharashtra.

Fellow/Fellowship

- Dr. R Viswanathan elected as a Fellow of the Indian Mycological Society, Kolkata.
- Dr. AK Mall conferred 'Fellow' of NESA 2023: National Environmental Science Academy, New Delhi.
- Dr. S. K. Goswami received Fellow (FIPS) of Indian Phytopathological Society, New Delhi.
- Dr. Shweta Singh awarded with Indian National Science Academy Visiting Scientist Fellowship 2024-2025.

Institute Awards

- Dr. R U Modi, Scientist, Agricultural Engineering Division, received the Best Young Scientist Award from the ICAR-ISRI, Lucknow during the 73rd Foundation Day of the Institute on 16th February, 2024.

Best Paper/Poster Awards

- Dr. Aalok Shiv received Best Oral Presentation Award in National Conference on Plant Health for Food Security: Threats and Promises held at ICAR-ISRI, Lucknow, Uttar Pradesh, India from 1st-3rd February, 2024.
- Dr. Dilip Kumar received the Best Oral Paper Presentation Award in the National Conference Plant Health for Food Security: Threats and Promises held at ICAR-ISRI, Lucknow, Uttar Pradesh during 1st-3rd February, 2024.
- Dr. R U Modi received the first prize for Best Oral Paper Presentation in the National Conference Plant Health for Food Security: Threats and Promises held at ICAR-ISRI, Lucknow, Uttar Pradesh during 1st-3rd February, 2024.
- Dr. RS Gujjar received Best Presentation Award (3rd) in International conference on Innovations to Achieve Climate Resilient Smart Agriculture for Ensuring Global Food and Nutritional Security, organized by ICAR-ISRI, Lucknow, India in 2024
- Dr. Rahul Kumar Tiwari received Best Oral Presentation award in National conference organized jointly by ISRI, Lucknow and IPS, New Delhi during 1st-3rd February, 2024.
- Dr. S I Anwar received first prize in oral paper presentation in 58th Annual Convention and International Symposium of ISAE held at Parbhani (Maharashtra) during 12th -14th November, 2024.
- Dr. Shweta Singh received best poster presentation award on Sugarcane virome analysis to decipher the prevalent sugarcane viruses at National conference on Plant Health and Food Security: Threats and Promises, conducted by IPS and ICAR-ISRI, Lucknow held during 1st-3rd February, 2024.
- Drs. D N Borase, Yogesh Thorat, S N Sushil and Deeksha Joshi (2024) received the best oral presentation award for the paper entitled “Bioprospecting of entomopathogenic bacteria for management of white grubs infesting sugarcane” during IPS National Conference on Plant Health for Food Security: Threat and Promises, held at ICAR-ISRI, Lucknow, Uttar Pradesh, India from 1st-3rd February, 2024.
- Drs. D. N. Borase, Y. E. Thorat, Rajeev Kumar, Mahesh Mhaske, Rutuja Nirmal, B. M. Bhalerao, and A. A. Kale (2024) received the best oral presentation award for the paper entitled post-harvest quality deterioration in manually and mechanically harvested sugarcane in a tropical climate during 2nd International Conference on Innovations in Biotechnology Research for Sustainable Bioresources and Bioeconomy: Challenges and Practices, held at Sanjivani Rural Education Society, Kopergaon, Maharashtra, India from 15th-16th February, 2024.
- Drs. Thorat Y. E., D. N. Borase, Dinesh Singh and R. Viswanathan (2024) received the best oral presentation award for the paper entitled 'Occurrence and abundance of plant-parasitic nematodes (PPNs) in sugarcane areas of Maharashtra' in the National Conference on Plant Health for Food Security: Threats and Challenges organised by IPS at ICAR-ISRI, Lucknow from 1st-

3rd February, 2024.

- Drs. Rutuja Nirmal, D. N. Borase, Thorat Y. E. Aruna Baitha and Mahesh Mhaske (2024) received the best poster presentation for the paper entitled Insecticidal activity of *Bacillus thuriengenenis* against white grubs infesting sugarcane in the National Conference On Current Advances and Opportunities in Agricultural Biotechnology organized at College of Agricultural Biotechnology, Loni (MS) from 4th-5th October, 2024.

Nominations/Recognitions/Reviewers

- Dr. A P Dwivedi acted as an External Examiner for thesis viva-voice of Ph.D. (Agronomy) student of Dr. Rajendra Prasad Central Agriculture University, Samastipur, Pusa, Bihar.
- Dr. A P Dwivedi nominated as Chief Editor, International journal of Agriculture and allied Sciences and Editor, *Ikshu Patrika*.
- Dr. A P Dwivedi, acted as Organizing Secretary of International Conference on Ecological Impact on Agriculture , Business and Technology(EIBT:2024) Venue, Agriculture and Forestry University, Chitwan, Napal jointly organized by Agriculture and forestry university, Rampur chitwan, Nepal, Sam Higgimbottom University of Agriculture and Technology, Prayagraj and R.S. Krishi Sodh Kendra, Prayagraj dtd.29-30April,2024.
- Dr. Arun Baitha acted as member for screening and selection for Guest Faculty/Teaching Associate of Entomology Department of C S Azad University of Agriculture and Technology, Kanpur.
- Dr. Arun Baitha appointed as external examiner to conduct comprehensive viva-voce examination of one Ph.D. (Entomology) from Bihar Agricultural College, Sabour, Bhagalpur (Bihar Agricultural University).
- Dr. Arun Baitha appointed as external examiner to evaluate two thesis of Ph.D student (Entomology) from Tamil Nadu Agricultural University, Coimbatore and Lovely Professional University, Phagwara, Punjab.
- Dr. Arun Baitha was nominated as Assistant Venue –in charge for ICAR computer based online examination of Assistant Director (OL).
- Dr. Arun Baitha was nominated as member for the selection of Assistant professor/Associate Professor/Professor (Entomology) at Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya.
- Dr. Arun Baitha was nominated as observer for ICAR computer based online examination PG and Ph.D. 2024.
- Dr. Dinesh Singh received Guest of Honour conferred during national symposium on Multidisciplinary perspectives for pest and disease management in sustainable production of crops held at SKUAST-K Srinagar from 28-30 August, 2024 jointly organised by SKUAT-K, Society of Plant Protection Sciences, New Delhi and Association of Plant Pathologist, Akola, Maharashtra.
- Dr. Dinesh Singh received Scroll of Honour conferred by Association of Plant Pathologist, Akola, Maharashtra during national symposium on Multidisciplinary prespetives for pest and disease management in sustainable production of crops held at SKUAST-K Srinagar from 28-30 Auguat, 2024.
- Dr. Dinesh Singh, Head, Crop Protection elected President of Indian Phytopathological Society, New Delhi.
- Dr. Dinesh Singh, Head, Crop Protection nominated as member of IMC, ICAR- NCIPM, Rajpur Khurd, Mehrauli, New Delhi.
- Dr. Dinesh Singh, Head, Crop Protection nominated as member RAC of NRC for Orchid, Pakyang, Sikkim, India.
- Dr. D. N. Borase acted as a chairman for the selection committee constituted for the selection of Project Assistants (4 posts) and Field Assistants (2 posts) under various projects at ICAR-IISR, BCC, Pravaranagar on 11th July 2023.
- Dr. D. N. Borase acted as a chairman of poster evaluation committee constituted for the poster presentation session of one day state level seminar on Application of Biotechnology for Good Health, Agricultural and Environment organized by College of Agriculture Biotechnology, Loni on March22, 2024.
- Dr. D. N. Borase acted as a member secretary of the Project Monitoring Committee for implementation of the RKVY Project constituted by Director Quality Control, Commissionerate of

Agriculture Govt. of Maharashtra

- Dr. D. N. Borase acted as expert member for Research Review Committee Meeting and Research Planning Meeting in the discipline Plant Pathology and Microbiology, organized by the Department of Plant Pathology and Agril. Microbiology, MPKV Rahuri, on January 23, 2024.
- Dr. D. N. Borase acted as expert member of the 59th Board of Studies (BOS) meeting in Plant Pathology, Mycology, Microbiology, Bacteriology, Seed Pathology, and Virology, organized by the Department of Plant Pathology and Agril. Microbiology, MPKV Rahuri, on May 29-30, 2024.
- Dr. D. N. Borase acted as expert member of the 60th Board of Studies (BOS) meeting in Plant Pathology, Mycology, Microbiology, Bacteriology, Seed Pathology, and Virology, organized by the Department of Plant Pathology and Agril. Microbiology, MPKV Rahuri, on December 5-6, 2024.
- Dr. D. N. Borase invited as resource person and also acted as chairman of poster evaluation committee constituted for the poster presentation session of National Conference on Current Advances and Opportunities in Agriculture Biotechnology organized by College of Agriculture Biotechnology, Loni on October 4-5, 2024.
- Dr. D. N. Borase was nominated as a member of the 10th Scientific Advisory Committee (SAC) meeting of Krishi Vidyan Kendra, Dahigaon-Ne, Ahmednagar on December 18, 2024.
- Dr. Indu received Best Participant Award in winter school training Climate Smart Sugarcane Agriculture for Food and Energy Security in India from 31st Jan 2024 to 20 Feb 2024 at ICAR-SBI, Coimbatore (Tamil Nadu).
- Dr. M K Tripathi acted as an Editor, Hindi magazine *IKSHU* published by ICAR-ISRI, Lucknow.
- Dr. M K Tripathi nominated for Evaluation and viva-voce of MSc. Ag. Thesis of agronomy, GBPUAT, Pantnagar.
- Dr. Sangeeta Srivastava chaired the session "Food and Agricultural Biotechnology" in the National Conference on "Women in Biotechnology: Contribution in Accelerating Research and Entrepreneurship (WiB-CARE)" jointly organized by Amity Institute of Biotechnology, AUUP Lucknow Campus and National Academy of Science India (NASI), Lucknow Chapter on 22 October, 2024
- Dr. Sangeeta Srivastava acted as Associate Editor of Journal - Frontiers in Plant Sciences.
- Dr. Sangeeta Srivastava acted as Editorial board member of Archives of Phytopathology and Plant Protection Journal (Taylor and Francis).
- Dr. Sangeeta Srivastava acted as Chief Editor of Indian J. Sugarcane Technology
- Dr. Sangeeta Srivastava acted as Editorial board member of Journal of Environmental Biology
- Dr. Sangeeta Srivastava acted as Sectional Editor-Section V (Cell and Molecular Biology; Cytogenetics and Plant Breeding), of Journal of Indian Botanical Society
- Dr. Sangeeta Srivastava acted as Editorial board Member of Agrica-International Journal of Plant Science Researches
- Dr. Sangeeta Srivastava served as reviewer of research papers for the journals- BMC Genomics, ABAD, Frontiers in Plant Sciences, Agronomy Research, 3Biotech, SugarTech, J. Env. Biol., JIBS, Vegetos and Nucleus
- Dr. Sangeeta Srivastava served as Subject Matter Expert in Selection Committee for Assistant Professor (Genetics and Plant Breeding) at Lucknow University, Lucknow for Acharya RamChandra College, Sitapur, on 10th November, 2024.
- Dr. Sangeeta Srivastava acted as External Examiner for the evaluation of the thesis of Ph.D. student, Department of Genetics and Plant Breeding, PGCA, RPCAU, Pusa.
- Dr. Sangeeta Srivastava acted as external examiner for the evaluation of students from M.Sc. Biotechnology II year/IV semester for their Seminar Presentation (BS514) in the Department of Biosciences, Integral University, Lucknow on 11/06/2024.
- Dr. Shweta Singh was reviewer for Australasian Plant Pathology, Emerging Issues in Agricultural Sciences, Indian Journal of Agricultural Sciences and Indian Phytopathology, and Sugar Tech.

- Dr. T K Srivastava acted as a Member, Expert Panel of UPCAR for evaluation of research work done under projects funded by the organization all across the state of Uttar Pradesh.
- Dr. T K Srivastava acted as a Member, Varietal Identification Committee of the AICRP on sugarcane &Principal Investigator (Crop Production) AICRP on Sugarcane.
- Dr. T K Srivastava nominated as a Thesis Examiner for two PhD (Agronomy) students of IARI, New Delhi, CSAU&T, Kanpur & DRPCAU, Pusa, Samastipur (Bihar).
- Dr. T K Srivastava represented the Institute in the State Level Weather based agro-advisory Committee of the UPCAR, Lucknow.
- Dr. Y. E. Thorat acted as a member for the selection of Project Assistants (4 posts) and Field Assistants (2 posts) under various projects at ICAR-IISR, BCC, Pravaranagar on 11th July 2023.
- Dr. Y. E. Thorat acted as a member of the editorial board (plant protection) of Food and Scientific Reports: A multidisciplinary electronic magazine (ISSN 23582-5437).
- Dr. Y. E. Thorat acted as a reviewer of the Journal of Environmental Science and the Plant Disease.
- Dr. Y. E. Thorat acted as an external member of the Board of Studies (BOS) for the Dept. of Agril. Entomology, MPKV, Rahuri.

CHAPTER 16

Publications

Research papers

Amaresh G, Nunavath A, Appunu C, Viswanathan C, Kumar R, Gujjar RS and Manimekalai R. (2024). Advanced genome editing technologies: Potentials and prospects in improvement of sugar crops. *Sugar Tech*. 1-5. https://doi.org/10.1007/s12355-024-01447-4. (NAAS IF. 7.80)

Borase DN, Thorat YE, Baitha A and Kolkar BE. (2024). Parasitizing efficiency of *Tetrastichushowardi* (Olliff) (Hymenoptera: Eulophidae) on *Galleria mellonella* (Linnaeus) (Lepidoptera: Pyralidae) larva and pupa. *Egyptian Journal of Biological Pest Control*. 34(14):1-7 https://doi.org/10.1186/s41938-024-00777-5(NAAS IF. 8.10)

Dayasena YAPK, Ariyawansha BDSK, Wijesuriya A, Abeyrathne KHD, Viswanathan R. (2024). Eliminating leaf scald disease in sugarcane: efficacy of hot water and cold soak treatments. *Indian Phytopathology* 77: 793-799. https://doi.org/10.1007/s42360-024-00776-4 (NAAS IF. 5.97)

Dey P, Singh SR and Sekhon BS. (2024). Systems approach *vis-à-vis* carbon sequestration: Issues and strategies. *Current Science* 127 (12): 1420-26. https://doi.org/10.18520/cs/v127/i12/1420-1426 (NAAS IF. 7.1)

Dwivedi AP, Dalvi SG, Kumari K, Singh KK and Tripathi MK. (2024). Responses of foliar application of low molecular weight derivatives gamma radiated chitosan (Bio stimulator) in sugarcane under irrigated condition in subtropical India. *International Journal of Research in Agronomy*. 7(5):05-09. https://doi.org/10.33545/2618060X.2024.v7.i5a.648.(NAAS IF. 5.20)

Goswami SK, Gujjar RS, Kumar R,Yadav P, Chakdar H, Choudhary P and Viswanathan R. (2024). Endophyte *Chaetomiumglobosum* CGSR-13 strain enhanced plant growth promotion and antifungal activity against Pokkah boeng caused by *Fusariumverticillioides* in India. *Indian Phytopathology*. https://doi.org/10.1007/s42360-024-00789-z. (NAAS IF. 5.97)

Goswami SK, Kashyap AS, Kumar R, Gujjar RS, Singh A and Manzar N. (2024) Harnessing rhizospheric microbes for eco-friendly and sustainable crop production in saline environments. *Current Microbiology*. 81(1):1-5; https://doi.org/10.1007/s00284-023-03538-z (NAAS IF. 8.30).

Goswami SK, Singh D, Singh SP, Kumar R, Gujjar RS, Raj C and Viswanathan R. (2024). Dual function of *Chaetomiumglobosum* CGSR13: Antifungal agent against wilt caused by *Fusariumsacchari* and promoter of sugarcane growth. *Sugar Tech*, 1-11. https://doi.org/10.1007/s12355-024-01522-w. (NAAS IF. 7.80)

Goswami SK, Viswanathan R, Kumar R, Gujjar RS and Yadav P (2024). Endophyte *Chaetomiumglobosum* Strain CGSR13 mediated sugarcane growth and bio-control of red rot caused by *Colletotrichum falcatum* in sub-tropical India. *Journal of Crop Health*.https://doi.org/10.1007/s10343-024-01059-8

Gujjar RS, Kumar R, Goswami SK, Singh A and Baidya A. (2024). *Colletotrichum falcatum* infection influences the abundance of sucrose transporters and disease resistant proteins in sugarcane stalk. *Journal of Plant Biochemistry and Biotechnology*. 33, 367-373. https://doi.org/10.1007/s13562-024-00899-9(NAAS IF. 7.60)

Gujjar RS, Kumar R, Goswami SK, Srivastava Sangeeta and Kumar S. (2024) MAPK signaling pathway orchestrates and fine-tunes the pathogenicity of *Colletotrichum falcatum*. *Journal of Proteomics*. 292:105056; https://doi.org/10.1016/j.jprot.2023.105056. (NAAS IF. 8.80)

Gujjar RS, Kumar R, Goswami SK, Srivastava Sangeeta and Upadhyay AK. (2024). *Colletotrichum falcatum* influences sucrose accumulation in sugarcane stalks by modulating the expression of SPS, SPP, SuSy, and invertases. *Physiological and Molecular Plant Pathology*. 130:102237; https://doi.org/10.1016/j.pmpp.2024.102237.(NAAS IF. 8.80)

Hasan SS, Baitha A, Gangwar LS and Kumar S. (2024). Evaluation of resampling techniques for artificial neural network based identification of promising genotypes in sugarcane (*Saccharum officinarum L.*) varietal trials. *Indian Journal of Genetics and Plant Breeding*. 84(1):92-98. https://doi.org/10.31742/

ISGPB.84.1.8. (NAAS IF. 7.00)

Jaiswal VP, Shukla SK, Sharma Lalan, Singh VP, Gaur Asha, JhaAnand, Srivastava Abhay. (2024). Integrated Use of 2, 4-D, Metribuzin and Pyrazosulfuron (UPH 114b) for Managing Weeds and Improving Sugarcane Yield in Subtropical India. *SugarTech*.https://doi.org/10.1007/s12355-024-01441-w.(NAAS IF. 7.80)

Joshi D and Goswami SK. (2024). Potential of *Trichoderma* spp. to control smut disease of sugarcane under sub-tropical conditions of India. *Journal of Eco-friendly Agriculture*. 19: 157-161. https://doi.org/10.48165/jefa.2024.19.01.27. (NAAS IF. 5.36)

Mall AK, Misra V, Solomon S and Viswanathan R. (2024). R & D Initiatives and prospects of sugar beet cultivation in India: ICAR-IISR, Lucknow leading the way. *Indian Sugar* 74(12): 17-26.

Mall AK, Srivastava Sangeeta, Mulet JM, Popovic V and Mishra V. 2024. Biotechnology and breeding techniques for stress-resistant sugar beet. *Sugar Tech*. 26(5): 1195-1198. https://doi.org/10.1007/s12355-024-01501-1(NAAS IF. 7.80)

Maurya SK, Vandana Priyam, Kumar Shubham, Singh Vikas, Singh Dinesh, Kumar Sanjeev. (2024). Screening of Varieties Resistant to Sugarcane Smut Disease Caused by *Sporisorium scitamineum* under Sub- tropical India. *Journal of Experimental Agriculture International*. 46:132-139. https://doi.org/10.9734/jeai/2024/v46i62465. (NAAS IF. 5.14)

Misra V and Mall AK. 2024. Global distribution, identification, pathogenesis, and advanced management strategies for *Sclerotium* root rot in sugar beet. *Sugar Tech* 26(5): 1220-1231.https://doi.org/10.1007/s12355-024-01478-x(NAAS IF. 7.80)

Misra V and Mall AK. 2024. Harnessing image processing for precision disease diagnosis in sugar beet agriculture. *Crop Design* 3: 100075.https://doi.org/10.1016/j.cropd.2024.100075

Modi RU, Singh S, Singh AK and Blessy VA. (2024). Convolutional neural networks to classify human stress that occurs during in-field sugarcane harvesting: a case study. *Journal of Field Robotics*. 41(8): 2530-2542. https://doi.org/10.1002/rob.22373.

Nalayeni, K, Barnabas L, Ashwin NMR, Franchin C, Battisti I, Carletti P, Ramesh Sundar A, Masi A, Malathi P, Viswanathan R and Arrigoni G. (2024). Comparative proteomics of sugarcane smut fungus - *Sporisorium scitamineum* unravels dynamic proteomic alterations during the dimorphic transition. *Journal of Proteomics* 304:105230. https://doi.org/10.1016/j.jprot.2024.105230 (NAAS IF. 8.8)

Nath CP., K. K. Hazra, N. Kumar, U. Singh, S. S. Singh, C. S. Praharaj & D. N. Borase (2024) Intensification of Cereal-Cereal System with Summer Mungbean Changes Carbon Pool with Net Increase in Soil Carbon. Natl. Acad. Sci. Lett. https://doi.org/10.1007/s40009-024-01546-6 (NAAS IF. 7.10)

Nithya K, Vishnu Vardhan J, Balasaravanan S, Kaverinathan K and **Viswanathan R.** (2024). Natural infection of ca. phytoplasma sacchari causing sugarcane grassy shoot disease in *Sorghum bicolor*. *Vegetos* 37: 94–98. https://doi.org/10.1007/s42535-022-00560-7(NAAS IF. 5.8)

Nunavath A, Nandhini M, Keerthana S, Kumar R, Gujjar RS, Gomathi R and Manimekalai R. (2024). Genome-wide expression profiling of cytochrome P450 genes in response to the oxidative stress in *Saccharum* spp. *Sugar Tech*. 1-15 (IF: 1.8) https://doi.org/10.1007/s12355-024-01509-7. (NAAS IF. 7.80)

Rao GP, Soloman S, Viswanathan R and Singh Dinesh. (2024). Strategies to contain red rot of sugarcane in sub-tropical India. *Indian Sugar*. 74:21-28. https://doi.org/10.1007/s12355-021-01013-2

Sahu T, Kumar D, Patel S, Sahu S and Painkra AK. (2024). Physico-chemical properties of solid and molten jaggery from CoLk 94184. *International Journal of Advance Biochemistry Research*. 8(1): 381-384. https://doi.org/10.33545/26174693.2024.v8.i1Sf.340 (NAAS IF. 5.29)

Saranya R, Malathi P, Nithiyanantham R, Mawar R and **Viswanathan R.** (2024). Evaluation of biofumigation strategy with mustard for the management of *Colletotrichum falcatum* Went–the red rot pathogen of sugarcane. *Sugar Tech* 26: 647-656 https://doi.org/10.1007/s12355-024-01369-1 (NAAS IF. 7.80)

Singh J, Singh MK, Modi RU, Kumar D and Singh SP. (2024). Role of agricultural engineers in building $5 trillion economy of India. RASSA *Journal of Science for Society*. 6 (2): 67-74. https://doi.org/10.5958/2583-3715.2024.00011.3.

Singh MK, Modi RU, Singh AK and Singh RD. (2024). Design and development of tractor-operated trash mulcher-cum-stubble shaver device for sugarcane ratoon crop. *Sugar Tech*. 26: 573-584. https://doi.org/

10.1007/s12355-024-01361-9(NAAS IF. 7.80).

Singh MK, Modi RU, Singh AK and Viswanathan R. (2024). IISR tractor-operated trash mulcher-cum-stubble shaver device for sugarcane. Proceedings STAI, 82nd Annual Convention & International Sugar Expo 2024. Jaipur Exhibition and Convention Centre, Jaipur. July 30 – 31, 2024. *Sugarcane Agriculture* 82: 56-61. https://doi.org/10.69794/82SAC/978-81-969264-0-3/56-61.

Singh P, Anam, Singh P, Chaurasia S and Kumar D. (2024). Chemical kinetics and thermodynamics of PPO activity, colour changes and microbial degradation during blanching of the sugarcane billets. *Journal of the Science of Food and Agriculture*. 104(12):7130-7142. https://doi.org/10.1002/jsfa.13536(NAAS IF. 9.30).

Singh Shweta, Prabha K, Saritha RK, Raj C, Baranwal VK and Youdol S. (2024). Association of 'Candidatus Phytoplasma asteris' with phyllody of Crown Daisy in India. *Australasian Plant Pathology*. 53(6): 521-526.https://doi.org/10.33545/26174693.2024.v8.i1Sf.340(NAAS IF. 6.90).

Srivastava S, Mishra V, Baitha A, Pandey H, Sushil SN, Mohan M, Pathak AD, Srivastava Sangeeta, Singh D and Mall AK. (2024). Genetic profiling of *Spodoptera litura* (Noctuidae: Lepidoptera) in Indian sub-tropical sugar beet. *Sugar Tech*.https://doi.org/10.1007/s12355-024-01458-1(NAAS IF. 7.80)

Thangavelu RM, Janiga PK, Nithyanantham R and Viswanathan R. (2024). Magnetic nanozyme-enhanced rapid immune flow through assay for the femtomolar detection of sugarcane yellow leaf virus. *ACS Agricultural Science & Technology* 4: 759−767 https://doi.org/10.1021/acsagscitech.4c00274

Thorat, Y.E., Dutta, T.K., Jain, P.K. Subramaniam, K. and Sirohi, A. (2024). A nematode-inducible promoter can effectively drive RNAi construct to confer *Meloidogyne incognita* resistance in tomato. *Plant Cell Reports* 43, 3. https://doi.org/10.1007/s00299-023-03114-6 (NAAS IF: 12.20)

Tripathi MK, Shukla SK, Jaiswal VP, Sharma Lalan, Nagargade Mona, Pathak AD, Dwivedi AP, Tripathi Ankur, Singh VK, Singh VP and Ranka Ajay. (2024). Integration of *Mycorrhizae*, *Azotobacter* and *Pseudomonas* spp (PSB) with NPK and their effects on sugarcane crop and soil health in Uttar Pradesh, India. *Sugar Tech*.https://doi.org/10.1007/s12355-024-01513-x.(NAAS IF. 7.80)

Vandana Priyam, Guru GR, Singh Dinesh, Srivastava Sangeeta. (2024). Suppression of sugarcane red rot disease through its rhizospheric mycoflora. *Journal of Experimental Agriculture International*. 46:99-109. https://doi.org/10.9734/jeai/2024/v46i52350(NAAS IF. 5.14)

Viswanathan R. (2024). Degeneration in sugarcane varieties: does the sugar industry realize it? *Sugar Tech* 26: 1501-1504 https://doi.org/10.1007/s12355-024-01439-4 (NAAS IF. 7.8)

Viswanathan R. (2024). Editorial vol 77(2) June 2024, *Indian Phytopathology*. 77: 255-256. https://doi.org/10.1007/s42360-024-00751-z (NAAS IF. 5.97)

Viswanathan R, Rao GP, Singh Dinesh and Solomon S. (2024). Strategies to contain red rot of sugarcane in sub-tropical India. *Indian Sugar*. 74(11): 21-28.

Viswanathan R, Yadav SK and Solomon S. (2024). Water footprint of sugarcane – wheat, rice & maize and its relevance to bioethanol production. *ISMA Times* 1 (1): 10-43.

Books/Book Chapters

Bahadur A, Singh D, Kumar M, Ram D, Singh K, Rawat S, Dev M, Deepshikha and Kumar S. (2024). Plant Pathogens: Other than Bacteria. In: Concepts of Plant Pathology and disease management. (Biswas K. K. eds). Indian Phytopathological Society, New Delhi, India. Pp. 154-168.

Banerjee N and Kumar S. (2024). Molecular breeding of crops: A new paradigm for sustainable agriculture. In: The Climate–Health–Sustainability Nexus, (Singh P and Yadav N, eds.), Springer-Nature, Pp. 375-386.

Singh Dinesh, Anwer Ali, Pervez Rashid, Nabi Asha, Gade R. M., Nisa Qadrul, Jan Roohi, Shabir Zohra, Junaid Rashid R., Gupta Shivanshi and Ingle Y. V. (2024). Dynamics of Crop Diseases and their Management. Today and Tomorrow's Printers and Publishers, Daryaganj, New Delhi- 110002, ISBN: 9788197361258. Page 660.

Sharma L, Kumar S, Jaiswal VP and Shukla SK. (2024). Advances and challenges in omics approaches for alleviating abiotic stresses and improving cane yield in sugarcane crop. In: Developments in Applied Microbiology and Biotechnology, Current Omics Advancement in Plant Abiotic Stress Biology, (Deepesh Bhatt, Manoj Nath, Saurabh Badoni, Rohit Joshi eds.) Academic Press, Pp. 269-276, ISBN 9780443216251, https://doi.org/10.1016/B978-0-443-21625-1.00018-X.

Majhi PK, Patra B, Behera PP, Bhoi TK, Shiv A, lenka D, Purohit A, Ahamad A.(2024). Designing the modern

crop genome architecture by harnessing the genes from crop wild relatives (CWRs): A Population Genetics and Genomics Perspective. In. Climate-Resilient Agriculture. (Ashutosh Singh and Saurabh Pandey, eds.) Apple Academic Press, Pp. 435-480. ISBN9781003455271.

Misra V and Mall AK. (2024). Mycorrhizal symbiosis response under pathogen attack in plants. In: Plant Endophytes and Secondary Metabolites: Microbiome Research in Plants and Soil (Egamnerdieva D, Parray JA and Davranov K., eds). Elsevier Publishers, Pp. 81-94.

Panday Himanshu, Barsati Lal, Kamta Prasad, R.K. Rai and Navneet Maurya (2024). "Wheat: Challenges and Strategies for Sustainable Production in India" Essentials of Agricultural Practices. ISBN: 978-93-61348- published by Convent Vibes. Pp.189-209.

Rathod NKK, Noor EM, Chandan, Singh Shweta and Chandramani R. (2024). Harmonizing nature's arsenal: Unravelling phenolic biosynthesis and mechanisms for fungal disease management. In: Plant nutrient and insect pest management. Biotech Books, Pp. 199.

Sahu S, Puru S, Sharma S, Shiv A and Singh DB. (2024). Role of bioinformatics in genome analysis. In: Integrative Omics: Concept, Methodology, and Application. (Manish Kumar Gupta, Pramod Katara, Sukanta Mondal and Ram Lakhan Singh, eds.) Academic Press, Pp. 187-199.

Shiv A, Samantara K, Ravi Kiran KT, Chand S, Kushwaha A, Goyal L, Indu, Chaudhary R and Kumar S. (2024). Towards Smart Plant Breeding: Genome Editing Tools for Efficient Manipulation of Economically Important Traits of Crop Species. In: Smart Breeding (Kailash Chandra, Subhash Chand, Ravi Prakash Saini and Rohit Sharma, eds.). Apple Academic Press. Pp. 123-153.

Vineeth TV, Ravi kiran KT, Sreekumar PM, Ajay LG and Rathod NKK. (2024). Engineering salt tolerance in crops by *CRISPR*-mediated genome editing technology: Target traits, present perspective and future challenges. In: Halophytes *vis-à-vis* Saline Agriculture: Perspectives and Opportunities for Food Security (Jagdish Chander Dagar, Sharda Rani Gupta and Ashwani Kumar, ed.). Singapore: Springer Nature Singapore, Pp. 263-284.

Training manual on "Development of agripreneurship through establishing healthy settling nurseries of sugarcane setts for supply of quality planting materials to farmers" under Advanced Entrepreneurship and Skill Development Program (A-ESDP) Eds. Chandramani Raj, Shweta Singh, SK Goswami. ISBN: 978-93-340-3748-7.

Chandramani R, Singh Shweta, Goswami SK, Tiwari RK and Sharma L. (2024) Field identification of major sugarcane diseases. Pp. 115-122.

Chandramani R, Singh Shweta, Goswami SK, Tiwari R and Sharma L. (2024). Thermotherapy to Sett treatment device culture in the development of a healthy settling nursery of sugarcane. Pp. 35-40

Goswami SK, Sharma L, Chandramani R, Singh Shweta and Tiwari R. (2024). Setting up a Commercial Healthy Seed Nursery in Sugarcane: Opportunities and Limitations. Pp. 67-73.

Sharma L and Goswami SK. (2024) Bio-priming of sugarcane sett with biocontrol agents and fungicides. Pp. 49-52.

Tiwari R, Chandramani R, Singh Shweta, Goswami SK, Sharma L and Singh D. (2024). Seed Health in Vegetatively Propagated Crops: Concepts and Considerations. Pp.53-66.

Popular Articles

Hashim M, Kumar D, and Kumar S. (2024). The importance of crop rotation in sustainable agriculture. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*. 4(12): 6-9.

Kumar M, Modi RU, Sanodiya R, Kumar R and Pagare V. (2024). Application of satellite navigator and light bar system in farm tractor. *Agriman*. 1(3): 17-18.

Kumar D and Kumar S. (2024). The integral role of farm machinery in optimizing crop stands and enhancing agricultural productivity. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*. 4(11): 1-5.

Kumar D and Kumar S. (2024). Agronomic Fortification: A sustainable approach to nutritional enhancement in crops. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*. 4(12): 15-18.

Kumar S and Kumar D. (2024). Organic carbon management for soil health in fodder-based systems. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*. 4(3):1-8.

Kumar S and Kumar D. (2024). Tech harvest: Unleashing the potential of AI in India's agricultural landscape. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*., 4(3):25-27.

Kumar S and Kumar D. (2024). Phosphorus management in agriculture: strategies for sustainable crop production. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*. 4(12): 10-14

Verma R R, Srivastava TK, Hasan SS and Singh P (2023). *Ikshu Kedar*: Mobile app for raising sugarcane water productivity in sub-tropics. *Indian Farming*, 73(3), 28–30.

अभिषेक कुमार सिंह एवं ब्रह्म प्रकाश (2024) हिंदी के राजभाषा बनने की विकास यात्रा। हिमज्योति 138—145.

अभिषेक कुमार सिंह, ब्रह्म प्रकाश, ओम प्रकाश एवं राकेश कुमार सिंह (2024) भारत में तुलसी का महत्व एवं खेती। मत्स्य लोक। अंक 13: 77—81.

अभिषेक कुमार सिंह, ब्रह्म प्रकाश, ओम प्रकाश एवं राकेश कुमार सिंह (2024) गाजर का औषधीय महत्व. सब्जी किरण. 18(2): 57.

गोस्वामी संजय, सिंह दिनेश, शर्मा ललन, गुज्जर रणजीत सिंह, कुमार राजीव, राज चंद्रमणि, सिंह श्वेता, तिवारी राहुल कुमार एवं बैठा अरुण (2024)। ट्राइकोडर्मा से गन्ने का उकठा रोग प्रबंधन। इक्षु ,13(1): 15—1.

त्रिपाठी ए, त्रिपाठी एस, त्रिपाठी, एम के, सिंह वी के, सिंह के के, द्विवेदी ए पी, सिंह ए के और पाठक पी. (2024). सिलिकॉन: पौधों के लिए एक लाभकारी पोषकतत्व। इक्षु, 13(1): 65—66.

त्रिपाठी एम के, त्रिपाठी ए, त्रिपाठी एस, सिंह वी के, द्विवेदी ए पी, सिंह के के एवं सिंह आर के. (2024). गन्ने के साथ अंत: फसली खेती। इक्षु,13(1): 1—3.

द्विवेदी ए पी, सिंह के के, त्रिपाठी एम के, कुमारी के, यादव एस के, सिंह ए के और सिंह वाई पी. (2024). भारतीय कृषि में कृत्रिम बुद्धिमत्ता का उपयोग: एक व्यापक समीक्षा। इक्षु,13 (1): 40—43.

पाण्डेय हिमांशु, लाल बरसाती, प्रसाद कामता एवं राय राहुल कुमार "कम्पोस्ट खाद का महत्व एवं बनाने की विधियाँ" किसान भारतीय पत्रिका 55—56। 12(1): 36—40.

मिश्रा वी, मल्ल ए के एवं संतेश्वरी (2024). फसल उत्पादन में मृदा पीएच की महत्ता। मृदा स्वास्थ्य आलोक,12—14.

मोदी आर यू, पांडे आर के और कंचेटी एम. (2024). कृषि ड्रोन: आवश्यकताएँ एवं अनुप्रयोग। इक्षु,13(1): 73—74.

मौर्य नवनीत, राय राहुल कुमार एवं पाण्डेय हिमांशु "जलवायु परिवर्तन में हरित गृह गैसों का व्यापक प्रभाव"। मध्य भारत कृषक मासिक पत्रिका (ISSN— 2582—5976 19(1):36.

यादव अंजलि, प्रसाद कामता, सिंह प्रिय, लाल बरसाती, एवं पाण्डेय हिमांशु "शकरकंद एक: फायदे अनेक" इक्षु ,13(1): 89—90.

लाल बरसाती, सिंह अपूर्वा, प्रसाद कामता एवं पाण्डेय हिमांशु "कृषि में कित्रिम बुद्धिमत्ता (ए आई) का उपयोग: भविष्य की खेती का मार्ग" किसान भारतीय पत्रिका 55—56। 12(10): 48—51.

संतेश्वरी, रहुरामन एम, मिश्रा वी एवं मल्ल ए के. (2024). मृदा स्वास्थ्य संकेतक: कोलोएंबोला कीट। मृदा स्वास्थ्य आलोक, 66—68.

सिंह ए के, प्रकाश बी, त्रिपाठी एम के एवं सिंह आर के. (2024). राष्ट्र के सर्वांगीण विकास के लिए शिक्षा का माध्यम मातृभाषा होना आवश्यक। इक्षु ,13(1): 10—13.

सिंह दिनेश, राज चंद्रमणि, बैठा अरुण, सिंह श्वेता, गोस्वामी संजय, रॉय शर्मीला, सिंह एम् आर, सिंह दिनेश, शर्मा लालन एवं विश्वनाथन आर. (2024). गन्ने के जीवाणु रोग: निदान, महामारी विज्ञान और प्रबंधन । इक्षु, 13 (1): 11—15.

सिंह वी के, सिंह वी पी, त्रिपाठी एम के एवं सिंह आर के. (2024). प्राकृतिक खेती: विष मुक्त खेती की तकनीक। इक्षु, 13(1): 34—39.

Papers/abstracts presented in Conference/ Seminar

Gangwar LS, Viswanathan R, Hasan SS and Singh D. (2024). Integrated Sugarcane Based Farming System for Achieving Food Security and Sustainable Development Goals –Prospects and Challenges. 3rd International Conference on "Climate-Smart Nutri Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges (ICNSFS-2024). ICAR-CIWA, Bhubaneswar. Nov. 06-08, 2024. Pp. 08.

Goswami SK, Singh D, Singh SP and Yadav P. (2024). Endophyte *Chaetomium globosum* strain CGSR-13 enhances sugarcane growth and shows antifungal activity against sugarcane fungal pathogens. National conference on "Expanding the horizons of microbial research in agriculture". ICAR-NBAIM, Mau. June 10-11, 2024. Pp. 210.

Goswami SK, Singh D, Singh SP, Yadav P, Gujjar RS and Kumar R. (2024). Deciphering growth promotion and antifungal activity of endophyte Chaetomium globosum strain CGSR-32 against sugarcane fungal pathogens. International Conference on "Transforming Agrifood Systems in the Face of Climate Changes and Energy Transitions" by Indian Ecological Society (IESIC-2024). PAU, Ludhiana. November 12-15, 2024, Pp. 333.

Gupta C, Saini SK, and Tamak RL. (2024). Advance Agro techniques for enhancing water use efficiency in sugarcane under subtropical India. Theme:

Agriculture Water Management, sub theme- Enhancing water use efficiency In: XVI World Aqua Congress 2024- International Conference & Exhibition, November 18-19, 2024

Indu and Kumar S. (2024). Navigating the shift from 'Co 0238' towards new resilient sugarcane varieties. International Conference "Current Innovations and Technological Advances in Agriculture and Allied Sciences". Department of Agriculture and Farmers Welfare, Horticulture Department, Govt. of Punjab, ISASTR-Noida & Just Agriculture Edu. Group. Guru Kashi University, Talwandi Sabo (Punjab). Aug. 29-31, 2024. pp. 412.

Mall AK, Misra V, Santeshwari, Pathak AD and Srivastava S. 2024. Sugar beet breeding in India: Retrospect, challenges and prospects. 3rdInternational Conference & Exhibition on Sustainability: Challenges & Opportunities in Global Sugar Industry, Vasantdada Sugar Institute, Pune. Jan. 12-14, 2024.

Sawnani A., N. Verma, Srivastava Sangeeta, Srivastava Abhay, Omprakash and Singh Kamini (2024). Abstract on 'The growing impact of climate change on global food security and agricultural Resilence' published in Souvenier of the 1st International Conference on "Innovations to Achieve Climate Resilient Smart Agriculture for Ensuring Global Food and Nutritional Security" held on November 18-19, 2024, Pp 150

Singh Dinesh (2024). Eco-friendly approaches for the management of crop diseases using bacteria. National Symposium on plant health management a sustainable tool in addressing crop diseases under climate resilient Agriculture. UAS, Dharwad, Karnataka. December 11-12, 2024. Pp. 160.

Singh Dinesh, Baitha Arun, Goswami SK, Sharma Lalan, Borse DN, Thorat YE, Raj Chandramani, Singh Shweta, Tiwari RK, Srinivas K and Viswanathan R. (2024). Present Scenario of insect pest and diseases of sugarcane and their management in subtropical India. National symposium on Multidisciplinary perspectives for pest and disease management in sustainable production of crops. SKUAST-K Srinagar. August 28-30, 2024, Pp. 15-16.

Srivastava Sangeeta (2024). Biotechnological interventions for stress resilience in sugarcane: Challenges and Prospects. In: National Conference on "Women in Biotechnology: Contribution in Accelerating Research and Entrepreneurship (WiB-CARE)" jointly organised by Amity Institute of Biotechnology, AUUP Lucknow Campus and National Academy of Science India (NASI), Lucknow Chapter on October 22-23, 2024

2nd International Conference on Innovation in biotechnology research for Sustainable Bioresources and Bioeconomy: Challenges and Practices organized by Sanjivani Rural Education Society, Kopergaon. February 15-16, 2024

Lokhande Prajwal, Borase DN, Mhaske Mahesh, Nirmal Rutuja, Thorat YE and Singh Dinesh. Utilizing entomopathogenic bacteria to mitigate white grub infestation in sugarcane: A novel approach for pest management. pp 16.

Borase DN, Thorat YE, Kumar Rajeev, Mhaske Mahesh, Nirmal Rutuja, Bhalerao BM, and Kale AA. Post-harvest quality deterioration in manually and mechanically harvested sugarcane in a tropical climate. pp 14.

Thorat YE, Mhaske Shubhangi, Pathade Shital, Kadam Aparna, Magar Bharat and Borase DN. Entomopathogenic Nematodes (EPNs): An Entailing Green Strategy for Management of Sugarcane Insect Pests. pp13.

13th Germplasm & Breeding/10th Molecular Biology Workshop, ICAR-SBI, Coimbatore India. July 8-12, 2024

Swapna M, Sreenivasa V, Kumar S and Kumar S. Improved sugar accumulating sugarcane genotypes as parents for population improvement. Pg. 10.

Raj Chandramani, Singh Shweta, Tiwari Rahul, Goswami SK, Singh Dinesh and Viswanathan R. Navigating the road to Red Rot resistance: A journey from Co 0213 to Co 0238 in Indian sugarcane cultivation.

Second National Genetics Congress. ISGPB & IARI, ICAR-Indian Agricultural Research Institute, New Delhi, Nov. 12-14, 2024

Indu and Kumar S. Sugarcane varietal planning: To boost profitability for growers and the sugar industry in Sub-Tropical India.

Rathod NKK, Taku M, Mujjassim NE, Reshma O, Saini M, Mallikarjuna BP, Yadav RR, Yadav M, Rajendran A, Lal SK and Talukdar A. Deciphering genetics and mapping of early maturity and yield-related traits in soybean [*Glycine max* (L.) Merr.].

1st International conference on Innovations to achieve climate resilient smart agriculture for ensuring global food & nutritional security, organized by ICAR-ISRI, Lucknow and AEE&T DS, Lucknow, UP, November 18-19, 2024.

Srivastava Abhay Kumar, V P Jaiswal, Priyanka Srivastava, Sangeeta Srivastava, S. K. Shukla, Raghvendra Tiwari and R K Tiwari. "Morphology and Biochemical analysis of Plant Growth-Promoting Rhizobacteria (PGPR) under Drought Stress in Sugarcane."

Goswami SK. Bio-control agents as potential and promising alternative for the management of sugarcane wilt caused by *Fusarium sacchari*.

Tiwari Mithilesh, Goswami SK and Singh D. Spicy jaggery production: A start-up opportunity to empower women India.

National Conference Plant Health for Food Security: Threats and Promises held at ICAR-Indian Sugarcane Research Institute, Lucknow, Uttar Pradesh, February 1-3, 2024.

Sawnani Anita, Srivastava Sangeeta, Srivastava AK and Singh K. From Soil to Plate: Enhancing Food Security by Prioritizing Plant Health.

Baitha Arun, Singh MR, Roy Sharmila, Singh Dinesh and Srinivas KKA. Varietal preference of the sugarcane pink mealy bug, *Saccharicccus sacchari* (Cockerell) (*Homoptera Pseudococcidae*). Pp. 204.

Banerjee N, Singh A, Swapna M, Kumar S, Singh D and Kumar S. GBS-based association mapping and prediction for red rot resistance in sugarcane. Pp. 124.

D N Borase, Yogesh Thorat, S N Sushil and Deeksha Joshi. Bio-prospecting of entomopathogenic bacteria for management of white grubs infesting sugarcane.

Choudhary P, Chakdar H, Verma S, Goswami SK, Srivastava AK. Fungal specific lectin FGB1 based LAMP assay for specific detection of *Fusarium oxysporumf*sp. ciceris causing *Fusarium* wilt in chickpea. Pp 57.

Gangwar LS, Viswanathan R, Singh Dinesh, Baitha A and Sharma AK. Assessment of economic losses with degeneration of sugarcane variety Co 0238 by red rot disease in Uttar Pradesh- Challenges and way forward. Pp. 193-194.

Gangwar LS, Viswanathan R, Singh Dinesh, Baitha A and Sharma AK. Assessment of economic lossess with degeration of sugarcane variety Co 0238 by red rot disease in Uttar Pradesh- Challenges and way for forward. Pp. 193.

Goswami SK, Gujjar RS, Kumar R, Yadav P, Singh D, Viswanathan R. Sugarcane growth promotion and antifungal activity shown by *Chaetomium globosum* CGSR-13 against Pokkah boeng caused by *Fusarium verticillioides* in India. Pp.78.

Gupta C, Baitha A, Singh VP, Gowda P, Gupta S and Gautam S. (2024). Effect of graded levels of NPKS fertilizers on incidence top borer in sugarcane of Sub-tropical India.

Gupta C, Goswami SK, Gowda P, Gupta S, Gautam S. Deciphering the impact of graded levels of NPK fertilizers on occurrence of sugarcane smut disease caused by *Sporisorium scitamineum* in sub-tropical India. Pp. 401.

Hasan SS, Sharma AK, Gangwar LS and Majumdar SG. Internet of Things (IoT) intervention in crop protection: a brief review. Pp. 172-173.

Kumar S, Singh J, Singh PK, Srivastava TK, Shiv A and Indu. CoLk 16202 (*IKSHU* 16)–an early maturing sugarcane variety moderately resistant to three pathotypes of red rot. Pp. 409-410.

Kumar Sumit, Maurya SK, Singh Vikas, Singh Dinesh, Kumar Sanjeev (2024) Studies on sugarcane wilt disease caused by Fusarium sacchari under sub-tropical India. Pp. 253.

Lal Barsati, Prasad Kamta and Panday Himanshu. Sugarcane cultivation practices adopted by the farmers in Barabanki districts of Uttar Pradesh.

Panday Himanshu, Lal Barsati, Prasad Kamta and Rai R. K. Socio-economic Status of Sugarcane Growers in Bareilly Districts of Uttar Pradesh.

Prasad Kamta, Lal Barsati, Panday Himanshu and Shankhla Gopal. Sources, access and utilization patterns of plant protection technologies among the sugarcane growers.

Singh MK, Modi RU, Singh AK, Singh RD. Eco-friendly trash management by tractor-operated sugarcane trash mulcher cum stubble shaver machine. Pp: 206.

Mall AK, Misra V, Singh S, Srivastava Sangeeta, Singh D. Identifying disease resistant sugar beet germplasm varieties for sustainable production in India. pp. 345-346.

Maurya SK, Singh Vikas, Singh Dinesh and Kumar Sanjeev (2024) Studies on sugarcane smut disease caused by Sporosorium scitamineum under sub-tropical India. Pp 244.

Modi RU, Singh AK, Singh MK and Singh S. Can artificial intelligence facilitate weed control for upholding the health of sugarcane crop? Pp: 207-208.

Pallavi, Gaur Asha and Jaiswal VP. Quality index of

sugarcane juice analysis. Pp: 432.

Prakash O, Baitha A, Singh VP, Singh KK, Goswami SK and Prakash B. Insect-pests management in organic farming of sugarcane through interventions in cultural practices. Pp.427.

Raj C, Singh S, Modi RU, Baitha A, Hasan SS, Borase DN and Viswanathan R. Computer vision aid for monitoring sugarcane insect pest injury symptoms using deep learning image classifier. Pp. 173

Raj Chandramani, Singh Shweta, Goswami SK, Singh Dinesh and Viswanathan R. Role of parent selection in evolution of *Colletotrichum falcatum* went pathotypes causing red rot in sugarcane. Pp. 195.

Roy Sharmila, Singh Akansha, Singh Avanendra, Tiwari Rahul and Singh Dinesh. Effect of fertilizer application on the microbial community of sugarcane rhizosphere. Pp. 378.

Sharma AK, Gangwar LS, Hasan SS and Sachan AK. Extent of mechanical control, biological control and chemical pest control on individual farm fields in Indian agriculture. Pp. 206-207.

Sharma AK, Gangwar LS, Hasan SS, and Sachan AK. Extent of mechanical control, biological control and chemical pest control on individual farm fields in Indian agriculture. Pp. 206-207.

Singh A, Banerjee N, Yadav K, Kumar P, Kumari M, Singh D and Kumar S. Role of DBT-Accredited Test Laboratory, ICAR-ISRI, Lucknow in virus indexing and genetic fidelity testing of tissue culture-raised planting materials. Pp: ?

Singh AK, Singh MK, Sukhbir Singh and Modi RU. Mechanization for cost-effective management of sugarcane health. Pp: 208.

Singh Dinesh (2024) Sugarcane varieties for sustaining yield and quality under biotic and abiotic stress. Pp: 196

Singh GK, Singh VP, Singh VK, Singh RK and Sachan AK. Sustainable water management strategies for sugarcane production in Northern India: a focus on water-saving techniques. Pp. 17.

Singh J, Kumar D, Singh P, Tiwari M and Rai RR. Value addition of jaggery-based products: A review. pp. 424.

Singh K, Gangwar LS, Srivastava S, Prakash B and Prakash Om. Intellectual property rights with artificial intelligence and mechanization: An association. Pp. 388.

Singh MR and Baitha A. Mass multiplication of entomopathogenic fungi, *Beaveria bassiana* and *Metarhizium anisoplie* on different organic media. Pp. 211-212.

Singh V. K., Singh V.P., Singh K.K., Mall A. K., Srivastava T. K., Tripathi M.K., Singh G.K. and Kumar Rajeev. Identification of drought tolerance varieties of sugarcane for sub-tropical India. Pp. 423.

Singh VP, Singh KK, Kumar Dileep and Singh GK. Weed a biotic stress: Challenges and opportunities in sugarcane production. Pp. 201.

Srivastava TK, Kumar S. and Singh D. Changing climate and red rot infection drags down the sugar recovery in early crushing season in Uttar Pradesh. Pp. 430.

Srivastava Sangeeta, Singh Dinesh and Pathak AD. Small ncRNA in sugarcane defence response under red rot challenge conditions: An over view.

Srivastava Abhay Kumar, Jaiswal VP, Srivastava Sangeeta, Gaur Asha, Srivastava Priyanka, Tiwari RK. Effect of plant growth promoting rhizospheric bacteria against the biotic stress in sugarcane in sub- tropics.

Swapna M, Sreenivasa V, Kumar S, Kumar S and Singh D. Improved population for sugar accumulation in sugarcane: A potential source for red rot resistance. Page no.?

Thorat YE, Borase DN, Singh Dinesh and Viswanathan R. Occurrence and abundance of plant parasitic nematodes (PPNs) in sugarcane areas of Maharashtra, India. Pp. 104.

Tripathi MK, Singh SR, Gupta C, Shukla SK, Sharma L, Dwivedi AP, Singh VK and Singh AK . Silicon nutrition to mitigate plant biotic and abiotic stresses. Page no.?

Verma RR and Gangwar LS. Soil health and sugarcane diseases status in western Uttar Pradesh under climate change scenario-A survey. Pp. 408.

Yadav SK, Singh GK, Dwivedi AP, Singh VP and Yadav P. Climate change impact on biotic and abiotic stresses of sugarcane and its management. Pp. 200.

Yogesh Mohan SinghYadav AK, Srivastava Sangeeta and Singh K. Accurate identification of insect pests and diseases of plants: a photographic approach- *et al*

Yadav AK, Singh YM, Srivastava Sangeeta, Sachan A and Singh K. Safeguarding plant and photographer: precautions in photographing insect pests and

pathogens on susceptible sugarcane plants.

58th Annual Convention of the Indian Society of Agricultural Engineers (ISAE) on Engineering Innovations for Next-gen Digital Agriculture and the International Symposium on Agricultural Engineering Education for Aspiring Youth in Transforming Agriculture held at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during November 12-14, 2024.

Modi RU, Singh VP, Singh AK, Kancheti M and Viswanathan R (2024). Optimization and assessment of spray deposition and weed control efficacy using UAV based spraying system in sugarcane crop. Pp: 97.

Anwar SI. (2024). Energy enhancement techniques in sugarcane processing for jaggery making. Pp: 475.

Lecture/Oral presentation

Dr. Arun Baitha presented annual progress report of Entomology (2023-2024) in 35th Biennial Workshop of All India Coordinated Research Project on Sugarcane at Punjab Agricultural University, Ludhiana (Punjab) on October 21st, 2024.

Dr. Dinesh Singh (HoD), delivered expert talk on "Recent advances in diagnosis of bacterial diseases of crops". Orientation workshop for new faculty members of Protection Sciences on Efficient teaching, high throughput research and extension. BAU, Sabour, Bhaghalpur. June 6- 8, 2024.

Dr. Dinesh Singh (HoD), delivered invited lecture on "Eco-friendly approaches for the management of crop diseases using bacteria". National Symposium on Plant Health Management a sustainable tool in addressing crop diseases under climate resilient Agriculture. UAS, Dharwad, Karnataka. December 11-12, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on "Diseases of sugarcane in tropical region and their management". Training programme on Innovative Technology for sugarcane cultivation". ICAR- ISRI, Lucknow. July 3, 2024

Dr. Dinesh Singh (HoD), delivered lecture on "Insecticides and their role in IPM with special reference to sugarcane" Rural Agricultural Work Experience for B. Sc. (Ag) students. ICAR- ISRI, Lucknow. September 18, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on "Integrated Disease management (IDM in wheat, chick pea and mustard under a training programme on integrated insect pests and disease management in wheat and chickpea and seed distribution under SCSP programme". ICAR- ISRI, Lucknow, UP. December 05, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on "Present issues in crop protection of sugarcane in India" under Module - Orientation Training schedule of ICAR-ISRI, Lucknow for newly recruited assistants of nearby institutes i.e. ICAR-CISH, Lucknow, NBFGR, Lucknow & IIPR, Kanpur. ICAR- ISRI, Lucknow, UP. December 16, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on "Sugarcane crop protection" Interactive meet with a team of five members officers from Department of Agriculture & Farmers Empowerment, Government of Odisha. ICAR- ISRI, Lucknow, UP. December 05, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on Characterization of races, genetic diversity of *Xanthomonas campestri* spv. *campestris* causing black rot disease of crucifer crops and its management through eco-friendly approaches. National conference on Plant Health for Food Security: Threats and Promises at ICAR- ISRI, Lucknow, UP during February 1-3, 2024.

Dr. Dinesh Singh (HoD), delivered lecture on Sugarcane insect pests and diseases and their management under virtual Training on "Sugarcane Crop Agronomy and Management". ICAR- ISRI, Lucknow. December 01, 2024.

Dr. Dinesh Singh (HoD), delivered plenary lecture on "Recent advances in diagnosis and management of bacterial wilt of solanaceous crops" National symposium on Climate smart disease management for sustainable plant health (CSDM 2024). BAU, Sabour, Bhagalpur, Bihar. July 10-12, 2024.

Dr. Lalan Sharma delivered lecture on "Principles, Concept and Methods of Biofertilizers Production". Training on the Innovative Technology for Sugarcane Cultivation in the Extension & Training. ICAR-ISRI, Lucknow. July 01-05, 2024.

Dr. Manoj Kumar Srivastava, delivered extramural lecture on "Alternative splicing of HipI superoxide dismutase genes in poplar: A process to generate different isoforms" MS University, Baroda. January 19, 2024.

Dr. Sangeeta Srivastava delivered Lecture on "Biodiversity of Sugar Crops in India" on under Rural Agricultural Work Experience for B. Sc. (Ag) students from Bihar. ICAR- ISRI, Lucknow. September 02, 2024.

Dr. Sangeeta Srivastava delivered lecture as subject specialist on "Aim, implementation and achievements of SCSP (Scheduled Caste Sub Plan)" during Kisan Goshthi and Distribution Programme of Improved seeds, fruit plants and agricultural equipment under SCSP Plan. ICAR- ISRI, Lucknow. October 9, 2024.

Dr. Sangeeta Srivastava delivered an invited lecture on "Biotechnological interventions for stress resilience in sugarcane: Challenges and Prospects" in National Conference on "Women in Biotechnology: Contribution in Accelerating Research and Entrepreneurship (WiB-CARE)" jointly organized by Amity Institute of Biotechnology, AUUP Lucknow Campus and National Academy of Science India (NASI), Lucknow Chapter on 22 October, 2024.

Dr. Sangeeta Srivastava delivered a lecture on 'सत्यनिष्ठा की संस्कृति से राष्ट्र की समृद्धि', "Culture of Integrity for Nation's Prosperity" Vigilance Awareness Drive at ICAR- ISRI, Lucknow. November 8, 2024.

Dr. Sanjeev Kumar (Biotech), delivered lecture on Augmenting sugarcane seed chain with tissue culture plants: achievements and challenges ahead for a clean seed system. *Invited Lecture* In. DBT, NCS-TCP. NIPGR, New Delhi. June 25, 2024.

Technical Bulletins/Reports/Souvenir & Abstract

Arun Baitha and K Srinivas (2024). Technical Report Entomology (2023-2024) All India Coordinated Research Project on Sugarcane, ICAR-ISRI, Lucknow.

Viswanathan R, Goswami S, Raj C, Singh Shweta, Tiwari RK. (2024). All India Coordinated Research Project on Sugarcane (ICAR), Technical report, Lucknow, Pp171.

Kumar S, Shiv A and Kumar S. (2024). Sugarcane Propagation through Tissue Culture: A Practical Manual (Advanced Entrepreneurship and Skill Development Program of Ministry of MSME), ICAR-IISR, Lucknow, ISBN: 7642 | ISBN | 2024 | A.

Viswanathan R, S Srivastava, TK Srivastava, M Swapna, AK Sharma, LS Gangwar, RU Modi and AK Srivastava (2024). Annual Report, ICAR- ISRI, Lucknow 2023.

Sangeeta Srivastava, Swapna M., Abhay Kumar Srivastava and Anita Sawnani (2024). Proceedings of Institute Research Council Meeting. September 11th – 13th and October 14th, 2024

Singh Dinesh, Biatha Arun, Yadav SK, Sharma Lalan, Singh GK, Zubair Adil, Srivastava Sajay Lal, Sahu Ambrish (2024). Annual Report (2023-24). Published by ICAR-AICRP (Sugarcane), ISRI, Lucknow.

Folders

Borase DN, Thorat YE, Baitha Arun, Singh Dinesh, Viswanathan R. (2024) Integrated Management of sugarcane borer complex. Published by ICAR-ISRI, Lucknow.

Srivastava Sangeeta, Srivastava AK and Srivastava SL. (2024). IISR- At a Glance. Published by ICAR-ISRI, Lucknow.

Thorat YE, Borase DN, Baitha Arun, Singh Dinesh and Viswanathan R. (2024) Integrated Management of White grub infesting sugarcane. Published by ICAR-ISRI, Lucknow.

Viswanathan R, Chandramani R, Singh Shweta and Goswami SK. (2024). Development of agri-preneurship through establishing healthy settling nurseries of sugarcane setts for supply of quality planting materials to farmers. Published by ICAR-ISRI, Lucknow.

CHAPTER 17

Review, Monitoring and Evaluation

XXIXth Research Advisory Committee Meeting

The XXIXth Meeting of Research Advisory Committee of ICAR-Indian Sugarcane Research Institute, Lucknow was held during January 04-05, 2024, under the Chairmanship of Dr. Bakshi Ram, 'Padma Shri' and Former Director, ICAR-SBI, Coimbatore. It was attended by RAC members: Dr. R.K. Singh, Dean, RLBCAU, Jhansi & Former ADG (Commercial Crops), ICAR, New Delhi; Dr. S.K. Saini, Former Director Research, GBPUA&T, Pantnagar; Dr. A. Ramesh Sundar, Head, Division of Crop Protection, ICAR-SBI, Coimbatore; Dr. Man Singh, Former Project Director, Water Technology Centre, ICAR-IARI, New Delhi, Dr. D.K. Yadava, Assistant Director General (Seeds & Commercial Crops), ICAR H.Q., New Delhi, Dr. R. Viswanathan, Director, ICAR-ISRI, Lucknow, Dr. Sanjeev Kumar, Pr. Scientist & Member Secretary (RAC), and all the Heads & In-Charges.

XXXth Research Advisory Committee Meeting

The XXXth Research Advisory Committee Meeting of ICAR-Indian Sugarcane Research Institute, Lucknow was held during Dec. 02-03, 2024 under the Chairmanship of Dr. Bakshi Ram, Padma Shree Awardee and Former Director, ICAR-Sugarcane Breeding Institute, Coimbatore. The Meeting was attended by RAC Members, Dr. R.K. Singh, Ex-ADG (Commercial Crops) & Dean, RLBCAU, Jhansi; Dr. Prasanta Kumar Dash ADG (Commercial Crops), ICAR, New Delhi (online), Dr. S.K. Saini, Former Director Research, GBPUAT, Pantnagar (Online); Dr. Man Singh, Project Director, Water Technology Centre, IARI, Dr. A. Ramesh Sundar, Head, Division of Crop Protection, ICAR-Sugarcane Breeding Institute, Coimbatore; Dr. Alka Singh, Professor & Head, Division of Agricultural Economics, ICAR-IARI, New Delhi and Dr. R. Viswanathan, Director of the institute, Dr. Sanjeev Kumar, Pr. Scientist & Member Secretary (RAC), and all the Heads & In-Charges.

Advance-Entrepreneurship and Skill Development Program (A-ESDP)

One week Advance-Entrepreneurship and Skill Development Program (A-ESDP) on "Sugarcane Propagation through Tissue Culture Techniques", and "Development of agri-preneurship through establishing healthy settling nurseries of sugarcane setts for supply of quality planting materials to farmers" sponsored by Ministry of MSME, GOI, New Delhi was undertaken from 12th to 18th March, 2024 at ICAR-ISRI, Lucknow with the objective to motivate youth of different sections of the society to consider self-employment or entrepreneurship as one of the career options, and to promote new enterprises and build entrepreneurial culture in the country.

Second Review Meeting of ICAR-Indian Sugarcane Research Institute, Lucknow

The second review Meeting of ICAR-Indian Sugarcane Research Institute, Lucknow was held on 11th June 2024 under the chairmanship of DDG (CS), ICAR Dr. T.R. Sharma to review the achievements of the institute, future targets of 100 days and five years, and the action taken report on the points emerged during the first Review Meeting of ISRI, Lucknow taken by Hon'ble DG, ICAR Dr. Himanshu Pathak on 23rd November 2023. Director, ICAR-ISRI, Lucknow, all the Heads & In-Charges were attended the meeting.

Inspection of wilt affected sugarcane fields in Western Uttar Pradesh

A team of scientists from ICAR-ISRI, Lucknow and UPCSR, Shahjahanpur conducted a field inspection during August 27-29, 2024 in Western Uttar Pradesh to investigate the suspected yellowing of sugarcane fields across various sugar mills. The inspection covered areas such as Dhanura, Deoband, Khaikheri, Rohana, Titawi, Mawana, Nagalamal and

Simbhaoli. The team identified incidences of root borer, wilt, or both in the varieties Co 0118, Co 15023, Co 11015 and Co 15027. Root borer infestation was found both in wilt affected and healthy canes across these varieties.

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) Meeting 2024 of the ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow, was conducted under the chairmanship of Dr. Rasappa Viswanathan, Director of the Institute, during September 11th–13th and October 14th, 2024. 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 48 scientists and 3 technical officers attended the meeting, along with the Chairman. Discussions emphasized the need to streamline research efforts and prioritize impactful projects, ensuring the Institute continues to make significant contributions to sugarcane and sugar beet research.

ICAR Regional Committee meeting

The Indian Council of Agricultural Research (ICAR), conducted the XXVIIth meeting of ICAR Regional Committee IV, comprising the states of Uttar Pradesh, Bihar, and Jharkhand, on 14th November 2024 through ICAR-Indian Institute of Vegetable Research (IIVR), Varanasi at ICAR-Indian Sugarcane Research Institute (ISRI), Lucknow. The event was graced by Hon'ble State Cabinet Minister, Agriculture, Research and Education Shri Surya Pratap Shahi, Agriculture Minister of Bihar, Shri Mangal Pandey, Dr. Himanshu Pathak, Secretary, Department of Agricultural Research & Education (DARE) and Director General (DG) of ICAR, Dr. K.V. Raju, Economic advisor to CM, UP Govt and Dr. Avanish Awasthi, Advisor, UP Govt .

AICRP Monitoring Team visits Motipur Centre

The AICRP (S) Monitoring Team visited ISRI Regional Centre, Motipur to monitor the Zonal Varietal Trials of AICRP (Sugarcane) on December 14, 2024. The team comprised of scientists: Dr. S.C. Singh (Agronomy), Dr. D. Sassikumar (Plant Breeding), Dr. Chandramani Raj (Plant Pathology) and Dr. Anil Kumar (Entomology). During their visit, the team closely evaluated the ongoing trials & expressed their appreciation for the excellent performance and growth of the crop. Dr. Ashutosh Kumar Mall, In-charge of the RC, Motipur, highlighted the centre's significant contributions, including the development of sugarcane varieties tailored for the North Central Zone.

Institute Management Committee meeting

LIInd Institute Management Committee (IMC) meeting was held at ICAR-ISRI, Lucknow in presence of Dr. R Viswanathan, Director, ICAR-ISRI, Lucknow & Chairman IMC, Shri Abhishek Srivastava, Chief Administrative Officer & Member Secretary, and all IMC members. Chairman IMC presented an overview and brief presentation of various research accomplishments of ISRI as well as other activities of the Institute. Member Secretary, IMC presented the financial statement of the Institute & staff position of the Institute. He also apprised the committee regarding efforts of the Institute for filling up the posts of various cadres by DR/ Transfer/ Deputation/ Promotion etc.

CHAPTER 18

Participation in Seminar / Conference / Group Meet / Workshop

Name	Program	Organized by	Date
Dr. K Srinivas	Winter school training for 21 days on Recent Advances in molecular diagnostics of insect species including invasive and *their natural enemies*	ICAR-NBAIR, Bangalore.	18th January - 07th February, 2024
Dr. R. Viswanathan Dr. AK Mall	3rd International Conference & Exhibition on Sustainability: Challenges & Opportunities in Global Sugar Industry	VSI, Pune	12th-14th January, 2024
Dr(s). Dinesh Singh Sanjeev Kumar	Zonal Breeders and Plant Protection Scientists Meet-2024	Online Mode	19th January, 2024
Dr. AK Singh	38th Workshop of AICRP on Farm Implements & Machinery (FIM)	IGKV, Raipur	20th- 23rd January, 2024
Dr Sanjeev Kumar	'Research Advisory Committee' of U.P. Council of Sugarcane Research.	UPCSR, Shahjahanpur, Uttar Pradesh	27th- 28th January, 2024
Dr(s). Rajeev Kumar & Indu	Winter school training for 21 days on Climate Smart Sugarcane Agriculture for Food and Energy Security in India	SBI, Coimbatore.	31st January – 18th March 2024
All Scientists of the Institute	National Conference on Plant Health for Food Security: Threats and Promises	ICAR-Indian Institute of Sugarcane Research, Lucknow, UP.	01st - 03rd February 2024
Dr. SI Anwar	SOLARIS-2024	Bag Energy Research Society and Bers Public School, Ballia, U.P.	07th- 09th February, 2024
Dr. Lalan Sharma	Celebrating life and work of Eminent Scientist Prof. M. S. Swaminathan on being conferred "*Bharat Ratna*"	(Virtual mode) ICAR-ISRI, Lucknow	13th February, 2024
All Scientists of the Institute	Sensitizing Workshop on innovations, access and benefit sharing in Intellectual property rights & Technology commercialization	ISRI, Lucknow & CSTUP, Lucknow	19th February, 2024.
Dr. Sanjeev Kumar	Meeting on 'Seed Cane and Sugarcane Varietal Release Sub - Committee for Uttar Pradesh' (SVRC)	Cane Commissioner office, Government of UP, Lucknow on	20th Feb., 2024

Name	Program	Organized by	Date
Dr. Sanjeev Kumar (Plant Breeder)	Planting of sugarcane varietal trial at the sugar mills farm	DSCL, Rupapur, Hardoi	22nd Feb., 2024
Dr(s). S S Hasan & Rajesh U Modi	ITU/FAO Workshop on Cultivating tomorrow: Advancing digital agriculture through IoT and AI	FAO & International Telecommunication Union	18th -19th March, 2024
Dr. Rajesh U Modi	Workshop on Digital Agriculture	ICAR, New Delhi	20th March, 2024
Dr Y E Thorat	One-day workshop on 'mechanical, biological, and chemical control of sugarcane insect pests'	VSI, Pune	23rd March 2024
All scientists of the Institute	One day workshop on Promotion of climate resilient crops/varieties/seed under mission LIFE (lifestyle for environment),	ICAR-IISR, Lucknow	26th April, 2024
Dr. K Srinivas	Training on Enhancing Pedagogical Competencies for Agricultural Education for 5 days	National Academy of Agricultural Sciences (NAAS), New Delhi.	29th April- 3rd May 2024
All Scientists of the Institute	4th Virtual Interaction Meeting on ARMS 2.0 (Online)	ICAR-IASRI, New Delhi	01st May, 2024.
All Scientists of the Institute	Meetings with Hon'ble DG, ICAR on Viksit Bharat	Online	01st - 02nd May, 2024.
Dr. Aalok Shiv	39th Annual Group Meeting of AICRP-Seed (Crops)	UAS, Bengaluru	02nd -03rd May, 2024
All Scientists of the Institute	Meeting with Hon'ble DG, ICAR on Ecoregional Programmes	Online	10th May, 2024.
Dr. Sanjeev Kumar (Plant Breeder)	Meeting with Governing Body of UPCSR, Shahjahanpur	Cane Commissioner Office, Government of Uttar Pradesh,	09th June, 2024
Dr(s). SK Goswami Lalan Sharma	National conference on Expanding the horizons of microbial research in agriculture	ICAR-NBAIM, Mau	10th- 11th June, 2024
Dr. Y E Thorat	Training program on adsali sugarcane yield 110 t/acre planation	RAMETI, Nasik (Govt. of Maharashtra)	27th to 28th June 2024
Dr. Dinesh Singh	National symposium on Climate smart disease management for sustainable plant health (CSDM 2024)	BAU, Sabour, Bhagalpur, Bihar.	10th- 12th July, 2024
All staff of the institute	96th ICAR Foundation and Technology Day program	Online Zoom transmission	16th July, 2024
Dr. M K Singh	82nd Annual Convention & International Sugar Expo 2024	The Sugar Technologists' Association of India	30th- 31st July, 2024
Dr Y E Thorat	Online training programme on Agri entrepreneurship development in plant protection	ICAR-NCIPM, New Delhi and MANAGE, Hyderabad	20th to 23rd August 2024

Name	Program	Organized by	Date
Dr. Indu	International Conference on Current Innovations and Technological Advances in Agriculture and Allied Sciences	Guru Kashi University, Talwandi Sabo (Punjab)	29th-31st August, 2023
Dr. Arun Baitha	Roundtable on Future -Proofing Sugarcane: Strategies for Yield Enhancement and Climate-Smart Agriculture	Govind Sugar Mills Limited, Lakhimpur, U.P.	30th September – 01st October, 2024
Dr. Dinesh Singh	RAC meeting as member of RAC of NRC for Orchid	NRC Orchid, Pakyong, Sikkim, India	03rd- 04th October, 2024
Dr. Dinesh Singh	Foundation Day celebration of NRC for Orchid	NRC Orchid, Pakyong, Sikkim, India	05th October, 2024
Dr. R S Gujjar	10 days Hands-on Training on Genome Editing Technologies in Crops	ICAR-IIRR, Hyderabad	14th -23rd October, 2024
Dr(s). Dinesh Singh, Arun Baitha, S K Yadav, Lalan Sharma . Sanjeev Kumar (Plant Breeder), AK Mall and Indu	35th Biennial Workshop of All India Coordinated Research Project on sugarcane	Punjab Agricultural University, Ludhiana (Punjab)	21st- 22nd October, 2024
Dr(s). Sanjeev Kumar (Plant Breeder), and Dr. Indu	2nd National Genetics Congress - Genetics an d Genomics for a better future	ICAR-IARI, New Delhi	12th-14th November, 2024
Dr. SK Goswami	International Conference (IESIC-2024)	PAU, Ludhiana	12th -15th November, 2024
Dr(s). SI Anwar & Rajesh U Modi	58th Annual Convention of the Indian Society of Agricultural Engineers on Engineering Innovations for Next-gen Digital Agriculture and the International Symposium on Agricultural Engineering Education for Aspiring Youth in Transforming Agriculture	ISAE, New De lhi & VNMKV, Parbhani	12th -14th November, 2024
Dr. Dinesh Singh	27th Meeting of ICAR Regional committee	ICAR- ISRI, Lucknow	14th November, 2024
Dr. SK Goswami	IACRSAEGNS-2024 (Theme-Climate Change)	ICAR-ISRI, Lucknow	18th -19th November, 2024
Dr. Dinesh Singh	22nd Institute Management Committee of NCIPM meeting	ICAR- NCIPM, New Delhi	26th November, 2024
Dr. Chandramani Raj	Training program on Genome Editing -Basic Principles and Practices	ICAR -IARI, New Delhi	02nd- 06th December, 2024
Dr D. N. Borase	Hands on training programme on DNA sequencing using Ion Torrent NGS platform and data analysis	Central NGS facility, ICAR-Central Institute of Fisheries Educations, Mumbai	4th to 11th December 2024

Name	Program	Organized by	Date
Dr. Dinesh Singh	National Symposium on Plant Health Management a sustainable tool in addressing crop diseases under climate resilient Agriculture	UAS, Dharwad, Karnataka.	11th-12th December, 2024
All Scientists of the Institute	Lecture of Dr. Himanshu Pathak, Hon'ble DG ICAR and Secretary DARE on 'Best Practices for Project Formulation	Online	16th December 2024
Dr(s). SS Hasan , Rajesh U Modi	National Conference on Digital Agriculture: Empowering Indian Farming	ICAR, New Delhi, NAAS, New Delhi & ICRISAT, Hyderabad	17th-18th December, 2024

CHAPTER 19

Events Organized

The Mid-Eastern Zonal Chapter of Indian Phytopathological Society, New Delhi

The Mid-Eastern Zonal Chapter of the Indian Phytopathological Society (IPS) encompasses the states of Uttar Pradesh and Uttarakhand. This chapter regularly organizes symposia and meetings to discuss advancements and challenges in plant pathology. A symposium titled "Emerging Tools in Crop Disease Management for Sustainable Agriculture under Changing Climate Scenario" was held on January 31, 2024, at the ICAR-Indian Sugarcane Research Institute in Lucknow, Uttar Pradesh.

Three days National Conference on Plant Health for Food Security: Threats & Promises

ICAR-ISRI, Lucknow organized three days National Conference on Plant Health for Food Security: Threats & Promises in collaboration with Indian Phytpathological Society, New Delhi from Feb 01-03, 2024. The conference was inaugurated in the presence of the Chief Guest Dr. T.R. Sharma, Deputy Director General (Crop Science) ICAR, Guest of Honour Dr. A.N. Mukhopadhyay, Ex- VC, AAU, Jorhat, Guest of Honour Dr. P.K Singh, Agriculture Commissioner, Ministry of Agriculture & Farmers' Welfare, Govt. of India, Guest of Honour Dr. S.C. Dubey, VC, Birsa Agriculture University, Ranchi & President, IPS, Dr. Kajal Kumar Biswas , Secretary, IPS, Dr. R. Viswanathan, Director, ICAR-ISRI, Lucknow & Organizing President, Dr. Dinesh Singh, Project Coordinator (Sugarcane) & Organizing Secretary of National Conference along with more than 600 participants across different states of India

Institute's Foundation Day

ICAR-Indian Sugarcane Research Institute, Lucknow celebrated its 73rd Foundation Day on February 16, 2024 with great fervor and zeal which marked the successful journey of 72 glorious years of sugarcane research since the establishment of the Institute in the year 1952. Sri Prabhu N. Singh, Commissioner Cane and Sugar, Uttar Pradesh was the Chief Guest on this occasion, while Dr Ajit Kumar Shasany, Director, CSIR- NBRI, Lucknow and Dr. Bhaskar Narayan, Director, CSIR-IITR, Lucknow were the Guests of honour. Presiding over the function, Sri Prabhu N. Singh congratulated ISRI for ushering into its 73rd year with outstanding contributions that has culminated in high sugarcane and sugar production and applauded the ISRI partnership with industries for commercialization of the technologies.

One-day awareness workshop on Intellectual Property Rights

The ICAR-Indian Sugarcane Research Institute, Lucknow and Council of Science & Technology, U.P.

jointly organised a one-day awareness workshop on Innovation, Access, and Benefit Sharing in Intellectual Property Rights and Technology Commercialization on February 19th, 2024 in hybrid mode. The workshop was funded by the CST, Govt. of U.P. Prevailing trends in IPR, SWOT analysis of technology commercialization, mitigation of obligatory rules in the field of IP protection regime, terms and conditions of genetic resource exchange, National Biodiversity Authority clearance and, access and benefit sharing mechanism as per the norms of WTO, TRIPS, ICAR IPR and technology commercialization guidelines were discussed with all the stake-holders.

Kisan Mela- Cum - Inauguration of KVK-II

ICAR-ISRI, Lucknow organized a Kisan Mela- Cum - Inauguration of KVK-II and Kisan Gosthi on Doubling of Farmers Income under SCSP at Institute KVK-II at Majhira in Lakhimpur Kheri district of Uttar Pradesh on 28th Feb 2024. Mr Ajay Mishra Taini, Union Minister of State, Home Affairs, Govt of India and the local MP inaugurated the ICAR-IISR KVK Lakhimpur Khiri-II Administrative Building in the presence of Sri Surya Pratap Sahi, Hon'ble Minister of Agriculture (Agriculture, Agri. Education and Research) and Dr. R.K. Singh, ADG (Agril. Extension), ICAR, New Delhi.

Fijian Sugarcane Growers delegation meet

A delegation of Fijian Sugarcane Growers Council visited ICAR-ISRI, Lucknow on 28th & 29th February 2024. The delegation comprised of an 18-member team of Sugarcane Growers from Fiji who have come to India for a customized course at National Sugar Institute, Kanpur under the ITEC (Indian technical and economic cooperation) Programme 2023-24 of Ministry of External affairs, Government of India from 26th Feb to 08th March 2024. The delegation took keen interest in the varietal development programme, integrated farming system model, paired-row planting, bio-control of insect-pests, jaggery making and farm machinery development activities of ISRI. A prolific exchange of ideas took place between Fijian sugarcane growers and ISRI scientists.

All India Seminar on Mechanization of Sugarcane Farming: Operational, Environmental and Policy Constraints

The ICAR-Indian Sugarcane Research Institute (ICAR-ISRI), Lucknow, in collaboration with the Sugar Technologists Association of India (STAI), organized a one-day National Seminar on "Mechanization of Sugarcane Cultivation: Operational, Environmental, and Policy Constraints" on March 7th, 2024, at the Indian Sugarcane Research Institute, Lucknow. Hon'ble Shri Sanjay Singh Gangwar, Minister of State, Department of Sugar Industry and Sugarcane Development, Government of Uttar Pradesh; Guest of Honor Dr. Sushil Solomon, Former Vice Chancellor, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur & Former Director of ICAR-ISRI, Lucknow, and Vice President IAPSIT; Shri V.K. Shukla, Additional Cane Commissioner (Development/Research and Coordination), Sugar Industry and Cane Development Department, Government of Uttar Pradesh, and all the delegates and farmers present on the occasion.

International Women's Day Celebration

The ICAR-Indian Sugarcane Research Institute, Lucknow celebrated International Women's Day on March 8th, 2024 with great enthusiasm and excitement.

At the outset, Dr. R. Viswanathan, Director, Indian Institute of Sugarcane Research, Lucknow welcomed the Chief Guest, Dr. Shalini Singh Visen, Director of the Amity Food and Agriculture Foundation, Amity University, Lucknow and the staff of ISRI. Emphasizing on the theme of International Women's Day 2024 "inspire inclusion", he deliberated upon significant contribution of women in Indian Agriculture system and focused on ensuring equality at workplace by providing equal opportunity for women staff.

PM Kisan Samman Nidhi live telecast program

Hon'ble Dr. P. Chandrashekhar Union Minister of State for Rural Development and Communication, Government of India presided over the live telecast program organized on the occasion of release of 17th instalment of PM Kisan Samman Nidhi on 18th June 2024 at ICAR-Indian Institute of Sugarcane Research, Lucknow. Dr. U. S. Gautam, DDG (Agriculture Extension), ICAR, New Delhi and Smt. Deeparanjan, Director, Rural Livelihood Mission, Gov. of UP were also present. Speaking on the occasion, Chief Guest Dr. P Chandrashekhar informed that the Government of India had launched the PM-Kisan Samman Nidhi Scheme in 2019 for the planned development of farmers. Under this scheme, more than 11 Crore farmers have been paid more than Rs. 3.04 lakh crore so far.

Visit of Dr. Himanshu Pathak, Secretary DARE and DG ICAR

Hon'ble Secretary, DARE, GoI& DG, ICAR, New Delhi Dr. Himanshu Pathak visited ICAR-Indian Sugarcane Research Institute, Lucknow on April 14th, 2024. He laid the foundation stone of Ikshu Hostel at ICAR-ISRI, Lucknow. On this auspicious occasion Dr V B Patel, ADG (Fruits and Plantation Crops); Dr. R Viswanathan, Director, ICAR-ISRI, Lucknow; Dr. T. Damodaran, Director, ICAR-CISH, Lucknow; Dr. Uttam K Sarkar, Director, ICAR-NBFGR, Lucknow; Dr. A.K. Dubey, Head, ICAR-CSSRI RRS, Lucknow and Dr. A.K. Singh, Academic Coordinator, IARI Lucknow hub & Head, Division of Agricultural Engineering, ICAR-ISRI, Lucknow were also present.

Celebration of World Intellectual Property Day

The "World Intellectual Property Day" was celebrated on 25th April, 2024 at ICAR-ISRI, Lucknow on the theme "IP and the SDGs: Building our common future with innovation and creativity". The event was organized by Institute Technology Management Unit (ITMU) for creating awareness programme on IP Management. The guest speaker, Dr. Vikas Bhati, delivered his lecture on "IP filing and Management" and discussed about the role of IP management, assessment of commercial value of IP products on

actual cost value for development of technology, strategically leverage of intellectual property assets within an organization and the role of IP agents/professional in writing the IP application, filing and IP protection in the area of agricultural research.

One Day workshop on "Promotion of Climate Resilient crops/ varieties/ seeds' under Mission LiFE (Lifestyle for Environment)

The ICAR-Indian Sugarcane Research Institute, Lucknow in association with NAAS- Lucknow Chapter, organized one day workshop on "Promotion of climate resilient crops/ varieties/ seeds" under Mission LiFE (Lifestyle for Environment) programme aligned with the theme of World Environment Day 2024, "Land restoration, Desertification and Drought Resilience" on 26th April 2024. The importance of conserving our precious natural resources and living in harmony with nature were the main focus of the workshop. Biodiversity conservation efforts, both at the individual and community level (through green clubs and volunteer groups, for instance), are essential enablers of healthy lifestyles. Various activities are related to climate change, environmental consequences, sustainable lifestyle and simple yet effective environment-friendly actions in our daily lives. All the scientists, research associates, young professionals of IISR, Lucknow and more than 50 students from Amity University, Integral University, Babasaheb Bhimrao Ambedkar University , SRM University, IT College, and SR Institute of Management and Technology, Lucknow participated in the event.

An interaction meet on Climate Change

An interaction meeting of all the Scientists of the institute was held with Dr. B. Venkateswarlu Dr. B. Venkateswarlu, National Member, NAHEP External Advisory Panel, Ex. Director, ICAR-CRIDA, Hyderabad and Former VC, Vasant Rao NaikMarathwadaKrishiVidyaPeeth, Parbhani visited ICAR- ISRI, Lucknow on 14th June 2024. He addressed the burning problem of climate change, its impact on agriculture vis-à-vis entire humankind and the key-points to mitigate the effect of climate change. His address was followed by a hearty discussion on inculcating climate resilience in sugarcane crop.

Visit of Management trainees from DCM SHRIRAM

The newly appointed Management trainees and CSR lead from DCM Shriram Ltd., Sugar & Distillery Unit - Hariawan, District Hardoi visited ICAR- ISRI, Lucknow on 23rd July, 2024. Dr. R. Viswanathan, Director, ICAR-ISRI, Lucknow gave a brief overview of Institute's mandate, goals and achievements vis-a-vis ongoing research activities. He expatiated about the future activities of the Institute encompassing conventional and cutting-edge technological interventions to improve the cane productivity and sugar recovery. The trainees took keen interest in knowing about scientific sugarcane cultivation, agronomical practices and mechanization.

Plantation Drive event "*Ek Ped Maa Ke Naam*"

Plantation Drive event "*Ek Ped Maa Ke Naam*" was organized by the NSS wing of IARI Mega University Lucknow Hub on August 15th and 29th 2024. Director

Dr. R. Viswanathan, all the HoDs, Academic Coordinators and students planted trees in front of guest house of the Institute and the boy's hostel in the *Ikshupuri* Colony.

Parthenium Awareness Week

Parthenium Awareness Week was successfully organized from August 16th-22nd, 2024, engaging all staff members, students and residents in a comprehensive initiative led by the Crop Production Division. The week long activities focused on the identification, uprooting and control of Parthenium weed, followed by an informative lecture on the subject. This collaborative effort aimed to enhance understanding and effective management practices for combating the invasive species.

A Farmer Seminar and Distribution Program under the Scheduled Caste Sub-Plan

Under the Scheduled Caste Sub-Plan (SCSP), a Farmer Seminar and Distribution Program for Improved Seeds, Fruit Plants, and Agricultural Equipment was organized at ICAR-ISRI, Lucknow, on October 9th, 2024. Around 100 farmers from Gosaiganj and Mohanlalganj blocks of Lucknow district participated in the program. Beneficiary farmers were provided with high-yielding wheat and mustard seeds, fruit plants such as mango, guava, jamun, bael, and 10-liter sprayers.

Vigilance Awareness Week

Vigilance Awareness Week was held at ICAR-ISRI, Lucknow from October 28th, 2024, to November 3rd, 2024, under the theme "Culture of Integrity for Nation's Prosperity." All employees of the institute, along with those at the regional centers in Motipur (Bihar), Pravaranagar (Maharashtra) and Krishi Vigyan Kendra (Lucknow & Lakhimpur Kheri), took the Integrity and Honesty Pledge on October 28th. Various competitions such as debate, quiz, slogan writing, rangoli, painting, walkathon etc. were organized on this occasion, in which all the employees participated enthusiastically. Apart from this, Gram Sabha Chaupal and meeting with farmers etc. were also successfully organized by regional centers and KVK for creating awareness among farmers.

Visit of NABARD team to ISRI

A team from NABARD, Lucknow led by Dr. M.S. Rao, Chief General Manager (CGM) and Principal, National Bank Staff College (NBSC), NABARD along with Dr. Vadivel Esakkimuthu, Deputy General Manager (DGM) & Faculty Member, NBSC and some scientists visited ICAR-ISRI, Lucknow on 6th November, 2024. A prolific exchange of ideas took place between the NABARD team and ISRI scientists. The main focus areas identified for future collaboration were inclusion of Sugar beet as a potential Feed-stock for biofuel production, Carbon sequestration through sugarcane cultivation in view of India's Net Zero initiative, to reduce water-logging through underground drainage system, improvement of irrigation efficiency and launching projects in PPP mode with sugar factories as partners.

Training on Wheat Production Technology Cum Input Distribution to SC farmers under SCSP

A training on Wheat Production Technology Cum Input Distribution to SC farmers under SCSP Programme was conducted at KVK, Pilkhi, Mau on 12th November 2024. The lectures related to intercropping with sugarcane and others aspects of production scenario of Sugarcane under eastern UP were delivered by the ISRI scientists including wheat and

pea production technology. About 100 SC farmers participated in this training programme. Seed material of Wheat and chick pea along with training kits along with a successful training completion certificate were distributed to each participating SC farmer.

An International Conference (IACRSAEGNS-2024) organized

1st International Conference on "Innovations to Achieve Climate Resilient Smart Agriculture for Ensuring Global Food and Nutritional Security (IACRSAEGNS-2024) (Theme-Climate Change)" jointly organized by Indian Institute of Sugarcane Research, Lucknow, (Uttar Pradesh), India; and Agriculture, Environment, Entrepreneur, and Technology Development Society (AEETDS), Lucknow (U.P.), India at ISRI Auditorium on November, 18th-19th, 2024.

Five days training for Officials of Govt. of Odisha

A five-member team from the Department of Agriculture and Farmers Empowerment, Govt. of Odisha, visited from December 4th-8th, 2024, to learn about sugarcane production technologies, processing, and value addition for Odisha conditions. The visit included expert lectures and exposure to sugarcane cultivation practices, crop protection, mechanization, and value-added products like jaggery. The team also visited various facilities and interacted with farmers at ISRI-KVK II, NDUAT-KVK, and K.M. Sugar Mill.

One day training and seed distribution programme under SCSP

An integrated insect pests and diseases management training programme in wheat, mustard and chickpea crops was conducted under SCSP scheme on 05th December, 2024 at ICAR-ISRI, Lucknow. A total of 50 farmers including men and women were present in the programme from Dubagga and Gosainganj (Lucknow). The lectures on "Integrated Disease Management (IDM) in wheat and chickpea", "Insect-pests management in wheat and chickpea" and "Management of diseases in sugarcane for doubling farmer's income" were delivered by ISRI Scientists. Seed of wheat, chick pea, mustard and vegetables along with training kits were distributed to fifty SC farmers.

As part of *Swachchhata Pakhwara and Kisan Diwas* celebrations, a "**Green Drive**" for plantation of saplings was organized on December 20th, 2024, involving all the staff members to promote environmental sustainability and cleanliness. In a campaign for eliminating single-use plastics, water conservation and bringing awareness, the relevant information was distributed/circulated among the residents of Ikshupuri, ICAR-ISRI, Lucknow.

Hindi Pakhwada

हिंदी पखवाड़ा समारोह (दिनांक 14 सितम्बर से 30 सितम्बर, 2024) :

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ में हिंदी पखवाड़ा (14–30 सितंबर, 2024) का आयोजन किया गया। आयोजित प्रतियोगिताओं में संस्थान के लगभग 150–170 कर्मिकों ने भाग लिया। पखवाड़ा के दौरान दिनांक 26.09.2024 को "राजभाषा हिंदी के 75 वर्ष" विषय पर प्रो. पवन अग्रवाल, लखनऊ विश्वविद्यालय, लखनऊ द्वारा एक व्याख्यान दिया गया। दिनाँक 30 सितम्बर, 2024 को समापन कार्यक्रम का आयोजन किया गया। समापन कार्यक्रम के मुख्य अध्यक्ष डॉ एस. पी. दीक्षित, पूर्व विभागाध्यक्ष, हिंदी विभाग, लखनऊ विश्वविद्यालय ने "राजभाषा का भविष्य" विषय पर अपना व्याख्यान दिया तथा फिजी में आयोजित बारहवें विश्व हिंदी सम्मेलन में हुए सुझावों पर चर्चा की। हिंदी पखवाड़ा के दौरान आयोजित विभिन्न प्रतियोगिताओं जैसे– यूनिकोड में हिंदी टंकण, निबंध प्रतियोगिता, अंत्याक्षरी प्रतियोगिता, हिंदी के सामान्य ज्ञान पर आधारित प्रश्नोत्तरी, हिंदी में स्वरचित कविता पाठ, भाषण प्रतियोगिता, टिप्पणी एवं परिपत्र, वर्ष भर में किए गए हिंदी कार्य की समीक्षा एवं पूरे वर्ष के दौरान हिंदी में उत्कृष्ट कार्य करने के लिए विभागों एवं कृषि विज्ञान केंद्र एवं हिंदी कार्यशाला इत्यादि के विजयी प्रतिभागियों को आयोजित समारोह में पुरस्कृत किया गया।

संस्थान में हिंदी कार्यशाला का आयोजन :

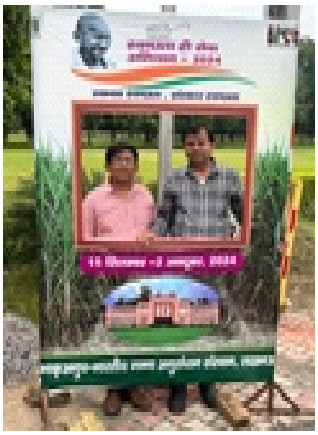
- दिनांक 27 जून 2024 को कार्यशाला का आयोजन किया गया जिसमें संस्थान के 37 कार्मिकों ने भाग लिया।
- दिनांक 26 सितम्बर 2024 को कार्यशाला का आयोजन किया गया जिसमें संस्थान के 39 कार्मिकों ने भाग लिया।
- दिनांक 30 दिसम्बर, 2024 को कार्यशाला का आयोजन किया गया जिसमें संस्थान के 39 कार्मिकों ने भाग लिया।

नराकास (कार्यालय–3) की बैठक :

- 25 जून, 2024 को नगर राजभाषा कार्यान्वयन समिति की बैठक का आयोजन किया गया जिसमें नराकास कार्यालय –3 के कार्यालय प्रमुखों एवं राजभाषा विभाग से श्री अजय कुमार चौधरी, सहायक निदेशक (कार्यान्वयन), राजभाषा विभाग, गृह मंत्रालय, गाजियाबाद ने भाग लिया। इसमें 11 कार्यालयों को हिंदी में उत्कृष्ट कार्य करने हेतु एवं 03 कार्यालयों को राजभाषा पत्रिका हेतु पुरस्कृत किया गया।
- 28 नवम्बर, 2024 को नगर राजभाषा कार्यान्वयन समिति की बैठक का आयोजन किया गया जिसमें नराकास कार्यालय –3 के कार्यालय प्रमुखों एवं हिंदी अधिकारियों ने भाग लिया। इसमें 10 कार्यालयों को हिंदी में उत्कृष्ट कार्य करने हेतु एवं 03 कार्यालयों को राजभाषा पत्रिका हेतु पुरस्कृत किया गया।

Swachhata Hi Seva Campaign (17 Sept. - 02 Oct., 2024)

Under Swachhata Hi Seva Campaign banners selfiee points, standees for SHS 2024 reflecting theme of 'Swabhav Swachhata, Sanskaar Swachhata displaed, swachhata pledge administered to ICAR-IISR, Lucknow staff and students of GNS, University Rohtas, Bihar, organised swachhata run, painting and poster competitions /slogan writing' activities were organised at Mavericks Jr. School, Bangla Bazar, Lucknow, the children were also taught about cleanliness, sanitation, and hygiene practices, Nukkad Natak on swachhata played at Gomti River Front, Gomtinagar, Lucknow to senitize the people about cliniliness and health benefits of cliniliness, farmers of Gonda and Amethi districts as well as sanitation workers were made aware about the sugarcane trash & other agricultural waste management for creating wealth. They were also made aware about the artistic use of waste materials, human chain activity carried out, mega cleanness drive organised in and around the office building premise, as well as religious & spiritual places, dirty spots were identified and cleaning activities in nearest Railway Station & ICAR-IISR, Lucknow were done, preventive Health Checkup Camp for sanitation workers was organised at ICAR-IISR, Lucknow, PPE kits & safety gears were given to safeguard the sanitation workers, a programme was organised for sanitation workers and their family members under Safai Mitra Samman/Talent Showcase, storytelling sessions activity and on 02nd Oct., 2024 Swatch Bharat Diwas was celebrated.



Special Swachhata Campaign 4.0 (2nd – 31st October 2024)

During the Special Swachhata Campaign 4.0, ICAR-ISRI, Lucknow actively resolved all 78 pending references along with 17 new references from the state government. A total of 27 physical files were reviewed, with 4 files transferred to the National Archives of India (NAI) and 23 weeded out. Additionally, 1544 e-files were closed. Two outdoor cleanliness campaigns were organized, and 25 sites were cleaned. Infrastructure improvements included vacating a 200 sq. ft. room in the Extension and Training Building, now repurposed for storing Audit and Accounts records, and clearing 450 sq. ft. in the Administrative Building, which will serve as the new Directors' Committee Room.

Swachhata Pakhwara (16th –31st December 2024)

Swachhata Pakhwara was observed from 16th to 31st December 2024 with a wide range of cleanliness and awareness activities. Banners and a Swachhata-themed selfie booth were displayed, and a pledge was taken by office staff. Over 800 school students and 10 teachers participated in educational visits where they learned about converting agricultural waste, like sugarcane residue, into valuable products. Educational materials were uploaded on the Institute's website, and awareness lectures were delivered to trainee officers of the Bihar Cane Department. Office and lab premises were cleaned, old materials and damaged structures were removed, and a plantation drive was carried out to enhance greenery. Community outreach included Shramdaan in primary schools, campaigns in villages adopted under the "Doubling Farmers' Income" project, and awareness drives in multiple colonies involving farmers, youth, and local celebrities. National Farmers' Day was celebrated with exhibitions and awards to progressive

farmers. Swachhata awareness activities were conducted in schools and public areas, including campaigns on water harvesting, recycling, and reducing plastic use. A Swachhata Run was also organized. Eminent personalities, including Ex-MLA Shri Dhananjay Kanaujia and Prof. Y.P. Singh, addressed gatherings to emphasize the importance of cleanliness. The event concluded with a press conference promoting Swachhata.

Training program on 'Identification and Management of Major Sugarcane Borers'

In the framework of the Scheduled Cast Sub Plan, ICAR-ISRI- Biological Control Center, Pravaranagar organized a one-day farmer training program on 'Identification and Management of Major Sugarcane Borers' at Krishi Vigyan farm, Bhenda, Newasa in Ahmednagar district. A total of 100 (Male-93 and Female 07) SC farmers were selected from the command area of Loknete Marutrao Ghule Patil Cooperative Sugar Factory, Ltd. Newasa for participation in this training program. The chairman of the sugar factory Hon. Dr. Narendraji Ghule Patil chaired the programme. The battery-operated knapsack sprayer along with training kits were distributed to the beneficiary farmers. Dr. Yogesh E. Thorat, the Scientist, delivered a talk on 'Identification and Management of Major Sugarcane Borers' with an emphasis on the use of bioagents for pest management in sugarcane at the farmer gathering. The dignitaries on the dais published the Marathi folder on the same subject.

CHAPTER 20

Distinguished Visitors

Sl. No.	Name and address of the visitors	Date of visit
1.	Dr. Bakshi Ram, 'Padma Shri' and Former Director, ICAR-SBI, Coimbatore.	Jan 05th, 2024
1.	Dr. T.R. Sharma, Deputy Director General (Crop Science), ICAR, New Delhi	Feb 01st, 2024
2.	Dr. A.N. Mukhopadhyay, Ex- VC, AAU, Jorhat, Guest of Honour	Feb 01st, 2024
3.	Dr. P.K. Singh, Agriculture Commissioner, Ministry of Agriculture & Farmers' Welfare, Govt. of India,	Feb 01st, 2024
4.	Dr. S.C. Dubey, Vice Chancellor, Birsa Agricultural University, Ranchi	Feb 01st, 2024
5.	Dr. J. S. Sandhu, former Deputy Director General (Crop Science), ICAR, New Delhi and former VC, SKNAU, Jobner, Rajasthan	Feb 03rd, 2024
6.	Sri Prabhu N. Singh, Commissioner Cane and Sugar, Uttar Pradesh	Feb 16th, 2024
7.	Dr Ajit Kumar Shasany, Director, CSIR- NBRI, Lucknow	Feb 16th, 2024
8.	Dr. Bhaskar Narayan, Director, CSIR-IITR, Lucknow	Feb 16th, 2024
9.	Dr. J.P. Mishra, Ex-ADG (IPR), ICAR, New Delhi and Honorary IP Expert, GBPUA&T, Pantnagar, US Nagar (U.K.),	Feb 19th, 2024
10.	Shri Sanjay Singh Gangwar, Honb'le Minister of State, Department of Sugar Industry and Sugarcane Development, Government of Uttar Pradesh	March 07th, 2024
11.	Dr. Sushil Solomon, Former Vice Chancellor, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur & Former Director of ICAR-ISRI, Lucknow	March 07th, 2024
12.	Shri V.K. Shukla, Additional Cane Commissioner (Development/Research and Coordination), Sugar Industry and Cane Development Department, Government of Uttar Pradesh,	March 07th, 2024
13.	Dr. Shalini Singh Visen, Director of the Amity Food and Agriculture Foundation, Amity University, Lucknow	March 08th, 2024
14.	Dr. P. Chandrashekhar, Hon'ble Union Minister of State for Rural Development and Communication, Government of India	June 18th, 2024
15.	Dr. Himanshu Pathak, Hon'ble Secretary, DARE, GoI & DG, ICAR, New Delhi	April 14th, 2024
16.	Dr V. B. Patel, ADG (Fruits and Plantation Crops),	April 14th, 2024
17.	Dr. B. Venkateswarlu , National Member, NAHEP External Advisory Panel, Ex. Director, ICAR -CRIDA, Hyderabad and Former VC, Vasant Rao Naik Marathwada Krishi VidyaPeeth, Parbhani	June 14th, 2024
18.	Dr. M.S. Rao, Chief General Manager (CGM) and Principal, National Bank Staff College (NBSC), NABARD	November 6th, 2024
19.	Dr. Vadivel Esakkimuthu, Deputy General Manager (DGM), National Bank Staff College (NBSC), NABARD	November 6th, 2024

CHAPTER 21

Personnel

(As on December 31, 2024)

Dr. Rasappa Viswanathan	Director
Division of Crop Improvement	
Scientist	
Dr. Sanjeev Kumar	Principal Scientist (Plant Breeding) & Head
Dr. Sangeeta Srivastava	Principal Scientist (Genetic & Cytogenetics)
Dr. Swapna M	Principal Scientist (Genetics)
Dr. Sanjeev Kumar	Principal Scientist (Agriculture Biotech)
Dr. Ashutosh Kumar Mall	Principal Scientist (Genetics & Plant Breeding)
Dr. Ranjit Singh Gujjar	Senior Scientist (Agriculture Biotech)
Dr. Indu	Scientist (Genetics & Plant Breeding)
Dr. Aalok Shiv	Scientist (Genetics & Plant Breeding)
Dr. N Krishna Kumar Rathod	Scientist (Genetics & Plant Breeding)
Technical	
Mr. Ajeet Pratap Singh	Assistant Chief Technical Officer
Dr. Ram Kishor	Assistant Chief Technical Officer
Mr. Anil Kumar Maurya	Technical Officer
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. Chandra Gupta	Principal Scientist (Agronomy)
Dr. Barsati Lal	Principal Scientist (Agriculture Extension)
Dr. Kamta Prasad	Principal Scientist (Agriculture Extension)
Dr. Manoj Kumar Tripathi	Principal Scientist (Agronomy)
Dr. Shiv Ram Singh	Principal Scientist (Agronomy)
Dr. Vinay Kumar Singh	Principal Scientist (Agronomy)
Dr. Ram Ratan Verma	Principal Scientist (Soil Science)
Dr. Aditya Prakash Dwivedi	Principal Scientist (Agronomy)
Dr. Vijai Prakash Jaiswal	Senior Scientist (Agronomy)
Dr. Dileep Kumar	Scientist (Agronomy)

Technical	
Dr. Om Prakash Yadav	Chief Technical Officer
Dr. Gaya Karan Singh	Chief Technical Officer
Dr. Ram Khilari Singh	Assistant Chief Technical Officer
Mr. Sanjay Gautam	Senior Technical Officer
Division of Crop Protection	
Scientist	
Dr. Dinesh Singh	Principal Scientist (Plant Pathology) & Head
Dr. Arun Baitha	Principal Scientist (Agriculture 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 (Agriculture Entomology)
Technical	
Mr. Dushyant Kumar	Technical Officer
Division of Plant Physiology & Biochemistry	
Scientist	
Dr. Manoj Kumar Srivastava	Principal Scientist (Biochemistry/Plant Science) & Head
Dr. Pushpa Singh	Principal Scientist (Organic Chemistry)
Dr. Radha Jain	Principal Scientist (Plant Physiology)
Dr. Surendra Pratap Singh	Principal Scientist (Plant Physiology)
Dr. Rajeev Kumar	Scientist (Biochemistry)
Technical	
Mr. K.K. Suman	Chief Technical Officer
Mr. Rajendra Kumar Singh	Technical Officer
Division of Agricultural Engineering	
Scientist	
Dr. Akhilesh Kumar Singh	Principal Scientist (FMP) & Head
Dr. Saiyed Irfan Anwar	Principal Scientist (FMP)
Dr. Dilip Kumar	Principal Scientist (AS& PE)
Dr. Mrityunjai Kumar Singh	Principal Scientist (FMP)
Dr. Rajesh U Modi	Scientist (FMP)
Technical	
Er. Mahmoodul Hasan Ansari	Chief Technical Officer
Mrs. Mithilesh Tiwari	Chief Technical Officer

Dr. Veenika Singh	Chief Technical Officer
Mr. Rajiv Ranjan Rai	Chief Technical Officer
Mr. Chaman Singh	Technical Officer
PME Cell	
Scientist	
Dr. Sangeeta Srivastava	Principal Scientist & Incharge
Dr. Swapna M	Principal Scientist (Genetics)
Technical	
Dr. Anita Sawnani	Chief Technical Officer
Mr. Abhay Kumar Srivastava	Technical Officer
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	
Shri. Atul Kumar Sachan	Chief Technical Officer
Rajbhasha	
Dr. Manoj Kumar Tripathi	Principal Scientist (Agronomy) & Incharge
Technical	
Mr. Abhishek Kumar Singh	Assistant Chief Technical Officer
Juice Quality Lab	
Scientist	
Dr. V. P. Singh	Principal Scientist (Agronomy) & Incharge
Technical	
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
SWPAM Lab	
Scientist	
Dr. V. P. Singh	Principal Scientist (Agronomy) & Incharge
Technical	
Mrs. Asha Gaur	Chief Technical Officer

HRD Cell	
Dr. Sangeeta Srivastava	Nodal Officer
Dr. Rahul Kumar Tiwari	Co-Nodal Officer
AICRP on Sugarcane	
Dr. Dinesh Singh	Project Coordinator (Sugarcane)
Dr. Sanjay Kumar Yadav	Senior Scientist (Agronomy)
Dr. Lalan Sharma	Senior Scientist (Plant Pathology)
Krishi Vigyan Kendra (KVK), Lucknow	
Dr. Akhilesh Kumar Dubey	Senior Scientist & Head
Krishi Vigyan Kendra (KVK), Lakhimpur Kheri	
Dr. Rakesh Kumar Singh	Senior Scientist & Head
Art & Photography	
Dr. Sangeeta Srivastava	Principal Scientist & Incharge
Technical	
Mr. Yogesh Mohan Singh	Chief Technical Officer
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
Dispensary	
Dr. Sanjay Kumar Goswami	Senior Scientist & Incharge
Landscaping	
Dr. Pushpa Singh	Principal Scientist & Incharge
Mr. Rajiv Ranjan Rai	Chief Technical Officer
Regional Station, Motipur (Bihar)	
Scientist	
Dr. Ashutosh Kumar Mall	Principal Scientist & Incharge

Technical	
Mr. Bikarama Dutt Singh	Assistant Chief Technical Officer
ISRI Biological Control Center, Pravaranagar (Maharashtra)	
Scientist	
Dr. Dnyaneshwar Namdeo Borase	Scientist Senior Scale (Microbiology) & Incharge
Dr. Yogesh Ekanathrao Thorat	Scientist Senior Scale (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 Officer
Mrs. Mamta Chakraborty	Principal Private Secretary
Mr. Prem Chand	Principal Private Secretary
Mr. Ajay Kumar Tandon	Finance & Account Officer
Mr. Manish Kumar	Administrative Officer
Mr. Ganesh Singh	Asst. Administrative Officer
Mr. Prashant Kamal Srivastava	Asst. Administrative Officer
Mr. Hem Chandra Pandey	Asst. Administrative Officer
Mr. Nag Chand Chauhan	Asst. Administrative Officer
Mrs. Rashmi Sanjay Srivastava	Private Secretary
Mrs. Veena Sharma	Personal Assistant

Appointment / New Joining		
Name of Official	**Designation**	**Date of joining**
Mr. Manish Kumar	Administrative Officer	22-04-2024
Mr. Vivek Kumar	Assistant	30-08-2024
Mr. Prashant Singh	Assistant	14-11-2024
Mr. Amit Kumar	Assistant	24-09-2024
Mr. Raghvendra Pratap Singh	Technician (T-1)	19.04.24
Mr. Vikram Saroj	Technician (T-1)	19.04.24
Mr. Virendra Kumar Patel	Technician (T-1)	19.04.24
Mr. Alok Bind	Technician (T-1)	22.04.24
Mr. Ankit Kumar Gautam	Technician (T-1)	22.04.24
Mr. Jais Ahmad	Technician (T-1)	22.04.24
Mr. Maneesh Kumar	Technician (T-1)	22.04.24
Mr. Sub ham Kumar	Technician (T-1)	22.04.24
Mr. Sachin Kumar	Technician (T-1)	23.04.24
Mr. Dileep Kumar Bind	Technician (T-1)	23.04.24

Mr. Pankaj Patel	Technician (T-1)	25.04.24
Mr. Vivek Kumar	Technician (T-1)	25.04.24
Mr. Krishna Kumar Verma	Technician (T-1)	25.04.24
Mr. Ankur Kumar Yadav	Technician (T-1)	25.04.24
Mr. Neeraj Kumar Singh	Technician (T-1)	26.04.24
Mr. Ajay Kumar Bharti	Technician (T-1)	26.04.24
Mr. ShaileMr. Kumar	Technician (T-1)	26.04.24
Mr. Ranu Verma	Technician (T-1)	29.04.24
Mr. A jay Kumar Sahu	Technician (T-1)	30.04.24
Mr. Rahul Kumar	Technician (T-1)	01.05.24
Mr. Himashu Raj	Technician (T-1)	06.05.24
Mr. Sujeet Kumar	Technician (T-1)	08.05.24
Mr. Amit Kumar	Technician (T-1)	08.05.24
Mr. Mithilesh Kumar	Technician (T-1)	27. 06.24

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. Sukhbir Singh	ICAR-ISRI, Lucknow	ICAR-CIAE, Bhopal	14.02.2024
R.B. Verma	Administrative Officer	Transferred from ATARI, Kanpur	21-05-2024
Reeta	Technical Assistant	Transferred from ICAR-NIPB, New Delhi	10-06-2024
Jai Prakash Verma	T-4	Transferred from ICAR- NRC Litchi	14-06-2024
Kamal Kumar Suman	T-6	Transferred from ICAR-NRRI Cuttuck	24-06-2024
Rai Ajay Kumar	SMS	Transferred from KVK Kushinagar	28-06-2024
Saryu Prasad	Sr. Tech. Assistant	Transferred from ICAR-CIAE Bhopal	28-06-2024
Pillu Meena	T-3	Transferred from ICAR- CSWRI Avikanagar	23-07-2024
Soni Devi	T-3	Transferred from ICAR-IARI, New Delhi	11-12-2024
Shatrughan Verma	LDC	Transferred from ICAR-NRC on Mithun	16-12-2024

Superannuation

Name of official	Designation	Date of retirement
Dr. Rajendra Gupta	Pr. Scientist	31-01-2024
Mrs. Chaman Ara Siddiqui	Assistant	31-01-2024
Mr. Ajay Prakash	Senior Technician (T-2)	31-01-2024
Dr. Niranjan Lal	Sr. Scientist	28-02-2024
Mr. Ghan Shyam Ram	CTO	28-02-2024
Dr. M.R. Singh	Pr. Scientist	31-03-2024
Mr. Rajeev Arora	P.P.S.	31-03-2024
Dr. A.K. Sharma	Pr. Scientist	30-04-2024
Dr. Sharmila Roy	Pr. Scientist	30-06-2024
Dr. R.D. Singh	Pr. Scientist	31-07-2024
Mr. Adil Zubair	CTO	31-08-2024
Mrs. Promila Lal	CTO	31-10-2024

CHAPTER 22

Meteorological Data

Important weather parameters during **January - December 2024** at ICAR-ISRI, Lucknow are given below:

Month& Year (2024)	Temperature (°C)		Relative Humidity (%) at		Rainfall (mm)	Rainy days (No.)	Bright sunshine (hrs/day)	Evaporation (mm/day)	Wind speed (km/hr)
	Maximum	Minimum	7:18 AM	2:18 PM					
January	17.8	7.9	95.0	66.1	12.8	1	2.7	0.8	1.9
February	25.3	10.5	89.9	39.8	17.0	2	6.4	2.7	3.0
March	30.7	14.7	35.4	33.5	16.4	2	8.2	4.4	3.2
April	38.8	21.4	48.9	16.6	0.0	0	9.0	9.5	5.7
May	39.9	25.4	57.4	29.3	0.2	0	8.9	7.6	3.1
June	41.4	29.3	59.9	34.8	81.0	4	7.5	8.8	4.5
July	34.4	28.5	85.3	69.9	129.8	8	5.2	3.5	1.9
August	33.0	26.7	92.9	76.0	375.8	17	4.6	3.0	1.8
September	33.1	26.0	93.0	73.6	188.0	13	5.5	2.8	2.6
October	34.0	22.7	91.4	49.2	1.2	0	7.5	3.0	1.6
November	30.1	14.3	95.2	39.0	0.0	0	5.4	2.1	1.2
December	24.8	8.7	92.5	42.2	2.4	0	6.3	1.7	1.7

Total Rain (mm) = 824.6

Notes

Notes

Notes