ANNUAL REPORT 2022

भा.कृ.अनु.प.-केन्द्रीय कपास अनुसंधान संस्थान, नागपुर

ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR

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ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR

ANNUAL REPORT 2022

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ICAR-Central Institute for Cotton Research, Nagpur

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PREFACE

Buoyed by the unprecedented higher cotton sale prices realized due to lower supply in the previous season, acreage under cotton registered a 6% hike in area to 130.49 lakh hectares during 2022-23 season cultivated across 11 major cotton growing states in the country. The crop experienced a mixed response across the states in different cotton growing zones due to prevailing weather (rainfall) and pest incidence. While in south, crop sowings were delayed in some pockets in Andhra Pradesh due to low rainfall, the crop experienced damage due to excess rainfall later in the season across Telangana and Maharashtra. Cotton in the north zone especially in Punjab and Haryana experienced severe dry weather conditions that triggered whitefly incidence which was more than the economic threshold level (ETL) for nearly 10 weeks during July/August. The dreaded pink bollworm pest damage was perceptibly lower across the country. Tobacco streak virus disease incidence was noticed in affected pockets in AP, Karnataka and Tamil Nadu states. Overall, the crop in 2022-23 season was estimated to show a revival in production (by about 8.5%, first advance estimate) compared to the previous season of 2021-22.

During the year, 10 cotton varieties were released and notified. In a first, two naturally colored (brown) cotton varieties of *G. hirsutum viz.*, CICR-H NC Cotton 58 (CNH 17395) and CICR-H NC-Cotton-53 (Vaidehi-1) for south zone states and two desi color cotton varieties CICR-A Cotton 57 (CNA 1091) and CICR-A Cotton 59 (CNA 17522) were released and notified. A medium staple *G. arboreum* variety CICR-A Cotton 56 (CNA1031) was also notified.

Concerted efforts of CICR to breed compact varieties amenable for high density planting system in rainfed conditions got a fillip with the release of a non-Bt CICR-H Cotton 54 (Nano) variety for both central and southern zones and four Bt varieties viz., CICR- H Bt Cotton 60 (Yugank Bt), CICR- H Bt Cotton 61 (Tejas Bt) CICR- H Bt Cotton 62 (Namami Bt) recommended for the states of Central Zone under rainfed conditions while CICR- H Bt Cotton 63 (Samrat Bt) for rainfed conditions of South zone states.

ICAR-CICR, Nagpur has more than 12,336 germplasm accessions covering all the cultivated species including wild species, interspecific derivatives, perennials and land races of *Gossypium*. During the year 1446 germplasm accessions were evaluated and showcased to breeders from SAUs for selection.

Multi-location trials of microbial volatile organic compounds identified as attractants for sucking pests are in progress through AICRP on Cotton for validation. Under NFSM Cotton, CIB R&C approved mating disruption technology in partnership with the technology provider was demonstrated in large clusters in 20 districts across the country for management of pink bollworm menace in cotton. Landscape diagnostic survey of cotton production practices in Maharashtra which has the largest acreage but lowest productivity has been initiated. ICAR-CICR engaged with all cotton stakeholders through interface workshops for technology dissemination and scaling up of best practices and for *"Shat Pratishat Shasaktikaran"* of farmers to commemorate the *Azadi ka Amrit Mahotsav*. ICAR-CICR, Nagpur organized '*Kapas Mela 2022*' on 24 Nov. 2022 to showcase improved cotton technologies and facilitate farmer-scientist interaction.

A notable initiative on addressing low productivity in cotton in consultation with the textile industry partners under the aegis of the Textile Advisory Group and Ministry of Agriculture led to the formulation of CICR cotton pilot project for implementation of scalable technologies on High Density Planting System (HDPS) and production practices for extra-long staple cotton.

Thirteen scientists from ICAR-CICR enthusiastically participated in the World Cotton Research Conference- 7 (WCRC-7) held in Caro, Egypt during 04-07 October 2022. During the period, a total of 69 research papers in refereed journals as well as 25 popular articles were published. Sixty Nine training programmes including virtual training programmes were organized where a total of about 5439 beneficiaries including farmers, students, field trainees, state government officials and extension functionaries participated. Linkages were fostered with sister ICAR Institutes, SAUs, other public sector Institutes, private companies, NGOs and farmer producer groups to commercialize and upscale varieties and technologies developed. Sixteen MoUs were inked during January to December 2022.

Guidance and constant encouragement received from Dr Himanshu Pathak, Secretary, DARE and Director General, ICAR and Dr T.R. Sharma, DDG (Crop Sciences) enabled the institute to perform well and attain the targeted research achievements. It is incumbent to deeply acknowledge the valuable guidance received from Dr. Trilochan Mohapatra, Former Secretary, DARE and Director General, ICAR.

I am grateful for the guidance and direction by the Research Advisory Committee (RAC) Chairman Dr SA Patil and respected members of RAC. I am grateful for the support extended by Dr R.K. Singh, ADG (CC),ICAR; Dr AH Prakash, Head, Regional Station, Coimbatore and Project Coordinator, AICRP on Cotton; Dr S.K. Verma, I/c Head, Regional Station, Sirsa. Heads of Divisions (HoDs) viz. Dr D. Blaise, HoD, Crop Production; Dr VN Waghmare, HoD Crop Improvement; and Dr Nandini Gokte, HoD, Crop Protection and Dr MV Venugopalan, Head, PME Cell at ICAR-CICR provided valuable support in carrying out the research programmes. Thanks are due to the Editorial Committee members for their unstinted work in bringing out this publication on time.

(Y.G. Prasad)
Director, ICAR-CICR, Nagpur

EXECUTIVE SUMMARY 01

Crop Improvement Division

- Four medium staple early maturing *G. hirsutum* Bt varieties *viz.*, ICAR-CICR 60 Bt (YugankBt), ICAR-CICR 61 Bt (TejasBt), ICAR-CICR 62 Bt (NamamiBt) for rainfed conditions of Central Zone and ICAR-CICR 63 Bt (SamratBt) for rainfed conditions of South Zone were released by CVRC and notified in the Gazette vide S.O. 4065 (E) dated 31st August, 2022.
- Four naturally color cotton varieties namely CICR-A Cotton 57 (CNA 1091), CICR-A Cotton 59 (CNA 17522) of *G arboreum* and CICR-H NC-Cotton-53 (ICAR-CICR-1630 DB) and CICR-H NC Cotton 58 (CNH 17395) of *G. hirsutum* for South Zone were released by CVRC and notified in the Gazette vide S.O. 4065 (E) dated 31st August, 2022.
- A medium staple *G. arboreum* variety CICR-A Cotton 56 (CNA1031) was released by CVRC and notified in the Gazette vide S.O. 4065 (E) dated 31st August, 2022.
- Evaluation of plants carrying an events Tg2E13 and Mon531, alone and in combination, revealed delay in maturity in plants carrying Tg2E13 across the genetic backgrounds (Coker310, NH615, Suraj and CISH3178). In light of the conclusive results which were discussed and deliberated with the developer, it was agreed by consensus that there is no merit in continuing the work further on evaluation and introgression of Tg2E13 event.
- Evaluation of Tma-12 events revealed that, the average population reduction of adults of whitefly under open choice condition ranged between 8.26 to 14.45 % in different events while under No-choice condition ranged between 11.18 to 20.00 % in comparison to N-Event (Coker 312). The Tma-12 event introgressed in elite lines up to BC_3. The introgressed population is not showing much promise. The results were discussed in presence of high-power committee of CSIR and ICAR and decided to stop further evaluation of Tma-12 events.
- Whole genome sequence data of the parent with event UASD78 (cry1Ac) was shared by the technology provider. The sequence data of the gene with flanking sequences was used for bioinformatics analysis and found the presence of sequence similar to transgenic events from china.
- A common station trial of 29 Bt entries along with four checks found that Ajeet 155 BG II hybrid (2719 kg/ha) has highest yielder followed by CICR Bt 201-833 (2033 kg/ha), CICR SBS BT-12 (1881 kh/ha) and RCH 608 BG II hybrid (1796 Kg/ha). The high-yielding compact early maturing test entries CICR 201-833 and CICR Bt 201-767 recorded 90% harvest at 150 DAS with a higher Bartlett's Index.
- Experiment on identification of suitable Bt varieties for HDPS found that, the seed cotton yield was higher in closer (90 x 15 cm) spacing compared to normal spacing (90 x 30 cm). Ajeet 155 was the highest yielder and PKV 081, CICR 21 Bt, and CICR 9 Bt were high yielders than RCH 608 BG II hybrid.
- A total of 103 intra *hirsutum* (H x H) hybrids were tested in two RBD trials with 2 replications. The highest seed cotton yield was recorded by check Ajeet 155 BG II (2296.29 Kg/ha) followed by DVP -37 (2251.85 Kg/ha), VG-3 (2248.88 Kg/ha), DVP-38 (2222.22 Kg/ha).

- Thirty-five deregulated Bt genotypes were evaluated for seed cotton yield and fiber quality; nine genotypes with >10% increase in seed cotton yield were identified as compared to check Rajat Bt along with good fibre length and strength.
- Bt conversion programme at Coimbatore Station generated BC_4F_2 and BC_3F_3 population using LRA 5166, Anjali, MCU 5-VT, Supriya, Surabhi, Sumangala, Suraj, CCH 2626, Suchitra, Sunantha, Suraksha, and Nano genotypes as recurrent parents.
- Bt conversion programme at Sirsa Station from 12 different cross combinations resulted in selection of promising progenies. Two Bt cotton genotypes(CICR Bt-26, CICR Bt-30) were sponsored in AICRP trial.
- Based on yield and fibre quality traits, 176 promising advanced progenies were selected from crosses between Phule Dhanwantari with PA255, PA812, PA740, PA785 and KWAN3.
- Canopy management techniques exhibited significant effect on most of the characters studied *viz*. height, chlorophyll content, LAI, no. of node, HNR at 60, 90, 120 DAS, days to flowering and seed cotton yield. Average across canopy management regimes both the BG II hybrids were more productive, however the response to high planting density was the highest in CICR 191-165 Bt.
- Total 25 Bt entries sponsored by ICAR-CICR were tested in Initial Evaluation Trial (17 entries). Advanced Evaluation Trial I (2) and Advanced Evaluation Trial II (6) in different zones (Table 1) during 2021-22.
- Under population improvement programme, 3*G. arboreum* entries (CNA 1084, CNA 1085 and CNA 1086) were sponsored to Br. 22(a/b) National trial. Two entries CNA1072 and CNA 1092 (a coloured linted *G. arboreum*) promoted and retained in Central Zone. One entry CNA 2034 promoted in South Zone.
- Evaluation of GMS based *G. arboreum* hybrids resulted in identification of hybrid CISAA 20-1 (3048.4kg/ha) with higher seed cotton yield than check hybrid CICR 2 (2800.5 kg/ha).
- Evaluated14 *G. arboreum* genotypes for spinnable cultures and high yielding traits, and identified 3 genotypes CISA-6-295, CISA-33-8 and CISA 33-2 having UHML (mm) >25.0mm and strength ~25.0 g/tex. Similarly, CISA 614 and CISA 310. CISA 33-9 (3002.4 kg/ha) have been identified as high yielding genotypes compared with local checks CISA 614 (2555.7 kg/ha).
- Several new crosses were attempted using GVS lines for pyramiding of traits against CLCuD & sucking pests.
- *G. arboreum* genotypes CISA-6-165 and CISA-33-9 sponsored in AICRP (Br 22a/b) National trial. *G. arboreum* geno type CISA 33-7 advanced to Zonal Trial Br 24a.
- Two intra-*arboreum* GMS based hybrids CISAA-21-1 and CISAA-21-2 were sponsored in Br 25a/b National trial and Two GMS based *G. arboreum* hybrids CISAA 20-1 and 19-4 were promoted to Co-ordinated trial Br 25a.
- Fourteen *G. hirsutum* parental lines were grouped into two groups based on the positive and negative general/specific combining based on evaluation of 91 F1 hybrid combinations (non-diallel). F1 crosses GM - 42 x IC-561248, GM - 28 x IC – 597398, GM – 14 x IC- 561248 has early maturity traits. F1 hybrids GM – 17 x IC – 553925, GM – 18 x IC – 296770, GM - 13 x IC-587405 and GM – 15 x IC -14/8/1 has late maturity with high number of bolls (> 40 bolls / plant).
- More than 12336 Cotton Genetic Resources including accessions of cultivated species, wild species and perennials were conserved at MTS facility and in-situ during 2021-22 at ICAR-CICR (Nagpur & Regional station, Coimbatore). One hundred eighteen accessions of *G arboreum*, 16 of *G. herbaceum* and 32 of *G. hirsutum* were collected from different regions of the country, deposited 480 *G.hirsutum* accessions in Long Term Storage, NBPGR, New Delhi while 322 trait-based Germplasm accessions from breeders of CICR Institute and Regional Stations were deposited in MTS at CICR, Nagpur.
- A set of 108 *G. barbadense* exotic accessions along with three checks were grown in augmented design at ICAR--CICR, Regional Station, Coimbatore. Fiber length (SL) varied from 24.3 mm to 40.3 mm (mean: 33.9 mm), uniformity ratio (UR) ranged from 81 to 89 (mean: 85.8), micronaire ranged from 3.2 to 5.9 (mean: 4.1), fiber strength varied from 23.2 g/tex to 45.6 g/tex (mean: 36.4 g/tex), and elongation ranged from 6.1 to 7.0 (mean: 6.8).
- A total of 402 *G. hirsutum* accessions were evaluated at Regional Station, Sirsa. Clustering was done using (SAS Institute Inc., Cary, NC) software, Wards Method and squared Euclidian distance method
- One thousand four hundred forty-six (1446) novel trait-based Germplasm accessions consisting of *G. hirsutum*; *G. arboreum* and *G. herbaceum* shared to breeders/ scientists of State Agricultural Universities and Private Seed Companies as well as Indenter/breeders within the institute for utilization in their cotton improvement programme.
- 25 wild species, 12 races of cultivated species and more than 45 synthetic polyploids are conserved in the wild species garden. Established plants of 21 accessions of 9 wild species imported from USDA in pots. Also established saplings of *G. mustelinum (3 nos.)and G. ekmanianum* (4 nos) from *Rasi* seeds Pvt Ltd in pots.
- 4225 new crosses were attempted between cultivars /Races and wild species while twenty one (21) F1 hybrids established in pot culture.
- 130 Single plant selections were made from F6 generation of the crosses viz. *G. arboreum* x *G. longicalyx; G. arboreum* x *G. thurberi; G. arboreum race indicum x G. davidsonii & AK 8401 x G. davidsonii. Ten progenies with best fibre properties (Fibre length (mm): 22.4 - 26.6; Fibre strength (g/tex): 24.92 – 28.85) derived from Jawahar Tapi x G. longicalyx* were shared with AICCIP centres namely CRS, Nanded, CRS, Parbhani, CICR RS, Coimbatore, CRS, Surat, CRS PAU Ludhiana & CRS PAU, Faridkot in Pre-breeding Project.
- More than Forty Five (45) colour cotton entries were evaluated in field for their fibre traits and 230 single plant selections were made based on yield and yield contributing traits.
- Sucrose synthase activity is higher in susceptible varieties both under control and water-logged conditions while the Nitrate reductase activity in roots is higher in tolerant varieties both under control and water-logged conditions.
- Ten *herbaceum* genotypes having seed cotton yield potential from 1,243 to 1,812 kg / ha and with early maturity traits that escape late season water stress were identified. CNh - 33 (1,812 kg/ha) and CNh - 66 (1,729 kg/ha) were entered in AICRP for multilocation evaluation during 2022-23.

- Field studies of early maturity genotypes have revealed that open boll damage is (negatively) associated with early maturity (% boll bursting) and an early maturing variety (≤ 150 days) sown in mid-June can potentially escape pink bollworm damage
- A total of 20.3 q breeder seeds from both Bt and non-Bt varieties of *G. hirsutum*, 2.6 q TFL seeds of two Bt varieties, 1.2 q breeder seeds of ELS cotton varieties and 4.5 q breeder seeds of *G. arboreum* varieties were produced during 2021-22.
- Nucleus seed production of nine Bt varieties viz., CICR Rajat Bt (75kg), ICAR-CICR PKV 081 Bt (110kg), ICAR-CICR Suraj Bt (99 kg), ICAR-CICR 16 Bt (87 kg), ICAR-CICR 23 Bt (68 kg), ICAR-CICR GJHV 374 Bt (15 Kg), ICAR-CICR 21 Bt (15Kg), ICAR- CICR 25 Bt (10 Kg) and ICAR- CICR 6 Bt (6Kg) was produced.
- The total soluble seed protein content showed positive correlation with seed weight whereas, the storage fractions (albumin, globulin, prolamina and glutalin) showed negative correlations.
- Seeds stored for 30 months under medium term cold storage and refrigeration conditions recorded highest seed germination as compared to seed stored under ambient storage in cultivars Suraj and Roja. Similarly, vacuum conditions favoured in maintaining the highest seed germination in both the varieties followed by non-vacuum, polythene bags and cloth bags.
- Regeneration experiments revealed that each seed of Coker 312 genotypes differ for induction of somatic embryos. Thus, those seeds showing high somatic embryogenesis were taken for multiplication in the controlled condition.
- Transcriptomes obtained from larva of cotton pink bollworm (Nagpur population) were sequenced. Using the filtered transcriptome assembly, a total of 30,124 genes were annotated. Two candidate genes (*PPGM* and *PUAP*) from the chitin biosynthesis pathway of PBW have been amplified, validating their full-length sizes of 1.6 and 1.4 kb respectively.
- The bio-efficacy of the Cry1D protein against field collected & laboratory reared pink bollworm populations of Nagpur was reconfirmed. Codon optimized *cry1D* gene sequence was custom synthesized and cloned in to plant expression vector.
- *GaDAR1* promoter sequence from *G. arboreum* was isolated and cloned upstream of the *uidA* gene for further functional characterization.
- Evaluated molecular markers (BNL3259, BNL1153 and BNL2884) reported to be linked to osmotic potential (OP) were polymorphic with recombinant Inbred Lines (RILs) derived from the interspecific cross between *G. hirsutum* (28I) a drought tolerant trait parent (P1) and *G. barbadense* (Suvin) (P2).
- *Agrobacterium* mediated transformation of Coker-312 hypocotyls using sgRNA3GhPHYA1: :CRISPR/Cas9 followed by somatic embryogenesis mediated regeneration resulted in 28 putative cotton plants and are being established at containment facility.
- Screening of 780 cotton germplasm lines for glyphosate resistance/tolerance identified 10 most tolerant (No-101, 118,165,265,250, 256, 267, 455, 237, and 310 and 10 most susceptible (No-80, 87, 163, 170, 325, 490, 515, 565, 575 and 594) lines for further research activities.

Crop Protection Division

- Large scale demonstrations on mass trapping of pink bollworm using pheromone traps were conducted on 150 acres of farmers' fields in Amravati, Nagpur and Chandrapur districts of Maharashtra state. Installation of 30 to 35 traps/acre led to a significant reduction in pink bollworm infestation in cotton with average yield benefit of 1-2 q/acres.
- The parasitization potential of the braconid wasp, *Bracon hebetor* (Say) on pink bollworm was studied under laboratory conditions. The release of parasitoid @ 30:5 host: parasitoid ratio resulted in 85-100% parasitization in second, third and fourth instar larvae of pink bollworm.
- The studies conducted on pink bollworm larval movement from rosette flowers indicated that 49.09% larvae from the infested flower moved to the soil for pupation, 15.34% larvae moved to infest bolls, 32.49% larvae moved to dried leaf debris on soil and 3.06% larvae perished due to the environmental factors.
- Five inundative releases of an egg parasitoid *Trichogramma bactrae* @ 45 60, 75, 90 & 105 DAS resulted in significant reduction in pink bollworm infestation in cotton fields.
- The pink bollworm populations collected from 36 different locations across North, Central and South cotton growing zones were subjected to diet incorporation bioassays to assess the resistance development against Cry 1Ac and Cry 2Ab toxins. The results revealed that the folds of resistance against Cry 1Ac ranged between 302-388, 20-1028 and 846 for north, central and south zones, respectively. Similarly, in case of Cry 2Ab, the range of resistance was 601-1050, 92-4940 and 468-5779 in North, Central and South zones, respectively.
- The demonstrations on pink bollworm management conducted under IRM-PBW project resulted in significant reduction in the number of sprays for the control of cotton pests in IRM fields (5.18 sprays) compared to non-IRM fields (8.20 sprays). The implementation of project has resulted in significant reduction in cost of pesticide use by 39.30% and increased benefit: cost ratio of 2.24 : 1.00.
- Under the crop pest surveillance and advisory project (CROPSAP), pre-sowing and in-season advisories were formulated, the technical guidance on cotton pest management based on the analysis of weekly pest data was provided to the Department of Agriculture for dissemination and timely action by the cotton farmers and other related stakeholders.
- Five fungal and 25 bacterial isolates were recovered from 150 dead pink bollworm larvae sampled from different geographic locations of cotton growing areas. The entomopathogenic fungi *Lecanicillium lecanii* (50 g /10L) resulted in lowest pink bollworm infestation in green bolls of cotton. Soil application of EPN against pupae of pink bollworm reduced the moth emergence by 65%.
- An economic threshold level (ETL) of 5-7% green boll infestation (%) has been proposed as a decision-making tool for insecticidal management of cotton pink bollworm based on the yield loss -pest density function established by fitting linear regression equation ($y = a \pm bx$) between mean pest infestation recorded at 120, 130 and 150 DAS, and seed cotton yields of picking 1, 2 and 3, respectively. Four sprays of insecticides (@ 55, 75, 105 and 125 DAS) were determined as optimum number of sprays to protect the cotton crop from pink bollworm damage

- A simple, reliable and robust method for rapid yield loss assessment in cotton due to pink bollworm and boll rot at field level is developed based on random sampling of loculi and working out the proportion of healthy and damaged loculi. The method estimated the mean loss in seed cotton yield due to PBW infestation at 17.4% and 39.5% in Bt and Non-Bt cotton cultivars, respectively. Similarly, the seed cotton yield loss due to boll rot was estimated at 15.7% and 13.6% in Bt and Non-Bt cotton cultivars, respectively.
- The qualitative losses like loss in seed weight, seed germination, oil and moisture content due to damage by pink bollworm and boll rot were also determined. PBW and BR damage reduced the seed oil content by 27.91 % and 19.33%, respectively. There was increase in seed moisture content by 5.72% and 10.82% due to PBW and BR damage, respectively.
- Among the different vegetable oils, the castor seed oil and cotton seed oil @ conc. of 2-3% reduced the egg laying of female *Helicoverpa armigera* by 84% and 47%, respectively. Amongst the various oils blended with cotton seed oil, the castor-cotton seed oil blend showed 66% reduction in egg laying. Likewise, amongst castor oil-based blends (1%), the sunflower + castor seed oil caused 79% reduction in egg laying in comparison to control.
- American bollworm populations from Maharashtra (10 districts) and Gujarat (8 districts) were screened against five newer (Chlorantraniliprole, Flubendiamide, Indoxacarb, Spinosad, Emamectin benzoate) and three conventional (Cypermethrin, Novaluron, Profenophos) insecticides. Newer molecules were promising compared to conventional insecticide molecules. Emamectin benzoate was the most effective among newer group of insecticides whereas profenophos followed by Novaluron and Cypermethrin were highly effective among conventional insecticides tested.
- Isolation of grey mildew pathogen *Ramularia areola*was carried out using different media like PDA, SDA, Richard's agar, Czapek's agar, V-8 juice agar, leaf decoction agar and Kirchoff's agar. ITS analysis of medium grown cultures revealed no similarity to *R. areola* sequence, whereas DNA extraction and ITS analysis with ITS 4 and ITS 5 primers from diseased leaves provided matching sequence. Conidial morphology of the isolates from three species of cotton was studied. Eighteen Bt hybrids were assessed for grey mildew incidence during the season 2021-22. At 130 DAS, maximum disease severity was seen in RCH-530 (>20%) and lowest severity was seen in Ajeet-5 (<5%).
- Race identification of *Xanthomonas citri pv. Malvacearum* was done by conducting pathogenicity test of isolates on nine different cultivars under glass house. The roving surveys carried out in different cotton growing districts of Maharashtra and Telangana revealed low incidence of BLB (0-5.56 %). The isolates of BLB were collected from North, Central and South cotton growing zones of India and submitted in the repository for future screening. Identification of *Xcm* isolates by biochemical tools was carried out. Molecular characterization of 12 isolates collected from different geographic locations of India was done by 16S r-DNA and pthn primers. Genetic diversity of collected Xcm isolates was studied by using ISSR primers.
- Standardized the protocol for rapid, sensitive and specific diagnosis of Xcm by using Loop mediated isothermal amplification techniques (LAMP).
- Expression studies of chitinase and chitinase like genes in response to *Corynespora cassiicola* infection in cotton plants was studied under glass house conditions. In vitro efficacy evaluation of label claim fungicides and fungal bioagents against *C. cassiicola* was carried out. Molecular characterization and identification of isolates collected from different locations were done by using ITS sequencing and translation elongation factor-1 and Beta tubuline housekeeping genes primers.
- Isolated and characterized 4 different species of *Trichoderma*. In vitro evaluation of bio efficacy of identified *Trichoderma* species against important diseases of cotton was done. Mass multiplication of Trichocash (1000 kg of talc-based formulation) was carried out. Total 750 Kg of Trichocash have been supplied for distribution to the farmers under SCSP and TSP leading to revenue generation of Rs 1,20,000 under KVK revolving fund.
- Survey, sampling and diagnostics of boll rot disease complex were done from Maharashtra, Telangana, Gujarat and Madhya Pradesh regions. The symptomatology and pathogenicity of boll rot disease complex caused by fungal and bacterial pathogens were studied on Bt hybrid and non-Bt variety of cotton. Transmission of boll rot pathogen *Pantoea* sp by thrips is investigated. The feeding of pathogen acquired thrips on healthy bolls resulted in 70.00% boll rot incidence. In vitro and field efficacy evaluations of label claim fungicides were carried out for boll rot management.

Crop Production Division

- Precision planting using pneumatic planter was validated an effective technology for sowing cotton under High density planting system. Further, under simulated skips and doubles conditions, there was no yield loss due to the introduction of 10% skips. However, when the percentage of skips introduced was increased to 20% or 25%, there was a significant loss in seed cotton yield despite the deliberate introduction of 10% doubles.
- The rainfed cotton ecosystem on Vertisols and associated soils was found to be a net sink for CO_2 . Throughout the season (180 days), the cumulative Gross Primary Production (GPP) was 803.4 g C m^{-2} and the and Ecosystem Respiration (R_{eco}) was 589.7 g C m^{-2}. Around 2.14 tonnes of C per ha was sequestered by the cotton ecosystem during the season of 2021-22.
- A methodology for rapid, sensitive and simultaneous profiling of phytohormones in cotton was attempted through GC-MS. A technique to derivatize phytohormones with BSTFA (N,O-Bis (trimethylsilyl) trifluoroacetamide) and MSTFA (N-Trimethylsilyl-N-methyl trifluoroacetamide) was standardized and limit of detection for majority of phytohormones (Internal standards) was recorded in the range of 150 to 250 ng.
- A microbial consortia formulation using native cotton rhizospheric bacteria was developed. In pot studies, its application as seed treatment and soil inoculation was found to significantly enhance the colonization and retention of the applied microbial inoculants in the cotton rhizosphere. This in-turn enhanced the root attributes, enhanced vigour, promoted plant growth and imparted drought tolerance in rainfed cotton.
- Intercropping of rainfed cotton under high density planting system with either soybean or black gram had a

complementary effect on the total system productivity. Based on cotton equivalent yield, gross monetary return, net monetary return and benefit-to-cost ratio; *G. hirsutum* (Suraj) +green gram and *G. arboreum* (Phule Dhanwantary) + soybean were the best intercropping systems for rainfed area.

- A novel zinc oxide nano fertilizer (nZnO) developed by ICAR-CIRCOT was evaluated against conventional Zn sources ($ZnSO_4$ and ZnO) for their efficacy on rainfed cotton in pot studies using different application techniques. Among sources, $ZnSO_4$ treated pots had taller plants (59 cm) followed by ZnO (54 cm), nZnO and control (47 cm). Among the methods tested, the average plant height was maximum in seed treatment (57 cm) followed by soil application (53 cm) and control without Zn (47 cm).
- Non-GM straight varieties of cotton were evaluated under organic cultivation on Vertsols under rainfed conditions. Long linted desi cotton variety PA 810 followed by PA 740 produced higher seed cotton yield than their non-GM, *G. hirsutum* counterparts. In laboratory studies, Neem leaves, NSKE, Dashparni, Panchgavya, Annona, Calotropis, Pongamia, Eucalyptus, and Vermiwash caused 100% mortality *of Spodoptera frugiperda, Helicoverpa armigera, Pectinophora gossypiella*.
- Microbial volatile organic compounds (mVOCs) can attract or repel insects. Selected microbial volatile formulations were evaluated under replicated field trials for their efficacy to control sucking pests of cotton. CICR-mVOC-W, CICR-mVOC-J, CICR-mVOC-A, and CICR-mVOC-T could increase the trap catch and attractive index by 168% & 1.46, 225% & 1.53, 189% & 1.49, and 148% & 1.42, respectively, for whiteflies, jassids, aphids, and thrips.
- Four calcium solubilizing bacteria, were shortlisted for preparing a calcium solubilizing bacteria (CSB) consortia. These have the potential for mineral solubilization and to enhance the availability of micronutrients in calcareous soils.
- Mepiquat chloride (25 g a.i./ha) sprayed twice at 45 and 65 days could induce compactness in all the genotypes identified for mechanical picking based on their phenotypic traits.

Regional Station Coimbatore

- The high strength long staple cotton variety, CICR-H Cotton 54 (Nano) has been released for both Central and South Zone States under both irrigated and rainfed conditions. The variety is characterized by ideal plant type for HDPS, recorded a mean seed cotton yield of 2123 kg/ha under South Zone (irrigated) 1469 kg/ha in South Zone (rainfed) and 1815 kg/ha in Central Zone (irrigated condition).
- An ELS Variety identified for release: CICR B Cotton 55 (CCB 51-2). It recorded mean seed cotton yield of 1317 kg/ha as against 1139 kg/ha of the Zonal check variety under irrigated condition. The proposed variety has combined fibre quality combination *viz.,* Upper Half Mean Length of 37.1 mm, micronaire of 3.7 and tenacity of 38 g/tex in HVI mode.
- Maintenance breeding and DUS characterization and of 130 extant cotton varieties and parental lines were carried out in tetraploid and diploid cotton viz.,82 in *G. hirsutum*, *7 in G.barbadense*, 38 in *G. arboreum, 3 in G.herbaceum.*
- Studies on crop weed interaction revealed that the relative density of dominant weed, *Trianthema portulacastrum* at 45 DAS has shown a steep reduction from 57.2 under ambient to 38.6 in elevated CO_2 The favourable growth condition due to elevated CO_2 reflected in higher boll numbers, boll weight and seed cotton yield enhancement up to 34.3 per cent over ambient condition.
- Significantly higher seed cotton yield was harvested from plots given drainage by ridges and furrow with foliar application of melatonin @ 100μM single spray (1723 kg/ha as compared to control (water logging) (1351 kg/ha) under water logging conditions. Moisture conservation by land shaping of ridges and furrow followed by moisture stress management by foliar application of glycine betaine 100ppm single spray (1761kg/ha) as compared to rainfed control (1324 kg/ha) significantly increased the yield in cotton.
- Increased plant density (90 x 30 cm; 37,037 plants/ ha) combined with drip fertigation and canopy management (Mepiquat Chloride application @ 60 ppm when height node ratio (HNR) reached 1.5 followed by 30 ppm twice at 15 days interval after first spray) significantly enhancedthe seed cotton yield of MRC 7918 (2766 kg/ha) vis-a-vis farmers' practice (90 x 60 cm; 18,518plants/ha; 2280 kg/ha) which was 21% yield increase over FP.
- Under long term fertilizer experiment using cotton – maize cropping system, nutrients applied through balanced form of inorganic fertilizers (NPK + Mg + Zn + B) with FYM once in two years (1921 kg ha^{-1}) and without FYM (1990 kg ha^{-1}) produced higher seed cotton yield than imbalanced form of chemical fertilizers (NPK) (1822 kg ha^{-1}) and organic sources of nutrients (FYM 10 t/ha every year + Biofertilizer – Azophos (seed treatment and soil application) + Neem cake 250 kg/ha + Sunnhemp incorporation) (1589 kg ha^{-1})
- The analysis on cultivation behavior of 450 respondents revealed that majority of them had positive attitude towards ELS cotton cultivation and medium level of knowledge and adoption. The technology adoption gap analysis revealed that major technology adoption gaps were found in adopting the technologies related to pest management, nutrients management and planting methods. A model called "Pluralistic Extension Model for Fostering the Production of ELS cotton" was conceptualized based on the above observations.
- Evaluation of different fabricated pheromone trapping systems revealed that, trap catches of *P. gossypiella* and *S.litura* were found to be similar in individual traps, combined traps and combined lure treatments. In mixed lure trap a significant reduction in trap catch was noticed. The wireless smart trap fabricated during 2020-21 was improvised with new 160° fish-eye camera module and new trap holder design.
- The Tea Mosquito Bug (TMB) population dynamics showed that the incidence started in September and peaked in December. Life cycle period of 14.30±1.27 and 23.07±1.01 days was observed for male and female respectively. Maximum yield decrease of 52% by 5 insects /plant compared to control.

Regional Station Sirsa

- A total of 1857 CLCuD free single plant selections were made among 14 crosses (F_6/F_7) involving GVS 9 and other CLCuD resistant genotypes for further evaluation in station yield trials. Apart of this using resistant GVS 8 and GVS 9, 16 new crosses were also attempted for pyramiding CLCuD resistance, high yielding traits and fiber quality traits.

- F_2 and back crossed (BC_1F_1) populations involving parents i.e. GVS 9 (CLCuD resistant) and HS 6 (CLCuD Susceptible) were developed for genetic analysis and molecular mapping.
- A total of 6.3 Q breeder seed of released varieties (CICR Bt-6, CSH 3075, CSH 3129, CICR-1 and CICR-3) was produced at ICAR-CICR, RS, Sirsa.
- 780 germplasm lines were evaluated under augmented design and trait specific lines were identified
- Seed cotton yield was significantly higher under zero tillage-permanent narrow raised bed with residue retention as compared to other treatments of zero tillage and conventional tillage. Total system productivity was higher under cotton-berseem cropping system. Grain yields of wheat, barley, mustard, chickpea, sunflower and spring / winter maize was significantly higher under Zero tillage - permanent narrow raised bed with residue retention over Conventional Tillage - Flat Bed without residue incorporation but was at par with Zero Tillage - Flat Bed with residue retention.
- A project entitled "Conservation agriculture practices for cotton-wheat system" has been initiated with fixed laid out plan. Sowing of Bt cotton hybrid for different treatments was done as per the approved lay out plan for the 2022-23 cropping year.
- Out of 112 entries, 4 entries namely EC 344834 (9.82/3leaves), EC 700041(9.91/3leaves), CNH 108(9.76/3leaves), LK 861 (7.04/3leaves) have been recorded with whitefly population comparatively less than the LPS-141(10.16/3leaves) resistant checks.
- Total nymphal duration and total life cycle was comparatively less in case whitefly reared on cotton leaf curl virus infected plants as compared to whitefly reared on healthy cotton plants whereas fecundity was more in healthy plants than infected plants.
- In bioassay of whitefly, the maximum mortality of whitefly nymph was recorded on Afidopyropen 50 DC and minimum mortality was observed on Azadirachtin 0.03.
- Whitefly outbreak during 2022 indicated advancement in incidence (27th SMW onwards) above Economic Threshold Level, longer persistence above ETL (<10 SMW) and high severity in average population as compared to whitefly outbreak in 2015. The average population of whitefly adults/3leaves was 20.93 and 20.32 in RCH 650 BG-II and HS 6 (Non-Bt) genotypes whereas, during the 2022 cotton season, it was 33.50 and 38.53, respectively.
- Among 108 cotton rhizospheric fungi (RFs), 16 RFs were selected based on *in vitro* confrontational assay test (mycelial growth inhibition) against *Rhizoctonia solani, Macrophomina phaseolina, Corynespora cassiicola* and *Alternaria alternata* in the laboratory. Further highest seed germination, the highest vigor index and the lowest root rot were recorded with the seed treatment of *Trichoderma asperellum* Rf-B-Th-11, *T. virens* Rf-16 and *Actinomortierella wolfi* Rf-63 at 90 days after sowing (DAS under pot conditions). *Trichoderma asperellum* RF-B-Th-11 was sponsored for evaluation at multilocation trials under AICRP on cotton.

General

- During the period, a total of 69 research papers of which 35 research papers with >6 NAAS Score and 34 research papers with <6 NAAS Score as well as 25 popular articles were published.
- 69 training programmes including virtual training programmes were organized where a total of about 5439 beneficiaries including farmers, students, field trainees, state government officials and extension functionaries participated.
- Linkages were fostered with sister ICAR Institutes, SAUs, other public sector Institutes, private companies, NGOs and farmer producer groups to commercialize and upscale varieties and technologies developed. Sixteen MoUs were inked during January to December 2022.

INTRODUCTION

02

2.1 : Brief History

The **ICAR-Central Institute for Cotton Research (CICR)** was established at Nagpur, in 1976. The two regional stations of IARI located at Sirsa (Haryana) and Coimbatore (Tamil Nadu) were transferred to ICAR-CICR to cater needs of north and south India, respectively.

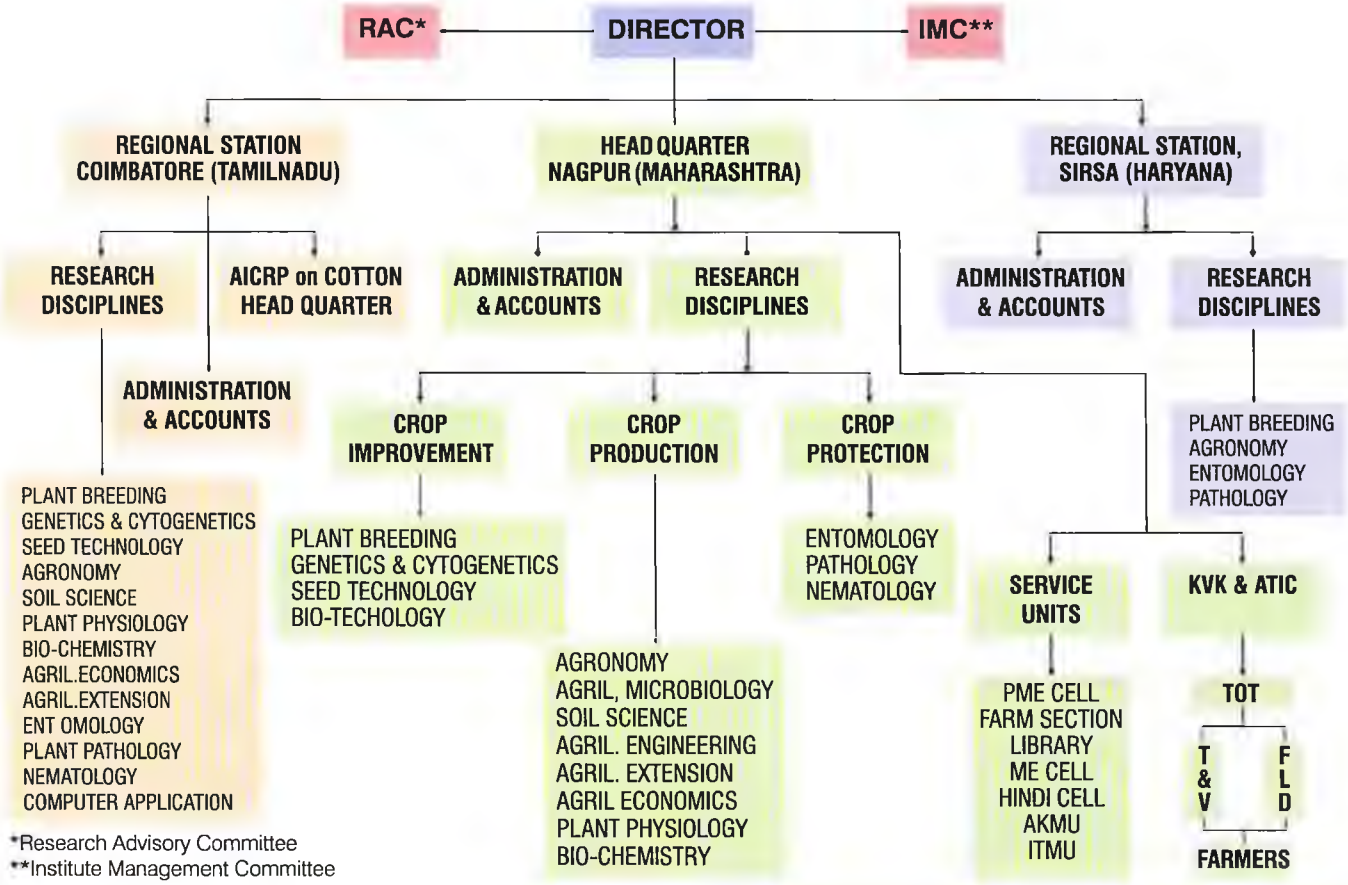
2.2 : Mandate

- Basic, strategic and adaptive research on production, protection, fibre quality and by-products of cotton.
- Creation of new genetic variability for location-specific adoption in cotton-based cropping systems.
- Coordination and monitoring of applied research on national and regional issues to develop improved varieties and technologies.
- Dissemination of technologies and capacity building.

Location of the of ICAR-CICR Institute

Center	Latitude (°N)	Longitude (°E)
ICAR-CICR, Head Quarters, Nagpur, MH	21.037	79.056
ICAR-CICR, Regional Station,Coimbatore, TN	11.014	76.929
ICAR-CICR, Regional Station, Sirsa, Haryana	29.543	75.038

ORGANOGRAM OF CICR



*Research Advisory Committee
**Institute Management Committee

2.3 : Staff Position (as on 31st December, 2022)

Category	Sanctioned Cadre Strength				Post Filled Up			
	NGP	CBE	Sirsa	Total	NGP	CBE	Sirsa	Total
Director (RMP)				1	1	--	--	1
Scientific				77	41	19	5	65
Technical				72	38	12	8	58
Administrative				46	15	4	3	22
Skilled Support Staff				44+31	29	11	17	44+13
Krishi Vigyan Kendra								
Training Organizer	1	--	--	1	--	--	--	1
Technical	11	--	--	11	10	--	--	10
Administrative	2	--	--	2	--	--	--	--
Skilled Support Staff	2	--	--	2	2	--	--	2

NGP – Nagpur; CBE - Coimbatore

Original sanction 44+31 additional sanction which will abolished as and when vacated.

**06 Sanction for Junagarh, Gujarat

2.4 : Financial Statement

The budget grant and actual expenditure for the year 2022 are furnished below :

(Rs. in Lakhs)

Name of Scheme	2021-22		2022 (Jan-Dec 2022)	
	Sanction	Expenditure	Sanction	Expenditure
Plan Scheme	2763.50	2736.73	1526.71	1481.61
Deposit Scheme	2232.84	1541.33	2773.71	2608.37
Revolving Fund	18.03	3.23	19.99	3.47
Govt. Grants	4610.61	4609.64	4424.26	4138.33
Total (in lakhs)	**9624.98**	**8890.93**	**8744.67**	**8231.78**
Revenue Generation (Revenue Receipts)	**159.86**		**46.44**	

RESEARCH ACHIEVEMENTS 03

CROP IMPROVEMENT DIVISION

3.1 Project Name : Development of elite Bt cotton varieties using deregulated transgenic events

Suman Bala Singh (April 2022 till superannuation)(PI), Co-PI's: Santosh HB, Rahul M Phuke Waghmare VN, Venugopalan MV, Balasubramani G, Raghavendra KP, Vivek Shah, Ramakrishnan GI, Patil DV, Manickam S, Rameash K, Sampathkumar A, Baghyalakshmi K, Verma SK, Rishi Kumar and Sain SK, Santhy V, Neelkanth Hiramani

The importance of the study : The cotton productivity in India can be improved by deploying early maturing, compact Bt cotton varieties in rainfed areas with the option of high-density planting to increase yields, low resource demand, and better protection from bollworms due to early maturity. This project aims to develop Bt varieties using deregulated transgenic events.

Salient findings

Release and notification of Bt varieties by CVRC : Four Bt

ICAR-CICR 60 Bt (Yugank Bt)

ICAR-CICR 61 Bt (Tejas Bt)

ICAR-CICR 62 Bt (Namami Bt)

ICAR-CICR 63 Bt (Samrat Bt)

varieties *viz.,* ICAR- CICR 60 Bt (Yugank Bt), ICAR-CICR 61 Bt (Tejas Bt), ICAR-CICR 62 Bt (Namami Bt), and ICAR-CICR 63 Bt (Samrat Bt) were released during the 88th meeting of CVRC chaired by hon'ble DDG (CS) T.R. Sharma held on 13th July 2022 and notified in the Gazette vide "S.O. 4065 (E) dated 31st August, 2022.

Nucleus seed production of nine released and notified *Bt* varieties: Nucleus seed production of nine Bt varieties viz., CICR Rajat Bt (75kg), ICAR-CICR PKV 081 Bt (110kg), ICAR-CICR Suraj Bt (99 kg), ICAR-CICR 16 Bt (87 kg), ICAR-CICR 23 Bt (68 kg), ICAR-CICR GJHV 374 Bt (15 kg), ICAR-CICR 21 Bt (15 kg), ICAR- CICR 25 Bt (10 kg) and ICAR- CICR 6 Bt (6 kg) was produced.

Evaluation of promising cultures in AICRP : Total 25 entries sponsored by ICAR-CICR were tested in Initial Evaluation Trial (17 entries), Advanced Evaluation Trial I (2) and Advanced Evaluation Trial II (6) in different zones (Table 3.1.1) during 2021-22.

Table 3.1.1: List of promising genotypes in different AICRP trials

Zone	IET (17 entries)	AET I (2 entries)	AET II (6 entries)
North zone (3)	CICR Bt 21-32Bt, CICR Bt 28-1, CICR Bt 27-1	NIL	NIL
Central zone (Rainfed) 8	CICR 21 -31 Bt, CICR 21-32 Bt, CICR 33 Bt, CICR 31 Bt, CICR 34 Bt, CICR 35 Bt, CICR 32 Bt, CICR 30 Bt, CICR 21-33 Bt	CICR 18 Bt, CICR 20-31 Bt	Bt 183059 -4, CICR 19-32 Bt, CICR 19 - 33 Bt, Bt 183059-5
Central zone (Irrigated) 7	CICR 33 Bt, CICR 31 Bt, CICR 34 Bt, CICR 34 Bt, CICR 35 Bt, CICR 32 Bt, CICR 30 Bt, CICR 21-33 Bt	CICR 18 Bt, CICR 20-31 Bt	NIL
South zone (Rainfed) 9	PKV 081 Bt, Rajat Bt, Suraj Bt, GJHV 374 Bt, CICR 34 Bt, CICR 32 Bt, CICR 33 Bt, CICR 35 Bt, CICR 31 Bt,	CICR 20-31 Bt	CICR Bt 19 -31, Bt 183059-2
South zone (Irrigated)11	PKV 081 Bt, Rajat Bt, Suraj Bt, GJHV 374 Bt, CICR 34 Bt, CICR 32 Bt, CICR 33 Bt, CICR 31-33 bt, CICR 35 Bt, CICR 31 Bt, CICR 16 Bt	NIL	NIL

Evaluation of Bt genotypes in station trial at Nagpur

- A common station trial of 29 Bt entries along with four checks (Ajeet 155 BG II, RCH 608 BG II, PKV 081 Bt, and Suraj Bt) was conducted in RBD having three replication in 90 x 30 cm spacing of 4 rows. The phenotyping for plant, yield and fibre quality traits were carried out along with protein expression for Cry1Ac, pest infestation, and disease incidence.
- Due to continuous rains, the jassid population with grade II damage in many entries was recorded at 90 DAS, whereas all the Bt entries recorded more than 90% mortality for *Helicoverpa armigera*. Bacterial blight incidence ranged from 2-43%, Corynespora leaf spot from PDI 4-65.6 %, and external boll rot from 0-35% were the major diseases recorded.
- The highest yield was recorded by Ajeet 155 BG II hybrid (2719 kg/ha) followed by CICR Bt 201-833 (2033 kg/ha), CICR SBS BT-12 (1881 kh/ha) and RCH 608 BG II hybrid (1796 Kg/ha). The high-yielding compact early maturing test entries CICR 201-833 and CICR Bt 201-767 recorded 90% harvest at 150 DAS with a higher Bartlett's Index.

Comparative evaluation of early maturing compact Bt entries under HDPS :

The compact early maturing Bt varieties were tested under a high-density planting system (HDPS) with the spacing of 90 x 15 cm along with checks Ajeet 155 & Ankur 3028 (BG II hybrids), PKV 081 Bt & Suraj Bt (released Bt varieties), Co17 (Compact), Anjali (early) and NH 615 (non-Bt variety). The check Bt hybrids Ajit 155 and Ankur 3028 were the highest yielders than Bt varieties under HDPS. The genotype 201-833 was better than Bt varieties checks and recorded a seed cotton yield (SCY) of >20 q/ha (Fig. 3.1.1). Many Bt genotypes performed better than compact check Co17 and early maturing check Anjali based on a percentage of boll bursting at 150 DAS.

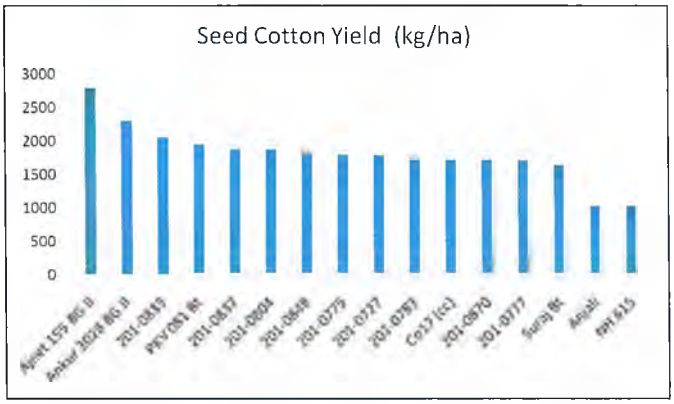


Fig. 3.1.1: Seed cotton yield of test varieties and checks under HDPS

Performance of promising Bt genotypes : At Nagpur, 35 BG I genotypes were evaluated for seed cotton yield and fiber quality. The SCY ranged from 954.10 – 1794.02 Kg/ha and 15 Bt genotypes were at par with Rajat Bt (1239.76 Kg/ha). Nine genotypes recorded >10% increase in seed cotton yield as compared to check along with good fibre length and strength. The four entries viz., CICR 291 Bt (1794.02 kg/ha), CICR 12 Bt (1564.31 Kg/ha), CICR 875 Bt (1531.83 Kg/ha) and CICR 30 Bt (1503.37 Kg/ha) recorded seed cotton yield of more than 15q/ha.

Development of Bt hybrids : A total of 103 intra *hirsutum* (H x H) hybrids were tested in two RBD trials with 2 replications. The highest seed cotton yield was recorded by check Ajeet 155 BG II (2296.29 Kg/ha) followed by DVP -37 (2251.85 Kg/ha), VG-3 (2248.88 Kg/ha), DVP-38 (2222.22 Kg/ha). These three test hybrids are on par for boll weight and GOT with a check. A sufficient quantity of seed has been produced for two hybrid combinations to be sponsored in AICRP Bt hybrid trial.

Bt conversion program at ICAR-CICR-Coimbatore

Selfing in BC_4F_1 plants : Cry1Ac positive plants were identified in BC_4F_1 plants with phenotypic background selection of recurrent parents viz., LRA 5166, Anjali, MCU 5-VT, Supriya, Surabhi, Sumangala, Suraj, CCH 2626, Suchitra, Sunantha, Suraksha, and Nano and were selfed to produce BC_4F_2 population.

Selection in BC_3F_2 population : Cry 1Ac positive plants were identified in BC_3F_2 population with phenotypic background selection of recurrent parents viz., LRA 5166, Anjali, MCU 5-VT, Supriya, Surabhi, Sumangala, Suraj, CCH 2626, Suchitra, Sunantha, Suraksha, and Nano and were selfed to produce BC_3F_3 population.

Selection in F_5 progenies : Cry1Ac positive plants were identified in 250 F_5 progenies with ideal plant type for HDPS, big boll, sucking pest tolerance, earliness etc. and were selfed to produce F_6 population. DNA was isolated in F_5 progenies and BC_3F_2 population to test for homozygosity of *cry*1Ac gene.

Evaluation of interspecific (H x B) Bt hybrids at ICAR-CICR-Coimbatore

- **Hybrid evaluation (Set I) :** Four hybrids namely GJHV 374 Bt x ICB 39, PKV 018 Bt x ICB 34, Rajat Bt x ICB 99 and Suraj BtxICB 34 showed significantly high positive specific combining ability effects for single plant yield. Whereas for fibre traits among the hybrids GJHV 374 Bt x ICB 28, GJHV 374 Bt x CCB 141 and Rajat Bt x ICB 99 was having significantly high positive sca effects.
- **The cross combinations :** GJHV 374 Bt x ICB 39, GJHV 374 Bt x ICB 99 and Rajat Bt x ICB 99 exhibited per se performances for single plant yield. The crosses GJHV 374 Bt x CCB 141, PKV 018 Bt x ICB 99, Rajat Bt x ICB 99, Suraj Bt x ICB 183 exhibited high heterotic effect and per se performances for fibre length.
- **Set II :** GJHV 374 Bt x ICB 176, Rajat Bt x ICB 176, Suraj Bt x ICB 264 and Suraj Bt x ICB 284 exhibited per se performances for single plant yield, Whereas the crosses GJHV 374 Bt x SUVIN, PKV 018 Bt x ICB 176, PKV 018 Bt x SUVIN, Rajat Bt x SUVIN and Suraj Bt x Suvin exhibited high heterotic effect and per se performances for yield and fibre related traits.

Rajat Bt x ICB 99: Bigger bolls and higher number of bolls (62)

Bt breeding program at ICAR-CICR-Sirsa

A total of 1335 Single Plant Selections (BG-I having no CLCuD) and a total of 1085 Single Plant Selections (BG-II having no CLCuD) were made from 12 different cross combinations. Promising Bt cotton genotypes i.e. Bt 20, Bt 26, Bt 28 and Bt 70 were identified in Replicated Evaluation Trial (10+1) of Bt Cotton entries (Table 3.1.2) and 02 Bt cotton genotypes i.e. CICR Bt-26, CICR Bt-20 were sponsored in AICRP trial.

Table 3.1.2: Details of evaluation of Bt cotton genotypes

Entry Name	SCY	Boll	Bolls/	Fibre Traits				
	(kg/ha)	wt(g)	plant	GOT (%)	UHML (mm)	UI	Strength(g/tex)	Mic.
Bt-20	3309.2	2.90	29	36.0	24.1	79	25.5	5.4
Bt-21	2923.8	3.10	33	36.3	24.0	78	25.2	4.9
Bt-22	3200.4	3.30	36	35.5	25.3	79	27.0	4.9
Bt-23	2817.7	3.70	32	34.3	24.8	79	25.8	5.3
Bt-24	2652.1	3.30	33	35.8	25.0	79	26.0	4.8
Bt-25	2767.4	3.40	34	37.7	23.8	79	24.0	5.1
Bt-26	3773.4	3.40	35	36.7	24.8	79	28.7	4.7
Bt-27	3157.4	3.50	29	38.3	27.2	79	30.7	4.2
Bt-28	3270.8	3.40	35	33.7	24.4	79	28.0	5.5
PAU Bt-3 (Ch)	4395.7	3.80	32	36.7	26.8	79	30.4	5.0
HS-6 (Ch)	2880.7	3.20	31	35.6	23.8	79	24.0	5.1
Range	**2952.1-4395.7**	**2.90-3.80**	**29-26**	**33.7-38.3**	**23.8-27.2**	**78.0-79.0**	**24.0-30.7**	**4.2-5.5**
CD	**324.43**							
CV (%)	**5.81**							

Agronomic evaluation of released Bt cotton varieties

A) Canopy management technique

A field experiment was conducted to standardize canopy management techniques for inducting compactness, earliness, and synchronous maturity in Bt varieties/hybrids to facilitate mechanical harvesting and double cropping. Two Bt varieties ICAR-CICR Bt 16 and CICR 191-165 Bt and two Bt (BG II)

hybrids viz. RCH 608 and Ajeet 155 were evaluated under 5 canopy management regimes- M1: HDPS (90 x 15 cm), M2: HDPS + CICR Canopy management, M3: HDPS + Rasi canopy management, M4: HDPS + Mechanical canopy management (Jalna), M5: normal spacing (90 x 45 cm)

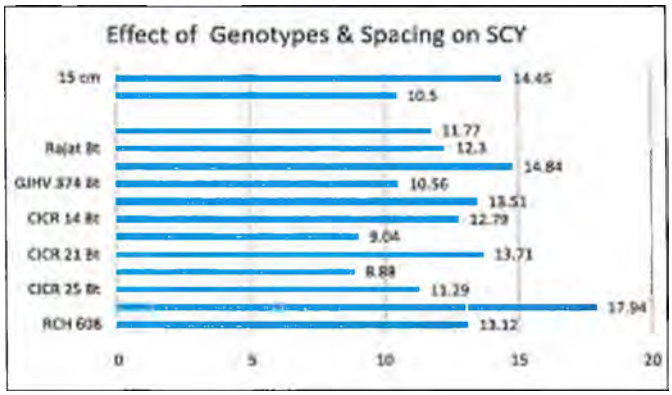
Canopy management has a significant effect on most of the characters studied viz. height, chlorophyll content, LAI, no. of node, HNR at 60, 90, 120 DAS, and days to flowering, seed cotton yield. Averaged across canopy management regimes both the BG II hybrids were more productive, however the response to high planting density was the highest in CICR 191-165 Bt

The modification in morpho-frame brought about by canopy management treatment was clearly evident by the decrease in height: node ratio compared to both normal (90 x 45 cm) and HDPS (90 x 15 cm) sowings.

Field view of canopy management experiment

B) Identification of suitable genotypes for HDPS

An experiment was laid out to identify Bt varieties suitable for HDPS. Ten Bt varieties viz., GHJV 374 Bt, Rajat Bt, CICR Bt 21, Suraj Bt, CICR 25 Bt, PKV 081 Bt, CICR 9 Bt, CICR 16 Bt, CICR Bt 14, and CICR 23 Bt were tested in factorial RBD design along with two BG II checks under two spacing 90 x30cm and 90 x 15 cm. The seed cotton yield was higher in closer (90 x 15 cm) spacing compared to normal spacing (90 x 30 cm). Ajeet 155 was the highest yielder and PKV 081, CICR 21 Bt, and CICR 9 Bt were high yielders than RCH 608 BG II hybrid (Fig. 3.1.2).



CD values: Spacing:1.57, Genotypes:3.85

Fig 3.1.2: Effect of genotypes and spacing on seed cotton yield (q/ha)

3.2 Project Name: Development of elite Bt cotton varieties using potential non-deregulated transgenic events (2018-23)

V.N. Waghmare (PI); Co-PI's : G Balasubramani, Vinita Gotmare, J Amudha, KP Raghavendra, M Saravanan, HB Santosh, Vivek Shah, Rakesh Kumar, Rishi Kumar, VS Nagrare

The importance of the study : Development of transgenic cotton varieties for sustainable bollworm management using available deregulated and indigenous new events available in ICAR-CICR and from Indian Research Institutions.

Salient findings

Introgression and evaluation of Tg2E13 event : The segregating populations of three crosses *viz.*, Suraj × Coker310 (Tg2E13), NH615 × Coker310 (Tg2E13) and CISH3178 × Coker310 (Tg2E13) were raised. Plants homozygous for Tg2E13 event (cry1Ac gene) of three crosses were identified. In CISH 3178 background, plants possessing Tg2E13 event (*cry1Ac* gene), Mon531 event (*cry1Ac* gene) and their combination (Tg2E13+Mon531) were identified for further comparative evaluation.

Evaluation of plants carrying an events Tg2E13 and Mon531, alone and in combination, was proposed for Confined Field Trial (CFT), however for want of NOC from the State Govt. CFT could not be conducted. The trial for evaluation of bio-efficacy and agronomic performance of Tg2E13 and Tg2E13+Mon531 introgressed plants was taken up in the contained facility.

Observations on 100 DAS on number of squares, flowers, total bolls and open bolls revealed delay in maturity in plants carrying Tg2E13 events across the genetic backgrounds (Coker310, NH615, Suraj and CISH3178). Across all backgrounds, plants carrying Tg2E13 event had late progression from flower to boll opening. Also, the plants carrying Tg2E13 event took more days for flower initiation and had lesser boll bursting at 145 DAS. In general, plants carrying Tg2E13 event were late in flowering with prolonged boll maturation period.

Early flowering was observed in non-Bt plants followed by hemizygous plants across the genetic backgrounds. The delay was 10-20 days for initiation of flowering. Delayed boll bursting was observed in homozygous Tg2E13 plants followed by hemizygous plants across the genetic backgrounds. The late maturity was confirmed at 180 DAS. Delay in flowering initiation with significantly larger flowering window and boll maturation period appears to be the basis of late maturity in plants carrying Tg2E13 event.

The results which were discussed and deliberated with the developer, it was agreed that there is no merit in continuing the work further on evaluation and introgression of Tg2E13 event.

Introgression of CH12 event (*cry2Ax1*):

The *cry2Ax1* and *cry1Ac* positive BC_4F_1 plants were identified and selfed to advance to BC_4F_2. The transgene positive plants were subjected to bioassay against American Bollworm *Helicoverpa armigera* and Pink Bollworm Pectinophora gossypiella. On plant bioassay indicated 20-100% mortality of the *H. armigera* larvae while on plants with pyramided genes *cry2Ax1* (CH-12) + *cry1Ac* (on limited bolls) at 100 DAS showed 100 % damage by pink bollworm.

Evaluation of Tma12 (Events) :

Four different TMA-12 events along with resistant and susceptible checks were evaluated for average whitefly adults

and nymphal counts during 2021-22. The average population reduction of adults under open choice condition ranged between 8.26 to 14.45% in different events while under No-choice condition ranged between 11.18 to 20.00 % in comparison to N-Event (Coker 312). Highest counts of whitefly adults were recorded in HS-6 (susceptible genotype). Among the TMA12 events, adult's population was highest on EP-14 (38.53) followed by E-402 (37.15) and least count of adults/3 leaves were observed on E-384 (35.93) in comparison to Non-event (42.00). Similarly, high number of nymphs were recorded on E-384 (52.27) and minimum count /3 leaves on E-403 (45.69). The average population reduction of adults under open choice condition ranged between 8.26 to 14.45% in comparison to N-Event (Coker-312)

Population dynamics under no-choice condition revealed that among all the genotypes, HS-6 (susceptible check) harbor maximum individual of both whitefly adults and nymphs/3 leaves. Comparatively less population of adults and nymphs/3 leaves was recorded on E-384 (35.17 & 56.66) followed by E-403 (35.34 & 45.89), E-402 (36.54 & 49.71), EP-14 (39.05 & 55.56) in comparison to N-Event (43.97 & 77.29). The average population reduction of adults under No-choice condition ranged between 11.18 to 20.00% in comparison to N-Event (Coker312).

Nymphal emergence and mortality (%) in different genotypes: The maximum nymphal mortality in red eyed nymph stage was recorded in E-402 (66%) followed by E-403 (62%), EP-14 (54%), LPS-141 (54%), N-Event (52%), E-384 (46%) and HS-6 (44%). The adult emergence recorded was maximum in HS-6 (56%) followed by E-384 (54%), N-Event (48%), EP-14 (46%), LPS-141 (46%), E-403 (38%) and E-402 (34%).

3.3 Project Name : Development of Asiatic cotton (*G. arboreum*) genotypes with high yield and improved fibre quality traits

Saravanan, M (PI); Co-PIs: V. N.Waghmare

The importance of the study: *Desi* cottons (*G. arboreum*) are inherently tolerant to both abiotic and biotic stresses particularly drought, salinity and aphids, leaf hoppers, rust, fungi, viral diseases. They are highly suitable for organic cotton cultivation. The project aims to breed high yielding and superior fibre quality *desi* cotton in the changing climatic conditions.

Salient findings

Fourteen white linted F4 progeny families of crosses viz., 4725 SP1 x Indicum 12, NA48 x H 483, H493 x NH-54-31-32, AC514 x AC 3066, NH-54-31-32 x GMS, Desi 70 x RG18, Desi 77 x AC3066, Desi 56 x AKA57, Desi 56 x 30810, Malvi x 10 NA 40, 1422 x 19, AC3066 x 19, Desi70 x AC 3066 and NA 48 x 30839 and 10 brown linted F4 progeny families of crosses viz., 1422 x Indicum 12-SP1, Desi 77 x Arboreum 12, G725-SP1 x Indicum 12, H492 x 30839, Desi 56 x Indicum 12-SP1, Indicum12-SP1 x H502, Indicum12-SP1 x H480, H480x Indicum12-SP1, 30814 x AC 3066 and AC514 x Desi 56 were evaluated. A total of 44 promising single plant progenies were selected based on yield and fibre quality traits.

Based on yield and fibre quality traits, 176 promising advanced progenies were selected from crosses between Phule Dhanwantari with PA255, PA812, PA740, PA785 and KWAN3.

3.4 Project Name : Harnessing the potential of wild and unadapted germplasm for cotton improvement

Vinita Gotmare (PI),Co-PIs : SK.Verma, Santosh HB, Chandrashekar N, Rachna Pande, Neelkanth Hiremani, A.H. Prakash, M. Amutha, A. Sampathkumar K. Baghyalakshmi

The importance of the study : Wild species of *Gossypium* are the reservoir of many useful genes governing different economic traits including lint yield, fibre quality and resistance to biotic and abiotic stress. In view of narrow genetic base of cultivated cotton, the available wild species, races of cultivated species and synthetic polyploids of *Gossypium* are conserved and utilized in introgression breeding to broaden the genetic base and to create newer genetic variations for various traits of interest.

Salient findings

First dark brown linted naturally coloured cotton variety (*G. hirsutum*) CICR-H NC Cotton 53 {ICAR-CICR 16301 DB (Vaidehi-1)} derived from wild species of Gossypium for cultivation in rainfed tracts of South Zone was released. The variety is a multispecies introgressed reverted tetraploid genotype derived from hexaploid progenies of the cross between *G. hirsutum, G. raimondii, G. barbadense* and *G. thurberi*. This variety recorded an overall mean seed cotton yield of 1495 kg/ha as against 1338 and 1812 kg/ha for white linted zonal and local check respectively with overall increase in seed cotton yield of 11.73 percent in South Zone for Rainfed conditions comprising states of Karnataka, Telangana, Andhra Pradesh and Tamil Nadu.

The characteristic features of this variety are:

- UHML of 23.8 mm, micronaire of 4.1 µg/in, and bundle strength of 25.1 g/tex.
- Open canopy and leaves with long pedicel that allow direct penetration of sunlight minimizing bollworm attack.
- Tolerant to sucking pests by virtue of being a derivative of wild species namely *G. raimondii* and *G. thurberi*.

Field view, Flower, Green boll & open boll of colour cotton variety CICR-H NC Cotton 53 {ICAR-CICR 16301 DB (Vaidehi-1)}

Introgression breeding

Evaluated introgressed derivatives (*G. arboreum* & *G. hirsutum*) in the field at Nagpur for fibre and economic traits and those with unique traits.

Table 3.4.1: Entries sponsored for AICRP 2021-22 trials

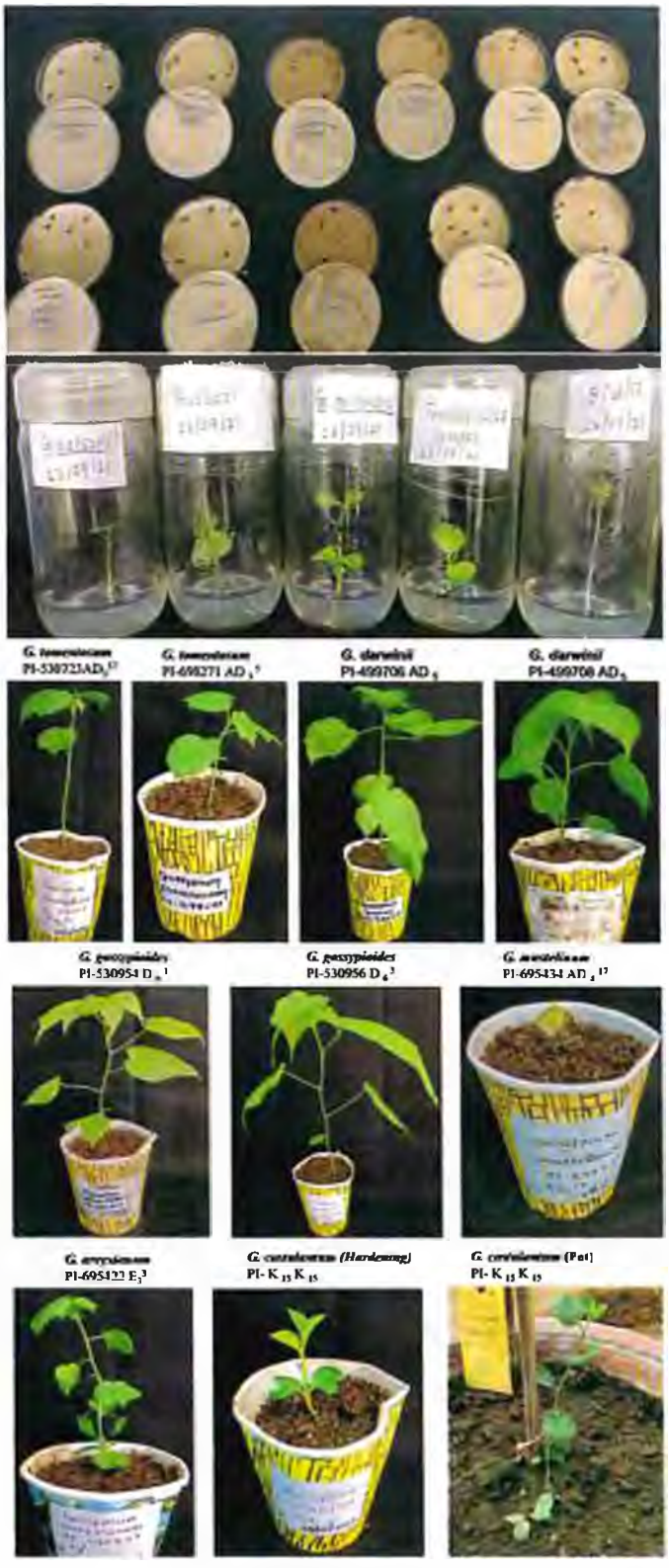
Name of Trial	Year 2021-22
Br 22 (a/b) IET of *G. arboreum*	CNA19086
Colour Cotton	
Br 02 a/b CC IET – *G. hirsutum* (Irrigated / Rainfed)	CCH 20449
	CCH 20452
Zonal Trials – Central Zone	
Br 03 (a/b) PVT CC Irrigated – Central Zone	CNH19325
	CNH19480
	CNH17395
	CNH 18529
	CNH 18528
Br 24 (b) CC CVT *G. arboreum* colour cotton – Central Zone	CNA19475
	CNA18562
	CNA18563
Zonal Trials – South Zone	
Br 03 a/b CC PVT Irrigated - South Zone	CNH 18529

Conservation : 25 wild species, 12 races of cultivated species and more than 45 synthetic polyploids are conserved in the wild species garden.

Enrichment : Seeds of 21 accessions of 9 wild species imported from USDA in October 2021 were sown in pots and plants have been established. Saplings of *G. mustelinum (3 nos.)* and *G. ekmanianum (4 nos) obtained from Rasi* seeds Pvt Ltd in December 2021 were also established in pots. Confirmed that *G. nelsonii* obtained from MPKV, Rahuri and existing *G. australe* species are distinct though they were morphologically similar.

Wild species accessions from USDA established in pots. *G. ekmanianum* & *G. mustelinum* established in Glass House

Around 20 different accessions of wild species seeds were subjected to In-vitro procedures involving seed treatments, germination paper, tissue culture media and modified potting mixtures. The wild species viz; *Gossypium tomentosum* (PI-530723, AD317), *G. tomentosum* (PI-698271, AD 3 5), *G. gossypioides* (PI-530954, D 6 1), *G. gossypioids* (PI-530956, D 6 3), *G. areysianum* PI-695422 , E33), *G. costulantum* (PI-K15), *G. darwinii* (PI-499706, AD 5 18), *G. darwinii* PI-499708, AD 5 20), and*G. mustelinum* (PI-695434, AD 4 17) were successfully established and molecular characterization of the introduced wild species have been initiated.



***In-vitro* establishment of wild species**

Crosses attempted between cultivar /races and wild species were 4225 while twenty one (21) F1 hybrids established in pot culture. Cultivars & Races used in the crossing programme included LRA5166, LRK 516, MCU5, MCU5VT, Arogya, Suvin, KH3, Moco, Suraj, MCU10, Africanum, Jawahar Tapti, AK5, AK7, PA255, PA402, CNA1003, Digvijay, AK8401, Gcot23, DLSA17, Latifolium, Palmeri, Richmondii, Sinense, Indicum, Burmanicum, Bengalense, Cernuum, Soudanense

Single plant selections were made from F_6 generation of the following crosses

G. arboreum x G. longicalyx; G. arboreum x G. thurberi; G. arboreum race indicum x G. davidsonii & AK 8401 x G. davidsonii.

Ten progenies with best fibre properties (Fibre length (mm): 22.4 - 26.6;Fibre strength (g/tex): 24.92-28.85) derived from Jawahar Tapi x G. longicalyx were shared with AICCIP centres namely CRS, Nanded, CRS, Parbhani, CICR RS, Coimbatore, CRS, Surat, CRS PAU Ludhiana & CRS PAU, Faridkot in Pre-breeding Project.

Colour cotton

Forty five (45) colour cotton entries evaluated in field for their fibre traits during the cropping season and 230 single plant selections were identified for yield and yield contributing traits.

Exploration of unadapted germplasm (Exotic Collections) for GOT improvement in upland cotton: The three high GOT exotic accessions viz., EC143506 (GOT-43.3%), EC141725 (GOT-41.2%) and EC137596 (GOT-41.7%) were crossed to LRA5166 (non-Bt, 35% GOT with wider adaptability), CNH 191901 (non-Bt, earliness, jassid tolerance, 36% GOT), CNH 191611 (non-Bt, earliness, 38% GOT), CNH181381 (non-Bt, earliness, jassid tolerance, 37% GOT), Suraj Bt (Bt-*cry1Ac*, high yielding, 37% GOT), CICR Bt 183059-4 (Bt-*cry1Ac*, high yielding, 37% GOT). The exotic accessions and their F1 plants were found to be susceptible to sucking pests. The F1 plants of the above crosses were backcrossed to their respective recurrent parents during 2021-22 as given below.

Backcrosses in Bt background	Backcrosses in non-Bt background
(EC143506xSurajBt)xSuraj Bt (EC141725xSurajBt)xSuraj Bt (EC137596xSurajBt)xSuraj Bt (EC137596xCICRBt183059 4) x CICR Bt 183059-4	(EC143506xLRA5166)x LRA5166 (EC143506xCNH 191611) x CNH 191611 (EC143506xCNH 191901) x CNH 191901 (EC141725xLRA5166)x LRA5166 (EC141725xCNH 191611) x CNH 191611 (EC137596xLRA5166)xLRA5166

Root enzyme activities of waterlogging susceptible and tolerant lines: Root enzyme assays were done in waterlogging susceptible and tolerant lines to be used for marker assisted breeding. The sucrose synthase activity is higher in susceptible varieties both under control and waterlogged conditions. However when compared to susceptible ones, the tolerant genotypes LRA5166 (391 µg/g/hr) and IC 63998(272 µg/g/hr) recorded almost 2 fold increase in sucrose synthase activity under water logged conditions when compared to other genotypes. Lactate dehydrogenase activity in roots is higher in tolerant varieties LRA 5166 and IC 63998 both under control and water logged conditions. Lactate formation is an important indicator of the ability of a plant to survive hypoxia without extensive cell damage. Among the lines, LRA 5166 recorded higher number of sympodia, higher root lactate dehydrogenase activity under stress conditions. Higher leaf alcohol dehydrogenase activity was recorded by both LRA 5166 and IC63998 under stress condition compared to susceptible ones. There is no notable difference in root alcohol dehydrogenase activity and root pyruvate decarboxylase activity among tolerant and susceptible ones under stress conditions. The Nitrate reductase activity in roots is higher in tolerant varieties both under control and water logged conditions. Hence the plants can cope up with nitrogen assimilation under hypoxic conditions.

3.5 Project Name : Collection, conservation, evaluation, documentation and maintenance of germplasm of cultivated species of *Gossypium*

Vinita Gotmare (PI), Co-PIs : Sunil S. Mahajan, M. Saravanan, Neelakanth S. Hiremani, Manickam, A.H. Prakash, A. Manivannan, SK. Verma, Debashis Paul, Anjali Kak

Importance of the study : The ICAR-CICR has been entrusted with the responsibility to plan, conduct, promote and coordinate the collection, characterization, evaluation, conservation, exchange, documentation and sustainable management of diverse germplasm of cotton and its storage (ex-situ at 5°C temp and 35% RH) with a view to ensuring their availability for use over time to breeders and other researchers.

Salient findings

Conservation : Cotton Genetic Resources (12336) were conserved in MTS facility and in-situ during 2021-22 at ICAR-CICR (Nagpur & Regional station, Coimbatore) (Table 3.5.1).

One hundred eighteen accessions of *G. arboreum*, 16 of *G. herbaceum* and 32 of *G. hirsutum* were collected from different regions of the country (Table 3.5.2) and evaluated along with respective check varieties.

Table 3.5.1: Germplasm holdings at ICAR-CICR in 2021-22

Name of Species	Total Numbers
G. hirsutum	8851
G. barbadense	536
G. arboreum	2053
G. herbaceum	565
WILD SPECIES	**25**
Races of Cultivated species and Derivatives	
G. hirsutum	4
G. barbadense	1
G. arboreum	6
G. herbaceum	1
Synthetic Polyploids	40
Perennials & Other Races	254
TOTAL	**12336**

Table 3.5.2: Collection of germplasm accessions through exploration

Sr. No	Name of the species	No.	Region of collection	Check Varieties
1	*Gossypium arboreum*	118	Arunachal Pradesh, Assam, Nagaland, Tripura and Mizoram	PA402, Roja, AKA8401 and AKA07
2	*G. herbaceum*	16	Gujarat & Tamil Nadu	Jayadhar, G.cot, DDHC-11
3	*G. hirsutum*	32	Sundarban region of West Bengal	Suraj, Surabhi & Sunantha

Rejuvenation/Multiplication/Evaluation of Germplasm accessions/Experimental material : Total 4585 germplasm accessions of *G. hirsutum, G. arboreum* and *G. herbaceum* consisting of base collection, core collections, registered lines, exotic collections, coker lines and released varieties were evaluated along with five checks mainly Arogya, Surabhi, Rajat, DCH32 and Jayadhar at Nagpur for fibre and other traits. Rouging, Single plant selections and recording of morpho-economical observations was taken up during the cropping season 2021-22. Screening for pests and diseases of Core Collection (*G. hirsutum*), Varieties, Registered Genetic stocks and other germplasm accessions against Jassid, *Helicoverpa armigera*, Pink Bollworm, Corynespora leaf spot, Bacterial blight & Grey mildew was done. One hundred and fourteen (114) Exotic accessions of *G. hirsutum* and *G. arboreum* were maintained in Pots at contained facility.

Introgression of CLCuD tolerance from immune lines BC_2–F_1 were developed using CLCuV immune accessions GVS-8 & GVS 9. Six one Way Crosses [CSH3075 ×GVS–8, CSH3129 ×GVS–8, HS6 ×GVS–8, CSH3075 ×GVS–9, CSH3129 ×GSV–9 & HS6 ×GVS– 9] and four reciprocal Crosses [GVS-8xCSH-75, GVS-8xCSH-2129, GVS-8xHS-6&GVS-9xCSH-3075] were harvested and will be further evaluated at CICR RS Sirsa.

CMS Conversion conducted on three identified Sterile Lines:

Backcrossing for CMS conversion on BC_1-F_1 was conducted to develop 12 BC_2–F_1 population viz. PF10165×IC357694, PF10165×IC358002, PF10165×IC358277, PF10165×AKH 9916, PF10166×IC357694, PF10166×IC358002, PF10166×IC358277, PF10166×AKH 9916, HA10167×IC357694, HA10167×IC358002, HA10167×IC358277 & HA10167×AKH9916

Sharing/distribution of seeds to indenter/breeders: One thousand four hundred forty-six (1446) novel trait based Germplasm accessions consisting of *G. hirsutum*; *G. arboreum* and *G. herbaceum* shared to breeders/ scientists of State Agricultural Universities and Private Seed Companies as well as Indenter/breeders within institute for utilization in their cotton improvement programme.

Multiplication and deposition of germplasm accessions in LTS, NBPGR, New Delhi and MTS at CICR Nagpur: Deposition of 480 *G. hirsutum* accessions including Exotic and Core collection accessions at LTS, NBPGR, New Delhi and 322 trait-based germplasm accessions from breeders of CICR Institute and Regional Stations were deposited at MTS CICR, Nagpur.

Management & Maintenance of Genetic Resources & documentation: Seeds of 12336 accessions *of G. hirsutum, G. barbadense, G. arboreum* and *G. herbaceum*, their races, interspecific derivatives, perennials and land races are being maintained and conserved in Medium Term Storage (MTS) Module at ICAR-CICR Nagpur and other set for Long-Term Storage at ICAR- NBPGR New Delhi. Seeds of 1667 accessions deposited by breeders are also conserved in the MTS and documented. Cotton germplasm database of base collection, core collection and registered accessions and other exotic material is also managed and maintained. Updated and compiled the passport data of Core collections, Base collections and working collection and submitted to NBPGR, New Delhi (Table 3.5.3).

Table 3.5.3: Range of Quantitative Character values in Germplasm

Registered Line (49)		
Sr. No.	**Characters**	**Range**
1	Plant Height (cm)	81.7-236
2	No. of Sympodia/plant	11-32
3	Boll weight (gm)	1.8-5.86
4	No. of Bolls /plant	13-45
5	Seed Cotton Yield/plant (gm)	17.28-67.78
6	Ginning Outturn (%)	26.0-41.30
7	Seed Index (gm)	5.2-9.6
Core Collection (780)		
Sr. No.	**Characters**	**Range**
1	Plant Height (cm)	39.5-179.3
2	Boll weight (gm)	2.92-6.38
3	Seed Cotton Yield/plant (gm)	8.08-156.0
4	Ginning Outturn (%)	25.91-45.15
5	Seed Index (gm)	5.2-13.9
6	Fibre Length (mm)	21-33.3
7	Fibre Strength (g/tex)	22.1-33.2
Sayaji (Exotic *G. hirsutum* Material - 346)		
Sr. No.	**Characters**	**Range**
1	No. of Sympodia/plant	8-26
2	No. of Bolls /plant	7-45
3	Boll weight (gm)	1.26-6.8
4	Seed Cotton Yield/plant (gm)	6.61-131.0
5	Ginning Outturn (%)	18.67-43.78
6	Seed Index (gm)	5.0-13.9

Coimbatore

Evaluation and maintenance of *G. barbadense* germplasm at Regional Station Coimbatore : A set of 108 *G. barbadense* exotic accessions along with three checks were grown in augmented design at ICAR-CICR, Regional Station, Coimbatore. Their fiber length (SL) varied from 24.3 mm to 40.3 mm (mean: 33.9 mm), uniformity ratio (UR) 81 to 89 (mean: 85.8), micronaire 3.2 to 5.9 (mean: 4.1), fiber strength 23.2 g/tex to 45.6 g/tex (mean: 36.4 g/tex), and elongation 6.1 to 7.0 (mean: 6.8). Accessions with High yield, high length and strength (CCB33, EC959191, ERB13738, ICB115),High yield, high length (EC959098, BAHTIM185, 14-15BAR, ICB121), High yield, high strength(ICB 254) and High yield, high micronaire: (ERS13754, ICB190, ICB22, EC9260, EC97633) were identified for their further utilisation in Breeding program. DB16, EA201, EA203, EA204, EA188, EC959191, ARBB20, 5746U & GSB39 were identified as genetically diverse accessions.

Improved accessions of *G. barbadense* over the year was identified on the basis of morphological traits viz., Brown

linted EA203 (Brown Colour lint found in *Gossypium barbadense)*, Big Boll EA159 (Boll Weight: 5.2 to 6.1gm per boll) and Naked Seeds - EC 959057 (Seeds surface is naked, little fuzz only on surface of the seed coat) which could be further utilized in introgression breeding or to register as genetic stock.

Sirsa

Rejuvenation and evaluation of G. *hirsutum* germplasm accessions

A total of 402 *G. hirsutum* accessions were evaluated. The Pearson correlation analysis showed a significant positive correlation among single plant yield and number of sympods (r=0.57*) and boll weight (r=0.365*). Four accessions viz. EC 138570(101.67g), EXO-37 (106.33g), EC138572cc (95g) and EC618300 (113.93g) had highest mean single plant yield(g).Three accessions viz. EC170340 (36.67 %), EC134389 (37.5 %) and IC 291694 (40.3 %) had highest mean GOT (%). Two genotypes EC128578 (29.3 mm, 29.8 g/tex) and EC344451 (31.5mm, 30.4g/tex) showed highest mean UHML (mm) as well as Fiber strength (g/tex).

3.6 Project Name : Development of broad based high yielding varieties of diploid and tetraploid cotton through recurrent selection (2020-26).

V.N. Waghmare (PI);Co-PI: SK. Verma

The importance of the study : The project involving several parental lines aimed at development of broad-based *G. arboreum* and *G. hirsutum* varieties with improved fibre traits and high seed cotton yield through cycles of selection and intercrossing. It also envisages development of high yielding spinnable as well coarse type *G. arboreum* varieties and GMS based hybrids for North Zone.

Salient findings

Population Improvement

Evaluation of advance cultures: During 2021-22, 174 stable selections of *G. arboreum* and 52 of *G. hirsutum* were evaluated in 9 replicated trials (4 rows plots in 2 replications). 92 advanced generation selections of *G. arboreum* and 24 of *G. hirsutum* were identified and retained for further evaluation in replicated trial during 2022-23. The range for seed cotton yield among the *G. arboreum* selections ranged from 132 to 2085 kg/ha while in *G. hirsutum* it ranged from 706 to 1652 kg/ha. Some of the *G. arboreum* selections possessed FL of 29.6 mm with FS of 30.0 g/tex while Some selections of *G. hirsutum* possessed FL of 29.5mm with FS of 30.3 g/tex.

Evaluation of single plant selection : About 1394 superior single plants selections were evaluated as plant to row progenies. Based on the performance and uniformity, 78 plant progenies of *G. arboreum* and 36 of *G. hirsutum* were identified for evaluation in replicated trials. 1347 single plants from the segregating progenies and population were selected for further evaluation as plant progenies during 2022-23.

Evaluation of sterile plants : Based on evaluation of 3269 single sterile plants from composite population (1244 of *G. arboreum* and 2054 of *G. hirsutum*) superior progenies for specific traits namely boll weight, GOT and seed cotton yield were identified. By employing selection pressure, about 10-15% superior progenies for specific traits were identified. The remaining seeds of the identified progenies from the previous year in equal quantity bulked together to raise traits specific population. About 519 single sterile plants were harvested separately and raised as plant to row progenies. All the single plant progenies were monitored for segregation and sterile and fertile plants were separately tagged. Fertile plants shall be evaluated for economic and quality traits to identify progenies for specific superior traits.

Recurrent population : Composite populations constituted for boll wt., GOT and SCY are grown for further selection and advancement of population.

Identification and release of varieties : CNA 1031 *G. arboreum* tested in Agronomy trial in Central Zone during 2019-20 and a colour cotton variety CICR-A Cotton 57 *(CNA 1091)* tested in Agronomy trial in South Zone during 2021-22 were identified for commercial cultivation by Varietal Identification Committee. Subsequently both the varieties CICR-A Cotton 56 (CNA1031) and CICR-A Cotton 57 *(CNA 1091)* were released by CVRC under the Chairmanship of T.R. Sharma DDG (CS), ICAR **and notified in the** Gazette vide S.O. 4065(E) dated August 31st, 2022 (Table 3.6.1).

Table 3.6.1: Evaluated *G. arboreum* varieties CNA1031 and CNA1091

S.No.	Characters	CNA 1031	CNA 1091
1	Seed cotton yield potential (Kg/ha.)	1356.5	1267
2	Boll weight (g)	2.60	2.60
3	Ginning Outturn (%)	35.9	32.9
4	Days to maturity (days)	150-160	150-160
	Fibre characteristics		
5	Fibre length (at 2.5% SL)	25.7mm	24.5 mm
6	Micronaire	5.2	5.2
7	Bundle strength (g/tex)	27.8	23.3
8	Zone of cultivation	Central Zone	South Zone

***G. arboreum* Variety CNA1031** ***G. arboreum* Variety CNA1091**

Entries Sponsored under AICRP: *G. arboreum* three entries CNA 1084, CNA 1085 and CNA 1086 were sponsored to Br. 22(a/b) National trial.

Entries promoted under AICRP trials: *G. arboreum* CNA1072 and CNA 1092 (a coloured linted *G. arboreum*) promoted and retained in Central Zone. CNA 2034 promoted in South Zone.

Agronomy Trial : CNA1091 a coloured cotton *G. arboreum* genotype was tested for agronomy in South Zone under rainfed conditions.

Maintenance and multiplication of varieties : CNA1028, CNA1032. CNA1031, CNA1054, CNA1003, CNA1091, CNH1111 and CNH 1128.

Sirsa

Evaluation of GMS based *G. arboreum* hybrids : Two GMS based hybrids were evaluated for seed cotton yield with two check hybrids AAH 1 and CICR 2. One GMS based hybrid CISAA 20-1 (3048.4kg/ha) recorded significantly higher seed cotton yield than the highest yielder check hybrid CICR 2 (2800.5 kg/ha). CISAA 20-2 (2842.8 kg/ha) was numerically higher than CICR 2 (2800.5 kg/ha) and AAH-1 (2766.9 kg/ha) both the check hybrid during 2021-22 (Table 3.6.2).Table 3.6.2: Performance evaluation of GMS based *G. arboreum* hybrids

Entry Name	SCY (kg/ha)	Boll wt(g)	Bolls/plant	Fibre Traits				
				GOT (%)	UHML (mm)	UI	Strength (g/tex)	Mic.
CISAA 20-1	3048.4	2.24	39	39.4	22.2	79	22.2	6.8
CISAA 20-2	2842.8	2.19	35	41.4	19.8	78	20.0	7.2
AAH-1	2766.9	2.23	36	40.6	20.2	78	20.9	7.2
CICR-2	2800.5	2.32	36	41.3	20.0	78	20.3	6.9
CD	255.93							
CV (%)	8.2							

Evaluation of Spinnable *G. arboreum* cultures : Fourteen cultures were tested in RBD along with two checks CISA 614 (2996.2 kg/ha) and PA 255 (2175.9 kg/ha). None of the genotypes gave significantly higher yield than the checks CISA 614 (2996.2 kg/ha). Three genotype namely CISA6-209 (2651.0 kg/ha), CISA 64 (2527.5 kg/ha) and CISA 33-4 (2471.6 kg/ha) showed significantly higher yield than the check PA-255 (2175.9 kg/ha). Three genotypes CISA-6-295, CISA-33-8 and CISA 33-2 were having UHML (mm) >25.0mm and strength ~25.0 g/tex in HVI mode during 2021-22.

Evaluation of high yielding *G. arboreum* genotypes : Fourteen genotypes were evaluated in RBD design with two check varieties CISA 614 and CISA 310. CISA 33-9 (3002.4 kg/ha) gave significantly higher seed cotton yield than the high yielding local checks CISA 614 (2555.7 kg/ha) and CISA 310 (2450.2 kg/ha). Two more genotypes i.e. CISA-6-165 (2785.2 kg/ha) and CISA-6-187 (2738.6 kg/ha) gave numerically higher seed cotton yield than high yielding local checks CISA 614 (2556.7 kg/ha) and CISA 310 (2450.2 kg/ha).

Maintenance of GMS lines : Four GMS lines DS 5, CISA 2, GAK 413A, CISG-20 and three more newly identified GMS lines, CISG-10, CISG-13, CISG-14, were maintained through sib mating. Pigmented GMS lines CISG-10 and CISG-13 possessed red flower colour with petal spot.

New Crosses attempted using GVS lines for pyramiding of traits against CLCuD & sucking pests : Some new crosses i.e. GVS-9 X CICR Bt-6, GVS-8 X CICRBt-6, GVS-8 X BGDS 1063, GVS-9 X BGDS 1063, GVS-9 X CSH 3075, GVS-8 X CSH 3075, GVS-9 X CSH-3129,GVS-8 X CSH-3129, GVS-8 X F2228, GVS-9 X DHY-286,GVS-8 X DHY-286, GVS-8 X HS-6,GVS-9 X HS-6,CSH-3075 X GVS-9,CSH-3129 X GVS-8 were attempted during the crop season.

- *G. arboreum* variety CISA-6-165 and CISA-33-9 sponsored in AICRP (Br 22a/b) National trial.
- *G. arboreum* variety CISA 33-7 advanced to Zonal Trial Br 24a
- Two intra-*arboreum* GMS based hybrids CISAA-21-1 and CISAA-21-2 sponsored in Br 25a/b National trial.
- Two GMS based *G. arboreum* hybrids CISAA 20-1 and 19-4 were promoted to Co-ordinated trial Br 25a.

3.7 Project Name : Breeding to improve performance of *Gossypium herbaceum* for adaptation to climate change in Central India

D.V. Patil (PI)

The importance of the study : *Gossypium herbaceum* species has immense inherent capacity to grow in abiotic stress conditions. This project aims to develop genotypes suitable for early maturity traits that escape late season water stress and fit in short season cropping system.

Salient findings

Ten herbaceum genotypes having seed cotton yield potential from 1,243 to 1,812 kg / ha and with early maturity traits that escape late season water stress were identified. CNh-33 (1,812.09 SCY kg/ha) and CNh - 66 (1,729.67 SCY kg/ha) were sponsored in AICRP for multilocation evaluation during 2022-23.

3.8 Project Name: Development of heterotic pools in hirsutum

D.V. Patil (PI)

The importance of the study: The project envisages developing the heterotic genepool and creating recombinational variability among the *hirsutum* parents.

Salient findings

Fourteen *G. hirsutum* parents grouped in two groups based on the positive and negative general combining ability based on evaluation of 91 F1 hybrid combinations (non-diallel). F1 crosses GM - 42 x IC-561248, GM - 28 x IC – 597398, GM – 14 x IC- 561248 has early maturity traits (Fig. 3.8.1 & 2). F1 hybrids GM – 17 x IC – 553925, GM – 18 x IC – 296770, GM - 13 x IC-587405 and GM – 15 x IC -14/8/1 has late maturity with high number of bolls (> 40 bolls / plant).

Table 3.8.1: Grouping of 14 genotypes to develop heterotic pools in *G. hirsutum* cotton

GCA effect : Seed Cotton Yield (g / plant)			
P1	IC-296770	P2	Suraj
P5	IC- 563997	P3	IC- 553272
P6	IC- 987405	P4	IC- 561248
P7	Rajat – NBT	P9	IC-611336
P8	IC- 597398	P10	IC-553925
P13	CNH-1123	P11	CNH-1110
P14	C-14/8/1	P12	CNH-1129
Group – I (Positive GCA)		Group – I (Negative GCA)	

Fig.3.8.1 : Performance of GM - 42 x IC-561248 for early maturity

Fig.3.8.2 : Performance of GM - 20 x IC-561248 for late maturity

3.9 Project Name: Breeding for early maturity, compact plant type and jassid tolerance in cotton

HB Santosh (PI); Co-PI: S Manickam

The importance of the study : Availability of cotton cultivars with compact plant architecture is a basic requirement for the success of HDPS. This project envisages to develop cotton varieties which will have the potential to produce higher yield per unit area (under HDPS) and per unit time (due to early maturity) along with inherent resilience to jassids, better yield and fibre quality attributes. Early maturing cotton variety can also help escaping pink bollworm damage.

Salient findings

Most promising lines for earliness, compact plant type and jassid tolerance were identified upon screening of potential germplasm over two years in replicated trial. The identified promising lines were utilized in hybridization programme to develop early maturing, compact, jassid tolerant cotton varieties/genotypes. Promising progenies and selections possessing earliness (120-150 days for 90% boll bursting), jassid tolerance (grade I), compact plant architecture (height 100-120cm and horizontal width 30-50cm with zero or short monopodia), good boll weight (3.5-5 gm), per plant yield of around 80-130gm, fibre length (24-31mm; HVI mode) and fibre strength (24-30g/tex; HVI mode) were identified, stabilized and seed multiplied, in both Bt and non-Bt backgrounds. A total of 15 Bt entries and 3 non-Bt entries were sponsored to different trials of ICAR-AICRP on Cotton. of the 15 Bt entries, 4 are in AET2, 1 is in AET1 and 2 are in IET. The promising Bt and non-Bt entries which matures as early as 120 days are seed multiplied and proposed for their registration as unique genetic stock. Molecular divergence among jassid tolerant and susceptible upland cotton genotypes was studied using 49 identified polymorphic SSR markers to identify the most divergent lines. Our field studies have revealed that open boll damage is (negatively) associated with early maturity (% boll bursting) and an early maturing variety ($\leqslant$ 150 days) sown in mid-June can potentially escape pink bollworm damage.

3.10 Project Name: AICRP on Seed (Crops)

V Santhy (PI); Co-PI's: S. S. Mahajan, K. Rathinavel, Debashis Paul

The importance of the study: The project aims to produce sufficient quantity of breeder seeds, foundation seeds and certified seeds as well as TFL seeds of released and notified crop varieties of cotton. In order to utilize the used land as well as to improve the soil properties of the land under cultivation, seeds of other crop varieties such as red-gram, chickpea and linseed are also taken up in kharif and rabi season.

Salient findings

At Nagpur, 120 Kg nucleus seed from 6 Bt varieties; at Sirsa, 56 Kg from one Bt and five non Bt varieties were produced. Additionally at Sirsa, 127 Kg pure seeds of parental lines of five popular hybrids were also produced. A total of 7.12 q breeder seeds of Bt varieties and 1.7 q TFL seed of one Bt variety were produced (Table 3.10.1). Among non Bt varieties, 13.0 q breeder seed of *G. hirsutum* varieties, 120 Kg breeder seed of two *G. barbadense* varieties and 4.56 q breeder seed of *G. arboreum* varieties were produced across centers during 2021-22 (Table 3.10.2).

With respect to quality (Foundation) seed produced under other crops, redgram seeds (BSMR 736): 52.5 q, linseed (NL260): 0.84 q and gram (Jacki 9218): 15.05 q and 180 Q seed of wheat (HD 3226) was produced at Nagpur and Sirsa.

Table 3.10.1 : Breeder and TFL seed produced for Bt varieties (Kg)

Location	Name	Quantity produced
Nagpur	SurajBt (BS)	51
	SurajBt (TFL)	174
	RajatBt (BS)	36
	PKV-081 Bt (BS)	152
	GJHV Bt (BS)	27
	CICR 16 Bt (BS)	23
	CICR 23 Bt (BS)	18
Coimbatore	23 Bt (BS)	45
Sirsa	Bt 6 (BS)	360

Table 3.10.2 : Breeder seed produced for non-Bt varieties (Kg)

Location	Name	Species	Quantity (Kg)
Nagpur	Suraj	hirsutum	128
	LRA 5166	hirsutum	21
	LRK 516	hirsutum	71
	Surabhi	hirsutum	65
	CNA 1028	arbroeum	64
	CNA 1032	arbroeum	53
	CNA 1054	arbroeum	34
	CNA 1003	arbroeum	45

Location	Name	Species	Quantity (Kg)
Coimbatore	Suvin	barbadense	90
	CCH 4474 (Subiksha)	hirsutum	110
	CICR-H-36 (Suraksha)	hirsutum	180
	CCH 14-1 (Sunantha)	hirsutum	160
	CICR B cotton 37	barbadense	30
	Surabhi	hirsutum	170
Sirsa	CSH 3129	hirsutum	110
	CSH 3075	hirsutum	300
	CICR-1	arbroeum	130
	CICR -3	arbroeum	130

3.11 Project Name: Seed characterization based on protein quantification and profiling in Cotton

V. Santhy (PI);Co-PI: Pooja Verma

The importance of the study: Cotton has reached close to becoming a major seed protein source for human nutrition. Seed protein content and their storage fraction needs to be understood among the present-day cotton genotypes, species, germplasm accessions and seeds of different seed quality etc. It is also essential to understand the variation for seed protein content for the same set of varieties over the seasons and, grown at different locations or stage of picking and seed quality.

Salient findings

The tris soluble (total soluble) seed protein content studied in released varieties were not consistent over the years of seed production indicating a high provenance effect. However, the genotypes showing high or low seed protein content remained similar irrespective of the location or season in which the seeds were produced. Among the sixteen wild species studied, *G. anomalum* and *G. raimondii* showed the highest and *G. somalense* showed the lowest total soluble seed protein content. The total soluble seed protein content showed positive correlation with seed weight whereas, the storage fractions (albumin, globulin, prolamina and glutalin) showed negative and indifferent correlation. Among the fractions, albumins and globulins were prominent in cotton seeds than prolamins and glutelins.

Reduction in total soluble seed protein content was observed as cotton seed loose its viability. SDS PAGE profile of tris-soluble, albumin and globulin proteins and isoenzyme profile (esterase, malate dehydrogenase) could not distinguish CICR released popular hybrid, CICR 2 from its male and female parents nor the four cultivated species. The seed coat contributes to 50-60% of the delinted seed weight, was another observation made under this project.

3.12 Project Name: Strategies to augment quality and storability of cotton seed under different environmental conditions

Sunil S. Mahajan, (PI); Co-PIs: V. Santhy, PR Vijayakumari

Importance of the study: The knowledge of cotton seed storability is essential to avoid loss of valuable genetic stocks, unsold commercial seed stocks, carry over seed stock and unused breeding cultures to be sown in subsequent sowing season. The information from such studies will help all stakeholders such as small holding farmers, researchers, gene bank custodians and commercial seed suppliers to maintain quality seeds without much loss in viability.

Salient findings

Seeds of cotton variety LRA-5166 was stored in a modified gases like, N_2, Argon and CO_2 along with proper control in ambient and refrigeration conditions for 48 months. The results indicated that seeds stored in argon gases maintained highest seed germination above 80% till 48 months in both the storage conditions. However, there was a significant difference observed among the storage conditions, storage period and modified gases. Similarly, seed of variety Roja (CNA-1003) could maintain the highest seed germination above 75% in Argon as compared to the other gases till 30 months in both the conditions. Whereas, the seeds of Suraj variety stored in N_2 gas maintained seed germination above 65% upto 24 months in refrigerated conditions. The seed germination of Suraj was 64% and 60% in CO_2 and N_2 gases in an ambient condition, respectively.

Seeds stored for 30 months under medium term cold storage and refrigeration conditions recorded highest seed germination as compared to seed stored under ambient storage in Suraj and Roja. Similarly, vacuum conditions favoured in maintaining the highest seed germination in both the varieties followed by non-vacuum, polythene bags and cloth bags.

Seed stored under airtight containers with zeolite beads revealed that the seeds of Roja could maintain seed germination of 75% and 70% under refrigeration and ambient conditions, respectively for 30 months. Whereas, in Suraj the seed germination was 65% and 69% in zeolite beads and polythene bags, respectively under refrigeration condition after 18 months of storage.

3.13 Project Name: Identification, cloning and functional validation of genes/enzymes involved in chitin biosynthesis pathway of cotton pink bollworm (*Pectinophora gossypiella*)

Joy Das (PI); Co-PI's: Raghavendra KP, Rakesh Kumar

The importance of the study : This study is aimed to characterize key genes of chitin biosynthesis pathway, UDP-N-acetyl glucosamine pyrophosphorylase (*PUAP*) and phospho-N-acetyl glucosamine mutase (*PPGM*), to elucidate their roles as targets for chitin biosynthesis inhibition in pink bollworm (PBW).

Salient findings

Transcriptome representing larva of cotton pink bollworm (Nagpur population) was sequenced. For transcriptome data analysis a *de novo* transcriptome assembly was created, as there was unavailability of reference genome of *Pectinophora sp.* The raw reads were cleaned and assembled generating 135,944 transcripts. Further filtering of cleaned reads narrowed down the data to 57,751 transcripts, with GC content of 42.16% among the filtered transcripts. Using the filtered transcriptome assembly, a total of 30,124 genes were annotated (UniProt). Following this, 12 genes with their respective isoforms were identified, whose homologs are known to play roles in chitin regulatory pathway in insects. Out of those, two candidate

genes (*PPGM* and *PUAP*) from the chitin biosynthesis pathway of PBW have been amplified, validating their full-length sizes of 1.6 and 1.4 kb respectively. KEGG analysis was done to explore the putative metabolic network of all the identified 12 chitin regulatory genes from PBW (Figure 3.13.1). For this purpose, KAAS online tool was used. This was followed by STRING analysis to establish protein-protein interactions among the twelve gene products i,e. enzymes.

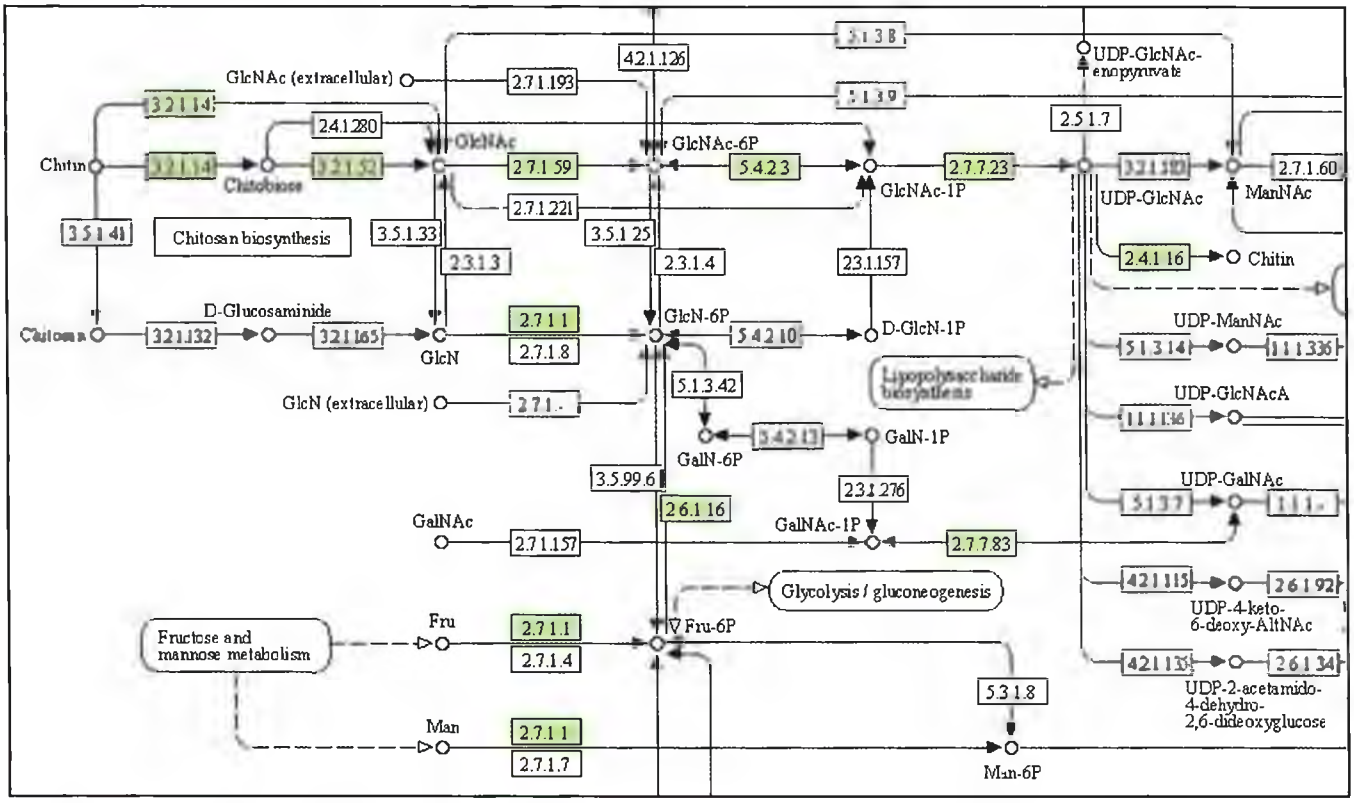


Fig.3.13.1: KEGG analysis for chitin regulatory genes from PBW (represented as their respective enzyme accession numbers in green boxes)

3.14 Project Name: Exploration of genomic resources for identification of candidate genes and promoters for cotton improvement

K P Raghavendra (PI); Co-PI's: Joy Das, Pooja Verma, Rakesh Kumar, Chandrashekar N

The importance of the study : The deployment of biotechnology tools for cotton crop improvement demands discovery of novel genes associated with economical important traits and to unveil the possible role of engineered Cry toxin for enhanced toxicity against cotton bollworms.

Salient findings

Genes for bollworm management: With the quest for new genes for pink bollworm (PBW) management, the recombinant Cry1D protein expressed in *E.coli* was purified and subsequently quantified using His-Tag detection ELISA kit. The induction, purification and concentrations using Millipore Ultra Centrifugal Filter Units (30 kDa) were repeated and the dilutions of different concentrations Cry1D proteins were prepared and used for PBW bioassays. The bio-efficacy of the Cry1D protein at different concentrations against field collected & laboratory reared pink bollworm populations of Nagpur was reconfirmed. Codon optimized *cry1D* nucleotide sequence was custom synthesized and cloned in to pJET cloning vector (Fig. 3.14.1). Developed gene construct for *cry1D* gene through sub cloning of plant codon optimized *cry1D* gene in to plant expression vector and mobilized into *Agrobacterium tumefaciens* EHA105. Development of transgenic events through Agrobacterium mediated transformation in cotton and tobacco and regeneration of transformants is in progress.

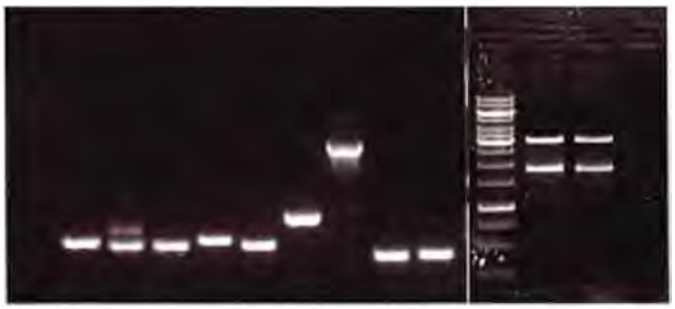


Fig 3.14.1 : Colony PCR and Restriction confirmation of clones containing cry1Dgene (1.8kb)

Gene constructs for GaDAR1 Promoter : uidA for functional validation under abiotic stress: PCR conditions for isolation of 1.45 kb *Gossypium arboreum* DAR (GaDAR) promoter sequence were standardized and the promoter sequence was isolated using specific primers. Directional cloning of the promoter fragment by replacing 35S promoter sequence using HindIII and Xbal restricton digestion into pBI121vector was done and confirmed through colony PCR and restriction digestion of the plasmid (Fig. 3.14.2).

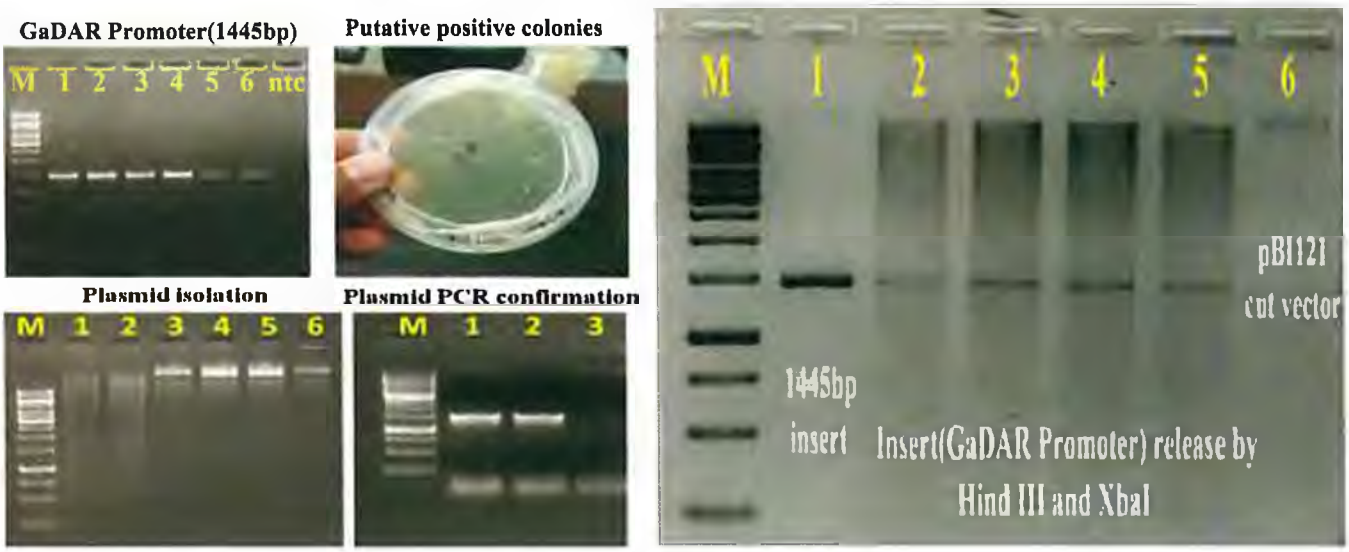


Fig 3.14.2 : Colony PCR and Restriction confirmation of clones containing *GaDAR promoter sequence(1.45kb)*

3.15 Project Name : An efficient regeneration system for transformation studies with CICR cry2Ab1Ac and fiber strength genes in cotton (*G. hirsutum*) (2017-2022)

G. Balasubramani (PI); Co-PI's: J. Amudha, K. P Raghavendra, N. Chandrashekar, Joy Das

Importance of the study: The project aims to develop an efficient regeneration system and development of transgenic cotton using indigenously made gene construct *CICR-cry2Ab1Ac::chitinase*.

Salient findings

Genetic transformation of Coker 312 cotton with *Agrobacterium* – mediation using CICR- *Cry2Ab1Ac* :: chitinase gene construct was carried out by direct and incubation method. Explants were co-cultivated in the medium comprising 0.1mg/l 2,4-D, 0.5 mg/l Kinetin, 100mM Acetosyringone (pH 5.8). After co-cultivation the explants were transferred on to the callus induction medium. Somatic embryos were induced, hardened, transferred and established. The regeneration experiments revealed that each seed of Coker 312 differ for induction of somatic embryos. Thus, those seeds showing high somatic embryogenesis were taken for multiplication in the controlled condition.

3.16 Project Name: Validation of molecular markers and genes linked to drought tolerance in cotton

J. Amudha (PI), (Co-PI's) Suman Bala Singh, J. H.Meshram, M.Saravanan

The importance of the study: Stress situation focused research is needed specifically for developing genotypes with tolerance to abiotic stresses.

Salient findings

Recombinant Inbred Lines (RILs) were derived from the interspecific cross between *G hirsutum* (28I) a drought tolerant trait parent (P1) and *G barbadense* (Suvin) (P2). Molecular markers closely linked to osmotic potential were identified from earlier studies to validate them with RILs. DNA was isolated from the parents and RIL progenies. SSR Markers linkedto Osmotic potential (OP) traitsviz.,BNL3259 on chromosome 14, BNL1153 on chromosome 25 and BNL2884 on chromosome 6 were selected for PCR analysis and screened parents and RIL progenies.

The RIL population was phenotyped for physiological parameters like canopy temperature (CT), chlorophyll content (SPAD value), RWC, Proline content. Canopy temperature and chlorophyll content were measured in the three replicates. Canopy temperature ranged between 27 to 31°C and the Chlorophyll content ranged from 31 to 40 SPAD value. Relative Water Content (RWC) ranged between 85 to 90% in the RIL population. Phenotyping data with high relative water content, proline content, chlorophyll content, lower canopy temperature, are good indicators of drought tolerance in cotton to explored for characterization and develop drought tolerant varieties with high-yielding traits.

3.17 Project Name: Targeted mutagenesis of ghPHYA1 through CRISPR/Cas9 in Cotton

Chandrashekar N(PI)

The importance of the study: PHYA1 is one of the apoprotein gene under phytochrome family that acts as a potential negative regulator of apoprotein encoding genes in the family *viz*; *PHYA2, PHYB PHYC* and *PHYE*. Targeting *PHYA1* through *RNAi* approach resulted in improved vegetative growth, flowering and early maturing phenotypes, more root mass and increased germination rate, more flowers and bolls, 5–8-mm increase in fibre length as compared to their controls. In view of these, GhPHYA1 seems to be the potential target which can be explored and targeted through CRISPR/Cas9 technology to develop mutant stocks to achieve improved cotton fibre quality parameters.

Salient findings:

Four sgRNAs were designed previously to target GhPHYA1 and respective CRISPR/Cas9::PHYA1 targeting vectors have been constructed. Agrobacterium mediated transformation of Coker-312 hypocotyls using sgRNA3GhPHYA1::CRISPR/Cas9 and sgRNA4GhPHYA1::CRISPR/Cas9 constructs has been performed. Sub culturing of callus cultures with CRISPR/Cas9::GhPHYA1sgRNA1, CRISPR/Cas9::GhPHYA1sgRNA2,CRISPR/Cas9::GhPHYA1sgRNA3,CRISPR/Cas9::GhPHYA1sgRNA4, is continued for achieving somatic embryogenesis.

Fig 3.17.1 Somatic embryogenesis and putative plantlets for CRISPR/Cas9::GhPHYA1sgRNA3

3.18 Project Name : Molecular Characterization of EPSPS Gene in Cotton Germplasm for the Development of Herbicide Resistant Cotton Through CRISPR/Cas9

Chandrashekar N (PI); Co-PI: Saravanan M

The importance of the study: Exploration of genetic diversity of cotton genotypes with herbicide tolerance/resistance trait would contribute for broadening the gene pool for enhanced traits and to develop non-transgenic glyphosate tolerant cotton.

Salient findings:

Field Experiment: During Kharif 2021, Screening of 780 cotton germplasm lines (Core collection maintained at ICAR-CICR, Nagpur) for glyphosate resistance/tolerance was carried out under field conditions. Glyphosate @ 100ml/15 litre water was sprayed at 45 DAS (Days after sowing) and screening data was recorded until 14 days after glyphosate spray in terms of chlorosis, wilting, growth response, stunting etc. Based on these observations 10 most tolerant (No-101, 118,165,265,250, 256, 267, 455, 237, and 310 and 10 most susceptible (No-80, 87, 163, 170, 325, 490, 515, 565, 575 and 594) lines were identified for further research activities (Figure 3.18.1).

***In-vitro* experiment:** An experiment has been initiated with

Coker-312 genotype *in-vitro* to explore the mechanism of glyphosate tolerance through the development of cell line/s under selection pressure. Callus cultures are being established on glyphosate concentrations at an increased dosage during sub-culturing of calli in phased manner to derive glyphosate resistant cell lines through somatic embryogenesis (Figure 3.18.2).

Fig 3.18.1 : Field screening of 780 cotton germplasm lines (Core collection) for glyphosate resistance/tolerance

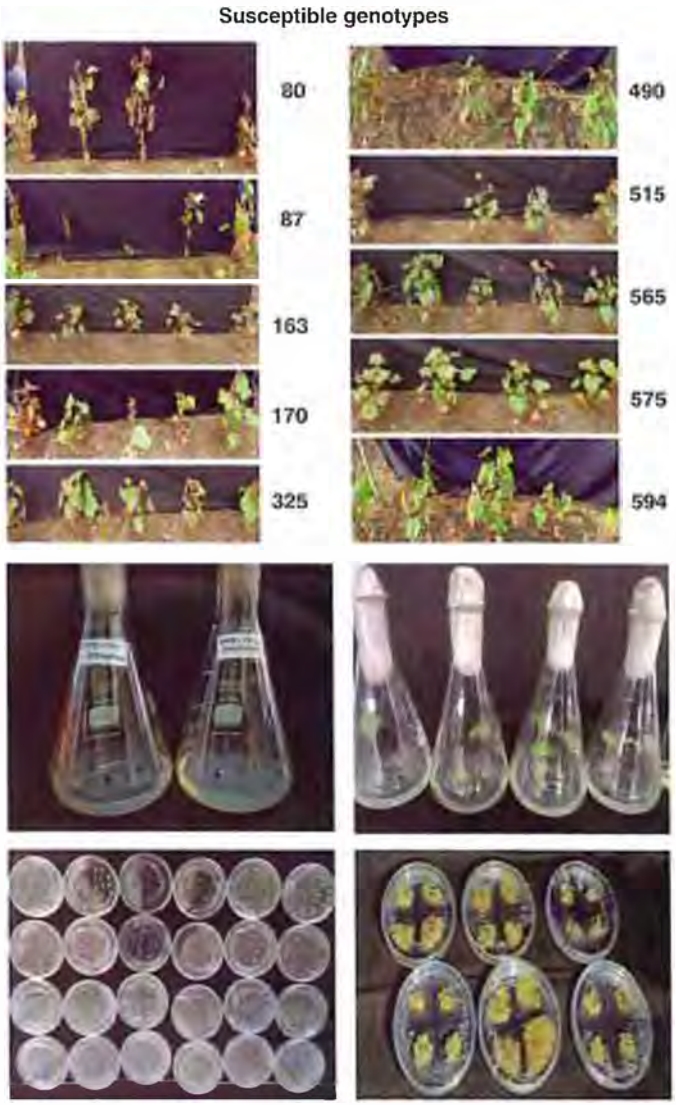


Fig 3.18.2 : *In-vitro* experiments for generating of Glyphosate tolerant cell line/s using Coker-312

CROP PROTECTION DIVISION

3.19 Project Name: Multi-pronged and Bio-rational management of Pink bollworm, *Pectinophora gossypiella* (Saunders) on cotton in India

V. Chinna Babu Naik (PI); Co-PI (s) - Y.G. Prasad, Babasaheb B. Fand, Rishi Kumar and K. Rameash

Importance of the study: The pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is one of the major pests of cultivated cotton across the globe, causing significant economic loss to cotton producers. The concealed feeding habit of the pest has made it difficult to control it under field conditions. The major tool employed by the farmers to manage the pest is chemical insecticides, which has led to the evolution of numerous problems *viz*., resistance, residue, pest resurgence and environmental pollution. Hence an eco-friendly tool that addresses the above problems is the need of the hour. Management of pink bollworm through semiochemicals provides for effective and environmentally safe alternative management tactic.

Salient findings

Mass trapping of Pink bollworm

The low-cost pink bollworm pheromone traps developed by ICAR-CICR were evaluated under farmers' field conditions. The evaluation of mass trapping technology in managing pink bollworm was conducted on 150 acres of farmers' field in Chandrapur, Amravati and Nagpur districts of Maharashtra during *kharif* 2020-2021. The field trial consists of seven treatments with four replications *i.e.,* T1: Control (No traps), T2:8 traps/acre, T3:20 traps/acre, T4:25 traps/acre, T5:30 traps/acre, T6:35 traps/acre and T7:40 traps/acre. The outcome of the experiment suggested that the mass trapping initiated from 45 days after sowing with 20 to 40 traps per acre was found

promising in managing the pink bollworm. Installation of 30 to 35 traps/acre led to a significantly higher level of mass trapping of pink bollworm in cotton. The infestation of pink bollworm was reduced to an extent of 10 to 15% in mass trapped fields as compared to control plots and also resulted in the average yield benefit of 1 to 2 q/acres.

In vitro parasitization of _Bracon hebetor_ on pink bollworm, _P. gossypiella_

Studied the parasitization potential of the braconid wasp, *Bracon hebetor* (Say), on different larval instars of *P. gossypiella* under laboratory conditions. The release of parasitoid, *B. hebetor* at 30:5 and 30:4 ratios led to a significantly higher level of parasitization on the pink bollworm larvae (85.8 - 94.2% in 2nd instar, 99.2 - 100% in 3rd instar and 100% in 4th instar of pink bollworms.

Pink bollworm, _P. gossypiella_ movement in perspective of rosette flower in cotton

A study was conducted at ICAR-CICR, Nagpur to find out the movement of *P. gossypiella* larvae present in the rosette flower. From the initiation of flowering to boll formation stage, the movement was keenly observed and recorded. About 49.09% larvae from the infested flower moved to the soil for pupation;15.34% larvae moved to infest bolls (neonate larvae bores newly formed bolls of same rosette flower) and 32.49% larvae moved to dried leaf debris on soil. Remaining 3.06% larvae presumably escaped or perished due the environmental factors like dampness in the soil. In contrast, the dry soils or light accumulation of debris accommodated maximum number of pink bollworm larvae.

Evaluation of oviposition substrate in laboratory rearing of pink bollworm, _P. gossypiella_

Evaluated different oviposition substrates like paper and muslin cloth for enhancing the recovery of eggs in laboratory rearing of pink bollworm, *P. gossypiella*. Use of black muslin cloth recorded recovery of eggs at par with natural substrate (cotton twig). The adoption of the artificial substrate has huge potential in rearing of PBW and avoids the drawbacks like tissue drying, carryover of diseases and reusability.

Evaluation of egg parasitoid _Trichogramma bactrae_ through inundative release to control pink bollworm

A field trial was conducted to evaluatethe egg parasitoid *Trichogramma bactrae*, through inundative releases at 15 days interval in cotton from 45 DAS to 120 DAS. There were3 replications and 8 treatments including T1: (No release of *Trichogramma*), T2: (1 release at 45 DAS), T3: (2 release at 45 & 60 DAS), T4: (3 release at 45, 60 & 75 DAS),T5: (4 release at 45, 60, 75 & 90 DAS), T6: (5 release at 45 60, 75, 90 & 105 DAS), T7: (6 release at 45, 60, 75, 90, 105 & 120 DAS), T8:Neem oil spray with one insecticide (No release). The dose of one release was 60,000 adult wasp/ha. The observations were recorded on rosette (%), number of exit holes, number of mines on the epicarp, number of larvae per boll, percent locule damage and per cent bolls damage by pink bollworm at 10-15 days interval. The lowest infestation of pink bollworm was observed at T6: (5 release at 45 60, 75, 90 & 105 DAS), T7: (6 release at 45, 60, 75, 90, 105 & 120 DAS) as compared to other treatments.

Emergence of parasitoid of pink bollworm from dead larvae (2020-2021)

Pink bollworm infested green bolls were collected from different cotton growing districts of India. The collected green bolls were dissected for pink bollworm larval recovery and the dead larvae were kept for the emergence of parasitoid. Parasitization by *Apanteles angaleti* and *Braconle froyi* was recorded in different geographical population in India.

3.20 Project Name: Mahyco-II: Monitoring changes in baseline susceptibility to Cry 1Ac and Cry2Ab toxins in the cotton bollworm, _H. armigera_, pink bollworm, _P. gossypiella_ and leaf eating caterpillar _Spodoptera litura_.

V.Chinna Babu Naik (PI); Co-PI (s) : Vivek shah

Importance of the study:

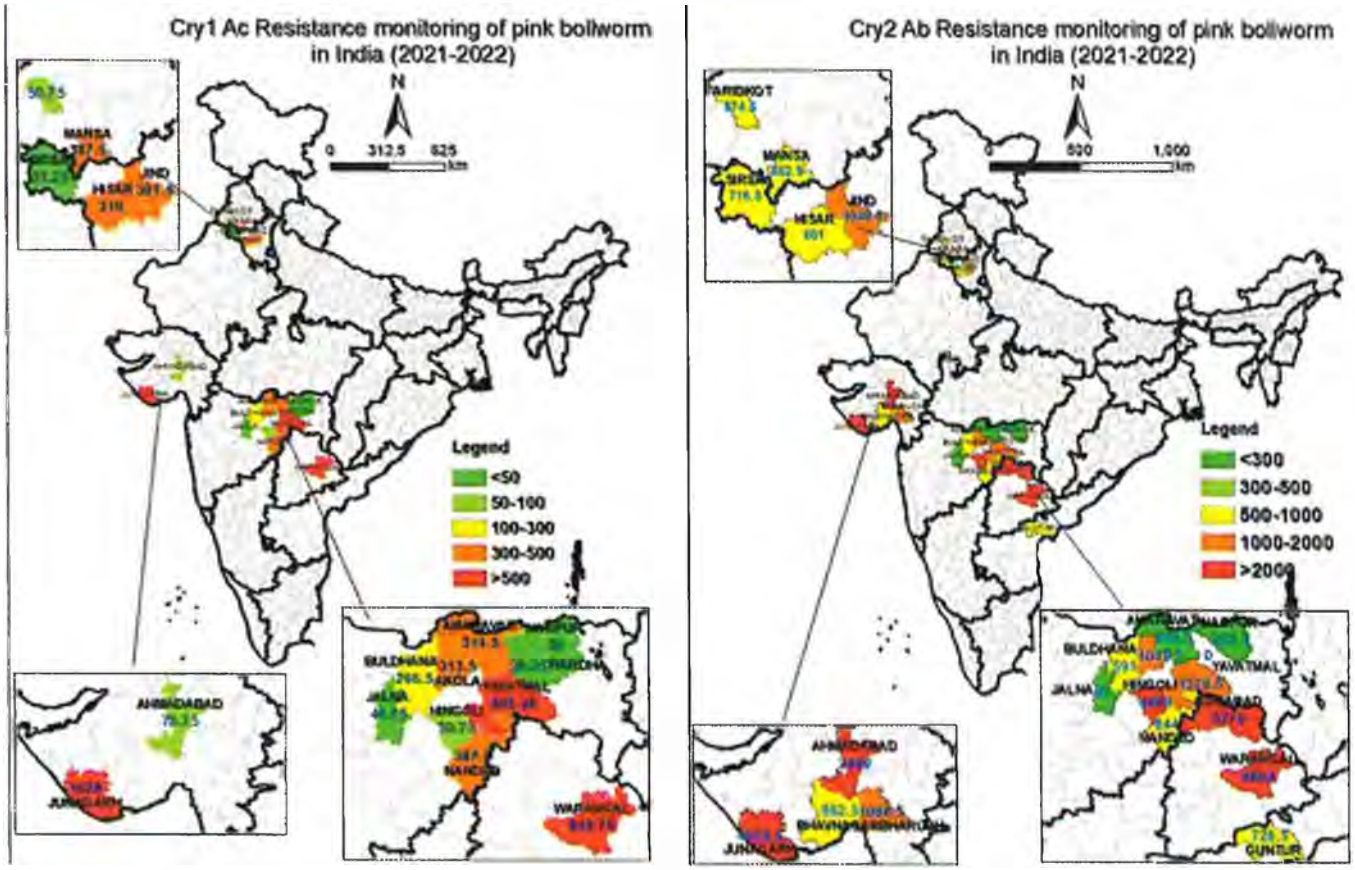
The commercial cultivation of Bt cotton started in India with release of bollguard-I in 2002 and bollguard -II in 2006 to tackle the menace of dreaded bollworm complex. Over a period of time, the pink bollworm *P.gossypiella* has adopted to feed on transgenic cotton carrying Cry1Ac and Cry2Ab genes expressing insecticidal Bt toxins resulting in resistance development against BG-I in 2010 and subsequently against BG-II in 2017. Re-emergence of pink bollworm in cotton due to development of Bt resistance posed a serious challenge to Indian cotton production, threatening the sustainability of Bt technology in combating dreaded bollworms of cotton. These warrants monitoring of the changes in baseline susceptibility to Bt toxins in the bollworm complex of cotton.

Salient findings

Status of resistance against Cry toxins in pink bollworm

- Diet incorporation bioassays were conducted to assess the resistance development against Cry 1Ac and Cry 2Ab toxins in pink bollworm populations collected from various cotton growing locations *viz*., Krishna, Prakasam, Guntur, Sriganganagar, Anand, Bharuch, Amreli, Hanumangarh, Wardha, Rajkot, Jalna, Surendranagar, Parbhani, Sirsa, Yavatmal, Nanded, Buldhana, Hingoli, Vadodara, Junagadh, Coimbatore, Bhavnagar, Ahmedabad, Akola, Aurangabad, Amravati, Fatehbad, Bathinda, Jind, Nandyal, Hisar, Mansa, Warangal, Raichur, Dharwad and Adilabad.
- One-day old F_1 larvae obtained by rearing samples collected from the above locations were subjected to varying doses of toxin under diet incorporation method. The resistance status was expressed in terms of resistance ratios by keeping the susceptible population as standard.
- In the North Zone, resistance ratios ranged from 302-388, with the highest level of resistance observed from Mansa. The mean range of resistance was found to be 333.
- In the Central zone, the resistance ratios (RR) ranged between 20-1028 averaging 294. A higher level of resistance against Cry 1Ac was exhibited by Junagadh population with RR of 1028.

- In the Southern zone, the highest resistance ratio was found to 846 in the populations of Warangal.
- Similar results were noticed even in case of Cry 2Ab toxin, where the range of resistance is 601-1050, 92-4940 and 468-5779 in the North, Central and South zones, respectively. The highest level of resistance was noticed from South India with mean RR of 5232.



Extent of resistance against cry toxins across country

Level of pink bollworm infestation

* The level of pink bollworm infestation was monitored across different locations in the country
* The highest level of infestation was found in the Mansa district followed by Warangal and Hisar districts, respectively (Fig. 3.20.1).

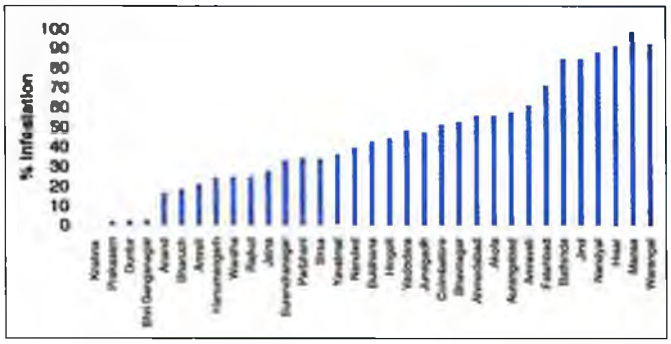


Fig. 3.20.1: Infestation of pink bollworm in different districts of India

3.21 Project Name: Rasi Seeds-Evaluation of nectariless rasi cotton hybrids against bollworms

V. Chinna Babu Naik (PI)

Importance of the study

The project aimed at evaluation of host plant resistance traits like nectariless cotton genotypes as an ecofriendly and sustainable approach for suppression of pink and American bollworms in cotton.

Salient findings

The data on per cent green boll infestation caused by *P. gossypiella* were recorded from 100 to 160 DAS. At 100 DAS, the highest per cent of green boll infestation was recorded in T_1: TH-10043(20.00%) and lowest was recorded in T_3: THCT-20-7852 (5.00%), followed by T_4: THCT-20-7850 (10.00%), respectively. Similarly, at 160 DAS the most effective and significantly best treatments was T_4: THCT-20-7850 with 62.50 per cent infestation. It was statistically at par with T_3: THCT-20-7852 (75.00% infestation),T_2: TH-10044 (77.50%), T_5: THCT-1629 (82.50%) and T_1: TH-10043(85.00%), respectively. It can be concluded that the lowest pink and American bollworm infestation was recorded in T_3: THCT-20-7852 or T_4: THCT-20-7850 treatment as compared to other treatments. The oviposition was recorded after 5 days of release, among the different treatments, T_3: THCT-20-7852 recorded the lowest number of eggs of *P. gossypiella* and *H. armigera*, followed by T_4: THCT-20-7850. The highest number of pink and American bollworm eggs were recorded in the plots T_5: THCT-1629, followed by T_6: TH-10043+THCT-20-7852 and T_7: TH-10043+THCT-20-7850 treatments, respectively.

3.22 Project Name: Insecticide Resistance Management: Dissemination of Pink Bollworm Management Strategies

V. S. Nagrare (PI), Co-PI (s) - V. Chinna Babu Naik, S.P. Gawande, Babasaheb B. Fand, D.T. Nagrale, S.S. Patil , K. Rameash ,Rishi Kumar, Rachna Pande, Nilkanth Hiremani, S.K. Sain, J.H. Meshram, K. Shankarganesh, Prabhulinga T.

Importance of the study

Since the introduction of Bt-cotton in India, the infestations of all three bollworms viz., cotton bollworm, spotted bollworm and pink bollworm (PBW) were under control. However, unfamiliar survival of PBW during 2008 in Gujarat state on Bt cotton established PBW resistance to Cry1Ac. Subsequently, high incidences of PBW were recorded from the Central and South India from 2014 and 2018 onwards in the North India on BG-II, confirming resistance development to both the genes employed in BG-II. The outbreak of PBW in all the three cotton growing zones of India presented a serious threat to cotton production of the country challenging cotton farmers' livelihood and Indian economy. Since the last 6-7 years this pest has become a serious menace on Bt cotton in India, causing widespread damage and significant yield losses to the tune of 20-30%. Keeping in view of the significant PBW infestation across all the cotton growing states, the project was approved during 2018-19 and since then continuing with the major objective to disseminate Pink Bollworm Management Strategies in Bt cotton funded by the Department of Agriculture & Farmers Welfare (Crops & PHMF Division), Ministry of Agriculture and Farmers Welfare, Govt. of India.

Salient findings:

Dissemination of PBW IPM strategies

- ICAR-CICR as a Nodal Institute implemented the project in collaboration with 10 State Agricultural Universities *viz.*, Dr PDKV, Akola, VNMKV, Parbhani, MPKV, Rahuri, NAU, Navsari, JAU, Junagadh, RVSKVV, Gwalior, UAS, Dharwad, UAS, Raichur, PITSAU, Hyderabad and ANGRAU, Guntur and 3 KVKs.
- During 2022-23, a total of 1050 IRM farmers and 180 non-IRM farmers from 105 villages in 8 cotton growing states were identified for project implementation.
- Critical input like pesticides, pheromone traps and Trichocards were provided to the identified farmers.
- PBW infestation was recorded by regular sampling at weekly intervals. Random surveys were also conducted during the season. Outreach activities carried out in IRM villages were: Field visits-792, Farmers trainings-51, Sensitization workshop to ginning mills-19, Mobile text /voice Messages sent-457, Exhibitions arranged-15, Training/ workshop conducted-58, TV Programs-38, Radio talks-89, Farmers queries replied-3911, Farmers Mela organized-5, Lectures delivered in training-196, Visit of farmer to station /personal contact-4437.
- The project helped to bring down the number of sprays for the control of cotton pests during the season to an average of 5.18 in IRM fields as compared to 8.20 in non-IRM fields.
- Reduction in pesticide usage in IRM vs non-IRM fields was 39.30% in terms of cost, while 38.11% in terms of volume.
- IRM fields recorded an average seed cotton yield 1,901 kg/ha as compared to 1,607 kg/ha in Non IRM fields.
- Benefit: Cost ratio accrued was 2.24:1.
- Infestation of pink bollworm was in the range of 0.00-22.25 & 0.00-50.43% in north India, 0-80.75 & 0.00-90.00 in Central India and 0-65.85 & 0-68.03% in south India in the IRM andNon-IRM fields, respectively.

Mating disruption for PBW management

- From the current year (2022-23), 20 KVKs (affiliated to SAUs & NGO) under 6 ATARIs (Ludhiana, Jodhpur, Pune, Hyderabad, West Bengal, Bengaluru) were involved in IRM project to conduct demonstrations on mating disruption technology for PBW management in 20 villages of 20 districts on 500 acres area.
- Mating disruption technology of wax based Gossyplure 4 % (RTU) formulation against pink bollworm on cotton in PPP mode (ICAR-CICR, ATARI, SAU-KVK & ATGC Biotech, Hyderabad) was demonstrated on additional 500 acres area (25 acres in each district).

3.23 Project Name: Crop pest surveillance and advisory project (CROPSAP) in Maharashtra.

V. S. Nagrare (PI)

Importance of the study:

Government of Maharashtra has formulated and implemented an innovative project based on Information and Communication Technology (ICT) in the field of plant protection from 2009-10. It's an e-pest surveillance and advisory project. Consistent pest monitoring and adoption of appropriate pest management strategies at proper crop growth stages of the crop have been implemented for crops as soybean, cotton, rice, tur and gram. The work assigned to ICAR-CICR was i) to formulate IPM strategies for cotton, ii) to develop pest specific advisory capsules, iii) to visit hot-spots for guidance to farmers and field functionaries and iv) to get feedback for future research and developing IPM Strategies.

Salient findings

- Disseminated cotton pest management strategies through ICT tools.
- Updated pest management strategies for target pests, monitored online pest situation through real time pest data uploaded on website.
- Issued 39 growth stage-wise advisories on pest and disease management.
- Conducted 7 Training/Lectures on pest and disease management.
- Conducted random field visits in 8 districts of Maharashtra.
- Updated existing survey sheet of surveillance with the inclusion of boll rot disease.
- Provided technical guidance to the State Agriculture Department on pest management aspects as and when required.

Status of pink Bollworm infestation in Maharashtra

- The infestation of pink bollworm was observed from 31ststandard week (SW) and continued at an increasing trend with the progress of the crop season.
- Pink bollworm infestation crossed ETL in 6-14 villages during 32-36thSW, slightly lowered down between 37-42ndSW (5-7 villages). Thereafter, pink bollworm infestation increased in 25-28 villages during 43 & 44thSW.
- After a month's time, pink bollworm infestation crossed ETL

in 61 villages and 50 villages in corresponding 49th and 50th SW, respectively, which was the highest number record during the entire crop season (Fig. 3.23.1).

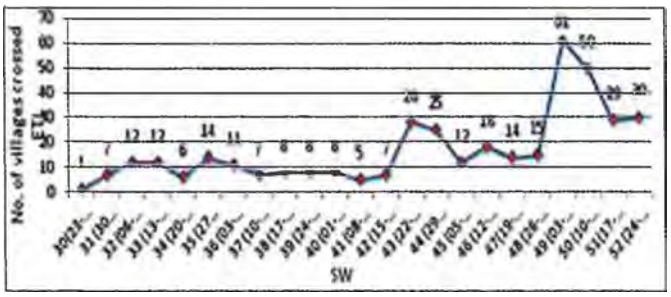


Fig. 3.23.1: Pink bollworm infestation crossed ETL in a number of villages over the season 2021-22 in Maharashtra

Status of jassid infestation in Maharashtra

The jassid population began to grow from 30th SW and it continues throughout the crop season.

- The peak incidence was noticed during 32 and 34th SW, crossing ETL in 17 villages of Maharashtra. Following that, during 36th and 37th SW, roughly 15 villages had jassid populations above ETL.
- From the 37th SW onwards, the incidence of jassid steadily decreases, with the number of villages crossing ETL varying from 0 to 7(Fig. 3.23.2).

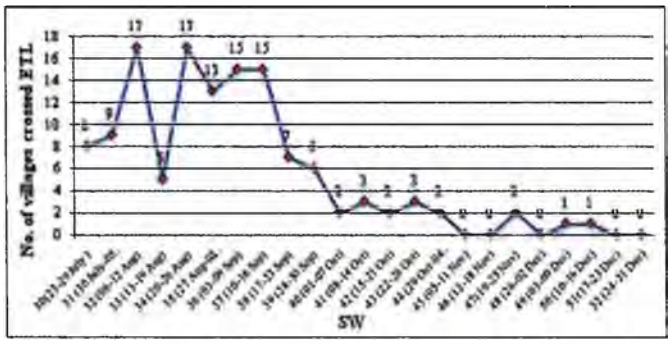


Fig. 3.23.2: Jassid infestation crossed ETL in number of villages over the season 2021-22 in Maharashtra

Boll rot disease incidence

- The boll rot disease incidence was noticed from 36th to 50th SW.
- The highest boll Rot incidence was noticed during 39th and 40th SW in11 and 22 villages respectively, and then it gradually declines (Fig. 3.23.3).

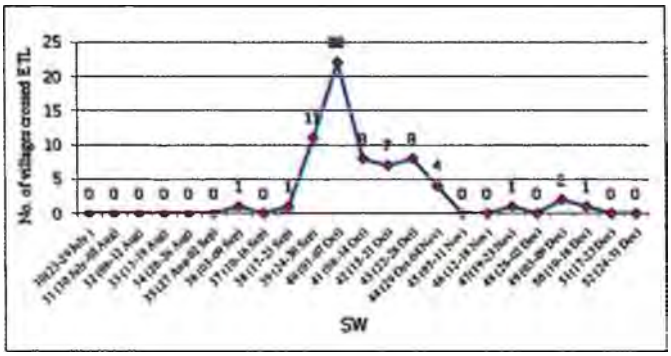


Fig. 3.23.3: Boll rot incidence in number of villages over the season 2021-22 in Maharashtra

Population dynamics of sucking pests

- Sucking pests *viz.*, cotton jassid, whitefly and thrips population were slightly higher in number till first week of October however, subsequently decreased to below ETL with the progress of season (Fig. 3.23.4).
- Jassid only once reached the ETL at 41st SW however whitefly and thrips were below ETL throughout season (Fig. 3.23.4).
- Peak aphid population was recorded at 31st SW (22.52 aphids/3leaves), but remained <10 aphids/3 leaves throughout the crop season (Fig. 3.32.5).

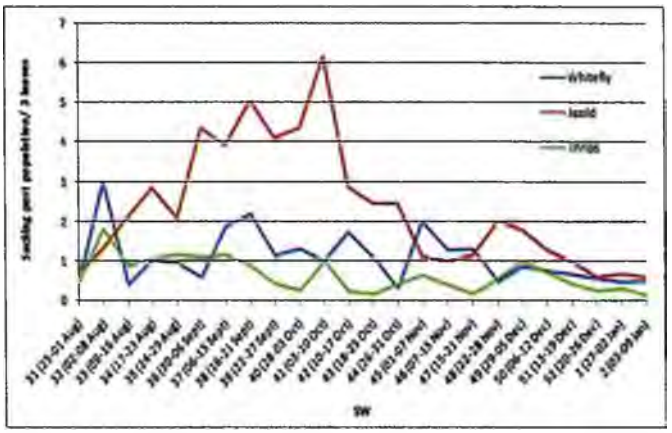


Fig. 3.23.4: Population dynamics of sucking pests (jassid, whitefly and thrips) over the season in RCH 2 during 2022

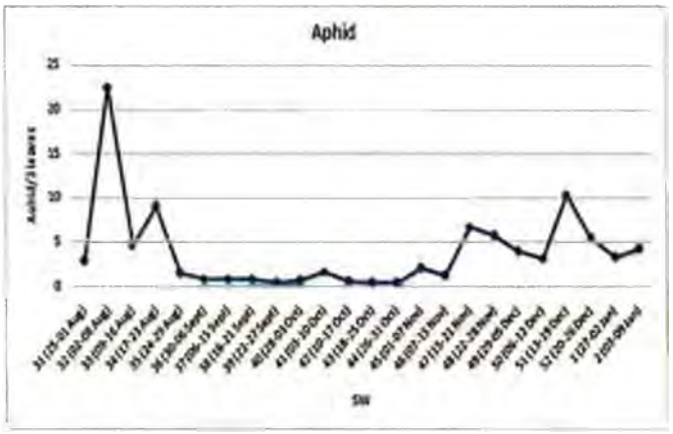


Fig. 3.23.5: Population dynamics of sucking pests (Aphid) over the season in RCH 2 during 2022

Pink bollworm infestation in non-Bt and Bt cotton

- In non-Bt cotton (Suraj) pink bollworm infestation was recorded above ETL (>10% green boll infestation) starting from 39th SW(25-30 Sep) and found to be the highest during 4th SW (17-23 Jan).
- While in Bt cotton (RCH 2 BGII) pink bollworm infestation crossed ETL during 46th SW (08-15 Oct) and increased with the progress of the season, peak infestation was recorded at 4th SW (17-23 Jan).
- Over the season, comparatively, the pink bollworm infestation was 47% higher in non-Bt cotton than Bt cotton (Fig 3.23.6).

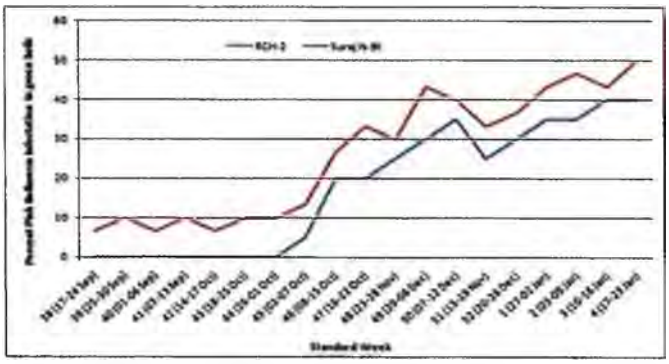


Fig. 3.23.6 : Pink bollworm infestation in Bt and non-Bt cotton during 2022

Pheromone trap catches

- During 2022, pink bollworm moth catches initiated from 44thSW (26-01 Nov); thereafter increased and maximum moths catches (34moths/trap/week) were recorded during 50thSW (06-12 Dec) which catch was almost 3.5 times less as compared to the previous year catch (123 moths/ trap/ week, at 48thSW (29-05 Dec 2021)).
- More than 10 Tobacco caterpillar moth catches were observed starting from 38thSW (14-19 Sept) and increased with the progress of the season however, infestation was not seen in cotton plants.
- Very negligible moth catches of cotton bollworm and spotted bollworm were recorded during the season (Fig 3.23.7).

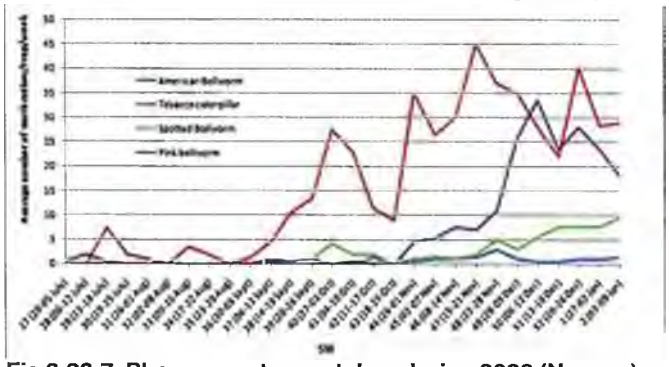


Fig 3.23.7: Pheromone trap catches during 2022 (Nagpur)

Yellow sticky trap catches of cotton jassid and Whitefly

- Two peaks of cotton jassid catches in yellow sticky traps were recorded viz., one at initial period 35thSW (23-29 Aug) and another between 39th(20-26 Sept) and 42ndSW(11-17 Oct), however the trap catch decreased thereafter.
- A small peak was also recorded at 49thSW(29-05 Dec). Populations of whitefly fluctuated over the season, however remained less than 105 whitefly/trap/week) (Fig 3.23.8).

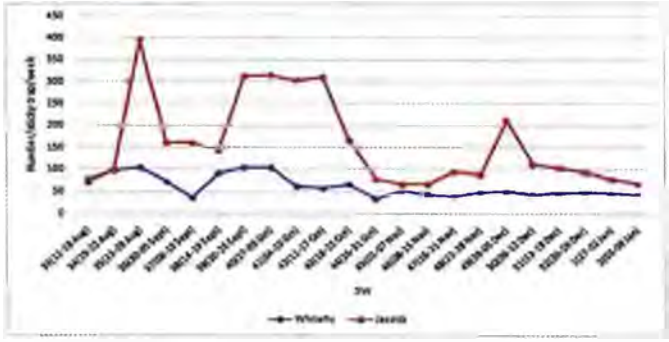


Fig 3.23.8: Sticky trap catches of Jassid and whitefly during 2022 (Nagpur)

3.24 Project Name: Investigations on bioefficacy of entomopathogens against cotton pink bollworm, *Pectinophora gossypiella* (Saunders)

V. S. Nagrare (PI); Co-PI (s) :V.Chinna Babu Naik, S. P. Gawande, D.T. Nagrale, J.Gulzar Banu

Importance of the study: The pink bollworm (PBW), *Pectinophora gossypiella* (Saunders) has re-emerged as a serious pest of cotton in India. The chemical control for PBW is very difficult as the larvae are internal feeders live inside the green bolls. Entomologists are exploring the possibility of using entomopathogens as biological control agents, and the researchers are working towards possible exploitation of entomopathogens (bacteria, fungi, virus, EPN and protozoa) for the control of many insect pests. The project aims to explore potential of entomopathogens for management of pink bollworm in field conditions.

Salient findings

- Five fungal and 25 bacterial isolates were recovered from 150 dead pink bollworm larvae sampled from different geographic locations of cotton growing areas.
- Larval assay and ovicidal effects of EPN have been carried out.
- Entomopathogens *viz.*, *Beauveria bassiana*, *Metarhizium anisoplie*, *Lecanicillium lecanii*, EPN, and HaNPV were evaluated against pink bollworm under lab conditions.
- Efficacy of entomopathogens *viz.*, *B. bassiana*, *M. anisoplie*, *L. lecanii*, EPN and HaNPV against pink bollworm evaluated under field conditions, where untreated control recorded the highestboll damage and was statistically different from the rest of the treatments.
- The lowest infestation was recorded in *L.lecanii* (50g/10L), *M.anisopliae*(50 g/10L) and *B. bassiana*+ *V. lecani*(25 g+ 25 g /10L)whichwereon par with *B. bassiana*(50 g/10L), PGPR (100 ml /10L), *L. lecani*+ *M. anisopliae*(25 g + 25 g /10L), *L. lecani* + *B. bassiana*+ *M. anisopliae*(16 g+16 g+ 16 g /10L) and Profenophos (30 ml /10L).
- Soil application of EPN against pupae of Pink bollworm has been evaluated, about 65% reduction in moth emergence was recorded.
- Soil baiting with pink bollworm larvae yielded a native isolate of entomopathogenic nematode, *Steinernema siamkayai.*
- Among three entomopathogenic nematodes tested, *S. siamkayai* caused significant high mortality of pink bollworm larvae and pupa than *Heterorhabditis indica* and *S. glaseri* under *in vitro* condition.

3.25 Project Name : Revisiting the ETLs and yield loss assessment for pink bollworm and boll rot in cotton

Babasaheb B. Fand ; Co-PI (s) - Vivek Shah, Dipak T. Nagrale

Importance of the study : Recent re-emergence of pink bollworm due to development of resistance against transgenic cotton has posed serious threat to Indian cotton production. As the Bt cotton failed to provide satisfactory control of pink bollworm, the cotton farmers are left with no choice other than to use synthetic chemicals. However, timings of insecticidal applications are crucial in order to get desired control of pink

bollworm. In this context, economic threshold level (ETL) serves the important decision-making tool. Considering the re-emergence of pink bollworm on Bt cotton and the changing scenario of cotton ecosystems, it is of paramount necessity to revisit the existing ETLs for pink bollworm so as to fine tune them with the changing agro-ecological situations of cotton farming.

The problem of boll rot disease resulting in significant yield loss in cotton is gaining importance in recent years. Boll rot in cotton is an important disease because it not only reduces the yield but also affects the quality of lint and seed. Most of the times, boll rot has become a complex problem and it's difficult to distinguish between internal boll rot infection and pink bollworm damage. There is a serious lack of a field level technique or method that can be used for assessing the yield loss due to pink bollworm and/or internal boll rot disease. Therefore, present proposal titled "Revisiting the ETLs and yield loss assessment for pink bollworm and boll rot in cotton" have been formulated.

Salient findings

Decision making tool for PBW management: Refinement of ETL based on green boll damage

- A field experiment was conducted during cotton growing season of 2021-22 to create the differential levels of PBW infestation in cotton crop by application of recommended insecticides at their field doses starting from 45-60 days after sowing (DAS). The PBW infestation was recorded on 10 randomly selected plants in each treatment plot at weekly intervals. The yield of seed cotton was recorded in each of the treatment plots during each of the three pickings.
- Based on the data recorded in field experimentation the yield loss -pest density function was established by fitting linear regression equation ($y = a \pm bx$) between mean pest infestation recorded at 120 DAS, 130 DAS and 150 DAS, and seed cotton yields of picking 1, 2 and 3, respectively (Fig.3.25.1).
- The green boll infestation follows the mean moth catches in pheromone traps at 15 days (2 weeks) prior to field manifestation of these symptoms.
- An economic threshold level (ETL) of 5-7% green boll infestation (%) has been proposed as a decision-making tool for pink bollworm management using following formula:

  Where, EIL is the economic injury level, C is the cost of control measures applied (Rs/ha), p is the market value of seed cotton (Rs/q), b is the slope of regression equation and k is the efficacy of control measures. The ETL as an action threshold was taken as 75% of EIL.

Table 3.25.1: Estimation of ETL for cotton pink bollworm based on linear relationship between green boll infestation (%) and seed cotton yield (kg/ha)

Crop growth window	Control expenditure (Rs/ha) (C)	Market value of produce (Rs/q) (p) #	Regression coefficient (b)	Efficacy of control measures (k)	EIL (C/p*b*k) *100	ETL (75% of EIL)
120 DAS	8435	5726	37.6	0.6	6.5	5
130 DAS			28.4	0.6	8.6	7
150 DAS			28.1	0.6	8.7	7

#Minimum Support price of cotton for the crop season 2021-22

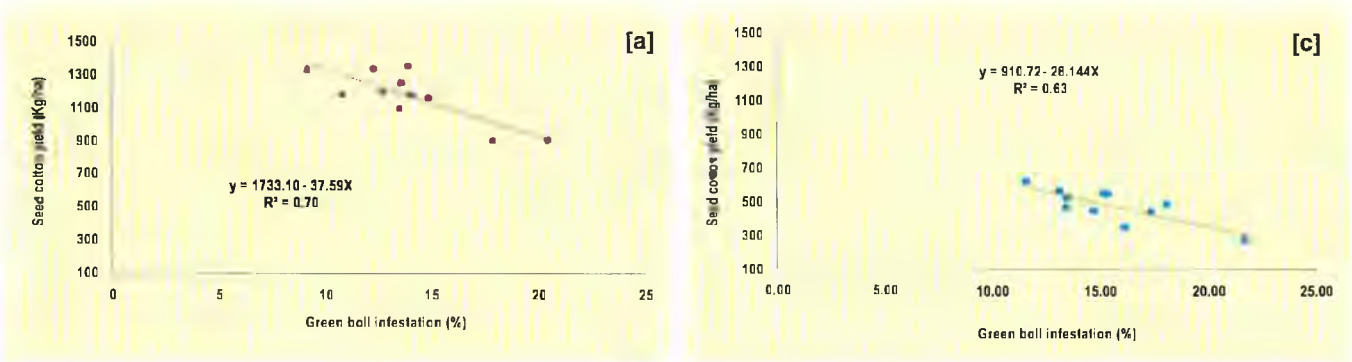


Fig. 3.25.1:Linear regression equation fitted between yield loss and mean pink bollworm infestation in green bolls (%) of cotton. PBW infestation at 120 DAS and yield of first picking (a), PBW infestation at 130 DAS and seed cotton yield at second picking(b); and PBW infestation at 150 DAS and seed cotton yield at third picking (c)

Rapid, reliable and robust method for field level yield loss assessment in cotton due to pink bollworm and boll rot

- Pink bollworm (PBW) and boll rot (BR) cause significant loss to the cotton yield mainly due to deterioration of lint quality and damage to the seed. The existing methods of yield loss estimation being time consuming and requiring high

technical inputs, are not sophisticated to be used for quick yield loss assessment in the event of "pest/ disease epidemic".

- Here, a simple, yet reliable and robust method for rapid yield loss assessment in cotton due to PBW and BR at field level is presented. According to the typical pattern of progressive increase in locular damage by PBW observed in random sampling of opened bolls, we selected the 'locule' as sampling unit for yield loss estimation instead of existing practices like 'boll sampling' or 'whole plant sampling'.
- The method involved : collecting the random samples of about 100-120 loculi (seed cotton) from each replication of experimental plots in which no sprays were given for managing PBW and BR; dividing the samples into three categories viz., healthy, damaged by PBW and damaged by BR; and working out the proportions and recording the weights of loculi in each of the three categories. The losses in weights of loculi of three categories were calculated according to the proportion of loculi damaged by PBW and BR present in each sample. The linear regression equation ($y = a \pm bx$) was fitted to establish the relationship between different grades of pest damage (PBW and BR) (x) (%) and loss in seed cotton yield (y) (%) (Table 3.25.2).
- By this method, the mean loss in seed cotton yield due to PBW infestation was estimated at 17.4 % and 39.5 % in Bt and Non-Bt cotton cultivars, respectively. Similarly, the seed cotton yield loss due to BR was estimated at 15.7% and 13.6 % in Bt and Non-Bt cotton cultivars, respectively (Table 3.25.3).
- The damage due to PBW and BR reduced the seed weight by 22.4% (Bt cultivars), 25.6 % (Non-Bt cultivars), and 14.2 % (both Bt and Non-Bt cultivars).
- About 53.86% and 47.40% reduction in seed germination due to PBW and BR, respectively was reported by paper towel method. Similarly, 46.78 and 37.14% reduced seed germination was observed due to PBW and BR, respectively by pot culture method (Table 3.25.4).
- PBW and BR damage reduced the seed oil content by 27.91 % and 19.33%, respectively. There was an increase in seed moisture content by 5.72% and 10.82% due to PBW and BR damage, respectively.

The proposed method of yield loss assessment has certain merits over the existing method that involves season long experimentation: it is useful for quick yield loss assessment in the event of "pest/ disease epidemic" as a decision-making tool to policy makers in view of compensation to the farmers; Does not require planning of season long specific experiment and thus is rapid, less time consuming, less laborious and cost effective; picking wise yield loss assessment is possible from the sample drawn thus obviating the need for final yield data; being simple and easier does not require a special expertise or skills; it is reliable and robust.

Table 3.25.2: Percent loss in seed cotton yield (Y) of Bt and Non-Bt cotton cultivars estimated based on different grades of loculi damage due to the infestation of pink bollworm and incidence of boll rot (X) recorded in untreated plots during the crop season of 2021-22 at experimental farm of ICAR-CICR, Nagpur, India (Fitted relationship: Linear regression, Y = a + bX).

Percent loculi damaged (X)	Percent loss in seed cotton yield (Y)				Percent loculi damaged (X)	Percent loss in seed cotton yield (Y)			
	Loss due to pink bollworm damage		Loss due to boll rot infection			Loss due to pink bollworm damage		Loss due to boll rot infection	
	Bt cultivars	Non-Bt cultivars	Bt cultivars	Non-Bt cultivars		Bt cultivars	Non-Bt cultivars	Bt cultivars	Non-Bt cultivars
5	1.3	1.7	1.2	1.3	70	16.3	21.9	16.7	18.8
10	2.3	3.1	2.4	2.6	75	17.5	23.6	17.8	20.2
15	3.6	4.7	3.5	4	80	18.6	25.1	19.1	21.5
20	4.7	6.2	4.8	5.3	85	19.8	26.5	20.2	22.8
25	5.8	7.8	6	6.7	90	21.1	28.3	21.4	24.2
30	7.1	9.4	7.2	8.1	95	22.1	29.5	22.6	25.5
35	8.2	11	8.4	9.4	100	23.3	31.5	23.8	26.9
40	9.3	12.5	9.5	10.7	**Intercept (a)**	**0.07**	**0.02**	**0.02**	**-0.05**
45	10.5	14.2	10.7	12.1	**Slope (b)**	**0.23**	**0.31**	**0.24**	**0.27**
50	11.8	15.7	11.9	13.4	**R^2**	**0.99**	**0.98**	**0.99**	**0.99**
55	12.8	17.3	13.1	14.7	**df**	**1,18**	**1,18**	**1,18**	**1,18**
60	14.1	19	14.3	16.1	**F**	**Sig.**	**Sig.**	**Sig.**	**Sig.**
65	15.2	20.1	15.5	17.4	**p**	**<0.001**	**<0.001**	**<0.001**	**<0.001**

Table 3.25.3: Estimates of seed cotton yield losses ± SE (%) in Bt and non-Bt cotton cultivars based on proportions of and weight loss in loculi damaged by pink bollworm and boll rot in untreated plots during cotton cropping season of 2021-22 at experimental farm of ICAR-CICR, Nagpur (India).

Cultivar	Seed cotton yield loss due to PBW damage (%)				Seed cotton yield loss due to BR damage (%)			
	Picking 1	Picking 2	Picking 3	Total	Picking 1	Picking 2	Picking 3	Total
Bt	5.2±0.6	8.3±0.9	3.9±0.2	17.4	7.2±0.7	4.4±0.6	4.1±1.7	15.7
Non-Bt	12.5±1.5	13.7±0.8	13.3±2.1	39.5	6.0±0.4	1.2±0.2	6.4±0.9	13.6

Grouping of loculi samples into different categories : Lint from healthy loculii (a), lint from PBW damaged loculii (b) and lint from BR damaged loculi (c)

Table 3.25.4: Mean seed germination (%) of healthy and damaged seeds

S.N.	Treatment	Seed germination (%)		Reduction in seed germination 9%)	
		Paper towel method	Pot sowing method	Paper towel method	Pot sowing method
1.	Seeds from healthy loculi	86.7± 5.1	77.8±4.8	-	-
2.	Seeds from loculi damaged by PBW	40.0± 1.9	41.1±1.1	53.9	46.8
3.	Seeds from loculi damaged by boll rot	45.6± 1.1	48.9±2.9	47.4	37.1

Seed germination from healthy and damaged seeds :
Seeds from healthy loculi (a), seeds from PBW damaged loculi (b) and seeds from BR damaged loculii (c)

3.26 Project Name: Identification of oviposition deterrent for ethological management of cotton coll worm *Helicoverpa armigera* (Hübner)

Rachna Pande (PI)

Importance of the study: Semiochemicals, the behavior modifying chemicals are the suitable alternatives for the ethological management of insect pests. The oviposition of insects is regulated by these semiochemicals which may be emitted by insects or plants. These compounds may accelerate the oviposition as attractant or they may deter the moth for oviposition. It is obvious that the presence of these semiochemicals on the oviposition substrate may orient the flight of mated female moth and hence can be explored as an eco-friendly management option.

Salient findings:

- The castor seed oil and cotton seed oil @ 2-3% reduced the egg laying of female *H. armigera* by 84% and 47%, respectively.
- Amongst the various oils blended with cotton seed oil, the castor-cottonseed oil blend showed 66% reduction in egg laying and was at par with the safflower + cottonseed oil and sunflower + cottonseed oil blend.
- Likewise, amongst castor oil based blends (1%), sunflower + castor seed oil caused 79% reduction in egg laying in comparison to control.
- The field applications of different oils (groundnut, sunflower, rice bran, soybean, safflower, sesame, cottonseed oil and castor) @2% and 4% performed better than control and some were at par with the insecticides(chlorantraniliprole 18.5 SC and emamectin benzoate 5%SG).
- Benefits from these oils over control was calculated for 2% conc. and it was found that among the oils maximum benefit (3.0) was in rice bran and groundnut which was better than the coragen (1.7). However, maximum benefit was shown by emamectin benzoate (4.4) among all the treatments.

- In another set of experiments all possible blends of oils at 1:1 were evaluated in cotton field @1%. A total of 15 blends were tested and compared with the recommended insecticides (chlorantraniliprole 18.5 SC and emamectin benzoate 5%SG).
- All the 15 possible oil blends(groundnut, sunflower, rice bran, soybean, safflower and sesame) in 1:1 proportion were effective to deter the female oviposition in cotton fields in comparison to control plots and few were at par with insecticides.
- Fields evaluation of 28 oil blends (groundnut, sunflower, rice bran, soybean, safflower, sesame, cottonseed oil and castor) @1% in chickpea field revealed that 5 blends viz., groundnut+ricebran, groundnut + cottonseed, rice bran + safflower, rice bran + sesame, soybean + sesame were effective and at par with the insecticides.
- Blend of different plant volatiles (pinene, careen, caryophyllene, humulene and γ-terpinene) of different *Gossypium* spp. was tested as oviposition deterrent under laboratory condition. It was found that the lowest number of eggs was laid in blend of *G. herbaceum* and *G. barbadense*. The egg laying on *G. hirsutum* was at par with the control.
- Single compound evaluation of plant volatiles (pinene, careen, caryophyllene, humulene and γ-terpinene) was also done under laboratory condition in different concentration (0.2 to 3%) to find out the compound responsible for deterrence. It was found that lesser egg laying was observed in γ-terpinene, humulene and caryophyllene as the concentration increases.

3.27 Project Name : Monitoring insecticide resistance in American bollworm, *Helicoverpa armigera* (Hubner) populations from cotton growing regions of Maharashtra and Gujarat (2021-26)

Shah Vivek (PI); Co-PI :Rachna Pande

Importance of the study: Insecticide applications under field conditions are subjected to various environmental factors that lead to sub-lethal dose exposure of insects. Continuous use of recommended insecticides under field conditions over a period of time has led to development of resistance. Hence, field efficacy of these insecticides should be monitored. In this context present study was formulated to know the status of resistance in American bollworm of cotton to recommended newer insecticides and selected conventional insecticides under laboratory conditions.

Salient findings

- American bollworm populations from Maharashtra (10 districts) and Gujarat (8 districts) were screened against five newer (Chlorantraniliprole, Flubendiamide, Indoxacarb, Spinosad, Emamectin benzoate) and three conventional (Cypermethrin, Novaluron, Profenophos) insecticides.
- Among different insecticides evaluated in newer molecules Emamectin benzoate had the best efficacy against *H.armigera* with Indoxacarb being least effective (Fig.3.27.1). However, the efficacy of newer molecules was far better compared to conventional insecticides.
- Among different conventional insecticides evaluated Profenophos was found to be the best followed by Novaluron and Cypermethrin (Fig.3.27.2).

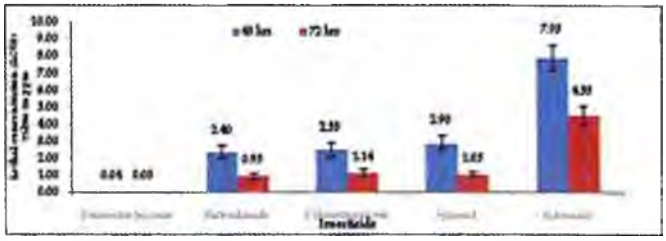


Fig 3.27.1: Mean lethal concentration of populations screened against newer insecticides

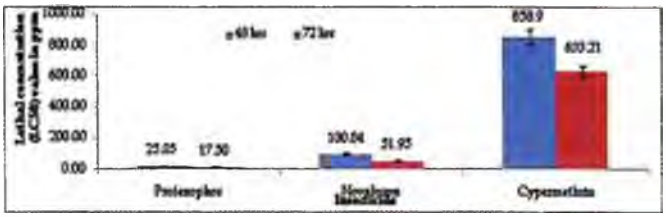


Fig. 3.27.2: Mean lethal concentration of populations screened against conventional insecticides

3.28 Project Name: Studies on grey mildew disease of cotton caused by *Ramularia areola*

Neelakanth S. Hiremani (PI); Co-PI: P. Valarmathi

Importance of the study: Grey mildew disease was first reported on upland cotton, then it spread to all the cultivated cotton species. The constant shift in this disease over the years may be due to the variability existing among the pathogen. There is very limited information available on the pathogenic and genetic variability of *R. areola* making it difficult to manage either through resistant cultivars or through fungicides.

Salient findings:

- Different media like PDA, SDA, Richard's agar, Czapek's agar, V-8 juice agar, leaf decoction agar and Kirchoff's agar were used to isolate the pathogen.
- *Ramularia areola* is very slow growing, sporulation was not seen in culture. Nevertheless, identification of the best growth medium for isolation of *Ramularia* is being carried out.
- Some of the aforementioned media produced little growth of the pathogen. Therefore, DNA was extracted from such cultures and ITS analysis was done. ITS analysis of medium grown cultures revealed no similarity to *R. areola* sequence, whereas DNA extraction and ITS analysis with ITS 4 and ITS 5 primers from diseased leaves could give matching sequence (Fig 3.28.1).
- Spore (conidia) morphology of the isolates from three species of cotton was studied wherein conidia of *G. hirsutum* were found large (3.45-8.17 X 0.58-1.31 μm) as compared to *G. arboreum* (3.85-6.2 X 0.67-1.23 μm) and *G. herbaceum* (3.31-6.3 X 0.63-1.26 μm).
- Eighteen Bt hybrids were assessed for grey mildew during the season and disease scoring was done at three intervals.

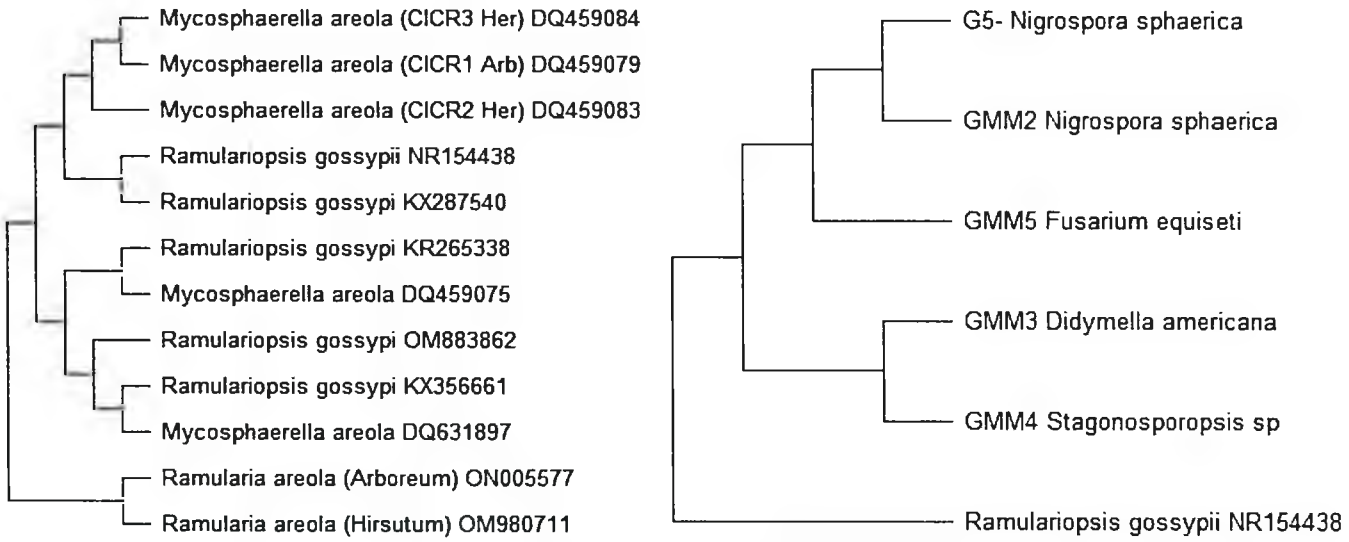


Fig 3.28.1. ITS based maximum likelihood tree of different fungal isolates obtained on growth medium compared to reference sequence from NCBI database (A) and Ramularia isolates (red) from direct DNA extraction and ITS sequenced from infected leaf compared to reference sequences (B).

3.29 Project Name: Studies on Prevalence of *Xanthomonas citri* pv. *malvacearum* races of Cotton and Breeding for BLB Resistant Varieties (Closing Project)

Shailesh P. Gawande (PI); Co-PIs: V.N.Waghmare, D.T.Nagrale, Neelkanth Hiremani, S.K.Sain and Sampath Kumar

Importance of the study: This study helps to determine morphometric, biochemical and genetic status of *Xanthomonas citri pv. Malvacearum* isolates obtained from different cotton growing zones of India. The study is also important for Identification of the prevalent races of Xcm and development of BLB resitant variety.

Salient findings

Identification race (s) prevalence by using host differentials.

- For race identification, the pathogenicity of the isolates was tested on nine different cultivars (Host differentials) of cotton in a glasshouse (Fig.3.29.1).
- Cotton seedlings at the six-leaf stage were inoculated with the Xcm isolates by tooth pick inoculation.
- The reaction of *Xcm* pathogenic cultures on the host differentials identified the test *Xcm* isolates as race 7,8,11,13 and 18 with the race 18 as the most prevalent one.
- The roving surveys carried out in farmers' fields in different cotton growing districts of Maharashtra and Telangana revealed low incidence of BLB (0-5.56 %) (Table 3.29.1 and 2)
- The isolates of BLB were collected from the North, Central and South cotton growing zones of India and submitted in the repository for future screening.
- Identification of *Xcm* isolates by biochemical tools was carried out.
- Molecular characterization of 12 isolates collected from different geographic zones of India by 16S r-DNA and pthn primers has been done and the sequences were submitted to NCBI database (Accession numbers:MG757833, MW789795, MW789796, MW789797, MW789798, MW789799, MH620778, MW757335, MW757336, MW757337,MW757338 and Mw757339) (Fig.3.29.2).
- Genetic diversity of collected Xcm isolates was studied by using ISSR primers.
- Selected, screened and grouped 55 no's of BC4-F4 and 37 no.s of BC5-F3 BLB resistant plants by marker assisted selection(Through CIR-246 marker) and artificial inoculation.
- Standardized the protocol for rapid, sensitive and specific diagnosis of Xcm by using Loop mediated isothermal amplification techniques (LAMP) (Fig.3.29.3) .

Table 3.29.1: Survey and surveillance of BLB in farmers' fields during 2021-22

Sr.No.	Location	District	GPS coordinates	BLB (PDI)
1	Shendola (kh)	Amravati	21.048, 77.977	5.56
2	Khartalegaon	Amravati	20.999, 77.635	0.0
3	Ghusar, Mhatodi	Akola	20.805, 77.055	2.78
4	JawalaPalaskhed	Buldhana	20.728, 76.708	0.0
5	Mahagaon	Buldhana	20.717, 76.701	2.78
6	Wadi Wadner	Buldhana	20.833, 76.419	2.78
7	Eklagne Bk	Jalgaon	21.016, 75.423	0.0
8	Eklagne Bk	Jalgaon	21.015, 75.419	5.56
9	VaradKh	Jalgaon	20.995, 75.392	0.0
10	Varad, kh	Jalgaon	20.004, 75.400	2.78

Sr.No.	Location	District	GPS coordinates	BLB (PDI)
11	Pimpalkota	Jalgaon	20.972, 75.371	0.0
12	Musai Bk	Jalgaon	21.021, 75.398	2.78
13	MusaiKh	Jalgaon	21.012, 75.396	0.0
14	Muktainagar	Jalgaon	21.045, 76.058	2.78
15	Pimpriakaraut	Jalgaon	21.032, 76.088	2.78
16	Piwandal	Akola	20.922, 76.928	0.0
17	Ganori	Akola	20.887, 77.132	0.0
18	Waroda	Chandrapu	19.8294, 79.2269	5.56
19	Arvi	Wardha	20.636, 79.125	0.0
20	Khapri	Nagpur	21.030, 79.069	2.78
21	Masala khurd	Telangana	19.664,78.732	0.0
22	Murumbakh	Nanded	19.314, 77.229	2.78
23	Panhera	Parbhani	19.316, 76.637	2.78
24	Pathri	Beed	19.197, 76.340	0.0
25	Rahuri	Ahmednagar	19.373, 74.665	5.56
26	Sonkhas	Yavatmal	20.416, 78.004	0.0
27	Charurkhati	Chandrapu	20.195, 79.0018	2.78
28	Raja takli	Jalna	19.333, 76.066	1.67
29	Chinchbardi	Yavatmal	20.397, 78.045	6.68
30	Deoli	Wardha	20.644, 78.474	1.67
31	Umarkhed I	Yavatma	19.597, 77.683	3.34
32	Ashti	Nanded	19.527, 77.655	1.67
33	Matarewadi	Jalna	19.869, 75.748	1.67

Table 3.29.2: Race identification of BLB based on disease reaction on host differentials

Sr.no.	Differentials	Disease Reaction on host differentials (+/-)													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	101-102-B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Stoneville – 20	+	-	+	+	-	+	+	+	-	-	-	+	-	+
3	Acala – 44	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4	Stoneville -B -5	+	+	+	+	-	+	+	+	+	-	+	+	-	+
5	Mebane – b	+	+	+	+	-	+	+	+	+	-	-	+	-	+
6	DP X P4	+	-	+	+	N/A	+	+	+	-	N/A	-	+	-	-
7	1-10-B	+	+	+	+	-	+	+	+	+	-	-	+	-	+
8	Gregg 419	+	+	+	+	N/A	+	+	+	+	N/A	+	+	-	+
9	Empire – B4	+	-	+	+	N/A	+	+	+	-	N/A	-	+	-	-
10	HS 6	+	+	+	+	-	+	+	-	+	-	+	+	-	+
11	Suraj	+	-	+	+	-	+	+	-	-	-	-	+	-	-
12	Suvin	+	-	+	+	-	+	-	+	-	-	-	+	-	+
Race Number		18	7	18	18	13	18	18	18	7	13	11	18	18	8

Where, 1=Junagarh isolate,2=Sirsa, 3=Nagpur isolate,4 Nagpur isolate, 5=Dharwad 3,6=Dharwad 5, 7=Faridkot isolate, 8=Dharwad -6, 9=Dharwad =7, 11=jamb isolate,12=Bhadrawati isolate, 13=Coimbtore,14=Rahuri

Table 3.29.3: Screening and selection of Bacterial blight resistant plants during 2021-22

BC5-F3						
Parents	Population Sown	No. of plants selected	Morphological Characters of the selected lines			
			Petal color	Pollen color	Boll shape	Boll Surface
Suraj×CSH- 3047 (a)	6a (27)	5	Cream	Cream	Ovate	Smooth
	7a(38)	3	Cream	Cream	Ovate	Smooth
	9a(16)	6	Cream	Cream	Ovate	Smooth
Suraj×GTHH-032 (b)	4b(42)	10	Cream	Cream	Ovate	Smooth
	9b(3)	0	Cream	Cream	Ovate	Smooth
	19b(15)	3	Cream	Cream	Ovate	Smooth
	25b(13)	0	Cream	Cream	Ovate	Smooth
	26b(34)	7	Cream	Cream	Ovate	Smooth
Suraj× CSH-3313 (c)	23c(2)	1	Cream	Cream	Ovate	Smooth
	26c(11)	2	Cream	Cream	Ovate	Smooth
	Total : 201	37				

BC5-F3						
Parents	Population Sown	No. of plants selected	Morphological Characters of the selected lines			
			Petal color	Pollen color	Boll shape	Boll Surface
BC4-F4						
Suraj×CSH- 3047 (a)	7a(35)	10	Cream	Cream	Ovate	Smooth
	9a(159)	23	Cream	Cream	Ovate	Smooth
Suraj×GTHH-032 (b)	2b(2)	0	Cream	Cream	Ovate	Smooth
	4b(29)	9	Cream	Cream	Ovate	Smooth
	26b(32)	12	Cream	Cream	Ovate	Smooth
Suraj× CSH-3313 (c)	23c(73)	1	Cream	Cream	Ovate	Smooth
	Total : 330	55				

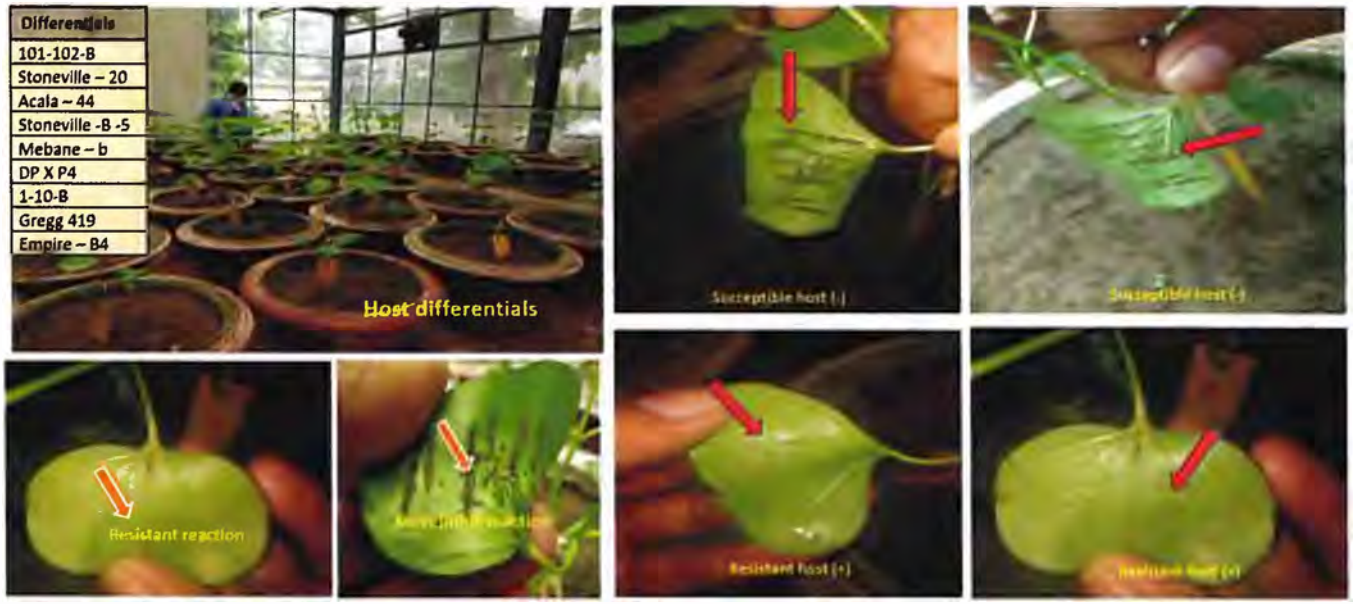


Fig 3.29.1: Disease reactions of *Xcm* isolates on host differentials 7 DAI

Fig. 3.29.2: Marker Assisted Selection of BLB resistant plant lines using CIR246 primer

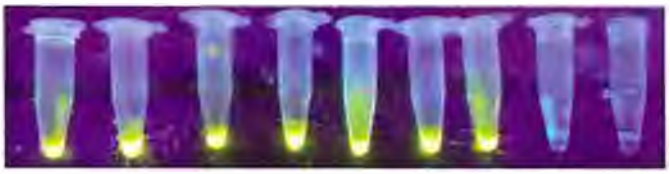


Fig.3.29.3: Standardized the protocol for diagnosis of Xcm by using Loop mediated isothermal amplification

3.30 Project Name: Studies on target leaf spot of cotton caused by *Corynespora cassiicola*

Shailesh P. Gawande (PI); Co-PIs: S.K.Sain, Chandrashekhar, N.

Importance of the study: Present investigation was proposed to gather the information about the target leaf spot of cotton, an emerging disease, for location specific management, which is presently lacking. More data about distribution across Indian cotton acreage disease onset and diversity are needed to understand disease development and potential impact on yield.

Salient findings: Ascertained the extent of severity and incidence of target leaf spot caused due to fugal pathogen *Corynespora cassicola* in farmers' fields through the roving surveys carried out in different cotton growing districts of Maharashtra. The incidence of target spot recorded in all 33 locations surveyed and disease severity (PDI) recorded in the range of 5.56% -65.34% (Table 3.30.1)

Screening of 18 popular private Bt-hybrids in the field were carried out to identify the resistance and susceptible sources against target leaf spot. Bt hybrid First class found highly susceptible whereas Ajeet-5 and Ajeet-155 showed resistant reaction.

Expression studies of Chitinase and Chitinase like genes in response to *C. cassiicola*

- Cotton plants were established under glass house conditions, bead inoculation of cotton leaves with *C. cassiicola* was performed and samples were collected at specific time intervals, stored at -80° C.
- Total RNA was isolated using Sigma Spectrum Plant RNA isolation kit. Further cDNA was synthesized for all the samples from good quality RNA. RT-PCR was performed for Chitinase genes, Ubiquitin gene was used as house-keeping gene, NTC (-Ve Control), genomic DNA (+Ve Control).
- Majority of the chitinase genes under study were significantly induced in response to *C. Cassiicola,* when compared to basal expression, 6h and 24h post inoculation showed higher levels of transcript accumulation compared to other time intervals.

- In vitro efficacy of label claim fungicides has been carried out and Carbendazim 50%WP @ 0.25% followed by Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l SC @ 0.06% showed 100 and 93.56 per cent inhibition over control respectively (Fig. 3.30.1). In case of bio efficacy of bioagents, *Trichoderma asperllum* and *T. longibrachiatum* were found effective against *C. cassicola* in vitro (Fig. 3.30.2).
- Molecular characterization and identification of isolates collected from different locations were done by using ITS sequencing and translation elongation factor-1 and Beta tubuline housekeeping genes primers.

Table 3.30.1: Survey and surveillance of *C. cassicolla* in cotton growing districts of Maharashtra

Sr. No.	Location	District	GPS coordinates	(PDI)
1	Shendola (kh)	Amravati	21.048, 77.977	19.46
2	Khartalegaon	Amravati	20.999, 77.635	8.34
3	Ghusar, Mhatodi	Akola	20.805, 77.055	65.34
4	JawalaPalaskhed	Buldhana	20.728, 76.708	19.46
5	Mahagaon,	Buldhana	20.717, 76.701	22.24
6	Wadi Wadner	Buldhana	20.833, 76.419	22.24
7	Eklagne Bk.,	Jalgaon	21.016, 75.423	19.46
8	Donwada	Akola	21.015, 75.419	42.00
9	Khudanpur	Jalgaon	20.995, 75.392	27.8
10	Varad, kh.,	Jalgaon	20.004, 75.400	30.58
11	Pimpalkota,	Jalgaon	20.972, 75.371	27.8
12	Musai Bk.,	Jalgaon	21.021, 75.398	25.02
13	MusaiKh.,	Jalgaon	21.012, 75.396	8.34
14	Muktainagar,	Jalgaon	21.045, 76.058	11.12
15	Pimpriakaraut,	Jalgaon	21.032, 76.088	5.56
16	Piwandal,	Akola	20.922, 76.928	8.34
17	Ganori,	Akola	20.887, 77.132	11.12
18	Waroda,	Chandrapur	19.829, 79.226	11.69
19	Arvi,	Wardha	20.636, 79.125	13.36
20	Khapri,	Nagpur	21.030, 79.069	20.04
21	Masala khurd,	Telangana	19.664,78.732	19.46
22	Murumbakh	Nanded	19.314, 77.229	18.37
23	Panhera	Parbhani	19.316, 76.637	18.37
24	Pathri	Beed	19.197, 76.340	23.38
25	Rahuri,	Ahmednagar	19.373, 74.665	21.71
26	Sonkhas	Yavatmal	20.416, 78.004	11.69
27	Charurkhati	Chandrapu	20.195, 79.002	25.05
28	Raja takli	Jalna	19.333, 76.066	18.37
29	Chinchbardi	Yavatmal	20.397, 78.045	13.36
30	Deoli	Wardha	20.644, 78.474	18.37
31	Umarkhed I	Yavatma	19.597, 77.683	13.36
32	Ashti	Nanded	19.527, 77.655	18.37
33	Matarewadi	Jalna	19.869, 75.748	11.69

Symptoms of target spot on cotton leaf

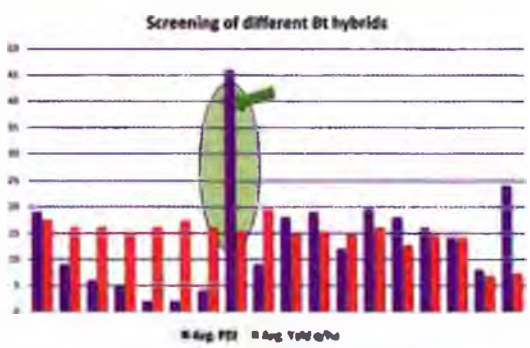


Table 3.30.2: Symptoms and Morphological characters of isolates of *Corynespora cassiicola* obtained from different cotton grown fields of North Western India and grown in PDA at 25±1 ºC with12/12 h photoperiod

Code	Area	Symptom's differentials spot size, color, ring	Colony Character (color, topography, margin, elevation and pigmentation at lower side)	Colony Diameter (mm) at 10 DAI
CS01	Sirsa, Haryana	brick-red spots, clear rings, light purple margin, 0.2 -3.3 cm size	Light gray turning to dark gray, colony dense and velvet, Entire, raised, Dark brown center and outer side tan Brown	45.0
CS02	Sirsa, Haryana	ash brown spots, clear rings, light purple margin, 0.2 -2.3 cm size	Gray, colony dense and Velvet, Filiform, Raised, Reddish brown	55.5
CS03	Raniya, Sirsa, Haryana	brown spots, light purple margin, 0.2 -1.1 cm size	Whitish gray, Dense and Velvet, Filiform, Raised, Light Reddish brown	56.5
CS04	Sirsa, Haryana	dusty-brown spots, light purple margin, 0.2 -1.5 cm size	Dim gray, Dense & velvety growth, Lobate, Unbonate, Tan brown	58.0
CS05	Bhadra, Rajasthan	light brown spots, dark purple margin, 0.2 -2.2 cm size	Gray, Dense and Velvet, Filiform, Raised, Center Light gray and outer side dark brown	49.0
CS06	Sriganganagar, Rajasthan	creamy brown spots, dark purple margin, 0.2 -2.1 cm size	Whitish gray, Dense & velvety growth, Lobate and Convex, Light brownish gray with light zonation	46.5
CS07	Faridkot, Punjab	ash-brown spots, clear rings, dark purple margin, 0.2 -3.1 cm size	Gray, Dense & velvet growth, Undulate (wavy), Convex, Center dark with outer side light gray with light to dark gray, zonation	45.0
CS08	Bhatinda, Punjab	brick-red spots, clear rings, sclerotia, light purple margin, 0.1 -3.3 cm	Gray, Dense & velvety growth, Undulate, Convex to flat, Light gray with zonation	49.0
CS09	Fatehabad, Haryana	ash-brown spots, clear rings, sclerotia, light purple margin, 0.1 -2.2 cm size	Light gray, Dense & velvety growth, Undulate, Raised, Center tan brown, margin light pinkish	46.0
CS10	Hisar, Haryana	light-dark brown spots, clear rings, sclerotia, light purple margin, 0.1 -2.5 cm	Dark gray, Dense & velvety growth, Filiform, Convex, Dark brown to gray	38.5
CS11	Hisar, Haryana	ash brown spots, clear rings, light purple margin, 0.2 -1.2 cm size	Gray, Dense and Velvet, Undulate, Convex, Gary with zonation	43.5
CS12	Sangria, Rajasthan	ash-brown spots, clear rings, sclerotia, 0.1 -3.5 cm size	Light gray to tan brown , Dense and Velvet, Undulate, Convex, Gray with zonation	45.5
CS13	Surat, Gujarat	brick-red spots, dark purple wide margin, 0.2 -2.3 cm size	Gray, Dense and Velvet, Undulate, Convex, Center dark brown & outer tan brown	43.5
CS14	Junagarh, Gujarat	brick-red spots, clear rings, dark purple wide margin, 0.2 -2.7 cm size	Whitish gray, Dense and Velvet, Undulate, Convex, Center dark brown and outer light gray with less zonation	56.0
CS15	Guntur, AP	reddish-brown spots with gray ash center, dark purple margin, 0.2 -1.8 cm	Grey, Dense and Velvet, Entire, umbonate, tan brown	55.1

Table 3.30.3: Conidial characters of different isolates of *Corynespora cassiicola*. obtained from different cotton grown fields of North Western India and grown in PDA at 25±1 ºC with12/12 h photoperiod

Isolates	Number of pseudosepta in per conidia, and beak	Measurement of Conidia at 40X			
		Length (µm)		Widths (µm)	
		Range	Mean	Range	Mean
CS01	8-12, slightly curved with truncate base, rounded tip	35.54-85.89	57.89	7.75-10.37	8.78
CS02	3-7, cylindrical with truncate base, rounded tip,	23.44-57.13	42.53	7.00-10.11	8.41
CS03	6-10, lorate, slightly curved with truncate base, tip-both sides rounded	62.16-136.73	85.39	10.40-14.41	12.46

Isolates	Number of pseudosepta in per conidia, and beak	Measurement of Conidia at 40X			
		Length (µm)		Widths (µm)	
		Range	Mean	Range	Mean
CS04	6-13, lanceolate, slightly curved at tip with truncate base, tip rounded, long beak	45.41-147.36	98.73	9.71-15.06	12.36
CS05	8-14, lanceolate slightly curved with truncate base, rounded tip, long beak	77.50-145.03	109.39	14.11-20.48	17.49
CS06	5-10, narrowly ovate, with truncate base, tip rounded, short beak	59.12-103.60	74.84	13.17-18.09	15.05
CS07	5-11, ovate, slightly curved with truncate base, tip rounded, long beak	55.37-117.20	86.70	10.78-17.18	14.72
CS08	6-11, subulate with truncate base, tip rounded, pseudobeak	86.17-111.04	99.52	14.73-20.91	17.66
CS09	5-11, lanceolate, slightly curved with truncate base, tip rounded, pseudobeak	58.14-128.72	98.57	12.88-18.38	15.20
CS10	5-9, cylindrical, slightly curved with truncate base, beak tapered	55.06-128.66	90.21	14.17-18.62	16.62
CS11	5-11, slightly curved with truncate base, tip tapered and rounded	60.69-124.26	102.50	13.87-19.49	16.71
CS12	5-13, narrowly ovate, with truncate base, beak slightly long, tip rounded	79.04-128.15	97.62	13.58-20.21	17.11
CS13	7-13, lanceolate slightly curved with truncate base, rounded tip, tapered beak	70.47-135.46	102.97	12.34-16.99	14.90
CS14	6-11, narrowly ovate, slightly curved at base with truncate base, tapered beak	72.20-130.71	96.88	6.37-17.53	13.54
CS15	4-10, cylindrical, truncate base, beak absent, tip rounded	55.63-75.68	63.64	4.56-8.45	5.88
	SEM±	0.35		0.08	
	CD	0.98		0.21	
	CV	11.86		6.16	

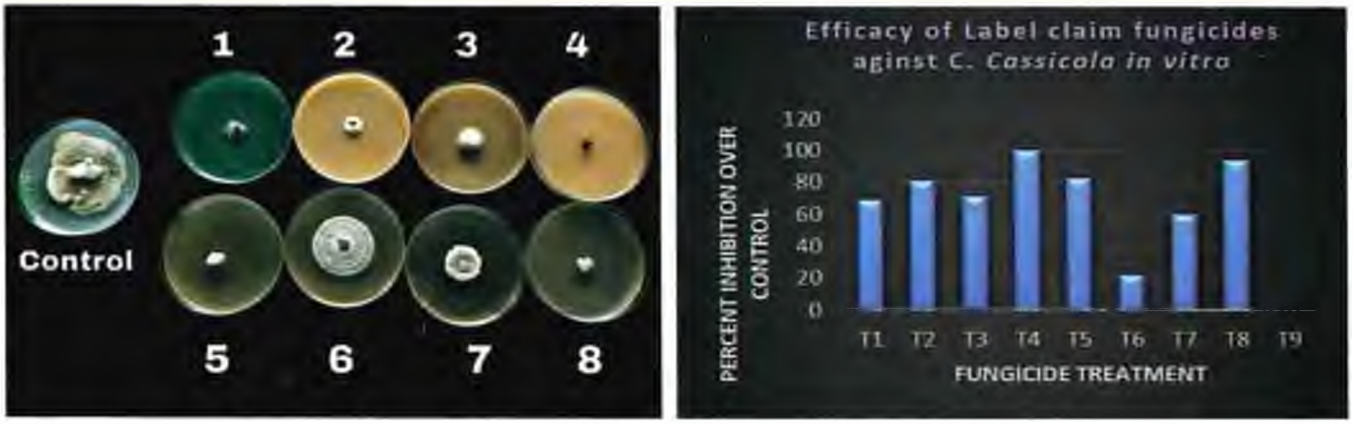


Fig. 3.30.1 : Efficacy of label cliam fungicides against *Corynespora in Vitro*

Fig. 3.30.2 : Bio efficacy of fungal bioagents against *Corynespora* leaf spot *in Vitro*

3.31 Project Name: Mass multiplication of CICR-Trichocash (*Trichoderma harzianum*) and validation of their efficacy under MGMG fields

Shailesh P. Gawande (PI); Co-PI: D. T. Nagrale

Importance of the study: *Trichoderma* spp. is the bio control agents widely used in management of crop plant. India has rich biodiversity pool of antagonists that can be explored as natural, eco-friendly and renewable resources for successful utilization as integrated management approaches of diseases. Therefore, the present study has been planned to utilize and validate native strains of antagonist CICR-Trichocash (*Trichoderma harzianum)* in the cotton based cropping system for the management diseases.

Salient findings:

- Isolated and characterize 4 different species of *Trichoderma viz., T.harzianum, T. longibrachiatum, T. asperllum and Taleromeces* sp. and deposited the ITS sequences in NCBI.
- Mass multiplication of Trichocash (1000kg of talc-based formulation) was carried out.
- In vitro evaluation of bio efficacy of identified *Trichoderma* species against important diseases of cotton.
- Total 750 Kg of Trichocash have been supplied for distribution to the farmers under SCSP and TSP leading to revenue generation of Rs 1,20,000 under KVK revolving fund.
- Provided the trichocash (250kg) for institute field experiments and organic fields for application after shredding.

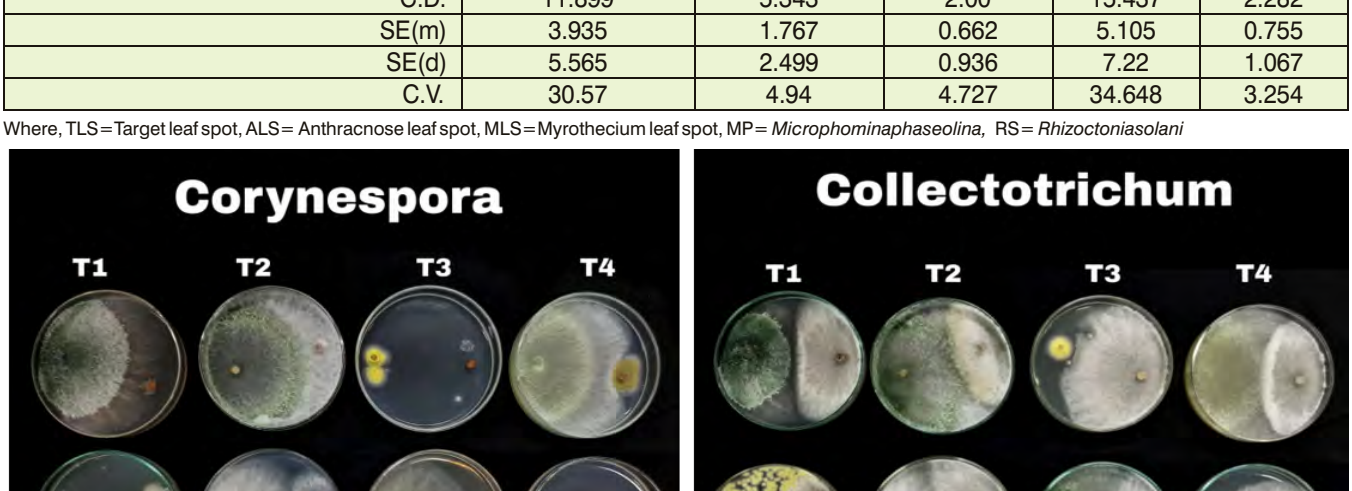
Table 3.31.1: Isolation and characterization of Trichoderma sp. from cotton rhizophere.

Sr. No.	Isolate	Location	Species identifies	NCBI accession no.
1	Tr-1	Waygaon, Wardha	*Trichoderma asperelum*	MW757231
2	Tr-2	Deoli, Wardha	*Taleromyces* sp.	NA
3	Tr-3	CICR	*Talaromyces* sp.	MW757232
4	Tr-4	CICR	*Trichoderma harzianum*	MW757233
5	Tr-5	Arvi, Wardha	*Trichoderma longibrachiatum*	MW757234
6	Tr-6	Samudrapur	*Trichoderma longibrachiatum*	MW757235
7	Tr-7	CICR, Nagpur	*Talaromycescellulolyticus*	MW757236
8	Tr-8	CICR, Nagpur	*Trichoderma longibrachiatum*	MW757237

Table 3.31.2: Evaluation of bio efficacy of *Trichoderma* isolates against important diseases of cotton *in vitro*

Treatment	Percent Inhibition over control				
	TLS	ALS	MLS	MP	RS
Tr-1 (*Trichoderma asperelum*)	100	28.57	65.04	69.16	6.89
Tr-2 (*Talaromyces* sp.)	6.99	38.41	61.68	97.12	100
Tr-3 (*Talaromyces* sp.)	100	17.58	49.07	88.50	40.61
Tr-4 (*Trichoderma harzianum*)	60.81	33.33	66.01	100.00	90.80
Tr-5 (*Trichoderma longibrachiatum*)	70.57	26.78	62.66	87.73	92.33
Tr-6 (*Trichoderma longibrachiatum*)	95.91	41.39	59.22	75.28	100
Tr-7 (*Talaromyces cellulolyticus*)	70.57	23.80	59.74	47.50	0.00
Tr-8 (Control)	0.00	0.00	0.00	0.00	0.00
C.D.	11.899	5.343	2.00	15.437	2.282
SE(m)	3.935	1.767	0.662	5.105	0.755
SE(d)	5.565	2.499	0.936	7.22	1.067
C.V.	30.57	4.94	4.727	34.648	3.254

Where, TLS = Target leaf spot, ALS = Anthracnose leaf spot, MLS = Myrothecium leaf spot, MP = *Microphominaphaseolina,* RS = *Rhizoctoniasolani*



Bio efficacy of *Trichoderma* isolates against important diseases of cotton *in vitro*

3.32 Project Name: Studies on boll rot in cotton – Etiology and Management

Dipak T. Nagrale (PI); Co-PI (s):Babasaheb B. Fand

Importance of the study: Boll rot disease complex is an important disease in cotton because it not only reduces the yield but also affects the quality of lint and seed. Most of the times, boll rot becomes a complex disease problem involving damage and injury symptoms produced by bollworms, principal pathogen (s) with unexplored etiology and secondary invaders causing damage at boll development stages. In recent years, emerging boll rot disease complex in climate change scenario are increasingly assuming among the major biotic challenges that may limit the cotton fibre quality and total production.

Salient findings

- Survey, sampling and diagnostics of boll rot disease complex samples were done from Maharashtra, Telangana, Gujarat and Madhya Pradesh regions (Table 3.32.1).
- Studied the symptomatology of boll rot disease complex caused by fungal and bacterial pathogens and pathogenicity of isolates on Bt cotton hybrid and non-Bt variety from different cotton growing regions
- Polyphasic characterization of the isolated bacterial and fungal boll rot pathogens was done was nucleotide sequences submitted to NCBI GenBank database (https://www.ncbi.nlm.nih.gov/nuccore/) (Table 3.32.2).
- Erect to semi-erect plant type, medium height, sucking pests tolerant and medium crop duration for BG-II hybrids with proper/well field drainage condition were observed with less severity of boll rot for medium to medium-heavy soil condition at farmers field
- Transmission of boll rot pathogen Pantoea sp by thrips is investigated. The healthy thrips allowed to feed on boll rot infected cotton bolls for 72 h could acquire the pathogen and transmit it into healthy green bolls. This resulted in 70.00% boll rot incidence in the treatment of thrips fed bolls compared to 6.19% observed in control treatment which were raised free of thrips infestation (Table 3.32.3)
- Copper oxychloride 50 WP+ Streptocycline (100 ppm) was best against bacterial boll rot pathogens, *Xanthomonas citri* pv. *malvacearum* and *Pantoea dispersa* under *in vitro* and *in situ*
- Thiram 37.5%+Carboxin 37.5% WS@ 0.35% was best as seed treatment fungicide in managing fungal boll rot pathogens under *in vitro* and field condition
- Propiconazole 25 EC@ 0.1%, Propineb 70% WP @0.25%, Copper sulphate 47.15%+Mancozeb 30% WDG @ 0.58%, Captan 70%+Hexaconazole 5% WP @ 0.15% and Pyraclostrobin 5%+Metiram 55% WG @0.2% were the best fungicides in inhibiting the infection of prevalent fungal boll rot pathogens i.e. *Lasidiplodia theobromae*, *Fusarium proliferatum*, *Aspergillus nidulans*, *Alternaria macrospora* and *Pestalotiopsis* sp. under *in vitro* and *in vivo*
- Copper oxychloride 50 WP+Streptocycline (100 ppm) followed by (Copper sulphate 47.15%+Mancozeb 30% WDG) @ 0.58%, (Captan 70%+Hexaconazole 5% WP) @ 0.15% and Copper hydroxide 53.8 % DF @ 0.2% was best for managing bacterial boll rot under field condition

Table 3.32.1: Fungal boll rot pathogens from different geographic locations of India

Sr. No.	Name of organism	Isolate ID	Location	No. of isolate	GPS co-ordinate	NCBI GenBank Accession no.
1	*Corynespora cassiicola*	ECBR-5FJAL	Jalna, Maharashtra	01	19°49'33.9"N 75°56'03.7"E	OM967463
2	*Fusarium proliferatum*	ECBR-2FCIPR	Rahuri, Maharashtra	01	19°22'03.0"N 74°39'11.7"E	OM967461
3	*Fusarium solani*	ECBR-6FWAR	Wardha, Maharshtra	01	20°37'51.2"N 79°08'39.1"E	OM967464
4	*Lasiodiplodia pseudotheobromae*	ECBR-4FJN	Adilabad, Telangana	01	19°37'46.5"N 78°27'33.0"E	OM967462
5	*Rhizomucor* sp.	ECBR-1FMoZ	Chhindwara, Madhya Pradesh	01	21°38'11.4"N 78°49'11.9"E	OM967460

Table 3.32.2: Bacterial boll rot pathogens from different geographic locations of India

Sr. No.	Name of organism	Isolate ID	Location	Nos. of isolate	GPS Co-ordinate	NCBI GenBank accession no.
1	*Pantoea agglomerans*	CBR-B5BC4N	Nagpur, Maharashtra	01	21°02'14.5"N 79°03'31.5"E	OM977100
2	*Pantoea anthophila*	CBR-JALG	Jalna, Maharashtra	01	19°49'33.9"N 75°56'03.7"E	OM977103
3	*Pseudomonas aeruginosa*	CBR-ADL	Adilabad, Telangana	01	19°43'26.4"N 78°43'01.2"E	OM977102
4	*Xanthomonas* sp.	CBR-SUT	Surat, Gujarat	01	21°10'34.9"N 72°48'16.5"E	OM977101

Table 3.32.3: Transmission of boll rot incidence in cotton by thrips

S. N.	Treatment details	Incidence of boll rot (%)
1.	Bolls developed from the flowers of cotton plants on which thrips culture was maintained	7.33±5.06 (10.13±6.95)
2.	Bolls developed from the flowers of cotton plants on which culture of *Pantoea* sp. was inoculated and after one week of inoculation, thrips were allowed to feed for 72 h	54.29±1.96 (47.46±1.12)
3.	Bolls developed from the flowers of cotton plants on which thrips were transferred from *Pantoea*sp. inoculated flowers	70.00±13.69 (63.00±12.32)
4.	Bolls developed from the flowers of cotton plants which were maintained completely free from thrips (control)	6.19±4.26 (9.26±6.35)
	F-test	16.77**
	SE(m)±	2.95
	CD	9.11
	CV(%)	2.27

•Common symptoms of boll rot disease caused by boll rot pathogens

Symptoms: (Bacterial boll rot)

•The developing fibers and immature seeds in locules of green bolls were discoloured with light yellow to brown coloured, occasionally with slimy appearance

•In some cases, seeds were swollen, discoloured with necrotic patches and rotted

•Mechanical damage or feeding sign of sucking pests and/or stink bug were rarely noticed externally on most of the developing green bolls.

•In most cases, infections were restricted to one or two locules of diseased bolls

Symptoms: (External/fungal boll rot)

•Several type of disease symptoms occurs by complex of phytopathogenic fungal and opportunistic microbe infections

•Generally, the bolls are with light brown to grey coloured spot/lesions noticed, that further extend and covers whole boll that results in rotted and decayed bolls with mycelial growth

•Fructifications and/or mycelial growth ranged from white, brownish-purple to blackish colour on bolls

• Water soaked, oily spots may appear on surface of bolls, further develop necrotic patch, later enter internally in bolls

Boll rot disease complex and symptomatology under field condition

a) *Pantoea dispersa*
(Facultative anaerobe pathogen)

A

b) *X. citri* pv. *malvacearum*
(Aerobic pathogen)

BG-II hybrid

Spore suspension
(10^6 CFU/ml)

Selfing

RH=>85%
Air temperature=28±2^{0}C

Boll rot incidence % (n=27)			
Strain	7 days	14 days	21 days
Pd	+	++	+++
Xcm	0	0	0
Control	0	0	0

Bolls were dissected after 7, 14 and 21 days for observation of internal boll rot infection

a) *Pantoea dispersa*
(Facultative anaerobe pathogen)

B

b) *X. citri* pv. *malvacearum*
(Aerobic pathogen)

BG-II hybrid

Mid-aged green bolls (> 3 weeks) was sprayed with spore suspension (10^6 CFU/ml)

RH=>80%
Air temperature=28±2^{0}C

Boll rot incidence % (n=27)			
Strain	7 days	14 days	21 days
Pd	0	0	+
Xcm	++	+++	+++
Control	0	0	0

a) *Pantoea dispersa*
(Facultative anaerobe pathogen)

C

b) *X. citri* pv. *malvacearum*
(Aerobic pathogen)

Mid-aged green healthy bolls (2 to 3 weeks) will be inoculated with hypodermic syringe infiltration (10^6 CFU/ml)

Boll rot incidence % (n=27)			
Strain	7 days	14 days	21 days
Pd	+++	+++	+++
Xcm	+++	+++	+++
Control	0	0	0

Revisiting bacterial boll rot pathogenicity and etiology

CROP PRODUCTION DIVISION

3.33 Project Name: Investigation on the effect of skips and multiples on the productivity of machine planted cotton

MV Venugopalan (PI), Co-PIs: G Majumdar, G.I Ramkrushna, and R Raja

Importance of the study : Precision pneumatic planters are now available to plant single cotton seeds at desired spacing thereby reducing the expense on seeds and labour for planting. Planters also ensure timely planting. The project aims to evaluate the efficacy of precision planters. It also investigates the growth pattern and productivity of cotton under different simulated regimes of skips and multiples in order to identify the extent to which cotton can compensate for skips and multiples.

Salient findings

- In summer irrigated conditions at Nagpur, doubles and multiples were negligible in pneumatic planter planted cotton. The miss index (MI) ranged from 13.9 to 21.4 % and Quality of Feed Index ranged from 76.9 to 86.1%. The precision in spacing decreased at closer spacing.
- Under rainfed conditions during *Kharif* season, the doubles and multiples were 7.7%. The MI ranged from 9.4 to 17.9% with a mean of 13.7% .The Quality of Feed Index ranged from 73.3 to 84.4% with a mean of 78.7%. The precision in spacing was 5.05 mm.
- Under winter irrigated conditions of Coimbatore, the mean values of MI was 20.2%, Multiple Index was 10.0%, Quality of

Feed Index was 69.8 and the precision in spacing was 21.4 mm.

- Precision in all the trials were lower than the upper limit of 29%.

Based on the pooled analysis (2020-21 and 2021-22), it is inferred that highest seed cotton yield (1837 kg/ha) on rainfed Vertisols of Nagpur was observed when 100% of the dibbles

had one plant/dibble. Skips (misses) upto 5% or 10% were compensated by the occasional doubles (10%) introduced. However, when the percentage of skips increased to 20 or 25%, significant yield penalty was observed despite the presence of 10% doubles.

3.34 Project Name: Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem: Integrating ground observations, satellite data and modeling (in collaboration with ISRO-NRSC)

MV Venugopalan (PI); Co-PI: A Manikandan

Importance of the study: Ecosystem level carbon fluxes are key indicators of the functioning of crop production system and their quantification can help in understanding the sustainability of the production system under the current set of management practices. Eddy-covariance (EC) technique was used to quantify the CO_2 fluxes from a rainfed cotton production system in Central India during the 2021-22 crop season.

Salient findings

- The ecosystem was found to be a net CO_2 source for about two weeks from the date of sowing, as the crop stand was meagre and ecosystem respiration superseded the photosynthetic processes. The ecosystem became net CO_2 sink thereafter with peak net CO_2 influx of 4-4.5 g C m^{-2} d^{-1} during flowering initiation to first boll opening stage during the month of September (Fig 3.34.1).
- The mean Gross Primary Production (GPP) was 1.5 g C $m^{-2}d^{-1}$ during sowing to germination, 3.3gC$m^{-2}d^{-1}$during germination to squaring, 5.2 g C m^{-2} d^{-1} during squaring to flowering initiation, 6.1 g C m^{-2} d^{-1} during flowering initiation to first boll opening. It reduced thereafter with value of 5.1 g C m^{-2} d^{-1} during first boll opening to first picking, 3.4 g C m^{-2} d^{-1} during first to second picking, 3.2 g C m^{-2} d^{-1} during second to last picking.
- The mean Net Ecosystem CO_2 Exchange (NEE) was found to be 0.9 g C m^{2} d^{1} during sowing to germination, - 0.4 g C m^{2} d^{1} germination to squaring, -1.8 g C m^{-2} d^{-1} during squaring to flowering initiation, -2.1 g C m^{-2} d^{-1} flowering initiation to first boll opening. It declined thereafter during the boll bursting stage and was -0.9 g C m^{-2} d^{-1} during the period from second to last picking.
- Throughout the season (180 days), the cumulative GPP was 803.4 g C m^{2}, NEE was - 213.8 g C m^{-2} and Ecosystem Respiration (R_{eco}) was 589.7 g C m^{2}.
- The ratio of R_{eco} to GPP was 73.4 % and the ratio of NEE to GPP was 26.6%.
- Around 2. 14 tonnes of C per ha was sequestered by the cotton during the season of 2021-22.

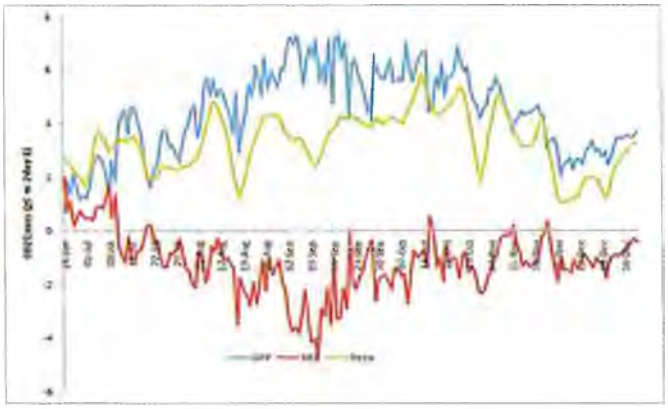


Fig 3.34.1: Dynamics of NEE- Net Ecosystem CO2 Exchange; GPP - Gross Primary Production and Reco-Ecosystem Respiration during the cotton crop season

3.35 Project Name: Bioprospecting microbial volatiles for plant growth promotion and sucking pest (Whitefly and Jassid) management in Bt cotton (DST-SERB Project)

K. Velmourougane (PI)

Importance of the study: Sucking pests are one of the major biotic factors, which affect cotton production in India. To manage sucking pests, farmers largely depend on conventional insecticides. Continuous and indiscriminate use of insecticides has resulted in resistance development in pests, apart from environmental pollution, adverse effects on natural enemies and resurgence of minor pests. Microbial volatile organic compounds (mVOCs) represent a new frontier in bioprospecting, where they produce several volatile compounds, which can attract or repel insects, and may act7 as an alternative and eco-friendly technology to manage sucking pests in cotton.

Salient findings

Based on the field trials with 250 volatile combinations, the best performing volatile combinations were identified individually for whiteflies (CICR-mVOC-W), jassids (CICR-mVOC-J), aphids (CICR-mVOC-A), and thrips (CICR-mVOC-T). These volatile formulations were evaluated under replicated field trials in six fields using a yellow sticky trap (YST) at 5 ppm concentration (fig. 3.35.1). The pest attraction efficiency was expressed in percentage increase over the control YST trap, and the pest attractive index (AI) was calculated using a formula (2*treatment group/ (treatment group + control group). The

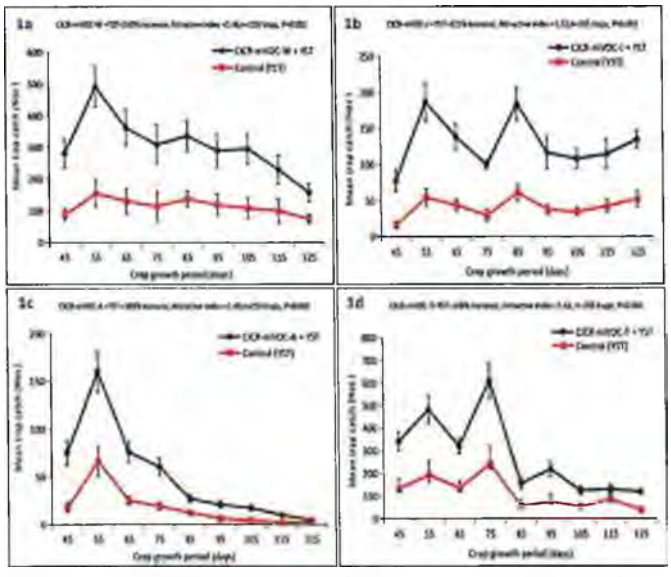


Fig. 3.35.1: Effect of microbial volatiles on sucking pest trap catch on 1a. whitefly, 1b. Jassid, 1c. Aphid, 1d. Thrips. All under are mean % of 6 independent field trials

values of AI, >1 indicate that the attractant is effective as an attractant of targeted pest. It was found that CICR-mVOC-W, CICR-mVOC-J, CICR-mVOC-A, and CICR-mVOC-T could increase the trap catch and attractive index by 168 % & 1.46, 225 % & 1.53, 189 % & 1.49 %, and 148 % & 1.42, respectively, for whiteflies, jassids, aphids, and thrips.

3.36 Project Name: Microbial dissolution of carbonate to ameliorate soil sodicity in Black Soil Regions of Maharashtra

K. Velmourougane (PI); Co-PIs: A. Manikandan, D. Vasu (NBSS & LUP)

Importance of the study: This study aimed to isolate calcium solubilizing bacteria (CSB), and to develop consortia of calcium dissolving bacteria for the dissolution of pedogenic $CaCO_3$ in soils through exogenous application to improve soil properties, enhancing soil and plant productivity.

Salient Findings

Based on the replicated pot experiment in 2021, four calcium solubilizing bacteria (CSB) were short-listed for CSB consortia preparation for their positive effects on plant growth parameters, soil nutrient availability, antioxidant enzyme activities, and soil biological properties. The CSB consortia have been evaluated in 20 farmers' field of Purna river valley in Akola and Amravati, where, soil calcareousness is a major constraint for cotton production.

The CSBs were also evaluated for their potential mineral solubilization to enhance micronutrient availability in calcareous soils. Based on the lab studies, it was found that the CSBs could significantly solubilize phosphate, zinc, magnesium and calcium sulphate (Fig. 3.36.1). Under this project, some native microbial isolates, which possess beneficial attributes were also identified and conserved (Table 3.36.1 and Fig. 3.36.2)

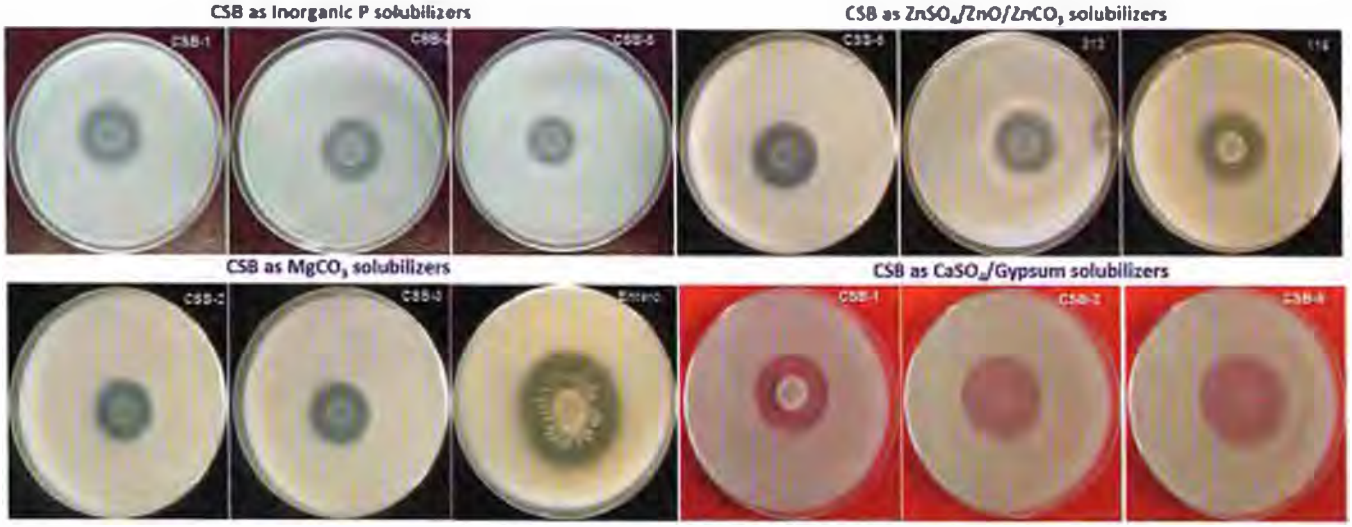


Fig. 3.36.1: Calcium solubilising bacteria as other mineral solubilisers

Table 3.36.1: Microbial resource conservation

S.No.	Code	Identified as	Beneficial attributes
1	CICR-116	*Alcaligenes faecalis*	Biofilm forming PGPR from cotton rhizosphere
2	CICR-310	*Bacillus tropicus*	Biofilm forming PGPR from cotton rhizosphere
3	CICR-78	*Lysinibacillus fusiformis*	Biofilm forming PGPR from cotton rhizosphere
4	CICR-174	*Lysinibacillus fusiformis*	Biofilm forming PGPR from cotton rhizosphere
5	CICR-Bt-4	*Alcaligenes faecalis*	Biofilm forming PGPR from cotton rhizosphere
6	CSB-1	*Lysinibacillus fusiformis*	$CaCO_3$ & micronutrient solubilising PGPR
7	CSB-2	*Lysinibacillus fusiformis*	$CaCO_3$ & micronutrient solubilising PGPR
8	CSB-4	*Lysinibacillus fusiformis*	$CaCO_3$ & micronutrient solubilising PGPR
9	CSB-5	*Lysinibacillus boronitolerans*	$CaCO_3$ & micronutrient solubilising PGPR
10	CSB-6	*Lysinibacillus fusiformis*	$CaCO_3$ & micronutrient solubilising PGPR
11	CICR-145	*Achromobacter denitrificans*	Drought tolerance imparting PGPR
12	CICR-86	*Lysinibacillus fusiformis*	Drought tolerance imparting PGPR
13	CICR-311	*Enterobacter mori*	Drought tolerance imparting PGPR
14	CICR-89	*Lysinibacillus fusiformis*	Drought tolerance imparting PGPR
15	CICR-165	*Enterococcus gallinarum*	Drought tolerance imparting PGPR
16	CICR-Bt-20	*Enterococcus gallinarum*	Drought tolerance imparting PGPR
17	CICR-Bt-32	*Enterococcus gallinarum*	Drought tolerance imparting PGPR
18	CICR-313	*Bacillus haynesii*	Drought tolerance imparting PGPR
19	CICR-B1	*Ralstonia mannitolilytica*	Cotton stalk degrading bacterium
20	CICR-B2	*Rhodobium gokarnense*	Cotton stalk degrading bacterium

S.No.	Code	Identified as	Beneficial attributes
21	CICR-B3	*Methylorubrum populi*	Cotton stalk degrading bacterium
22	CICR-B4	*Pseudomonas otitidis*	Cotton stalk degrading bacterium
23	CICR-B6	*Pantoea dispersa*	Cotton stalk degrading bacterium
24	CICR-B7	*Kosakonia pseudosacchari*	Cotton stalk degrading bacterium
25	CICR-23	*Alcaligenes faecalis*	PGPR with pest & disease biocontrol properties
26	CICR-75	*Alcaligenes faecalis*	PGPR with pest & disease biocontrol properties
27	CICR-148	*Enterococcus gallinarum*	PGPR with pest & disease biocontrol properties
28	CICR-219	*Enterococcus gallinarum*	PGPR with pest & disease biocontrol properties
29	CICR-F-5	*Trichoderma caribbaeum*	Cotton stalk degrading fungus

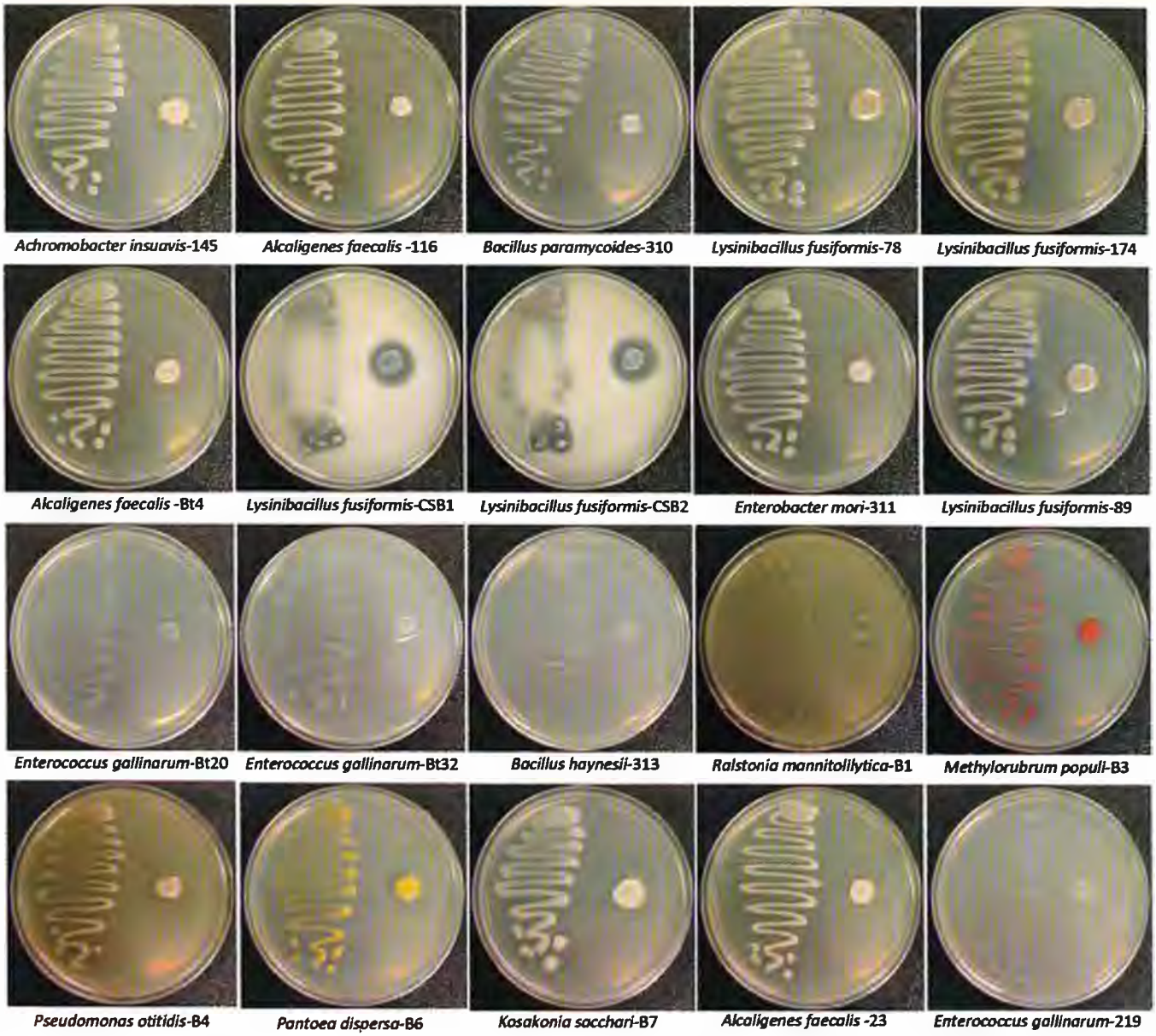


Fig. 3.36.2: Native microbial isolates identified from cotton rhizosphere with beneficial attributes

3.37 Feeler Trial: Improving farm income from cotton grown on shallow, medium and calcareous soils farm income through nano and other inputs (adhoc for one year)

R. Raju (PI)

Importance of the study: To validate the recommendations of Zn and B in different soils

Salient Findings: Flooded calcareous soils produced lint yields 1.5 times of their normal capacity. The N, P, K content of index leaves was reduced to more than 50% during September flooding when compared to before flooding nullifying all previous soil applications of N, P, and K fertilizers. Economical returns with better cost benefit ratio were observed with three foliar applications nano Zn, Zn and chelated Zn at squaring, flowering and boll development stage.

3.38 Project Name: Evaluation and Refinement of spindle type header prototype and development of a cotton picker (in collaboration with CSIR-CMERI)

Gautam Majumdar (PI); Co-PIs: Ramkrushna G.I., Jayant Meshram, Blaise Desouza, A. Raja, Amarpreet Singh

Importance of the study: Cotton genotype that are compact, determinate and early maturing are amenable to mechanical picking. Genotypes also differ in their response to the application of defoliants. This study identifies the best genotypes for mechanical harvesting.

Salient findings:

Cotton genotypes were identified at all the three centres at Nagpur, Coimbatore and Sirsa and evaluated in long strips under HDPS for their compactness and amenability to mechanical picking with and without the plant growth regulator. The genotypes evaluated were; Nagpur- Rajat Bt, ADB 39, Co 17, RCH 608 BG II, NCS 4748 BG II, AnkurKirti BG II, SP 7149 BG II (First Class) and Ajeet 5 sown in long strips (60 m) at 90 x 16 cm spacing, under medium deep soils; Sirsa- 4 Bt varieties namely, Rajat Bt, ADB39, Co17, CICR16Bt and 6 hybrids namely, RCH 608 BG II, NCS 4748 BG II, AnkurKirti BG II, SP 7149 BG II (First Class), NCS2778 and Ajeet 5 were sown in long strips (60 m) at 90 x 16 cm spacing under shallow soils for evaluation under application of mepiquat chloride (PGR). Three Bt varieties, PAU Bt-1, PAU Bt-3, CSH3129; 2 non-Bt varieties, CSH-3075, F-2383 and 7 Bt Hybrids (BG-II), Solar -56, JKCH-109, RCH-773, US 51, RCH- 926, SWCH-4711 and Shakti-9, were sown under HDPS (90 x 15 cm) and evaluated for compactness and amenability to mechanical harvesting. At Coimbatore, five Bt varieties viz., Suraj, Subiksha, Suraksha, Co 17, BB7 at 90 x 10cm and three Bt hybrids, NCS 2728 BGII, RCH 608 BGII and RCH 578 BGII were evaluated for their compactness with application of PGR and suitability to machine picking under HDPS. The promising compact hybrids identified under deep soils in central zone were: RCH608, SP7149, Ajeet 5 and varieties namely, ADB39, CO17, had plant height around 100 cm and width 50 cm. All the hybrids and varieties evaluated were found to be compact after the application of mepiquat chloride. In the north zone, PAU Bt-3 and CSH-3075 among varieties and RCH- 773 and RCH-926 among hybrids were found promising in terms of compactness and higher yields. In the south zone, Subiksha among varieties and CH 578 BGII among hybrids outperformed the rest in terms of compactness and height of lowermost boll, with the application of mepiquat chloride. PGR- Mepiquat chloride (25 g a.i./ha) sprayed twice at 45 and 65 days could induce compactness in all the genotypes.

3.39 Project Name: Validation and refinement of organic cotton production technology

Ramkrushna G.I. (PI); Co-PIs: Rachna Pande, Neelakanth S. Hiremani, Savitha Santosh

The importance of the study: During cotton production and processing, lots of unnatural and highly hazardous chemicals are used. Hazardous synthetic pesticides used in non-organic farming can damage ecosystems, poison waterways and endanger workers who cannot always afford safety equipment needed to protect them. The effects of this overuse of chemicals on the environment and human health are alarming. Organic cotton is a great eco-friendly fabric. It is grown without the use of pesticides, herbicides or other chemical fertilizers, and is simply better for human health and the environment. By encouraging biological diversity, farmers create conditions which reduce the likelihood of any insect, bird or mammal doing any major damage to their crop. Keeping this in view, a project is planned to validate and refine available organic cotton production practices.

Salient findings

Evaluation of cotton cultivars under organic cultivation

Non-GM straight varieties of cotton were evaluated under organic cultivation during the crop season. Three desi (*G. arboreum*) long linted varieties, PA 812, PA 810, PA 740 and nine *G. hirsutum* varieties, NDLH 1938, NH615, Subhiksha, Suchitra, Suraj, ADB 542, Suraksha, Sunantha and BS 30 were evaluated under organic condition. Long linted desi cotton variety PA 810 followed by PA 740 produced the highest seed cotton yield with, respective yields, of 9.51 and 9.02 q/ha. The soil biological activity studies (DHA, SMBC, Phosphatase etc.) suggest that activities were higher in cotton variety PA 812 compared to other cultivars. *Corynespora* leaf spot disease severity in cotton cultivars ranged from 1.2 to 24.4%. Highest PDI of *Corynespora* leaf spot was seen in NH-615 (24.4%) followed by NDLH-1938 (23.2%). Lowest disease index was seen in Anjali (LRK-516).

Comparative study of botanicals in organic cotton

A field trial was conducted to test the efficacy of different botanical extracts against incidence of insect pests and diseases in cotton. The treatments were Neem seed kernel extract (NSKE), Neem leaf extract, Neem oil (Nimbicidin), Panchgavya, Dashparni, Eucalyptus leaf extract (*Eucalyptus globosus*), Calotropis leaf extract (*Calotropis gigantea*), Pongamia leaf extract (*Pongamia pinnata*), Anona leaf extract, which were compared against inorganic management and control. The schedule of spray was 1st spray at 40 days after sowing (DAS), 2nd spray at 60 DAS, 3rd spray at 80 DAS, 4th spray at 110 DAS, 5th spray at 125 DAS and 6th spray at 145 DAS. Against sucking pests Dashparni 10%, Pongamia 5%, Panchgavya 10%, Neem oil 0.5% were found effective. Bacterial blight disease severity (PDI) ranged from 5.33% to 12.67% among the treatments. Reduction in disease severity was observed after spraying. However, disease severity increased in control. Plants remained healthy 10 days after spraying of different botanicals, no symptoms on young leaves were observed.

Laboratory evaluation of extract of Neem leaves, NSKE, Dashparni, Panchgavya, *Annona*, *Calotropis*, *Pongamia*, *Eucalyptus*, and vermiwash was taken up against *Spodoptera frugiperda, Helicoverpa armigera, Pectinophora gossypiella*. NSKE 10% was effective and caused 100% mortality of American bollworm and fall armyworm. However, in the case of pink bollworm, neem leaves, NSKE, panchgavya, *Annona*, *Calotropis* and *Eucalyptus* caused 100% mortality.

3.40 Project Name: Phytohormone profiling by targeted metabolomics in Cotton

Pooja Verma (PI); Co-PI: Joy Das

The importance of the study: Plant hormone physiology has been a key focus for the advancement of agriculture since a plant hormone can affect crop output directly or indirectly by functioning as a plant-development controller or a plant-environment mediator. Plant hormonomic, an approach for collective estimation of major phytohormones with advanced LC-MS, HPLC or GC combined with mass spectrometry (MS) has been successful in targeted profiling of more than 100 phytohormones altogether in model plants like Arabidopsis. With this background, the present study aims to formulate a

methodology for rapid, sensitive, and simultaneous profiling of phytohormones in cotton. It will not only provide the quantitative snapshot of physiological status of cotton tissues under stress but also facilitate the correlation of fibre traits with interplay of phytohormones in cotton.

Salient findings

The study was initiated by calibrating the phytohormone standards (IAA, Abscisic acid, cytokinin, Salicylic acid, Jasmonic acid, Azelaic acid, t-cinnamic acid, linoleic, linolenic acid etc. (Fig. 3.40.1) with three different silylating agents i.e. BSTFA (N,O-Bis (trimethylsilyl)trifluoroacetamide), MSTFA (N-Trimethylsilyl-N-methyl trifluoroacetamide) and BSTFA with 1% TMCS (Trimethylchlorosilane). To work out the limit of detection (LoD) of different phytohormone standards, range used was 200 µg/ml to 20 ng/ml. A method to derivatize phytohormones with BSTFA and MSTFA was standardized for internal standards and limit of detection for majority of phytohormones (Internal standards) was recorded as 150 to 250 ng. Cotton samples from two *Gossypium* spp. (*G hirsutum*; Suraj and *G. arboreum*: Phule Dhanwantary) were used for extraction and purification of phytohormones prior to derivatization with silylating agents. While replicating the same method with cotton leaves and seedlings, only IAA, succinic acid and azelaic acid have been detected with their precursors and related derivatives or metabolites.

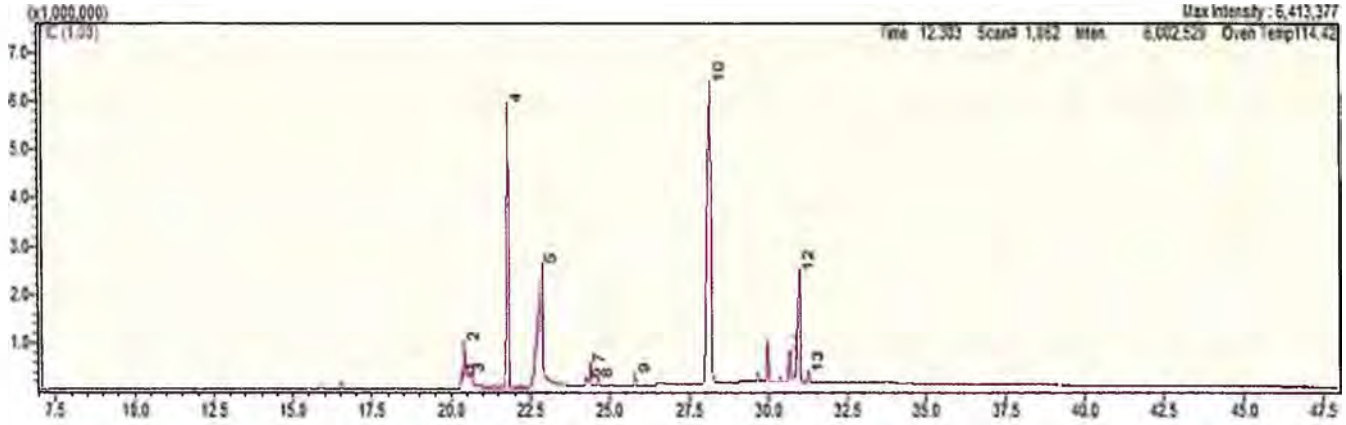


Fig 3.40.1: Calibration of phytohormone standards through GC-MS

3.41 Project Name: Efficient nitrogen fixing legumes for cotton cropping systems

A. Manikandan (PI); Co-PIs: D. Blaise, P. Nalayini, V. S. Nagrare

The importance of the study: Profitability of rainfed sole cotton is low. Including legumes as intercrop with cotton ensures additional income. Legumes through their nitrogen (N) fixing capacity supplement about 20 to 30 kg N per hectare. Further, it reduces the infestation of sucking pests and bollworm. Intercropping with legumes effectively utilizes the resources and maintains soil productivity through minimizing soil erosion, enhancing soil carbon, and biological properties of cotton cropping system. Although cotton + legume intercropping system improve land use efficiency, their system productivity is poorly understood under high planting density. Thus, shortlisted legumes were tested with alternate row of cotton.

Salient findings

The shortlisted legumes had a complementary effect with cotton and they significantly influenced the cotton equivalent yield (CEY) when intercropped with *G. hirsutum* var. Suraj (27 – 61%) and *G. arboreum* var. Phule Dhanwantary (20 - 57%), respectively, compared to sole cotton (Table 3.41.1). There were differences among the six legumes tested, with suraj intercropped with green gram had maximum CEY (up to 27%) higher than other intercropping systems. Similarly, in Phule dhanwantary, soybean was found to yield higher CEY (up to 31%) compared to other legume intercrops. Among the intercropping systems tested, based on gross monetary return, net monetary return and benefit-to-cost ratio; Suraj + greengram and Phule Dhanwantary + soybean were the best intercropping systems for rainfed area.

Table 3.41.1: Effect of legume intercrops on Cotton Equivalent Yield, Gross Monetary Returns, Net Monetary Returns and B: C ratio under rainfed conditions

Intercropping system	CEY (kg ha^{-1})		GMR (Rs. ha^{-1})		NMR (Rs. ha^{-1})		B:C ratio	
	H	A	H	A	H	A	H	A
Cotton (C)	1500	1551	76605	71455	14001	13851	1.22	1.24
C+Blackgram	1899	2342	96982	107896	25962	41876	1.37	**1.63**
C+Clusterbean	1968	1956	100506	90113	28428	23036	1.39	1.34
C+Cowpea	1967	1853	100455	85368	27835	17748	1.38	1.26
C+Greengram	**2416**	2211	123385	101861	51778	35254	**1.72**	1.53
C+Groundnut	2125	2100	108524	96747	34291	27514	1.46	1.40
C+Soybean	2412	**2419**	123181	111443	49669	42932	**1.68**	**1.63**

H-Hirsutum; A- Arboreum; CEY-Cotton Equivalent Yield; GMR-Gross Monetary Returns; NMR-Net Monetary Returns

Cotton + legume intercropping systems a) Green gram b) Soybean

3.42 Project Name: Efficacy evaluation of ICAR-CIRCOT nano-ZnO as nanofertilizer in field crops (Inter-Institute Project)

N. Vigneshwaran (PI) (CIRCOT), Co-PI: A. Manikandan (Collaborating Center PI)

The importance of the study: Although conventional fertilizer ($ZnSO_4$) is commercially used, its use efficiency is low. Therefore, germination test and pot experiments were conducted to evaluate a novel zinc oxide nano fertilizer (nZnO) developed by ICAR-CIRCOT with BGII hybrid and compared with conventional Zn sources ($ZnSO_4$ and ZnO) through six methods (ST-seed treatment (50 mg L^{-1}), SA-soil amendment (12.5 kg ha^{-1}), Fss-foliar spray at squaring (200 mg L^{-1}), FSF-foliar spray at flowering (200 mg L^{-1}), FSSF-foliar spray at squaring and flowering (200 mg L^{-1}) and control (No Zn)) in factorial completely randomized design (FCRD) replicated thrice with 120:60:60 kg N-P_2O_5-K_2O ha^{-1}. Seed germination test was done with 25 seeds on germination paper. In pots, 3 seeds were sown and cotton plants were uprooted at boll initiation, boll development and harvest for Zn estimation.

Salient findings

Seed treatment of Zn sources did not affect the germination. Non significant differences were observed on seed germination, root and shoot length. The initial soil -DTPA extractable Zn was 0.5 mg Zn kg^{-1}. Soil application enhanced dry weight (g/plant) over control at 30 DAS. No significant differences were observed in plant height at 150 DAS. However, among the three Zn sources evaluated, $ZnSO_4$ had taller plants (59 cm) followed by ZnO (54 cm), nZnO and control (47 cm) . Within methods tested, average plant height was maximum in seed treatment (57 cm) followed by soil application (53 cm) had and control (47 cm) (Fig 3.42.2). Non significant differences were observed on boll numbers and boll weight at 150 DAS. Among the Zn sources evaluated, $ZnSO_4$ had more bolls with bigger size followed by ZnO , nZnO and control .

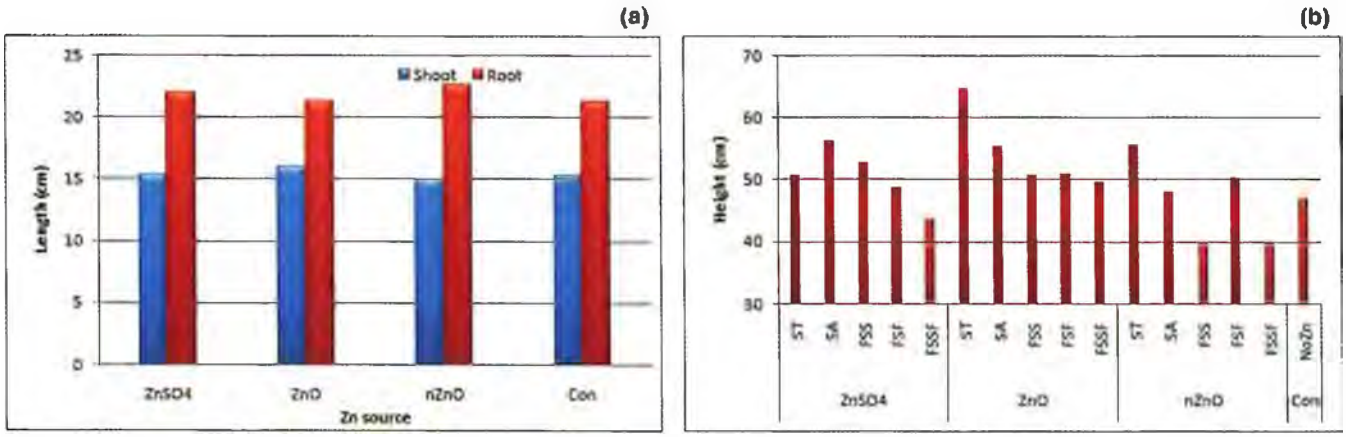


Fig. 3.42.2. Efficacy of zinc sources under protected pot culture study(a), root and shoot length @ 7 DAS, b) plant height @ 150 DAS

3.43 Project Name : Evaluation of PGPR and microbial inoculants to alleviate drought stress in cotton (*G. hirsutum* L.)

J.H. Meshram (PI) Co-PIs : Pooja Veram, Deepak Nagrale

Importance of the study

Continuous dry spell during critical crop growth periods of squaring, flowering and boll development may affect yield of the crop. Microbial formulation or consortia of Plant Growth

Promoting Rhizobacteria (PGPR) can be used for improving the plant health and ultimately cotton productivity in integrated and organic farming system.

Salient findings

Over all 34 native PGPRs were isolated and characterized and 7 inoculants were shortlisted based on plant growth and physiological drought tolerance traits in pot studies. Sixteen bacterial isolates were tested for osmotic tolerance (PEG 8000) 50g/L (0.05 Mpa), (100g/L (0.15 Mpa), (150g/L (0.30 Mpa), (200g/L (0.49 Mpa), (250g/L (0.73 Mpa) and observed for IAA activity and protein level. Under field conditions, *Solibacillus* (T3), *Micrococcus luteus* (T4) and T-7 (VM) microbial consortia has better growth potential in terms of no of sympodia, no. of bolls, plant height, SPAD value (40-50) for chlorophyll greenness and root traits on Bt RCH-608 (Table 3.43.1).

Microbial consortia formulation (MC) using native cotton rhizospheric bacteria were developed. Based on two years of replicated pot studies, application of microbial consortia as seed and soil application was found to significantly enhance the colonization and retention of the applied microbial inoculant in the cotton rhizosphere by enhancing root attributes (Table 3.43.2) and plant growth promotion in RCH 608 BG II. Microbial consortia application also proved to significantly enhance vigor of cotton plants. Further, the application of microbial consortia was shown to enhance drought stress tolerance in rainfed condition.

Table 3.43.1: Beneficial Rhizospheric Osmotolerant bacteria with PGPR activities

Strain	Optical density (OD_{600}) – PEG 40% (after 48 h)						Protein (µg/ml)	IAA (µg/ml)
	Ctrl	0.05 Mpa	0.15 Mpa	0.30 Mpa	0.49 Mpa	0.73 Mpa	0.73 Mpa	0.73 Mpa
145	1.652	0.682	1.056	0.944	1.380	1.046	6.95	4.57
311	1.864	0.830	0.950	0.828	1.098	1.014	6.61	5.12
275	1.648	0.678	0.790	0.772	0.722	0.566	6.56	4.41
Bt-21	3.762	1.014	0.986	0.888	1.254	1.162	9.59	3.22
Bt-10	1.462	0.542	0.964	0.894	1.080	0.848	5.01	4.54
Bt-20	2.902	0.782	0.390	0.894	1.372	1.006	5.48	6.02
78	3.184	0.842	0.398	0.882	1.156	1.082	6.05	4.03

Table 3.43.2: .Root attributes under field evaluation inoculated with beneficial PGPR

Bacterial Strain	Root Length (cm)	Lateral RL (cm)	Root FW (g)	Root DW (g)
Control	25.44 ± 1.19	25.33 ± 1.36	33 ± 2.26	0.028 ± 0.001
Sphingomonas Sp.	27.77± 2.265	27.55± 1.49	27.33± 2.11	0.034± 0.003
Agrococus sp	30.77 ± 2.82	30.00 ± 2.04	24.11 ± 1.28	0.064 ± 0.02
Solibacillus isronensis	27.00 ± 1.93	29.11 ± 3.65	29.77 ± 2.11	0.028 ± 0.002
Micrococus luteus	26.44 ± 2.03	28.11 ± 1.97	27.33 ± 1.60	0.033 ± 0.002
Acineto bacter sp.	23.88 ±1.05	26.44 ± 1.70	28.66 ± 1.43	0.028 ± 0.003
Brevibacterium	22.77 ± 0.88	25.11 ± 1.46	30.33 ± 1.56	0.023 ± 0.001
Microbial Consortia	26.00 ± 1.36	30.88 ± 2.61	32.44 ± 1.10	0.037 ± 0.002

REGIONAL STATION, COIMBATORE

3.44 Project Name: Development of high strength cotton genotypes by reducing the short fiber content

S. Manickam (PI); Co-PIs : A. H. Prakash, J. Gulsar Banu

Importance of the study: Fibre quality, especially fibre length, tenacity and micronaire assumes significance for determining the usefulness of the fibre for spinning into yarn. Ideal combination of these characters for a given length is still more important. The development of high strength cultures of long staple category will be useful for spinning good quality yarn of higher counts. By working out suitable geometry and agronomy, yield maximization can be achieved in the high strength cultivars which may be released as variety for the benefit of both the farmers and the end users, the textile mills.

Salient findings

Progeny bulks with superior fibre quality attributes (75 nos.) were seed multiplied for further evaluation and utilization. The high strength long staple cotton variety, CICR-H Cotton 54 (Nano) has been released for both Central and South Zone States under both irrigated and rainfed conditions (Table 3.44.1). The variety is characterized by ideal plant type for HDPS, recorded a mean seed cotton yield of 2123 kg/ha under South Zone (irrigated) 1469 kg/ha in South Zone (rainfed) and 1815 kg/ha in Central Zone (irrigated condition). However, the variety has an yield potential of 2859 kg/ha in South Zone (irrigated), 2381 kg/ha in South Zone (Rainfed) and 2963 kg/ha in Central Zone locations (Irrigated). The variety showed yield superiority in closer spacing at 90 x 10 cm with the spray of Mepiquat Chloride in agronomic study at Coimbatore. The average values of Upper Half Mean length of 30.8 mm, Micronaire of 4.1 and tenacity of 30.8 g/tex in HVI mode in South Zone (Irrigated), Upper Half Mean length of 29.4 mm, Micronaire of 3.9 and tenacity of 30.4 g/tex in HVI mode in South Zone (Rainfed) and Upper Half Mean length of 30.1 mm, Micronaire of 3.7 and tenacity of 30.2 g/tex in HVI mode in Central Zone (Irrigated) indicates its superiority in fibre quality.

3.45 Project Name: Implementation of PVP legislation and DUS testing of cotton under ICAR and SAU system

K.Rathinavel (PI); Co-PI: V.Shanthy

Importance of the study: ICAR-CICR, Regional Station is the Nodal center for Implementation of PVP legislation, 2001, This project is a centrally sponsored and funded by PPV &FRA with an objective to establish and maintain database on extant cotton varieties, conduct DUS test of new candidate, varieties of common knowledge, farmers varieties and essentially derived varieties, maintenance breeding of reference cotton varieties, morphological characterization of extant cotton varieties and also registration of extant cotton varieties under this act.

Salient findings

During the year 2021-22, the data base on extant cotton varieties and cotton varieties notified under section 5 of the Seeds Act, 1966 has been updated. Data sets of tetraploid and diploid cotton varieties registered under PPV&FR Act, 2001 was acquired from PPV&FRA, New Delhi. Maintenance breeding and characterization and of 130 extant cotton varieties and parental lines were carried out in tetraploid and Diploid cotton viz.,82 in *G. hirsutum*, *7 in G. barbadense*, 38 in *G. arboreum, 3 in G. herbaceum.*

Field trials for the characterization and establishment of Distinctiveness, Uniformity and Stability was conducted with 8 hybrids in the First-year trial and 48 candidate hybrids along with its corresponding hybrids produced at PPV&FRA center at Shivamoga were accommodated in the second-year trial. Three varieties are also included in the second-year trial. The Bt. Hybrids involved in both the trials as references were 17 recommended for cultivation in central and south zone. Field sowing was taken up on 16.8.2021 in randomized block design with 3 replications. Germination count at 12 DAS in corresponding plot was recorded in all the entries. Morphological characters such as Hypocotyl: Pigmentationm, Leaf: Colour, Leaf: Hairiness, Leaf: Appearance, Leaf: Gossypol glands, Leaf: Nectaries, Leaf: Petiole pigmentation, Leaf: Shape, Plant: Stem hairiness, Plant: Stem pigmentation, Bract: Type, Flower: Time of flowering, Flower: Petal colour, Flower: Petal spot, Flower: Stigma, Flower: Anther Filament colouration , Flower: Pollen colour, Flower: Male Sterility, Boll: Bearing habit, Boll: Colour, Boll: Shape, Boll: Surface, Boll: Prominence of tip were recorded in 10 plants of all varieties. The data received from participating centers would be compiled and submitted to PPV&FRA for issue of registration certificate. Monitoring of DUS trials at the participating centers have also been done through online meetings on 16.11.2021 at RRS bathinda, at CICR, Nagpur and MPKV Rahuri, on 29.12.2021 at CICR Coimbatore and on 20.1.2022 at UAS Dharwad.

At CICR, Nagpur, the DUS testing trial for the period 2021-22 consisted of five trials and variety maintenance. The trials included New year (6), second year (20), EDV (3), VCK (7) and reference. Additional sowing of 46 varieties for maintenance was also taken up.All the characters as per the National test guideline were recorded in the entries The virtual monitoring of the trial was held on 16th November 2021.

3.46 Project Name: National Seed Project (Crops)

K.Rathinavel (PI);

Importance of the study:

- Development of priming technologies for enhanced planting value of seed under sub-optimal conditions in field crops
- Quantification of the Seed Vigour in Field Crops Using a Universal Scale

Salient findings

With an objective to demonstrate the benefits of identified priming technologies in different field crops for sub-optimal/ stress conditions, a field experiment was conducted using the seeds of cotton variety Suraj and Suraj Bt., during July 2021 at ICAR-CICR Regional station, Coimbatore. The pre cleaned seeds were given the following treatments : Control (Untreated), Control (Recommended PoP) Imida cloprid@100ml/kg (10% polymer solution), Seed coating (on hydro primed (12h @ 25°C) seeds) with Drought Alleviating Bacteria (0.2 ml/100gm).

The treated seeds were evaluated for their quality at laboratory condition. The following parameters were recorded Seed Moisture content (ISTA), Time (hrs) for maximum numbers of radicle emergence (≥ 2mm), Germination % (ISTA), Vigour index-I & II (Abdul Baki and Anderson, 1973).

The remaining seeds were used for sowing in the field on 17.9.2021, with recommended spacing and package of practices. There were two varieties with three treatments sown in 60 sq.mtr each. Field observations such as Final plant stand establishment (%), Plant height (cm), number of bolls /plant, number of sympodia/plant, per boll weight, Seed cotton yield/plant, 1000 seed weight, Plot yield (kg) were recorded.

Since, the seeds were dried to the original moisture level, seed treatments did not alter seed moisture content significantly (Table 3.46.1).

Table 3.46.1: Status of seed moisture (%) after seed treatments

Treatments	Suraj	Suraj Bt.
Control	8.35	8.98
Seed coating with imidacloprid	8.75	8.40
Seed coating with Drought Alleviating Bacteria	8.92	8.90

Table 3.46.2: Effect of priming seed treatments on non-Bt. and Bt. Suraj cotton seeds.

Treatment	Germination %	Root length (cm)	Shoot length (cm)	Vigour Index I	Vigour index II	Dry matter production (g)	Radicle emergence (hrs)
Suraj (Control)	70	21	11.3	2272	18.8	0.27	24
Suraj (Seed coating with imidacloprid)	74	19.2	13.2	2404	19.3	0.26	24
Suraj (Seed coating with Drought Alleviating Bacteria)	78	20.2	12.9	2589	20.7	0.27	24
Suraj Bt. (Control)	69	16.9	9.92	1867	15.9	0.23	22
Suraj Bt. (Seed coating with imidacloprid)	76	16.7	12.3	2204	15.7	0.21	22

Treatment	Germination %	Root length (cm)	Shoot length (cm)	Vigour Index I	Vigour index II	Dry matter production (g)	Radicle emergence (hrs)
Suraj Bt. (Seed coating with Drought Alleviating Bacteria)	72	18.4	12.3	2222	15.2	0.21	22
Mean	73.2	18.7	12	2260	17.6	0.24	23
SEd	4.38	1.37	0.86	254	2.29	0.02	
CD(0.1)	NS	4.05	2.55	NS	NS	0.06	NS

Table 3.46.3: Effect on growth performance of non-Bt. and Bt. Suraj cotton seeds due to priming seed treatments.

Treatment	Field emergence (%)	Speed of germination	Plant stand (%)	Plant height (cm)	No. of sympodia /plant	No. of bolls/plant	Seed cotton yield/plant (g)	Boll weight (g)	1000 seed weight (g)	Plot yield (Kg)/ 60 sq.mtr
Suraj (Control)	53.5	12	58.8	77.8	18.8	24.3	83.8	4.76	92.1	2.87
Suraj (Seed coating with imidacloprid)	57	11.2	56	97.4	21.9	26.5	107	5.03	93.9	3.16
Suraj (Seed coating with Drought Alleviating Bacteria)	61	12.6	63.3	104	22.5	32.8	133	5.38	103	3.97
Suraj Bt. (Control)	54.8	10.7	55.3	87	19.9	23.5	102	4.83	92.8	2.68
Suraj Bt. (Seed coating with imidacloprid)	59.5	11.8	58.5	89.4	20.6	28.8	119	5.1	79.1	2.85
Suraj Bt. (Seed coating with Drought Alleviating Bacteria)	57.8	10.8	56.3	95.7	22.8	34.4	140	5.53	98.7	3.65
Mean	57.3	11.5	58	91.9	21.1	28.4	114	5.1	93.3	
SEd	4.26	0.81	4.01	2.43	0.87	1.25	3.43	0.1	8.81	
CD(0.1)	NS	NS	NS	5.18	1.84	2.66	7.31	0.22	NS	

Under laboratory condition significant improvement in seedling length, dry matter production was observed in treated seeds compared to control in Bt. and non-Bt. suraj cotton seeds. The time taken for radicle emergence was not influenced by seed treatments (Table 3.46.2). Under field condition, the plant height, no. of sympodia, bolls/plant, boll weight and seed cotton yield/plant were influenced significantly due to seed treatments (Table 3.46.3). However, an arithmetic increase in seed germination, seedling vigour, speed of germination, field emergence and plant stand were noticed due to seed treatment in Bt. and non-Bt. suraj cotton seeds.

Quantification of the Seed Vigour in Field Crops Using a Universal Scale

With the objective of reliable estimation and comparative evaluation of vigour in seed lots of field crops, a laboratory experiment using the seeds of ten cotton varieties was conducted at ICAR-CICR, Regional Station, Coimbatore. The cotton varieties used are Abadhitha, JLH168, PRS74, RHC004, Jalandar, TCB 209, Sujatha, RHCB001, LD210 and G. Cot.19. Observations on Time (hrs) for maximum numbers of radicle emergence (≥2mm), Germination % (ISTA), 4 replications, Total Seedling Length (TSL) or Total Seedling Wt (TSW*) were taken on at 10 normal seedlings per replication on final count day and field emergence (%) were recorded. As per the methodology provided variables such as GSF based on seedling length, GSF based on seedling dry weight, germination percentage, Vigour Index 1 and Vigour Index 2 were calculated and each of these variables was correlated with field emergence. The computed 'r' value is presented below. Based on the r value it may be concluded that germination percent is more reliable to predict the field emergence, followed by GSF (based on seedling length) and Vigour Index1. (Table 3.46.4 and 3.46.5)

Table 3.46.4: Seed lots used for the study with computed values of variables

Varieties/ Seed lots	Germination (%)	Vigour Index I	Vigour index II	GSF (L)	GSF (W)	Field emergence (%)
Abadhita	87.25	3118	43.74	0.80	0.61	80.00
Jalandar	83.00	2937	38.64	0.75	0.54	73.00
JLH 168	82.50	2738	27.99	0.70	0.39	74.00

Varieties/ Seed lots	Germination (%)	Vigour Index I	Vigour index II	GSF (L)	GSF (W)	Field emergence (%)
PRS 74	75.00	1982	32.55	0.51	0.45	67.50
RHC 004	68.00	1736	32.35	0.44	0.45	63.50
RHCb 001	92.50	3105	58.28	0.79	0.81	85.50
Sujatha	89.25	2832	58.46	0.72	0.81	82.75
TCB 209	91.75	2862	59.17	0.73	0.82	73.00
G Cot 19	79.75	1762	22.78	0.45	0.32	67.50
LD 210	85.75	2184	28.69	0.56	0.40	77.75

Table 3.46.5: Correlation values

	Field Emergence (%)
GSF(L)	0.666
GSF(W)	0.567
G (%)	0.728
V1	0.666
V2	0.567

3.47 Project Name: Development and evaluation of ELS interspecific hybrids with better yield and fibre quality

K. Baghyalakshmi (PI); Co-PIs: M.Amutha, A. Sampath Kumar

Importance of the study: Although Indian cottons offer a very wide range of quality, many of the common types and hybrids lack the ideal combination of fibre length (33-37mm), fibre strength (25 to 37 g per tex), and micronairee (4-4.5). The promotion of these cottons, whose quality might be closer to that desired by contemporary textile mills, is urgently needed, and HxB fills the void.

Salient findings

Fifty *Gossypium barbadense* genotypes were used to estimate the stability for yield and fibre related traits for three consecutive years from 2019 to 2022. The stability of the genotypes was studied using AMMI model which had both additive and multiplicative effects. The superior and stable genotypes were selected for the breeding programme from the interactive model (Table 3.47.1).

Two sets of twenty-eight hybrids crossed in LxT fashion with common lines were evaluated in replicated trials to select best combiner and the best performing hybrids.

Parental Screening: Among the parents, the best general combiner was line CCH 15-1 for number of bolls and fibre traits followed by MCU VT 5 for yield traits, similarly, among tester the parent with good GCA was ICB 99, ICB 264and suvin for single plant yield and CCB 11 A and Suvin for fiber traits.

Hybrid evaluation (Set I): The best cross combinations were Suraj x ICB 99 exhibiting per se performances for number of bolls per plant (61.41) and single plant yield (99.16), similarly, CCH15-1xICB 99 (single boll weight – 5.56g), MCUVT5xICB 124 (Single plant yiels-85.42g/plant), Surabhi x CCB 11 A (single boll weight – 5.63g), Suraj x CCB 25 (single boll weight – 5.62g), Suraj x ICB 124 (single boll weight – 6.04g) exhibited high heterotic effect and per se performances for yield-related traits. Hybrids CCH15-1 x CCB 11 A, CCH15-1 x CCB 25, MCUVT5 x CCB 11 A, MCUVT5 x CCB 25, Surabhi x CCB 11 A and Surabhi x ICB 46 had superior per se performance for fibre length and strength along with micronaire value (Fig. 3.47.1 a,b).

Set II: CCH15-1 x SUVIN, Surabhi x SUVIN, Suraj x ICB 264, Suraj x SUVIN exhibited per se performances for single plant yield, Whereas the cross, Suraj x SUVIN exhibited high heterotic effect and per se performances for yield and fibre-related traits. Among the hybrids MCUVT5 x ICB 176 and MCUVT5xSUVIN had superior per se performance for fibre length (> 40 mm) (Fig. 3.47.2 a,b).

Disease and pest reaction: Nine crosses namely MCU VT5 x ICB99, MCU5 VT X ICB284, MCU5 VT X CCB143B, MCU5 VT X ICB174, CCH15-1 X ICB258, CCH15-1 X ICB284, CCH15-1 X ICB174, Surabhi X ICB258 and Surabhi X ICB284 were found to be free from all diseases.

Twelve hybrids namely CCH15-1 x ICB 174, CCH15-1 x ICB 264, CCH15-1 x SUVIN, Surabhi x ICB 174, Surabhi x ICB 176, Surabhi x ICB 284, Surabhi x SUVIN, Suraj x CCB 143 B, Suraj x ICB 161, Suraj x ICB 258, Suraj x ICB 284, Suraj x ICB 99 were found to be free from sucking pests. Further 8 and 19 hybrids were found to be resistant to aphids and Jassids respectively

Suraj x ICB 161 (Bigger boll size)

Surabhi x ICB 46- More number of bolls (45 nos)

Table 3.47.1: Genotypes stable for various traits across environments (2019-2022)

Traits	Genotypes
UHML	CCB 141, ICB 290, ICB 77
FS	ICB 220, CCB 29, ICB 73, ICB 262, ICB 244 ICB 177
Micronaire	CCB 28, CCB 143, ICB 262, ICB 273, ICB 244, CCB 11 A, ICB 129, ICB 86
NB	ICB 264, ICB 35, ICB 194, ICB 199, ICB 34, ICB 183, CCB 26, ICB 255, ICB 129, CCB 11
NS	ICB 290, ICB 73, CCB 26
SBW	ICB 96, ICB 46, ICB 39, ICB 255, ICB 129
SPY	ICB 194, ICB 46, ICB 273, ICB 244, ICB 129

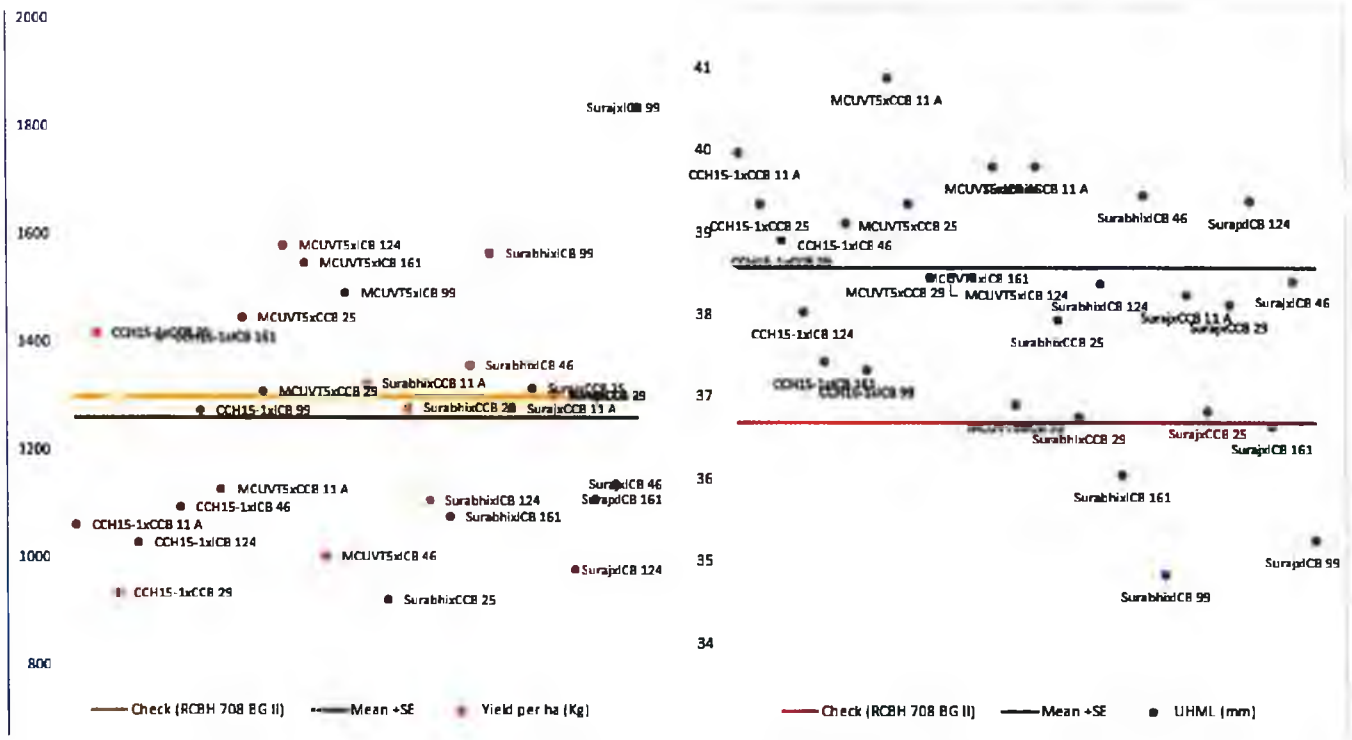


Fig. 3.47.1 a,b. Set 1. LxT: Scattered plot showing the hybrids with mean yield and fibre length. The genotypes above the lines are performing significantly better than the check

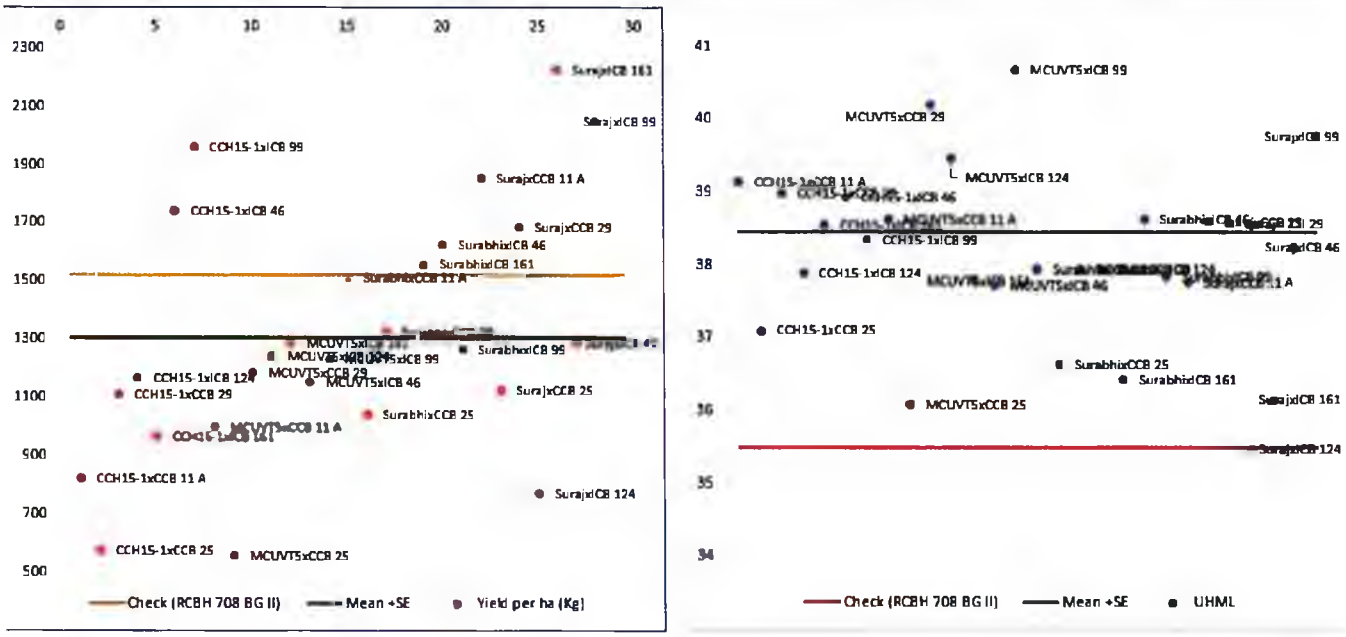


Fig. 3.47.2 a,b. Set 2. LxT: Scattered plot showing the hybrids with mean yield and fibre length. The genotypes above the lines are performing significantly better than the check

3.48 Project Name: Crop-weed interactions under ambient and elevated CO_2

P.Nalayini (PI); Co-PIs: AH Prakash, M.Amutha

Importance of the study:

The current atmospheric burden of the most important greenhouse gas, carbon dioxide is unprecedented and is predicted to have major impact on agriculture. An adverse effect of weeds on crops is anticipated. Therefore, a thorough understanding of weeds such as relative density, growth pattern, and competitiveness with cotton crop will help us to design weed management strategy for a changing climate.

Salient findings

To study the impact of elevated CO_2 on crop-weed interactions in irrigated cotton ecosystem, open top chamber (OTC) experiments were conducted with five treatments viz., IWM and unweeded check under ambient and elevated CO_2 and

compared against weed free open field. This study indicated visible changes in relative density of weed species, dry matter accumulation and nutrient uptake due to elevated CO_2 The relative density of dominant weed, *Trianthema portulacastrum* at 45 DAS had shown a steep reduction from 57.2 under ambient to 38.6 in elevated CO_2 The same trend was observed with the sedge weed, *Cyperus rotundus*, which was reduced to 4.7 in elevated CO_2 from 16.2 under ambient condition. However, the RD of *Dactyloctenium aegyptioum* enhanced from 5.2 under ambient to 12.7 with elevated CO_2 condition. The RD of weeds on 90 DAS also followed similar trend as on 45 DAS. The dry matter accumulation in both weeds as well as cotton crop recorded enhancement due to elevated CO_2 as the DMP of weeds enhanced from 5.27 t/ha in ambient to 7.88 t/ha in elevated CO_2 while the DMP of cotton during this period was enhanced from 2.08 t in ambient to 5.26 t in elevated CO_2 The photosynthetic rate was influenced greatly due to elevated CO_2 and the enhancement was as high as 151 percent on 90 DAS (Fig 3.48.1). The favourable growth condition with elevated CO_2 resulted in more than two fold enhancement in uptake of major, secondary and micronutrients on 90 DAS (Table 3.48.1). The elevated Co_2 recorded significant enhancement in soil enzymes like urease (44.9 (μ g /g dry soil, phosphatase 91.5 P-NP μ g /g dry soil and Dehydrogenase 0.22 TPF μ g /g dry soil) due to elevated CO_2 as compared to 21.4, 0.89 and 0.13, respectively, under ambient condition. The biochemical parameters like soluble sugars enhanced from 45.8 to 50.9% and soluble protein from 8.2 to 9.6 (μg /gram due to elevated CO_2 on 60 DAS. Among sucking pests, aphid population was significantly enhanced while other sucking pests like jassids, thrips and whitefly incidence was reduced due to elevated CO_2. Higher soluble sugars and soluble protein in cotton might have promoted the consumption index of Spodoptera from 2.64 (ambient) to 3.04 (elevated CO_2 Higher adult weight and shorter longevity and developmental period of *Aphis gossypii* was recorded with elevated CO_2 and the mean longevity was reduced by two days from 19.9 to 17.9 days. The boll damage by Spodoptera reduced from 12.4 to 8.7% while the locule damage due to pink boll worm enhanced from 8.4% to 10.1% due to elevated CO_2 The partial closure of stomata with elevated CO_2 observed through SEM studies confirmed for possible enhancement in water use efficiency during changing climate. The favourable growth condition due to elevated CO_2 reflected in higher boll numbers, boll weight and seed cotton yield enhancement up to 34.3% over ambient condition (Fig. 3.48.2)

Table 3.48.1: Nutrient uptake (Kg/ha) in Cotton and weeds

Pamameters	Cotton		Weeds	
	Ambient	Elevated	Ambient	Elevated
Nitrogen	42.18	99.80 (2.36 fold↑)	95.91	150 (1.56 fold ↑)
Phosphorus	5.82	12.18 (2.09)	6.79	12.98 (1.91)
Potassium	22.22	58.27 (2.62)	66.93	146.43 (2.18)
Calcium	40.11	105.03 (2.61)	54.20	83.9 9 (1.54)
Magnesium	6.57	15.06 (2.29)	19.31	31.99 (1.65)
Boron	0.03	0.08 (2.66)	0.08	0.14 (1.75)
Manganese	0.15	0.34 (2.26)	0.33	0.65 (1.96)
Iron	1.93	4.67 (2.34)	5.20	11.78 (2.26)
Copper	0.009	0.02 (2.22)	0.03	0.05 (1.66)
Zinc	0.0217	0.047 (2.16)	0.06	0.11 (1.83)
Molybdenum	0.00067	0.0019 (2.83)	0.002	0.002

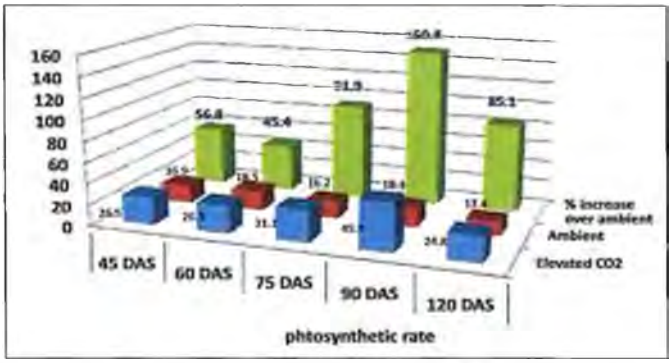


Fig 3.48.1 : Photosynthetic rate (umol $m^{-2}s^{-1}$) in cotton due to elevated Co_2

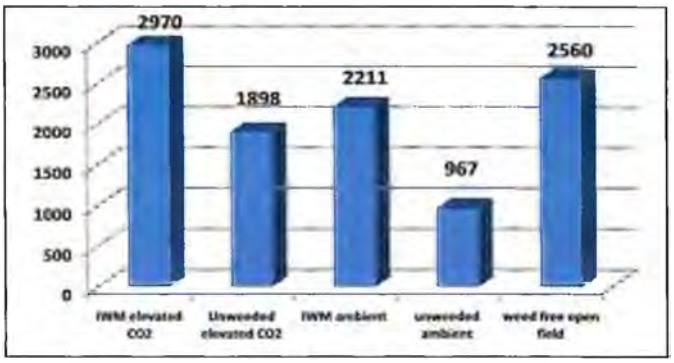


Fig 3.48.2 : Seed cotton yield due to elevated Co_2 and weed control treatments

3.49 Project Name: Evaluating of agro-techniques for overcoming weather aberration of drought and waterlogging in cotton

K. Sankaranarayanan (PI); Co-PIs: J. Annie Sheeba, M Amutha, P. Valarmathi, J.H.Meshram, B.Bhargavi

Importance of the study: Erratic distribution of rainfall and continuous dry and/or wet spells during critical crop growth periods of squaring, flowering and boll development affects crop yield. Waterlogging coupled with drought leads to poor crop performance. The contingent from this project could be useful for managing low and excess moisture stress

Salient findings

Significantly higher seed cotton yield was harvested under water logging management treatment with drainage by ridges and furrow with foliar application of melatonin 100μM single spray (1723 kg/ha as compared to control (water logging) (1351 kg/ha).

Field experiment on waterlogging

Ten days continuous waterlogging at different crop growth periods indicated that the crop is sensitive for waterlogging at early stage with maximum yield reduction at squaring stage (40.1%) and the least reduction at boll bursting stage (10.1%).

Significantly higher yield was registered with moisture conservation by land shaping (ridges and furrow) followed by moisture stress management by single spray of glycine betaine (100ppm) (1761kg/ha) than rainfed control (1324 kg/ha).

3.50 Project Name: Sustainable Intensification of Extra Long Staple Cotton Production in South Zone

R. Raja (PI); Co-PIs: J Annie Sheeba and K. Rathinavel

Importance of the study: Predominant cultivation of *G. hirsutum* in India through introduction of high yielding intra-hirsutum *Bt* Hybrids in the past decades has marginalized the cultivation of other species of cotton including the extra long staple (ELS) cotton in the subcontinent. Although ELS cotton has considerable economic significance in the domestic and international market, limited availability of H x B *Bt* hybrids offered limited choices to farmers in traditional ELS cotton growing areas. Thus, slowly but steadily an inevitable shift occurred towards cultivation of H x H *Bt* hybrid cotton. This has led to huge shortage in the demand and supply scenario of ELS cotton in our country. Higher productivity is possible by adoption of higher plant density with appropriate canopy management and drip fertigation. Field experiments were conducted at ICAR-CICR Regional Station, Coimbatore to study the effect of increased plant density and use of growth regulators on the productivity of ELS cotton under drip fertigation system.

Salient findings

Increased plant density (90 x 30 cm; 37,037 plants/ ha) combined with drip fertigation and canopy management (mepiquat chloride (MC) application @ 60 ppm) when height node ratio (HNR) reached 1.5 (in inches) followed by 30 ppm twice at 15-days interval after first spray) significantly enhanced the seed cotton yield of MRC 7918 (2766 kg/ha) vis-a-vis farmers' practice (90 x 60 cm; 18,518plants/ha; 2280 kg/ha) which was 21% yield increase over FP. Application of MC regulated canopy architecture and plant height (90.5cm) compared to the farmer's practice (143.9cm). Similarly, in case of Suvin, increased plant density combined with drip fertigation and canopy management produced higher seed cotton yield (1195 kg/ha) than farmers' practice (=1076 kg/ha). The prevalence of cloudy weather and occurrence of high rainfall during November (271.7 mm) and December (53.5 mm) months contributed for the comparatively lower seed cotton yield in both the cultivars during *kharif* 2022 *vis-a-vis kharif* 2021.

For optimization of dose and frequency of plant growth regulator application in *G. barbadense* cv. Suvin, MC and Lihocin under different combinations of low dose multiple sprays under 90 x 30 cm was tested. Foliar spraying of MC (60 ppm when) HNR reached 1.5 followed by 30 ppm twice at 15 days interval after first spray has reduced the plant height and maintained a HNR of 1.7 when compared to control (1.9). However, spraying of MC @ 30ppm when HNR reached 1.5 followed by 30 ppm (15 days after first spray) and 60ppm (30 days after first spray) registered highest number of bolls per m^2. This in turn produced higher seed cotton yield (1491 kg/ha) compared to control (1177 kg/ha). There was no significant difference in SPAD values among treatments

3.51 Project Name: Active Optical Sensors based Nitrogen Management and Yield Prediction in Cotton using Unmanned Aerial System

R. Raja (PI); Co-PIs: D Kanjana and T. Arumuganathan

Importance of the study: An attempt has been made to examine relationships between canopy reflectance at specific wavelength bands and vegetation indices at different cotton growth stages to biomass, leaf tissue N concentration, aboveground total N content and seed cotton yield.

Salient findings:

Field experiment with graded levels of N was conducted at ICAR-CICR Regional Station, Coimbatore during Kharif 2021 in order to develop variable management maps for N in cotton crop field and cotton yield prediction. Cotton variety Suraksha and hybrid RCH 578 BG II were planted on 28 August 2021 using tractor drawn pneumatic planter at a row to row spacing of 90cm. The plant to plant spacing adopted for Suraksha and RCH 578 BG II was 10 and 15 cm, respectively. Irrigation was given through drip system from 29 August 2022 onwards. The recommended dose of N: P: K for Suraksha and RCH 578 BG II were 80:40:40 kg ha-1 and 90:45:45 kg ha-1, respectively. Half of the nitrogen dose was applied as per treatment (No nitrogen, 25%, 50%, 75%, 100%, 125%, 150% and 200% of recommended N dose) as basal and the remaining half of N was top dressed at the time of earthing up (45 days after sowing). For hybrid RCH 578 BG II, one third of the N dose was applied as basal and the remaining in two equal splits at the time of earthing up (45 DAS) and at 65 DAS. Periodical multispectral imaging of the cotton field was done on 32, 70, 95, 126 and 148 days old cotton crop using Mica Sense Red Edge multispectral camera mounted on DJI Inspire-I drone. Leaf samples were collected during multispectral imaging of the cotton field and processed and analyzed for leaf N content using standard protocols. The five discrete spectral bands collected by the Mica Sense Red Edge were Blue (475nm), Green (560 nm), Red

(668 nm), Red Edge (717 nm) and NIR (840 nm). The flight altitude was set at 40 m above ground level and the speed was set to 4 m/s. Images were collected with 80% frontal overlap and 75% side overlap. Multispectral images were collected of a radiometric calibration panel provided with the Mica Sense Red Edge pre-flight for proper calibration. The drone imageries were processed using Agisoft Metashape Professional Software. The calibration panel images were used to normalize the reflectance values in the images of the multispectral data. All individual images for each band were stitched together to create an accurate orthomosaic image. The raster calculator in Agisoft metashape was used to create vegetation indices viz., Normalized Difference Vegetation Index (NDVI) and Normalized Difference Red Edge Index (NDRE). The experimental plot size was 14 x 8.1 m and QGIS 3.18 software was used to create a shape file around each plot that placed a polygon over seven rows leaving one row on either side of the plot to avoid border effect. The VI data was clipped to each plot and the zonal statistics option in QGIS was used for extracting data in tabular format. The NDVI (Fig 3.51.1) and NDRE values of different treatments were correlated with leaf N content and found that NDRE is a better indicator of leaf N content.

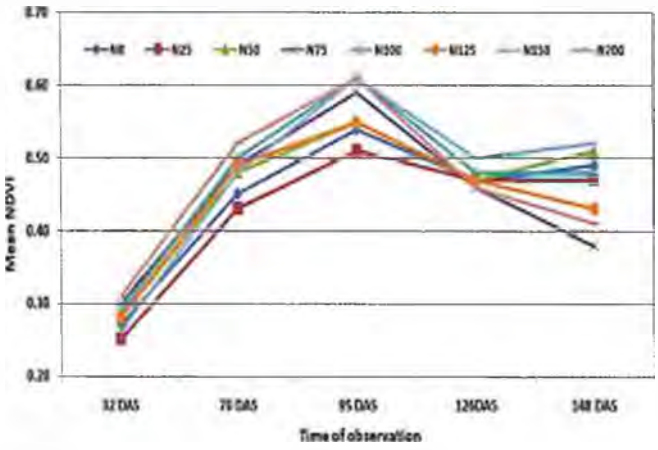


Fig 3.51.1: Effect of graded levels of N application on mean NDVI at different stages of crop growth in Suraksha

The findings of the study conducted during *kharif* 2021 season indicated that multispectral data could be a viable method for detecting N levels in cotton. NDRE and leaf N% at different crop stages exhibited better coefficient of determination than NDVI and leaf N%. However, for variable N management purpose frequent observations need to be taken from Squaring stage onwards at weekly interval and the optimal time and NDVI/NDRE values need to be fixed for preparing management zone map for variable rate N application. The cotton cultivar Suraksha produced 3369 kg seed cotton yield per hectare.

3.52 Project Name: Effect of long term application of organic and inorganic sources of nutrients on continuous cultivation of *Bt* and non *Bt* cotton cropping system under irrigated conditions

D. Kanjana (PI); Co-PIs: K. Sankaranarayanan, Amarpreet Singh

Importance of the study : Long term fertilizer experiment under continuous cotton – maize and cotton -wheat cropping system was conducted to measure the sustainability of irrigated cotton – maize and cotton wheat cropping systems under different nutrient management practices by assessing yield trends and calculating soil nutrient balance.

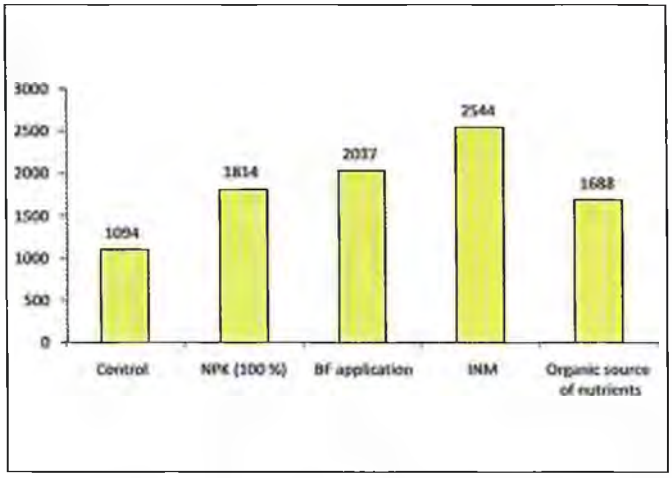
Salient findings

In the fourth cropping sequence of cotton-maize cropping system, drip irrigation system was installed in long term fertilizer experimental field in order to reduce the labour cost for irrigation and adopt an integrated water management practice. In drip irrigated cotton – maize cropping system, nutrients were applied as inorganic fertilizers (NPK + Mg + Zn + B) and application of FYM once in two years (had higher seed cotton yield than an imbalanced form of fertilizer (NPK) (1822 kg ha^{-1}) and organic sources of nutrients (FYM 10 t/ha every year + Biofertilizer – Azophos (seed treatment and soil application) + Neem cake 250 kg/ha + Sunnhemp incorporation) (1589 kg ha^{-1}) (Table 3.52.1). Among the cotton-maize cropping systems, the lowest seed cotton yield (1644 kg ha^{-1}) was noticed in *Bt* cotton hybrid – fallow cropping system whereas the highest was observed in *Bt* and non *Bt* cotton variety – maize cropping system (1801 and 1880 kg ha^{-1} respectively).

Similarly, in the fourth cropping system of cotton-wheat, the highest seed cotton yield (2544 kg ha^{-1}) was recorded in combined application of inorganic and organic sources of nutrients (NPK + Mg + Zn + B + FYM (5 t/ha) once in two years) whereas the lowest was noted in control (1094 kg ha^{-1}). Among the cropping systems, *Bt* cotton hybrid – wheat (1945 kg ha^{-1}) and *Bt* cotton hybrid – fallow (2321 kg ha^{-1}) cropping system recorded higher seed cotton yield than other cropping systems (Fig 3.52.1).

Table. 3.52.1: Growth and yield attributes of cotton under drip irrigated cotton-maize cropping system (IV sequence)

Treatments		No. of opened bolls /m2	Boll weight (g/boll)	Seed cotton yield (kg/ha)
Bt cotton hybrid - Maize		46.5	5.6	1792
Bt cotton variety-Maize		127.6	3.6	1801
Non Bt cotton variety -Maize		62.7	5	1880
Bt cotton hybrid - Fallow		41	6.2	1644
Control		59.9	4.8	1572
NPK		63.4	5	1822
BF application		73.7	5.3	1990
INM		78.9	5.3	1921
Nutrient through organics		71.4	5	1589
CD (0.05 %)	C	12.0 **	0.49 **	NS
	T	13.0 *	0.33 *	157.3 **
	C X T	NS	NS	NS



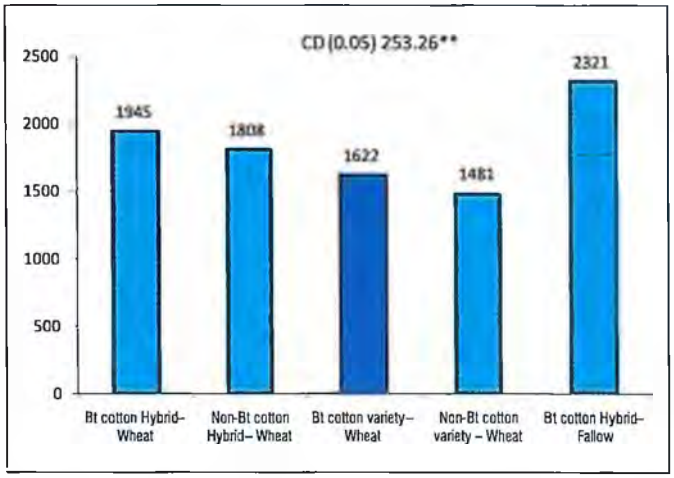


Fig.3.52.1: Seed cotton yield under cotton-wheat cropping system due to different sources of nutrients

Non Bt suraj variety - Control

Non Bt suraj variety - INM

Bt suraj variety – Organic nutrients

Bt suraj variety – INM

Visual difference of cotton crop between control (T1) and INM (T4) in non Bt suraj variety and organic sources of nutrient (T5) and INM (T4) in Bt suraj variety plot

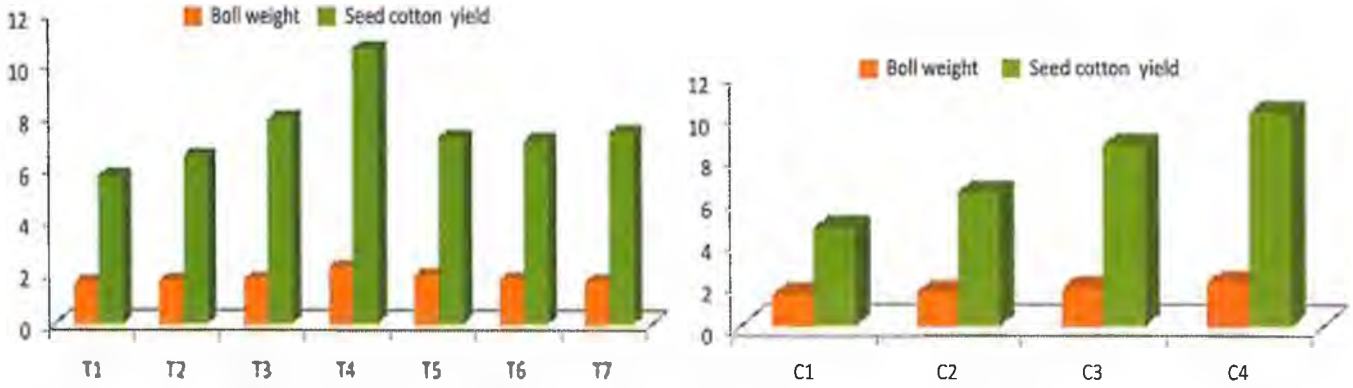
3.53 Project Name: Formulation of customized fertilizers for cotton

D. Kanjana (PI); Co-PIs: R.Raja, S. Usharani

Importance of the study: To achieve the balanced nutrition, enhance the fertilizer use efficiency, realize the full yield potential in crops and sustain the farm profitability under different soil conditions, custom made fertilizers *i.e.,* customized fertilizers / multi nutrient carriers are needed by cotton growers.

Salient findings

A replicated pot experiment was conducted in a factorial design with Suraksha cotton variety to develop the best secondary and micronutrients combinations along with suitable chelates for enhancing growth and yield of cotton. Soil application of 200 per cent recommended dose of magnesium (Mg), zinc (Zn) and boron (B) increased the mean plant height (60.0 cm at 85 DAS), boll weight (2.17 g/boll) and seed cotton yield (10.6 g/plant). Among the different types of chelates, polymeric chelate produced higher plant height (61.5 cm at 85 DAS), boll weight (2.10 g/boll) and seed cotton yield (10.2 g/plant) than other



T1-Control T2-MgZnB(100%) T3-MgZnB(150%)
T4-MgZnB(200%) T5-T2+FeCuMnMo(100%)
T6-T3+FeCuMnMo(100%) T7-T4+FeCuMnMo(100%)

C1 - No Chelate C2 - EDTA
C3-Organic acid chelate C4-Polymeric chelate

Fig.3.53.1: Boll weight (g/boll) and seed cotton yield (g/plant) as influenced by secondary and micronutrient combinations and different types of chelates

Visual difference of cotton crop among different micronutrient combinations and chelates

3.54 Project Name: *Ex Ante* Analysis of the Impact of COVID 19 on Cotton Economy in India

Isabella Agarwal (PI); Co-PIs: A.R.Reddy, Amarpreet Singh

Importance of the study : The impact of COVID-19 on the economy is no doubt devastating and its impact on agriculture is complex and varied across diverse segments that form the agricultural value chain. Globally, exports of agricultural goods declined. In India, there were (a) disruptions in the supply chains; (b) disruptions in the collection of harvests from the farms by traders; (c) disruptions in the logistics network; (d) shortage of trucks and truck drivers; (e) inter State blockades in the transport of commodities; (f) limited operations of APMC mandis; and (g) shutdown of the retail markets. This study was taken up at this juncture to know the real situation existing in cotton production and marketing in India.

Salient findings : At the world level, there was a decline in cotton production during pandemic period but gained momentum during the next year.

Cotton export declined during the year 2021-22 to 10.87 per cent. There was 17.44 per cent increase in cotton imports in 2020 and reduced to 12.8 per cent in 2021-22 as compared to 2019-20.

The pandemic did not show any effect on the cotton consumption scenario. The world total demand of cotton increased from 2019 to 2021 narrowing down the ending stocks making an impact on world price of cotton.

An upward trend in price at a slower pace was observed right from May'2020 onwards itself and after that it fully recovered once all the restrictions got phased out completely (Fig 3.54.1).

At national level, there was a decline of 3.14 per cent in cotton area but an increase of 1.53 per cent in production and 4.98 per cent increase in yield during 2020-21 implying a meagre effect of COVID 19 on the cotton scenario in India.

Regarding the arrivals in cotton market, there was a drastic reduction to the tune of 43.5 per cent during the pandemic period as a result of lockdown, labour non-availability and transport problems combined with fewer prices for cotton

At district level, the lockdown resulted in a situation wherein about 20 per cent of the current year's crop was either stuck up

in fields without being harvested or stacked in farmer's homes, because they were not able to transport or sell it.

Artificial Intelligence (AI) based Time Series Intervention Models viz., ARIMA Model, ARIMA Intervention Model, Support Vector Regression (SVR) Model, Support Vector Regression (SVR) Intervention Model and Artificial Intelligence AI-Based Intervention Models were used to assess the impact of COVID 19 pandemic on cotton supply and prices in India (Table 3.54.1). The model results showed that the pandemic had a negative effect on supply in all the tested cotton growing States during the year 2020. Regarding price, it had a positive effect in Rajasthan and Maharashtra. During 2021, the effect of pandemic scenario was positive facing supply problem except in Rajasthan which reflected on the price scenario

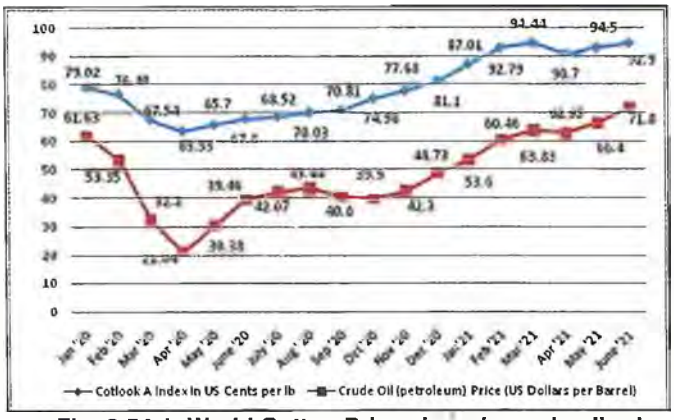


Fig. 3.54.1: World Cotton Price *vis-a-vis* crude oil price during Jan' 2020 to June '2021

Table 3.54.1: Artificial Intelligence (AI)-Based Intervention Models

States	Arrivals Impact (ω)			Modal Price Impact (ω)		
	Coeff	Z value	p value	Coeff	Z value	p value
2020						
Raj	-795.5	1.1	0.1324	65.472	1.65	0.0504
Mah	-1012.38	0.965	0.1677	36.983	0.7973	0.2130
Guj	-504.449	0.692	0.2445	-204.496	0.8677	0.1931
Kar	-362.600	1.586	0.0568	-104.843	1.0014	0.1587
Tel	-3116.42	3.148	0.0010	-6.414	0.0678	0.4730
2021						
Raj	-46.593	0.082	0.4669	14.535	0.1422	0.4435
Mah	19.759	0.031	0.4874	-247.007	0.9778	0.1647
Guj	377.072	0.447	0.3275	-8.817	0.0475	0.4810
Kar	22.172	0.262	0.3966	-171.590	0.5971	0.2754

3.55 Project Name: Economic Analysis of Value Chain of Cotton Market in Tamil Nadu

Isabella Agarwal (PI)

Importance of the study: The lack of an efficient feedback system at all levels of the cotton chain hinders information flow and scope for change in practices needed to improve the quality of cotton. Knowing the commercial importance of cotton at the country and State levels, it is felt that there is need to map the cotton chain (consisting of producer and various processors) and study the same through functional and financial analysis.

Salient findings

A total of 250 farmers from nine districts were selected based on ranking through composite index approach along with five ginners and three spinners were as sample market intermediaries were selected (Table 3.55.1).

Five channels were identified during the study i.e., Farmers-Brokers/Traders-Co-op market; Farmers-Commission agent-Co-op market/Ginners; Farmers-Co-op markets; Farmers-Ginners/Millers; Farmers-Wholesalers-Co-op markets/Ginners.

The cost of cultivation of cotton computed from the data collected from the sample farmers revealed that the average total cost per hectare of cotton was Rs. 124194 and total cost of cultivation incurred to produce one quintal of cotton was Rs.5825 (Table 3.55.2)which comprised of variable cost (Rs. 4678.47) and fixed cost (Rs.1147.78). Packing material with packing charge was the major component followed by commission charges, transportation cost, loading and unloading charges and weighing charges accounting for 43.51%, 37.87%, 9.7% and 8.85% of the total marketing cost, respectively. The net returns obtained were Rs.11225.38/ha and Rs.507.94/qtl of cotton. The benefit cost ratio worked out to 1.08.

On an average, the total cost incurred in the processing of kapas to lint worked out to Rs.25009.83 per quintal of kapas with total variable cost (Rs.24031.54/qtl) to the tune of 96.09% of the total cost of processing of kapas to lint. The gross returns obtained were Rs. 26532.90 from ginning one quintal of kapas out of which the returns from main product (lint) was Rs.3978.81 and that from by product (seed) was Rs.2106.37. The net value added as a result of processing of kapas to lint was Rs.1523.07/qtl. with BC ratio of 1.23.

Average total cost incurred in the processing of lint to yarn was Rs.36522.41/qtl, of which the total variable cost was Rs.32884/qtl (90.0%) and total fixed cost being Rs.3637.78/qtl (9.96%). The net value added as a result of processing of lint to yarn was Rs.1888.83/qtl. with BC ratio 1.64.

The results indicated that an additional value to the extent of Rs.3919.77/qtl was created in the course of processing kapas into yarn (Table 3.55.3). The breakup of the same at different levels of processing was Rs.1523/qtl (38.8%) at ginning and Rs.1888.83/qtl (48.19%) at spinning process. These results indicated that cotton production, marketing and processing under the current price and cost situation is profitable.

Table 3.55.1: Ranking of districts based on Composite Index (CI)

Districts	Zone	Rank	Districts	Zone	Rank
Perambalur	CDZ	1	Madurai	SZ	14
Salem	NWZ	2	Thoothukudi		15
Tiruchirapalli	CDZ	3	Cuddalore		16
Dharmapuri		4	Namakkal		17
Thiruvarur	CDZ	5	Vellore		18
Ariyalur		6	Krishnagiri		19
Villupuram		7	Erode		20
Theni		8	Tiruppur		21
Dindugal		9	Sivagangai	SZ	22
Virudhunagar	NWZ	10	Coimbatore	WZ	23
Nagapattinam		11	Karur		24
Thanjavur		12	Pudukottai		25
Tirunelveli		13	Ramanathapuram	SZ	26

CDZ Cauvery Delta Zone; NWZ North west Zone; SZ South zone; WZ west Zone

Table 3.55.2: Cost of Cultivation of the sample cotton farmers in Tamil Nadu

S.No.	Particulars	Rs./ha	Rs./qtl	%
A.	Variable Cost			
1	Human labour	68800.53	3227.04	51.97
2	Bullock labour	745.28	34.96	0.56
3	Tractor power	10474.29	491.29	7.91
4	Seed	3488.16	163.61	2.63
5	FYM	3408.7	159.88	2.57
6	Fertilizers	7485.89	351.12	5.65
7	PP chemicals	2959.19	138.80	2.24
8	Int on working capital	2382.93	111.77	1.80
	Total variable Cost (A)	99744.96	4678.47	75.35
B.	Fixed Cost			0.00
1	Rental value of land	21981.07	1031.01	16.60
2	Interest on fixed capital	1705.93	80.02	1.29
3	Depreciation	762.41	35.76	0.58
	Total fixed cost (B)	24449.41	1146.78	18.47
C.	Total COC (A+B)	124194.37	5825.25	93.82
D.	Marketing Cost			0.00
1	Packing material and packing	3562.15	167.08	2.69
2	Loading and unloading	724.26	33.97	0.55
3	Transport	800	37.52	0.60
4	Commission	3100	145.40	2.34
	Total Marketing Cost (D)	8186.41	383.98	6.18
	Total Cost (C+D)	132380.78	6209.23	100.00
	BC Ratio	1.08	1.08	

Table 3.55.3: Total net value of addition to one quintal of processed cotton

S.No.	Stages of processing	Net Value addition (Rs.)	%
1.	Production	507.94	12.96
2.	Ginning	1523.00	38.85
3.	Spinning	1888.83	48.19
		3919.77	100.00

3.56 Project Name: Development of Extension Model for Promoting the Production of Extra Long Staple Cotton in India

S. Usha Rani (PI); Co-PIs: S. Manickam (until 2021), K. Sankaranarayanan, M. Sabesh, M. Amutha, P. Valaramathi, S. M. Wasnik

Importance of the study: ELS cotton (34.9 mm and above) is highly demanded by the industries and mostly imported from other countries. To meet the above requirement, India has to import significant quantities of ELS Cotton namely Supima from USA, Giza cotton from Egypt as well as some quantities of CIS and Sudan cotton. As India accounts for 40% of the global share in the fine and super fine cotton yarn trade, it is the country's R & D institutes' responsibility to foster the production of ELS cotton. There are good varieties, interspecific hybrids and other technologies available for improving the production of ELS cotton. But, diffusing them to the end users through an appropriate tailor-made diffusion model, documenting the concerns of end users as regards cultivation and marketing of ELS cotton and providing empirical evident data for finalizing the policy are not there in the present system. Hence an extension project has been executed to develop an extension approach to foster the production of ELS cotton by disseminating the appropriate yield enhancing technologies with novel TOT innovations.

Salient findings

Problem Tree Analysis conducted among 238 ELS cotton growers in five Focussed Group Discussions facilitated to map out the causes and effects of the major problem found "Low Adoption of ELS Cotton" and further the objective and strategy analyses.

Primary data collected from 450 respondents in the study area revealed the profile characteristics of ELS cotton growers which would be useful in planning development projects

The analysis on cultivation behaviour revealed that majority of them had positive attitude towards ELS cotton cultivation and medium level of knowledge and adoption.

The technology adoption gap analysis revealed that major technology adoption gaps were found in adopting the technologies related to pest nutrient management and planting methods

Similarly, the marketing behaviour, information seeking behaviour and the willingness for contract farming and FPOs were analyzed.

Constraints faced by the cultivars and other stakeholders were documented

Value chain present in one of the study ELS cotton growing districts was documented as a case study

To know the Prospects of FPOs to foster the production of ELS cotton, a critical analysis was made on the FPOs promoted by SFAC/NABARD in total, on cash crops including cotton and in the study area

Based on above said observations and collected data, a model called "Pluralistic Extension Model for Fostering the Production of ELS cotton" was conceptualized. Based on the analysis of empirical data and stakeholders' perceptions, an Empirical model was developed.

Empirical Model

- Stage I - Pre Production
- Stage I - Pre Production
- Stage I - Pre Production

Pluralistic Extension Model for Fostering the Production of ELS cotton

Stage I - Pre Production

1. Mapping of ELS cotton area
2. Selection of study area
3. Formation of Farmers Producer Company
4. Selection and integration of input service provider by the FPC
5. Integration of credit service provider
6. Integration of labour Service provider
7. Entering into pre-season contract with the procurement firm/ CCI
8. Pre-Season Campaign
9. Pre – season training
10. Documentation

Stage II – Production

1. Technology backstopping - Best management Practices of CICR
2. Extension Backstopping - Synergistic Extension Model

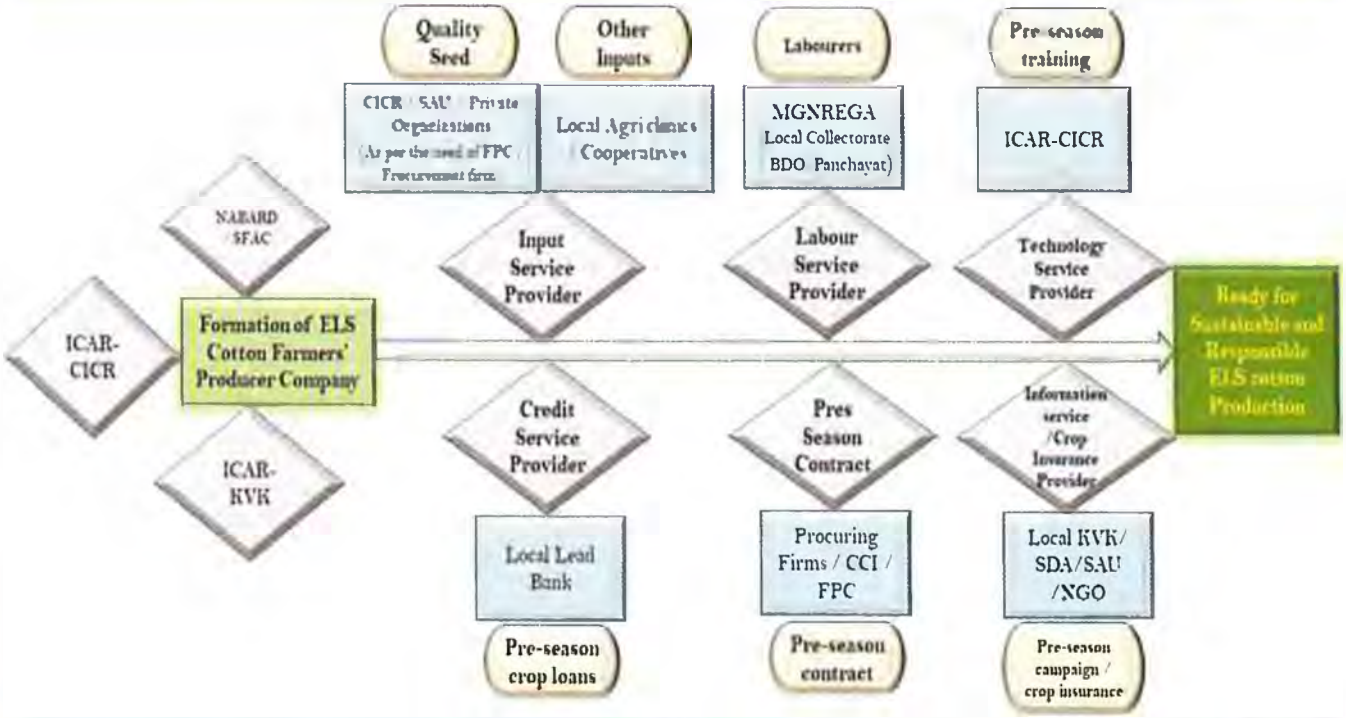
At various stages of crop cultivation

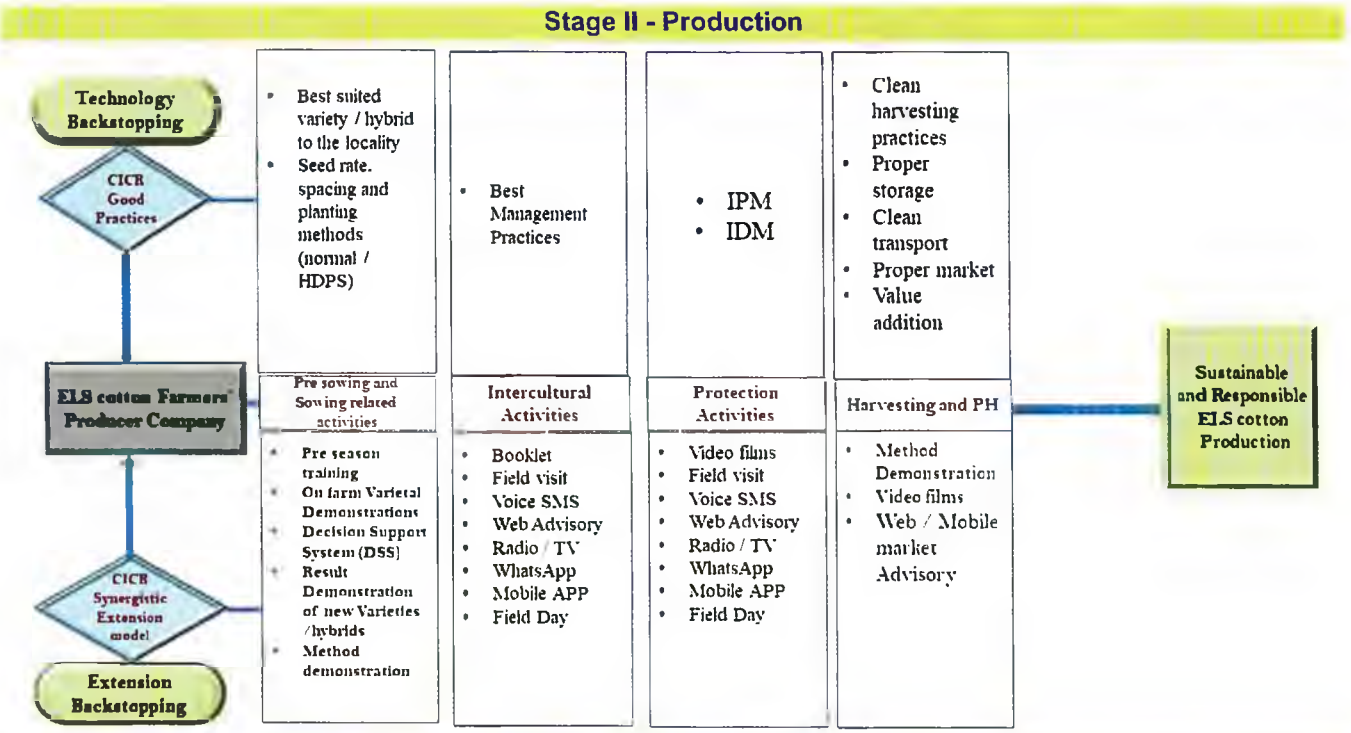
- Land preparation and Sowing
- Intercultural Operations
- Plant Protection
- Clean Harvesting

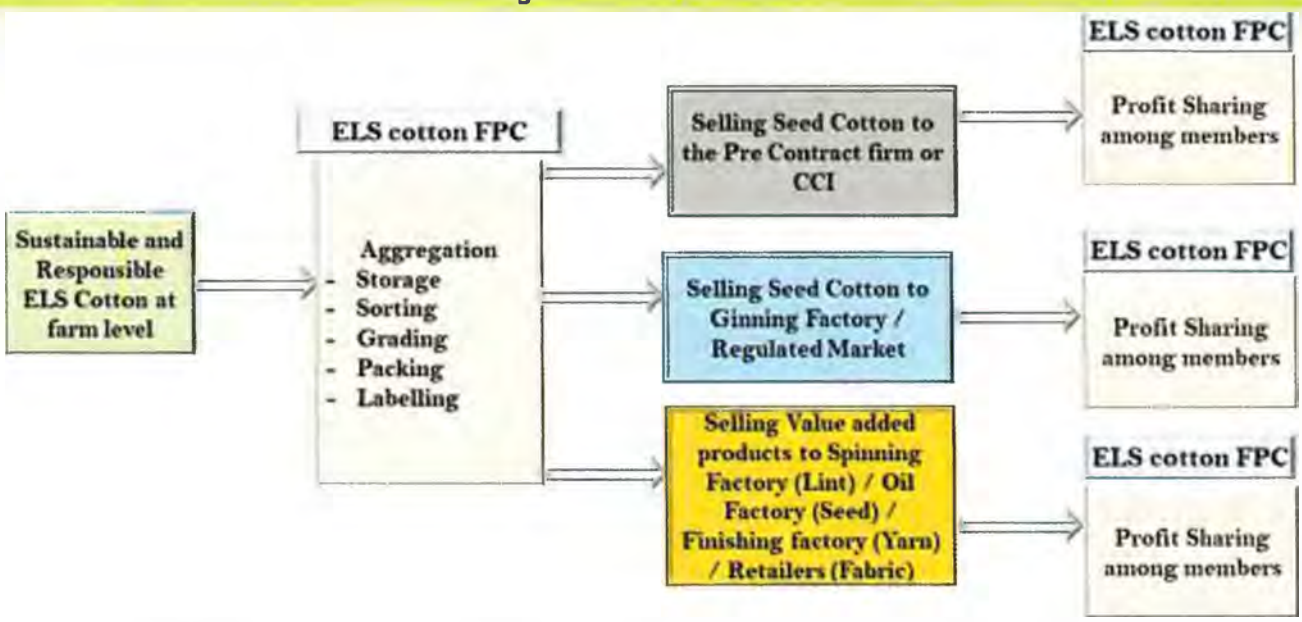
Stage III - Post Production

1. Clean Post harvesting practices
2. Packing and labelling with traceability
3. Procurement on pre contract prize or premium prize
4. Profit sharing by the FPC

Stage I - Pre Production







3.57 Project Name: Exploiting the epigenetic transgenerational inheritance of stress responsive traits for imparting abiotic stress tolerance to cotton

J. Annie Sheeba (PI)

Importance of the study: The epigenome (chemical "tags" present in DNA) changes rapidly in response to signals from the environment. The epigenome remains flexible as environmental conditions continue to change. However if an epigenetic change in response to environmental conditions is inherited, the epigenetic inheritance may allow the plants to continually adjust its gene expression to fits its environment without changing its DNA code. Recent evidences in plants indicate that few epigenetic traits are stably inherited across generations. Use of epigenetic regulating chemicals for improving stress tolerance in plants is gaining importance in recent days. Also studies have offered proof that it is possible to increase stress tolerance in the immediate progeny by exposing ancestral plants to mild/short-term stress signals due to transgenerational transmission of stress memory and associated patterns of gene expression. With the above background, considering the scope of stable epigenetic inheritance and use of epigenetic regulating chemicals in obtaining a stable inheritance of epiallele, an experiment was conducted to explore the possibility of using epigenetic inheritance for imparting abiotic stress tolerance in cotton.

Salient findings

Screening for drought tolerance was done based on physiological and biochemical parameters such as relative

water content, excised leaf water loss, epicuticular wax content, peroxidase activity, proline content and chlorophyll content in fifth generation plants. The results revealed that seed treatment with 5-Azacytidine 40μM contributes to drought tolerance up to five generations in cotton varieties Suraj and LRA 5166 by enhancing important drought tolerant traits (water conservation and osmolyte production).Hence transgenerational inheritance of drought tolerance imposed by ERCs is confirmed. Other ERCs like Sulfamethazine and Epigallocatechin gallate are effective in enhancing cell membrane stability and Chlorophyll Stability Index.

In the field trials, higher total chlorophyll and higher proline contents were recorded by 5 azacytidine 40 μM treated plants in both Suraj and LRA 5166 in the fifth generation. No significant differences were observed in SPAD value, Chlorophyll Stability Index, Relative Water Content, Carotenoid contents and yield in case of Suraj. Single Plant yield was higher in 5 azacytidine 10 μM treated plants when compared to control in LRA 5166.

Whole genome bisulphite sequencing revealed that the higher proportion of differentially hypo methylated regions was observed in Chromosome 9 and 12 in third generation plants of LRA 5166 (Fig.3.57.1). In case of Suraj, higher proportion of differentially hypo methylated regions were observed in Chromosome 5 of third generation plants (Fig 3.57. 2). This indicates increase in gene expression in chromosome, 5, 9 and 12under drought stress conditions, thus imparting drought tolerance to cotton.

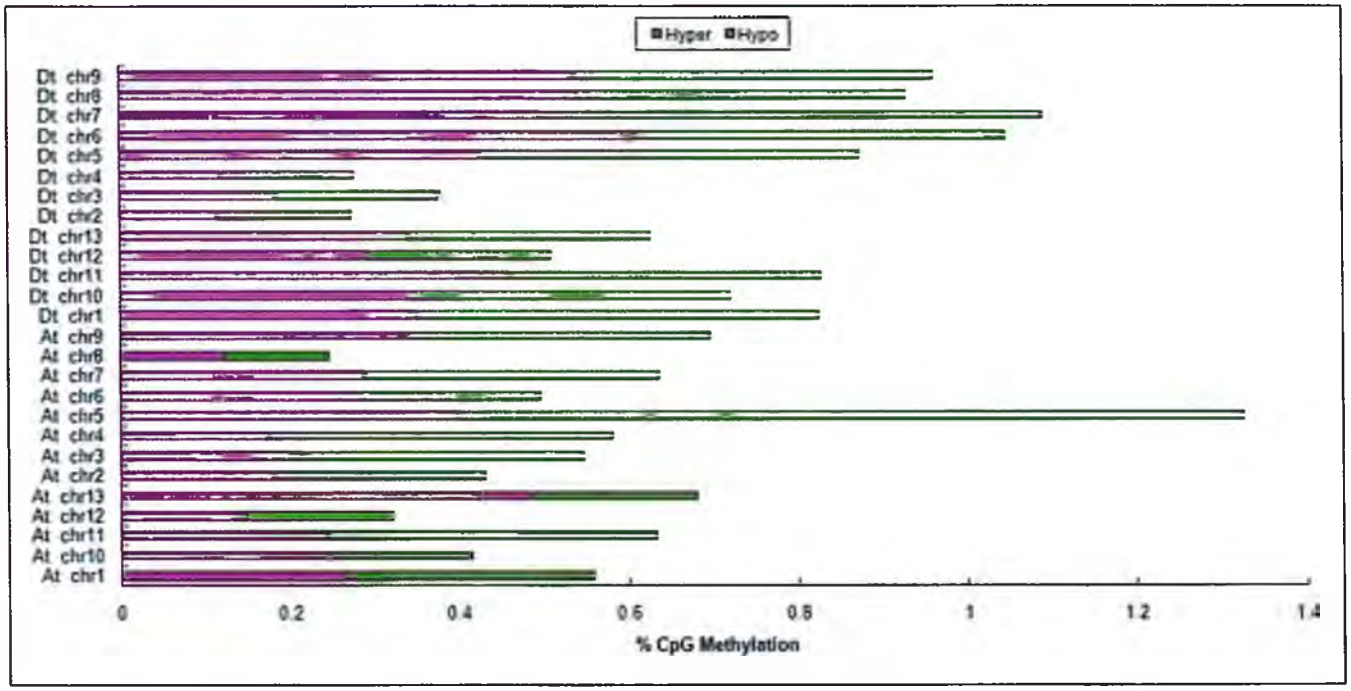


Fig. 3.57.1: Proportion of hypo and hypermethylation in third generation of LRA 5166

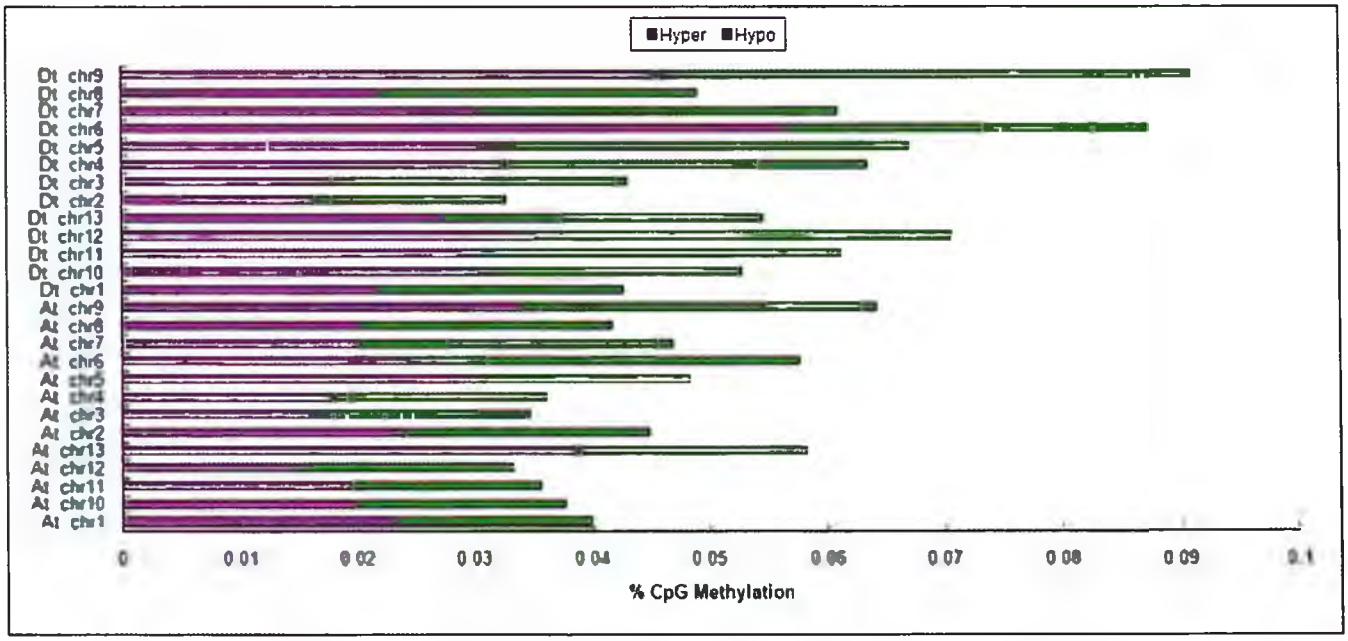


Fig.3.57.2: Proportion of hypo and hypermethylation in third generation of Suraj

3.57(a) Project Name: Breeding for high yielding, early maturing sucking pest tolerant extra-long staple G. barbadense genotypes with improved fibre properties

A. Manivannan (PI), Co-PI:K.Rameash

Importance of the study: Improvementof extra-long staple(ELS) cotton (G.barbadense) genotypes for early maturing, sucking pest tolerance, high yielding with improved fibre quality properties

Salient findings :

ELS Variety identified for release: CICR B Cotton 55 (CCB 51-2)

It recorded mean seed cotton yield of 1317 kg/ha as against 1139 kg/ha of the Zonal check variety under irrigated condition. The proposed variety has combined fibre quality combination viz., Upper Half Mean Length of 37.1 mm, micronaire of 3.7 and tenacity of 38 g/tex in HVI mode. It is identified for cultivation in the states Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu.

CICR B Cotton 55 (CCB 51-2) a new variety of *G. barbadense* identified for release in South Zone

Promising ELS genotypes in AICRP trials during 2021-22: CCB26(CVT Br 14a),CCB 6(CVT Br 13a),CCB22-1and CCB22-2 (IET Br12a).

Genetic stock registered with NBPGR: CCB12 (IC0641999; INGR21212) a Cleisto mutant linesidentified from the G. barbadense intra cross Suvin x Giza-45.

Insect resistant lines: CCB-25 and CCB-28 for Aphids, CCB-28 for both Aphid and Jassid tolerant were identified for sucking pest tolerance.

Evaluation of Advanced Progenies for sucking pest tolerance: A set of 10 advanced progenies with high yielding and sucking pest tolerance were evaluated namely H1 Suvin x (ICB-241 x CCB-29), H2 Suvin x(EC-18 x CCB-3), H3 Suvin x (ICB85 x CCB-29), H5 Suvin x(ICB126 x CCB-29), H6 Suvin x(ICB124 x CCB-29), H7 Suvin x(ICB124 x CCB-6), H8 Suvin x (ICB-124 xCCB-5), H9 Suvin x (ICB-27 xCCB-12), H10 Suvin x (ICB-214 xCCB-6), H11 Suvin x (EC18 xCCB-29). Among them H1, H5 & H8 were found to be moderately resistant for aphids, thrips, hoppers and whitefly.

Germplasm maintenance: A set of 327 G. barbadense germplasm is being maintained at CICR, Regional Station, Coimbatore.

Spontaneous mutants: Brown linted mutant identified from the EA 203, Big boll from (EA159) and naked seeds (EC 959057).

Seed multiplication: Mass multiplication of seeds of advance cultures (CCB 3, CCB 4, CCB 5, CCB 7, CCB 8, CCB 12, CCB 13, CCB 28, CCB 64, CCB 64B, CCB 129, CCB 141, CCB 142) and AICRP trials cultures (CCB 51-2, CCB 26, CCB 6, CCB 15, CCB 29, CCB 1, CCB 2) and released varieties CICR B Cotton 37 and 45.

Mutants derived from advanced cultures; brown (EA 203)

3.57(b) Project Name: Induced mutagenesis for improvement of ELS cotton (G.barbadense)

A. Manivannan (PI), Co-PIs: K. Rathinavel, K. Shankarganesh, A.Sampathkumar

Importance of the study: Induced mutagenesis in Suvin (*G.barbadense*) variety through Fast Neutron (FN) for Identifying of novel mutant with high ginning out turn(GOT).

Salient findings :

- Fast Neutron was used as a source of inducing mutation in the popular variety suivn in order to increase the Ginning out turn (GOT) percentage. A set of 5000 populations of M2 progeny was evaluated for various traits (Table 3.57(b-1)). Significant variability was found among the M2 Progenies.
- In M2, progeny, the highest heritability was observed for the traits days to flowering, monopodia and sympodia. Moderate heritability was observed for plant yield, single plant yield, boll weight and number. However low heritability was found for the trait GOT. It was observed the range of 27 to 39 %.
- From the M2 population, 25 lines with highest GOT with yield been selected to forward into M3 progeny row.

Table 3.57(B)1 Genetic variability observed among M_2 population

S.N.	Traits	PCV	GCV	ECV	H2	GA%
1	PH	18.15	15.32	2.5	78.14	37.03
2	DF	6.51	6.208	3.9	91.62	12.11
3	DM	5.85	6.012	1.37	84.78	11.73
4	GOT	15.21	10.15	5.41	68.77	29.53
5	MOP	30.62	31.48	7.31	94.6	61.35
6	SYMB	14.01	14.72	4.53	90.53	27.46
7	NBL	11.48	6.11	3.84	69.92	22.43
8	SBW	19.86	16.26	4.01	76.07	40.1
9	SPY	38.82	31.33	6.34	77.4	78.92

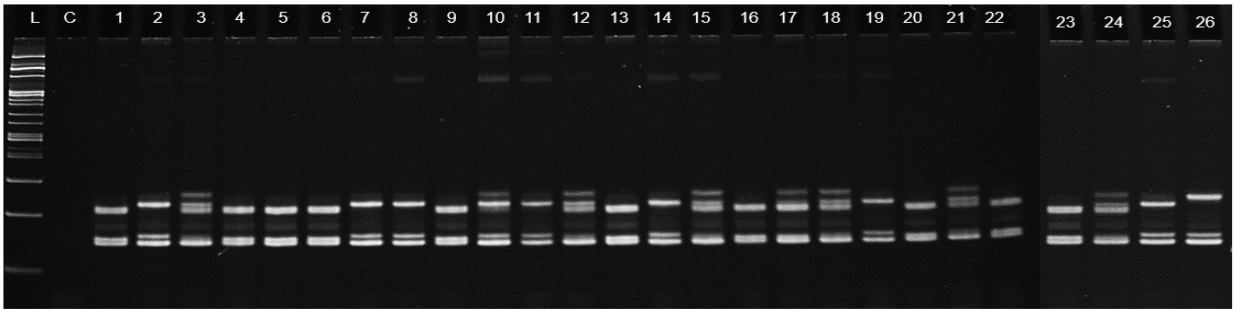
3.57 (c) Project Name: DST CRG Project : Unraveling the Differential Expressed Proteins (DEP) in cotton genotypes with contrastingresistance to leafhopper anddevelopment of the protein biomarkers/functional markers forleafhopper resistance

A. Manivannan (PI), Co-PI: K.Shankarganesh

Importance of the study: Discerning the Differential Expressed Proteins (DEP) towards leafhopper resistance aids in identifying the key peptides involved in resistance. Unravelled peptides sequence information would help in development of functional markers for marker-assisted selection towards leafhopper resistance in cotton.

Salient findings :

Based on leafhopper resistance screening, a set of 26 genotypes including two susceptible checks (Suvin, DCH 32) were genotyped using SSR markers. This study was undertaken to measure the genetic diversity and population structure of leafhopper resistant cotton accessions, which are having contrasting resistance towards leafhopper using 56 polymorphic simple sequence repeat (SSR) markers to select unique parents for breeding. The mean polymorphic information content (PIC) of 0.491 major allelic frequency (MAF) of 3.27 suggesting high polymorphism for the selected SSR markers among the cotton accessions.



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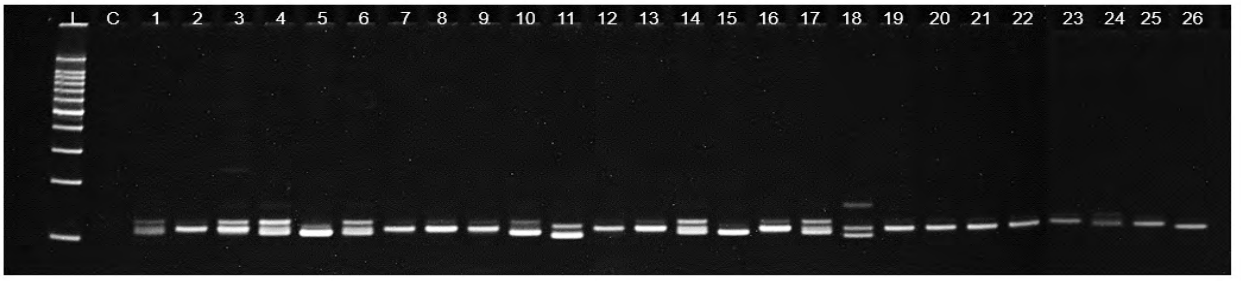

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L – 100 bp DNA Ladder ; C – Negative control ; 1-26 – DNA of *Gossypium* was amplified with primer HAU0190; 1- RS2711 2- DCH32 3- NDLH 1938 (RC) 4- RS 2765 5- LHDP 1 6- F 2164 7- GISV 267 8- GISV 216 9- SCS 1062 10- NH 630 11- GSHV 173 12- GSHV 171 13- JK 35 14- AKH09-5 15- Suvin 16- CSH 3129 17 - AKH 2006 -2 18- AKH 2012 -8 19- LRA 5166 20- PUSA 5760 21- H 1464 22- H 1454 23- AKH 1351 24- AKH 1355 25- NDLH 2010 26- AKH 1301

3.58 Project Name: Development of a nutrient and plant hormone- enriched foliar formulation for cotton

J. Annie Sheeba (PI); Co-PI: D. Kanjana

Importance of the study: Foliar fertilization can improve the efficiency and rapidity of utilization of a nutrient required by the plant for maximum growth and yield Foliar feeding provides for a more rapid material utilization and permits the correction of observed deficiencies in less time than can be accomplished by soil application. Foliar fertilization during boll development, particularly N, K, and B, used to further supplement plant nutrient requirements when tissue tests indicate potential deficiencies. Supplementing the nutrient supply to the developing fruit would be beneficial especially if the root system operates slowly. As large percentage (66 to 75%) of the yield is produced on first-position fruiting sites, retention and maturation of these bolls is critical. Use of PGRs may increase boll retention at the first fruiting sites, enhance and accelerate crop maturity, promote an earlier harvest, and improve lint quality, and potentially alter membrane properties associated with enhanced tolerance to deviation in temperature. With this background this project is formulated to develop a foliar formulation of nutrients and hormones combining the nutrients and plant hormones.

Salient findings: Nine treatment combinations were tried in cotton variety to test the effective combination of hormones and nutrients to improve the productivity in cotton under field conditions. Among the treatment combinations, T5 (KNO_3 (2 %) + MAP (0.5 %) + Mg SO_4 (0.5 %) + Ferrous Sulphate (0.25%) + Zinc Sulphate (0.25 %) + Boric Acid (0.1%) + NAA (20 ppm) + Na- EDTA 0.02 mM + $CuSO_4$ (0.05 %) + Sodium molybdate (0.01%)), increased the total chlorophyll (4.1 mg/g), chlorophyll a (1.9 mg/g), chlorophyll b (2.2 mg/g) and carotenoid contents (1.15 mg/g) over control. Higher NR activity of 113 μg NO_2 /g/hr was recorded by T 7 : (Urea (1 %) + MAP (0.5 %) + KCl (0.5%) + Mg SO_4 (0.5 %)+ Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25 %) + Boric Acid (0.1 %) + NAA (20 ppm) + $CuSO_4$ (0.05 %) + Sodium molybdate (0.01%) + Na - EDTA 0.02 mM) which is followed by NR activity of 109 μg NO_2 /g/hr by T3: MAP (1%) + Potassium Chloride (0.5 %) + Magnesium Sulphate (0.5%) + Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25%) + NAA (20 ppm) + Boric Acid (0.1 %) + $CuSO_4$ (0.05 %) + Sodium molybdate (0.01%)+ Na-EDTA (0.02 mM)). Total Soluble Sugars, soluble protein content, nitrogen content, seed cotton yield were higher in (T 3 : MAP (1%) + Potassium Chloride (0.5 %) + Magnesium Sulphate (0.5%) + Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25%) + NAA (20 ppm) + Boric Acid (0.1 %) + CuSO4 (0.05 %) + Sodium molybdate (0.01%) + Na-EDTA (0.02 mM)).

3.59 Project Name: Development of Web-based Cotton Data Query System (IXX15679)

M. Sabesh (PI); Co-PIs: Isabella Agarwal, Sunil Mahajan

Importance of the study: This project will document cotton datasets and create databases on different aspect of cotton under single window system exclusively on cotton in India. This project also indented to delivers online data query system for stakeholders including researchers, policy makers, students and general public. Also, this project broadcasts the research activities in ICAR-CICR through Cotton Portal

Salient findings: Cotton data or Information are found that different agencies collect and maintain different data sets. In addition, many data sets are in in reports, periodicals, books, technical bulletins, etc., but not in digital form. User found it difficult to get the data as and when required. It is felt that digitization all the available data sets and making it as online digital data query system will help user to query the required information instantly. Under this project various datasets have been collected from different authentic sources and which has been analysed and database was developed. User friendly data query systems have been developed with database. So far, we developed a query system for each component of cost of cultivation parameter from the year 1996 to 2019; district wise cotton area, production and productivity for all cotton growing states from the year 1996 to 2019; query system to query cotton genetic resources available in ICAR-CICR. Besides, under this project, cotton web portal (www.cicr.org.in) has been maintained. The portal has been in global view since the year 2002 and incorporates wide variety of cotton information for different stakeholders.

3.60 Project Name: Development of wireless smart trap for automated monitoring of lepidopterous pests in cotton

K. Rameash(PI); Co-PIs: K. Shankarganesh, BabasahebFand(for 2021-22)

Importance of the study: The project is aimed at developing an automated trap with image sensors for providing real time surveillance for multi species lepidopterous pests of cotton and integrated weather sensor for giving information on weather parameters corresponding to the trap catches for efficient pest monitoring. By integrating the traditional trapping method with modern information communication technology , the trap system would provide a real-time information on the field conditions and the dynamics of the pest population at different monitoring sites.

Salient findings :

During 2021-22, two field experiments were conducted to evaluate different pheromone trapping systems fabricated with four pheromone septa containing 2 mg each of pheromone compounds viz., 7,11-Hexadecadienyl acetate; (Z,E)-9,11-Tetradecadienyl acetate; (Z)-9-Hexadecenal; (E,E)-10,12-Hexadecadienyl in the attraction of *Pectinophora gossypiella*, *Spodoptera litura*, *Helicoverpa armigera* and *Earias vitella* in cotton. The results revealed that, trap catches of *P. gossypiella* and *S.litura* were found to be similar in individual traps, combined traps and combined lure treatments. In mixed lure trap a significant reduction in trap catch was noticed.

The wireless smart trap fabricated during 2020-21 was improvised with new 160° fish-eye camera module and new trap holder design. A BME280 weather sensor module was integrated with the smart trap that sends the information on the corresponding temperature, relative humidity, atmospheric pressure and altitude along with the image. The combined data was optimised and transmitted via 4G GSM and delivered to the end-user via an e-mail client and mobile application (Telegram Bot). The automated pest monitoring system with wireless telecommunication technology would provide a real-time environmental data along with the trap catch of key insect pests of cotton. The smart trap system would increase the effectiveness and the precision of pest control strategies and would support to establish a highly reliable pest forewarning system in cotton.

3.61 Project Name : Biology and holistic management strategies for emerging pest Tea mosquito Bug (*Helopeltis* sp.) in Cotton.

M. Amutha(PI)

Importance of the study : Tea mosquito bug (TMB) *Helopeltis* is the emerging pests on cotton. The key elements for developing decision-making systems for pest management were quantifying crop losses and standardising sampling procedures. Therefore, research on these variables was conducted for cotton.

Salient findings

The Tea Mosquito Bug (TMB) population dynamics showed that the incidence started in September and peaked in December. The incidence of TMB was positively correlated with rainfall and rainy days, while temperature, sunshine hours, and solar radiation exhibited negative correlations.

Life cycle of TMB carried out in laboratory condition. TMB consist of five instars and adult stage. The life cycle periods in days were as follows, egg period- 6.97±0.67, 1stinstar-2.83±0.89, 2nd instar-2.73±0.63, 3rd instar-3.43±0.51, 4th instar-2.70±0.54 and 5th instar-2.13±0.27 days respectively. Life cycle period of 14.30±1.27 and 23.07±1.01 days observed for male and female respectively.

The quantity of cotton yield loss due to tea mosquito bug was estimated by artificially confining the insects in net. One insect / plant has the potential to reduce yield by 10% compared to control. Maximum yield decrease of 52% by 5 insects /plant compared to control was observed.

Sampling methodology was defined for TMB with respect to time, portion and size of sampling. Morning hours, 15 numbers of plants per acre, and the top one third of the area of the cotton plant were found to be ideal for sampling.

The tea mosquito bug has been observed on sixteen different alternate hosts from different families.

Table 3.61.1: Estimation of quantitative yield loss due to *H. theivora* on cotton

Treatments	Shoot infestation %	Shoot infestation Index	Bolls damage (%)	Boll damage Index	Yield of single plant (g)	Percent redn. over control
T1-(1 insect/plant	59.26	1.56	45.19	1.60	35.99	9.57
T2-(2 insect/plant)	62.96	1.78	49.56	1.83	33.67	15.41
T3-(3 insect/plant)	70.37	2.30	51.28	1.94	28.97	27.22
T4-(4 insect/plant)	77.78	2.63	53.40	2.00	23.58	40.74
T5-(5 insect/plant)	92.59	3.26	54.08	2.06	18.95	52.38
T6- Control	0.00	1.00	0.00	1.00	39.80	
S.Ed	7.194	0.066	1.517	0.019	0.108	
CD	16.236	0.149	3.423	0.043	0.243	

Table 3.61.2: Determination of sampling time for *H. theivora* on cotton

Treatments	No. of insects	Total bolls	Affected bolls	Bolls damage (%)	Shoot infestation %	Grade
Morning	1.39	17.83	4.02	22.23	32.58	2.23
Afternoon	0.94	18.00	4.45	26.98	37.24	2.02
Evening	0.64	18.12	4.58	27.10	32.98	1.98
S.Ed	0.060	0.161	0.115	1.613	1.810	0.038
CD	0.133	NS	NS	NS	NS	NS

Table 3.61.3: Determination of sampling portion of plant for *H. theivora* on cotton

Treatments	No. of insects	Total bolls	Affected bolls	Bolls damage (%)	Shoot infestation %	Grade
Top	0.53	1.25	0.67	54.74	47.24	2.46
Middle	0.29	6.07	2.01	33.42	29.05	1.99
Bottom	0.14	11.27	1.82	15.94	25.81	1.74
S.Ed	0.026	0.053	0.051	2.136	0.945	0.020
CD	0.058	0.118	0.111	4.705	2.083	0.045

Table 3.61.4: Determination of number of plants for sampling H. theivora on cotton

Treatments	No. of insects	Total bolls	Affected bolls	Bolls damage (%)	Shoot infestation %	Grade
T1-(5 plants/acre)	0.819	15.74	3.51	26.27	34.29	2.13
T2-(10 plants/acre)	1.071	17.86	4.52	25.78	34.44	2.16
T3-(15 plants/acre)	1.263	18.82	5.02	26.73	36.19	2.01
T4-(20 plants/acre)	0.857	19.50	4.35	22.97	32.14	2.01
S.Ed	0.020	0.148	0.061	1.889	1.705	0.030
CD	0.043	0.313	0.130	NS	NS	NS

3.62 Project Name: Identification of semiochemicals associated with host plant cotton and insect pest stem weevil *Pempheres(=Pempherulus)affinis* (Faust)

K. Shankarganesh(PI)

Salient findings

Characterization of semiochemicals associated with stem weevil incidence

Stem weevil male antennal response to female body extracts revealed the presence of varying level of behavior modifying chemicals. Male antennae was responded to the compounds such as Styrene, Bicyclo[4.2.0]octa-1,3,5-triene, Propane, 1,1,3-triethoxy-, p-Propylbenzaldehyde, 2-Butenedioic acid (Z)-, dibutyl ester, Hexylcyclohexanecarboxylate, 1,3-Pentanediol, 2,2,4-trimethyl-, diisobutyrate, 5,5,7,7-Tetraethylundecane, 3,5-di-tert-Butyl-4-hydroxybenzaldehyde, 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester, 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione and Ethyl hexadecanoate. The head space volatiles collected from sugarcane revealed the presence of 3- Pentanol, 2,4-dimethyl-, Propanoic acid, 3-chloro, 2-Butyl-1,3-dioxolane, Disulfide, methyl (methylthio) methyl, 3,4-Dimethylbenzaldehyde, Ethyl-benzaldehyde, 4-Ethylacetophenone, 1,5,6,7-Tetramethylbicyclo[3.2.0]hepta-2,6-diene, p-Cymen-7-ol, Phenol, 5-methyl-2-(1-methylethyl)-, Carvacrol, 4-Ethylbenzoic acid, Benzoic acid, 3,4-dimethyl, 1,3-2H-Isobenzofuranone, 3,3-dimethyl-, 1,4-Diacetylbenzene, 5,5,7,7-Tetraethylundecane, 3-Methylheptadecane, tert-Hexadecanethiol, 1-Oxa-spiro[4.5]deca-6,9-diene-2,8-dione, 7,9-di-tert-butyl- and Heneicosane at varying level. All these compounds have elicited the response from female stem weevil.

Screening for egg laying preference of stem weevil on nine varieties of cotton under confined condition

Six Cotton varieties such as MCU-5 VT, Sumangala, Suraj, Surabhi, LRA 5166, MCU-3 (Non -Bt cotton) and three Bt hybrids viz., Mallika, Bahubali, RCHB 625 BGII were sown in pot and the seedling were gauged with mylar film sheet. Twenty days old seedlings were exposed to mated females of stem weevil for egg laying. The results revealed that the egg laying was observed in all the varieties, the number of egg laying per treatment was high in Mallika. More than one egg was observed in all varieties, except MCU-3.

3.63 Project Name: Investigation on the susceptibility status and possible detoxification mechanism for neonicotinoids and newer molecules against cotton leafhopper

K. Shankarganesh(PI); Co-PI: V S. Nagrare

Importance of the study: To understand the variation in the level of susceptibility of leafhopper to most commonly used insecticides in cotton ecosystem.

Salient findings

Shift in the susceptibility of leafhopper to different insecticides

Bioassay of different insecticides against cotton leafhopper was carried out for three consecutive years (2019-20, 2020-21 and 2021-22). The susceptibility level of leafhopper to different insecticides was changed over three years. As compared to bioassay results of 2019-2020 with 2021-2022. Shift in the susceptibility of leafhopper to insecticides such as thiamethoxam (53.41 times), imidacloprid (29.41 times), diafenthiuron (28.94 times), thiacloprid (25.68 times) and spriromesifen (21.68 times) was observed in Coimbatore population. The susceptibility of leafhopper population from Nagpur region revealed that there is no significant variation in the LC_{50} values of 2020 to 2022.

3.64 Project Name: Identification and genetic variability of *Alternaria* and *Cercospora* isolates of cotton using molecular markers

A. Sampathkumar(PI)

Importance of the study: Alternaria leaf spot/blight caused by *Alternaria macrospora* and *Alternaria alternata* is one the major leaf spot diseases affecting cotton production and productivity in all the three cotton growing zones of India. Alternaria blight (*A. macrospora*) has been reported to cause about 20-30 per cent losses in seed cotton yield (Srinivasan, 1994; Mayee and Mukewar, 2007). *Alternaria* leaf spot causes yield losses up to 26 per cent (Chattannavar et al., 2006). Two *Alternaria* species *viz.A. macrospora* and *A. alternata* are causing leaf spot and leaf blight symptoms. Housekeeping gene primers are widely used to identify the *Alternaria* pathogen as well as species differentiation. *Cercospora* infects the cotton leaves of mature plants. Reddish lesions will appear on these leaves during the early stages. As the disease progresses, the lesions enlarge and turn white to light brown or grey in the centre with a purple, dark brown or blackish margin. The lesions are circular or irregular in shape and vary in size depending on the time of

infection. Water and nutrient stressed plants are highly susceptible to the disease. Pathogen variability studies are required to know the pathogen population distribution and its virulence.

Salient findings

Survey and collection of *Cercospora* leaf spot samples from South Zone

Fifty-five *Cercospora* leaf spot samples have been collected from nine major cotton growing districts of Karnataka namely Dharwad, Haveri, Gadag, Belagavi, Raichur, Vijayapura, Yadagiri, Kalaburagi and Ballari (Fig. 3.64.1) during Nov, 2021 for Cercospora isolation. PDI ranged from 2.5 to 12.0 in the survey fields. Ten leaf spot samples have been collected from Kurnool district of Andhra Pradesh during Nov, 2021. PDI ranged from 2.5 to 7.0 among the fields. Fifteen leaf spot samples have been collected from Ranga Reddy, Warangal, Nirmal and Adilabad districts of Telangana during Dec, 2021. PDI ranged from 4.0 to 7.0 among surveyed fields.Twenty leaf spot samples have been collected from Coimbatore, Annur and Kinathukadavu blocks of Coimbatore district of Tamil Nadu during Jan, 2022. Two to 8.5 PDI recorded in the fields. *Cercospora* isolates have been isolated using PDA medium. Total of fifty-one isolates were isolated from the collected samples.

Morphological identification of *Cercospora* isolates

Colony characters varied from dull brown to dark brown colour with ashy white in centre. Mycelial growth varied from sparse to dense with smooth or irregular margins. Surface of the colony appeared as grey with irregular patches of white or smoke grey (Fig. 3.64.2). Conidia are solitary, broadly fusiform, septate, hyaline, thin-walled, smooth, apex sub obtuse, base subtruncate (Fig. 3.64.1).

Identification of *Alternaria* isolates using housekeeping gene primers

Seven pairs of Alternaria specific housekeeping gene primers namely Alt a1 gene, Plasma membrane ATPase, Actin, Calmodulin, TEF1-alpha, RPB2, Glyceraldehyde -3- Phosphate dehydogenase (GAPDH) were used for confirmation of Alternaria isolates at genus level. Fifteen reference isolates of Alternaria from Karnataka, Tamil Nadu and Telangana have been amplified using 10 pairs of seven housekeeping gene primers.

Alt a1 gene primers (Alt-for and Alt-rev) amplified 497 bp for selected 15 Alternaria isolates (Fig. 3.64.4). Glyceraldehyde -3-Phosphate dehydrogenase (GAPDH) gene primers (gpd1 and gpd2) amplified 550 bp for all the isolates (Fig. 3.64.5). Plasma membrane ATPase gene primers (ATPDF1 and ATPDR1) amplified 1201 bp for 8 out of 15 isolates. Calmodulin gene primers (CALDF1 and CALDR1) amplified 566 bp for 13 isolates and 800 bp for one isolate and no amplification for another isolate. TEF-1 alpha gene primers (EF1-728F and EF1-986R) amplified 300 bp for all isolates (Fig. 3.64.6). TEF1 and TEF2 primers amplified 835 bp for 9 isolates and 900 bp for 5 isolates (Fig. 3.64.7)). β-tubulin gene primers (β-tub1 and β-tub2) amplified 300 bp for all isolates (Fig. 3.64.8) and Bt1a and Bt1b primers amplified 1419 bp for all isolates (Fig. 3.64.9). RPB2 gene primers (5F2 and 7cR) amplified 1000 bp for all isolates and DF and DR primers amplified 940 bp for 9 isolates and 1100 bp for 2 isolates. Sequencing of the gene products will precisely identify pathogen at species level as *A. macrospora* or *A. alternata*. Among them, except Plasma membrane ATPase gene primers, all other 6 pairs of housekeeping gene primers were found suitable for amplification of Alternaria isoaltes and useful for further identification through sequencing. Fifty hyper variable SSR primers have been designed from the whole genome sequence of *A. macrospora* (BMP 1949 – isolated from cotton) retrieved from JGI (MycoCosm) website. Genetic diversity analysis using these SSR primers are in progress.

Fig. 3.64.1: Cercospora leaf spot symptoms in the different districts of Karnataka

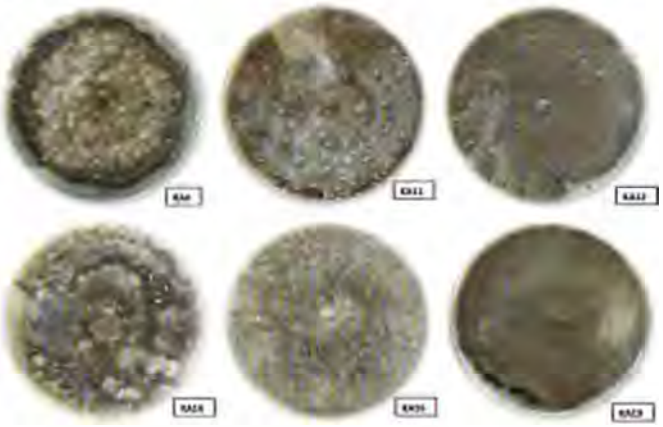


Fig. 3.64.2: Cercospora isolates from leaf spot samples of Karnataka

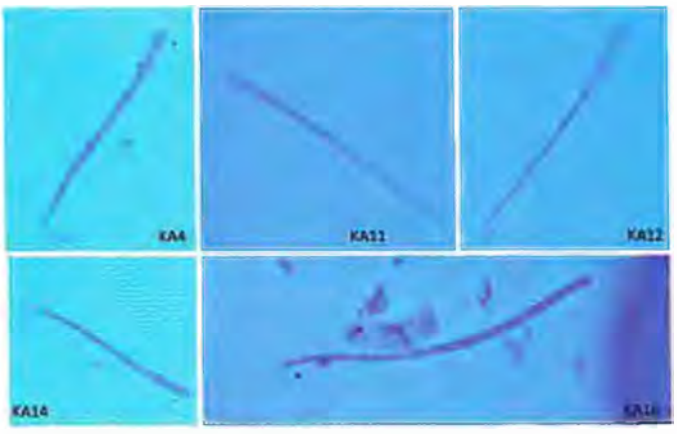


Fig. 3.64.3: Microscopic images of conidia of Cercospora isolates from Karnataka

Fig. 3.64.4: Amplification of *Alt a1* house keeping gene of *Alternaria* isolates using Alt-for and Alt-rev primers

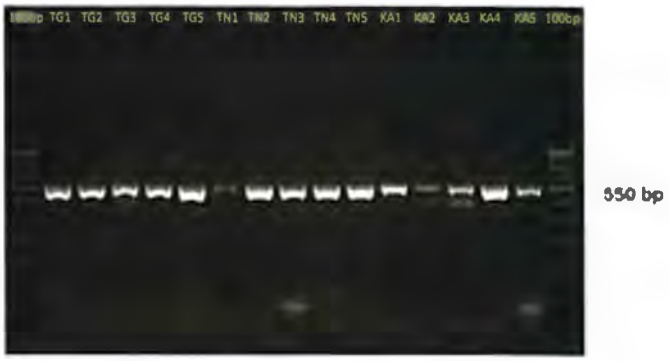


Fig. 3.64.5 : Amplification of GADPH house keeping gene of *Alternaria* isolates using gpd1 and gpd2 primers

Fig. 3.64.6: Amplification of TEF1 alpha house keeping gene of *Alternaria* isolates using EF1-728F and EF1 986R primers

Fig. 3.64.7: Amplification of TEF1 alpha house keeping gene of *Alternaria* isolates using TEF1 and TEF2 primers

Fig. 3.64.8: Amplification of β-Tubulin house keeping gene of *Alternaria* isolates using β-tub1 and β-tub2 primers

Fig. 3.64.9 : Amplification of β-Tubulin house keeping gene of *Alternaria* isolates using Bt1a and Bt1b primers

3.65 Project Name: Studies on rust disease of cotton caused by *Phakopsora gossypii* and its management

P. Valarmathi(PI);

Importance of the study: *Phakopsora gossypii* is an emerging disease in cotton that has caused significant yield losses. The disease is widely distributed and causes significant yield reduction under favorable weather conditions. The basic aim of this project was to study the symptomatology of disease and epidemiological factors to know disease progress with weather parameters.

Salient findings

Symptoms of the disease appears as rust pustules *i.e.*, uredia on the leaves as small (1-3 mm), pinkish brown spots with a purple halo(Fig 3.65.1). Symptoms also appeared on petioles, stem and boll. The uredia were elongated in shape. There was a decrease in photosynthetic area of leaves due to rust pustules and finally severe defoliation was noticed in the field which resulted in the reduction of cotton yield. The rust disease incidence ranges from 5.31 % to 52.12 % in various Bt hybrids and varieties(Fig 3.65.2). In many of the hybrids, the range of PDI was from 20.12 % to 27.53%. The highest PDI was observed in hybrid RCH659-55.11% and in variety Suraksha-15.34 % with lowest PDI. The disease progress with weather parameters such as rainy days, rainfall, temperature, relative humidity, sunshine hours and windspeed were recorded during the cropping season from August 2021 to January 2022. Uredeospores of *Phakopsoragossypii* are thin-walled, single celled, oval in shape and rusty red or pale brown in colour (Fig 3.65.3). Teliospores was not observed in the infected leaves of cotton. In hybrids the disease started to occur during the month of November 2021 wherein in varieties it occured in the third week of November 2021. The highest disease intensity was recorded during the last week of December 2021 in all hybrids and varieties. Maximum temperature and wind speed were found to be positively correlated with PDI of rust disease in both hybrids and varieties. The Correlation values 'r' (0.575) for windspeed was found to be significantly correlated with rust disease(Table 3.65.1).

Table 3.65.1: Correlation values between weather parameters and rust of cotton (Correlation coefficient -r)

S. No	Entry /PDI	Rainfall	Rainy days	Temp. (°C)		Relative Humidity (%)		Sunshine hours (BSH)	Wind speed (km/h)
				Max.	Min	Morning	Evening		
1.	RCH659 (55.1)	-0.281	-0.441	0.371	-0.673	-0.129	-0.204	-0.168	**0.575**
2.	Suraj Bt (42.7)	-0.349	-0.433	0.294	-0.701	-0.094	-0.225	-0.175	**0.550**
3.	CCH 15 (27.3)	-0.523	-0.590	0.203	-0.569	-0.098	-0.535	-0.135	**0.505**
4.	Suraksha (15.3)	-0.509	-0.574	0.231	-0.610	-0.044	-0.407	-0.020	**0.552**

Fig3.65.1. Typical symptoms of rust on abaxial and adaxial surfaces

Fig3.65.2. Typical symptoms of rust on abaxial and adaxial surfaces

Fig3.65.3. Uredeospres of Phakospora gossypii

3.66 Project Name: Studies on plant parasitic nematodes of cotton

J.GulsarBanu(PI); Co-PI: NandiniGokte-Narkhedkar

Importance of the study: This study aims to study the distribution of plant parasitic nematodes and to identify novel nematicidal molecule from the nematode antagonistic fungus for the eco friendly management of plant parasitic nematodes in Cotton.

Salient findings

Survey conducted in Akola, Shegaon, Motala,Jalgaon Jamod, Deulgaon Raja, Shindkhedraja and nearby areas revealed the dominance of reniform nematode, *Rotylenchulus reniformis* among plant parasitic nematodes identified. Cotton grown under drip has been reported to harbour higher nematode population. In cotton under drip irrigation system for more than 3 years population of *R.reniformis* as high as 870 preadults per 250 cc soil recorded (3.48 pre adult/g soil). Fields with high nematode infestation recorded stunting of crop. Response Surface Methodology (RSM) was used to identify optimum components to maximise propagule yield of *Pochonia chlamydosporia*. Among different solvents tried, ethyl acetate was found to be the best solvent for the extraction of metabolites, and the hatching inhibition and juvenile mortality were significantly more in ethyl acetate fraction than in crude metabolite. Chemo-profiling ethyl acetate fractions of *P. chlamydosporia* by GC-MSyielded 38 compounds. In order to know which metabolite among all these 38 biomolecules is highly effective against the *R.reniformis*, molecular docking was done between the virulent protein targets of *R.reniformis* and the metabolites obtained by GC-MS analysis from *P.chlamydosporia*. Protein sequence for targets β-1,4-endoglucanase and Cytochrome c oxidase subunit 1 were retrieved using the UniProt database and Molecular modeling was done using SWISS-MODEL.To predict the binding energy of ligand and target protein, structurally validated protein targets of *R.reniformis* have been docked with biomolecules through Auto Dock Vina module in PyRx 0.8 software. Nematicide, carbofuran 3G was used as a positive check to compare the binding affinity. Docking analysis revealed that among all the metabolites lavendustin-C was having the highest binding affinity for β-1, 4-endoglucanase (- 4.1 kcal/mol) and Cytochrome c oxidase polypeptide I (- 5.0 kcal/mol) compared to -3.6 and -4.8 kcal/mol for the nematicide, carbofuran 3G. Besides, lavendustin-C also had the maximum binding energy for the target sites. The novel molecule, lavendustin-C produced by *P.chlamydosporia* served as a potential inhibitor of the target sites associated with interrupting the functions of β -1,4-endoglucanase and Cytochrome c oxidase polypeptide I in the reniform nematode. Besides, the increased binding affinity of lavendustin-C with the protein target sites facilitated exploring it as a novel nematicidalbiomolecule for the management of reniform nematode.

REGIONAL STATION, SIRSA

3.67 Project Name: Development of varieties of upland cotton having better fiber traits and tolerance to CLCuD

S. K. Verma (PI); Co-PI: V. N. Waghmare

Importance of the study : Development of *G. hirsutum* genotypes having better fiber trait and tolerance to CLCuD.

Salient findings

A total of 14 crosses (F_6/F_7) (Table 3.67.1) involving GVS 9 and other tolerant genotypes were evaluated for CLCuD. Among these crosses, a total of 1857 CLCuD free single plant selections with good boll weight (3.0-4.7g) were made for further evaluations.

A total of 16 new crosses were attempted using GVS-8 and

GVS-9 for pyramiding CLCuD resistance, high yielding traits and fiber quality traits.

CLCuD resistant genotypes i.e. GVS 8 & GVS 9 and highly susceptible genotype for CLCuD i.e. HS 6 were being maintained. For genetic studies and molecular mapping, F1 (GVS 9 X HS 6), F2 (GVS 9 X HS 6), BC 1{(GVS 9 X HS 6) X GVS 9} and BC 2 {(GVS 9 X HS 6) X GVS 9}were developed.

Table 3.67.1: Details of crosses evaluated for CLCuD resistance

S. No.	Name of Cross/Entries	CLCuD Free Single plants selection	Average Boll Wt.(gm)	Range Boll Wt.(gm)
1.	GVS-9 x CSH-3129	294	3.3	3.0-4.7
2.	GVS-9 x F-2228	05	3.1	3.0-3.1
3.	Bhiyani 251xCSH-27	14	3.4	3.0-4.0
4.	Biyani 251x CSH46	15	3.2	3.0-3.5
5.	Bhiyani 251x CSH-538	97	3.4	3.0-4.1
6.	MR-786 x CSH-27	143	3.2	3.0-4.0
7.	MR-786 x CSH-46	98	3.3	3.0-3.9
8.	MR-786 x CSH-538	338	3.2	3.0-4.2
9.	CSH-46 x Bhiyani 251	67	3.3	3.0-4.1
10.	CSH-538 x CSH-46	38	3.3	3.0-4.0
11.	CSH-27x HS-6	109	3.4	3.0-4.1
12.	CSH-27 x F-846	200	3.2	3.0-4.2
13.	CSH-46 x F-846	69	3.1	3.0-3.9
14.	CSH-538 x HS-6	370	3.3	3.0-3.7
		1857		

3.68 Project Name : Development of Cotton based cropping systems under Conservation Agriculture for North- Western Indian conditions

Amarpreet Singh (PI)

Importance of the study: Cotton based cropping systems in the North-Western India are characterized by intensive, yearly tillage leading to soil quality degradation and reduction in productivity of the cropping system. The need for conservation agriculture practices has become necessary in this region for long-term resource conservation and for improvement of soil

health. Therefore, under this project an experiment with fixed lay out plan is being conducted under split plot design with six *tillage and land configuration treatments* (as main plots) and seven cropping systems (as sub plots).

Salient findings

- Under the conservation agriculture based cropping system experiment, seed cotton yield was significantly higher under Zero tillage - permanent narrow raised bed (2,787.9 kg/ha) with residue retention as compared to Conventional Tillage - Flat Bed (Farmer's Practice) (1,937.5 kg/ha) and with Cotton - Chickpea (Bengal gram) cropping system (2,940.3 kg/ha).
- The total system productivity was higher under Cotton - Berseem (Fodder) cropping system (6,890.6 kg/ha cotton equivalent yield) and second best total system productivity was under Cotton - Wheat cropping system (4,152.5 kg/ha cotton equivalent yield).
- With respect to *Rabi* crops (harvested in 2021) grain yields ofwheat, barley, mustard, chickpea, sunflower and spring / winter maize was significantly higher under Zero tillage - permanent narrow raised bed with residue retention (5,417.0; 3,363.3; 1,728.0; 1,629.7; 2,427.3 and 6,519.3 kg/ha, respectively) over Conventional Tillage - Flat Bed without residue incorporation (4,221.3; 2,394.4; 1,044.4; 1,208.0; 1,505.0 and 4,523.0 kg/ha, respectively) but was at par with Zero Tillage - Flat Bed with residue retention (5,126.7; 3,132.7; 1,606.7; 1,464.0; 2,203.4 and 6,224.4 kg/ha, respectively). However, highest berseem (green fodder) yield was obtained under Conventional Tillage - Flat Bed with residue incorporation (112,879.3 kg/ha) and it was significantly higher over Conventional Tillage - Flat Bed without residue incorporation (87,795.7 kg/ha) (Plates 1a, 1b, 1c and 1d).

Plate – 1a

Plate – 1b

Plate – 1c

Plate – 1d

Plates 1a: Wheat in Zero Tillage - Flat Bed with cotton residue retention (note the cotton residue in wheat); 1b: Cotton in Zero Tillage - Flat Bed with berseem residue retention; 1c: Cotton in Zero Tillage - Flat Bed with mustard residue retention; 1d: Winter / spring maize crop residue after harvesting on permanent narrow raised beds at ICAR-CICR, Regional Station, Sirsa, Haryana 125 055.

3.69 Project Name: Conservation agriculture practices for cotton-wheat system

Amarpreet Singh (PI) ; Co-PI: Er. G. Majumdar (Co-PI)

Importance of the study: Cotton-wheat is the second most important cropping systems in South Asia after rice-wheat spanning over an area of ~4.19 Mha in India and Pakistan. The present cultivation practices are degrading the soil health and there is a need for soil ameliorative, conservation agriculture practices.

Salient findings

An experiment under the project entitled "Conservation agriculture practices for cotton-wheat system" has been initiated with fixed laid out plan. Sowing of Bt cotton hybrid was been done as per the approved lay out plan for the 2022-23 cropping year. No tillage and crop residue management treatments could be applied to the cotton crop as it was the first crop of the cropping cycle and the field was mould board ploughed and laser levelled before start of the experiment.

Tillage and crop residue management treatments have been executed during the sowing of wheat crop in Rabi season of the 2022-23 cropping year (Plates 2a, 2b, 2c and 2d).

Plate – 2a

Plate – 2b

Plate – 2c

Plate – 2d

Plates 2a: Mulching of cotton stalks with tractor operated Mulcher Machine before wheat sowing; 2b: Cotton stalk shredding with tractor operated Cotton Stalk Shredder Machine before wheat sowing; 2c: Wheat sowing with Happy Seeder Machine in standing cotton stalks; 2d: Wheat sowing with Supper Seeder Machine in standing cotton stalks at ICAR-CICR, Regional Station, Sirsa, Haryana 125 055.

3.70 Project Name : Whitefly : Studies on Ecology and Host Plant Resistance

Rishi Kumar(PI); Co-PIs: S,K. Sain & T. Prabhulinga

Importance of the study : Ecological aspect of whitefly management and host plant resistance are important components for sustainable pest management of cotton whitefly and also to avoid pest outbreaks.

Salient findings

Screening of genotypes against whitefly: Total 112 entries were screened in field and polyhosue conditions against whitefly. Based on the 9 weekly observations, at peak activity period, whitefly adults and nymphal counts ranged between 13.8-25.4 & 13.0-27/3leaves in Germplasm, 13.4-24.2 & 14.8-24.8/3leaves in exotic germplasm and 9.8-20.2 and 14-24/3leaves in other entries. Few entries namely EC 344834(9.82/3leaves), EC 700041(9.91/3leaves), CNH 108(9.76/3leaves), LK 861 (7.04/3leaves) have been recorded with whitefly population comparatively less than the LPS-141(10.16/3leaves) resistant checks.

In case of settling preference under polyhouse out of total 112 entries, 38 entries in germplasm, 27 entries in exotic germplasm and 10 entries in other and in case of settling preference under laboratory total 38 entries in germplasm, 31 entries in exotic germplasm and 13 entry in other were fairly superior to the resistant check.

Biology of whitefly on CLCuD infected and healthy plant: The CLCuD-infected plant affected the whitefly biology. The total nymphal duration(days) was comparatively less in case of whitefly reared on infected plants 14.6±1.50(12-16) in comparison to whiteflies reared on healthy plants i.e.20.8±2.49(17-23) days. Similarly, total life cycle duration(days) of females was 34.22.39(30-34) in case of whitefly reared on healthy and 26.6±1.36(25-29)days on infected plants, total no. of egg laid were 36.8±3.96(30-39) and 24.2±2.23(20-26), respectively on healthy and infected plants.

Resistance monitoring in whitefly nymphs against insecticides : The insecticide resistance monitoring bioassays were conducted against commonly used and label-claimed insecticides. Maximum mortality was due to afidopyropen 50 DC (64%) followed by pyriproxyfen (59%) >buprofezin (53%) >spiromesifen(52%) >dinotefuran (51%) >ethion (48%) >diafenthiuron (46%) >flonicamid (40%) >azadirachtin 0.03 (36%) and the maximum LC_{50} g or ml/litre (Fiducial limits) was in diafenthiuron 4.56 (2.19-49.12) and minimum in dinotefuran 0.50 (0.35-0.96) in whitefly red-eyed nymphs at the experimental area of ICAR-CICR, RS, Sirsa.

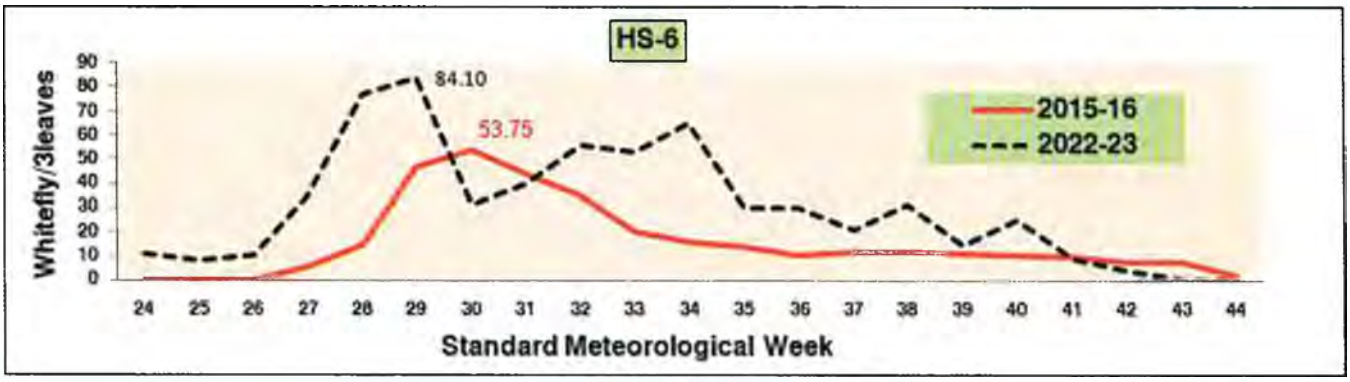
Whitefly outbreak experienced in the zone : A severe outbreak of whitefly was experienced in 2015 in North India on cotton. The next outbreak occurred during current season of 2022. Based on the weekly data recorded under unprotected conditions, during 2015 outbreak, the average population of whitefly adults/3leaves was 20.93 and 20.32 in RCH 650 BG-II and HS 6 (Non-Bt) genotypes whereas, during the 2022 cotton season, it was 33.50 and 38.53, respectively. Peak population recorded was 57.74 & 74.10 in RCH650BG-II during 2015 & 2022 whereas in HS-6 it was 53.75& 84.10 /3leaves. During 2015 the peak incidence of whitefly was noticed during 31st SMW whereas, its advancement was recorded during the 2022 cotton season i.e., 29th SMW indicating longer persistence above Economic Threshold Level (ETL). During 2015, whitefly crossed ETL (18adults/3leaves) during 28th SMW and remained above ETL till 35th SMW but during 2022 its population above ETL was recorded during 27th and remained above ETL till 36th SMW indicating advancement in incidence, longer persistence above ETL(<10SMW) and high severity in terms average population during the season (Fig. 3.70.1).

Screening of genotypes against whitefly under polyhouse

Whitefly biology on Healthy Plant of HS-6 Genotype

Whitefly biology on Cotton Leaf Curl Virus Infected plant of HS-6 Genotype

Resistance monitoring in whitefly nymphs against insecticides



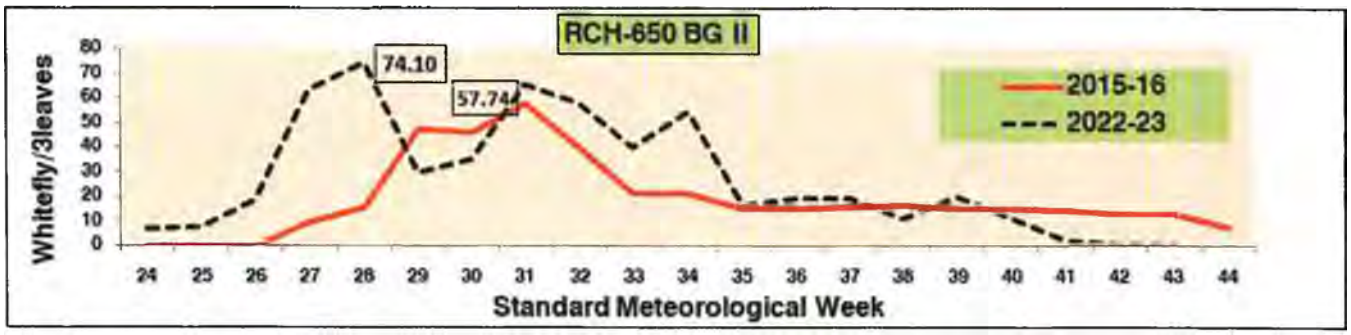


Fig. 3.70.1: Weekly incidence of adults of whitefly in two cotton genotypes HS6 and RCH 650 BG II during the two outbreak years

3.71 Project Name: Collection, characterization and evaluation of beneficial fungal microorganisms from North, Central and South Cotton growing zones.

S.K. Sain (PI), Co-PIs: Nandini Narkhedkar, S.P. Gawande, P. Valarmathi, Savitha Santosh

Importance of the study: Rhizospheric microorganisms play a key role in the agricultural ecosystem for plant disease control and plant growth. They act as phyto-stimulators, promote plant growth development through altering root architecture and induce tolerance in plants to biotic stress. Until now, research on the isolation, characterization and screening of rhizosphere fungi from cultivated cotton for plant health management in India is lacking. The cotton rhizospheric fungal strains found in this study can further be used singly or as a consortium for disease management, plant growth and enhancing productivity in the integrated and organic farming system.

Salient findings

Sixteen cotton rhizospheric fungi (RFs) were selected from 108 RFs based on in vitro confrontational assay test (mycelial growth inhibition) against Rhizoctonia solani, Macrophomina phaseolina, Corynespora cassiicola and Alternaria alternata in the laboratory and evaluated against root rot pathogen under pot conditions (Fig. 3.71.1). . The highest seed germination and lowest mortality were recorded with the seed treatment of Rf-B/Th-11 (Trichoderma asperellum) followed by Rf-16-3-(T. virens) and Rf-63-1 (Actinomortierella wolfi) at 90 days after sowing (DAS). At the same time, these three isolates also enhanced the highest shoot length compared to other isolates (Fig. 3.70.1). Similarly, in another pot experiment, the highest vigor index at 30 DAS was recorded with the seed treatment of Rf-b/Th-11, Rf-16-3 and Rf-63-1. The experiments conducted at ICAR-CICR, Nagpur, TR-8 (T. longibrachiatum), TR- 4 (T. harzianum) and TR-5 (T. longibrachiatum) showed higher mycelial growth inhibition of Macrophomina sp., Fusarium sp., Corynespora cassiicola in in vitro bioassay conducted under laboratory conditions (Fig. 3.71.2). These isolates also showed the highest increase in plant height with the seed & soil treatment in pots compared to another five isolates at 70 DAS under polyhouse conditions (Fig. 3.71.3). At ICAR-CICR, RS, Coimbatore, 35 cotton field samples were collected from TNAU, Kinathukadavu, Madukarai, Annur, Veppanthattai, Kovilpatty and Guntur. A total of 160 colonies observed were culturally and morphologically characterized. Among all, two Trichoderma sp. from TNAU and Veppanthattai samples were purified and maintained for further studies.

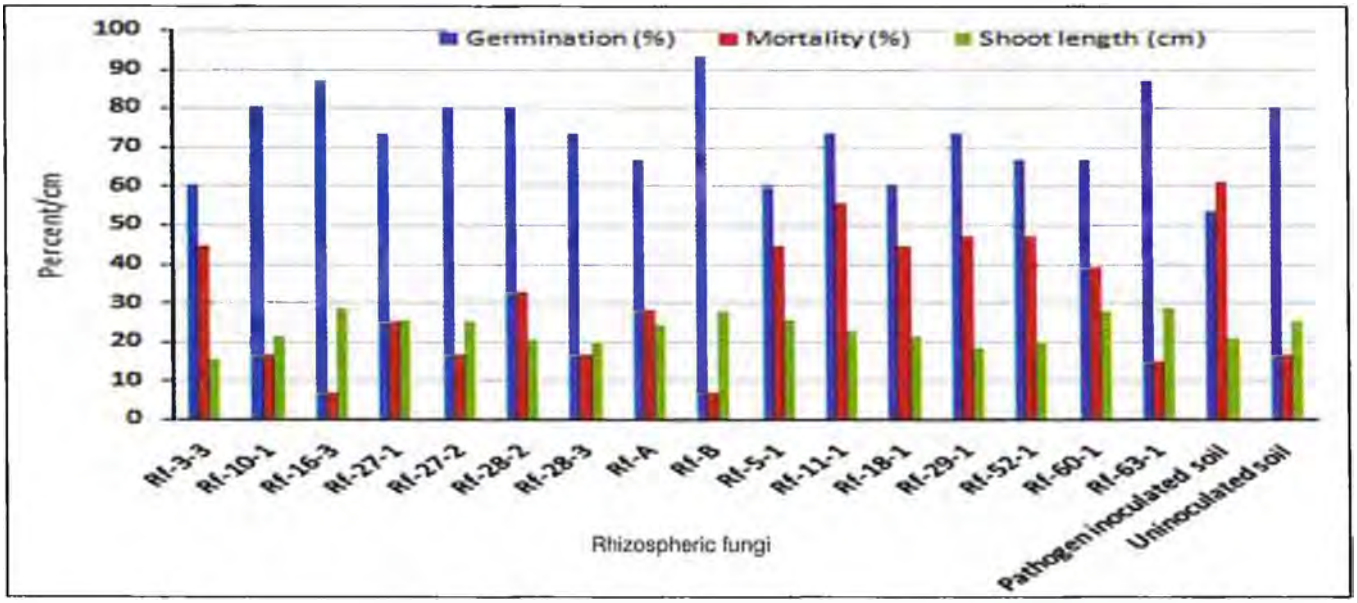


Fig. 3.71.1: Effect of selected cotton rhizospheric fungi (RFs) against root rot control and plant height at 90 DAS: Rhizospheric fungiRF-3-*T. pleuroticola*, RF-10-1-*T. pleuroticola*, RF-16-3-*T. virens*, RF-27-1-*T. asperellum*, RF-27-2-*T. asperellum*, RF-28-2-*T. asperellum*, RF-28-3-*T. asperellum*, RF-A-Th-4-*T. asperellum*, RF-B-Th-11-*T. asperellum*, RF-5-1-*Mortierella sp.*, RF-11-3-*Mortierella* sp., RF-18-*Actinomortierellaambigua*, RF-29-1-*Fusarium fujikuroi*, RF-52-1-*Mortierella alpina*, RF-60-1-*A. ambigua*, RF-63-1-*A. wolfii*

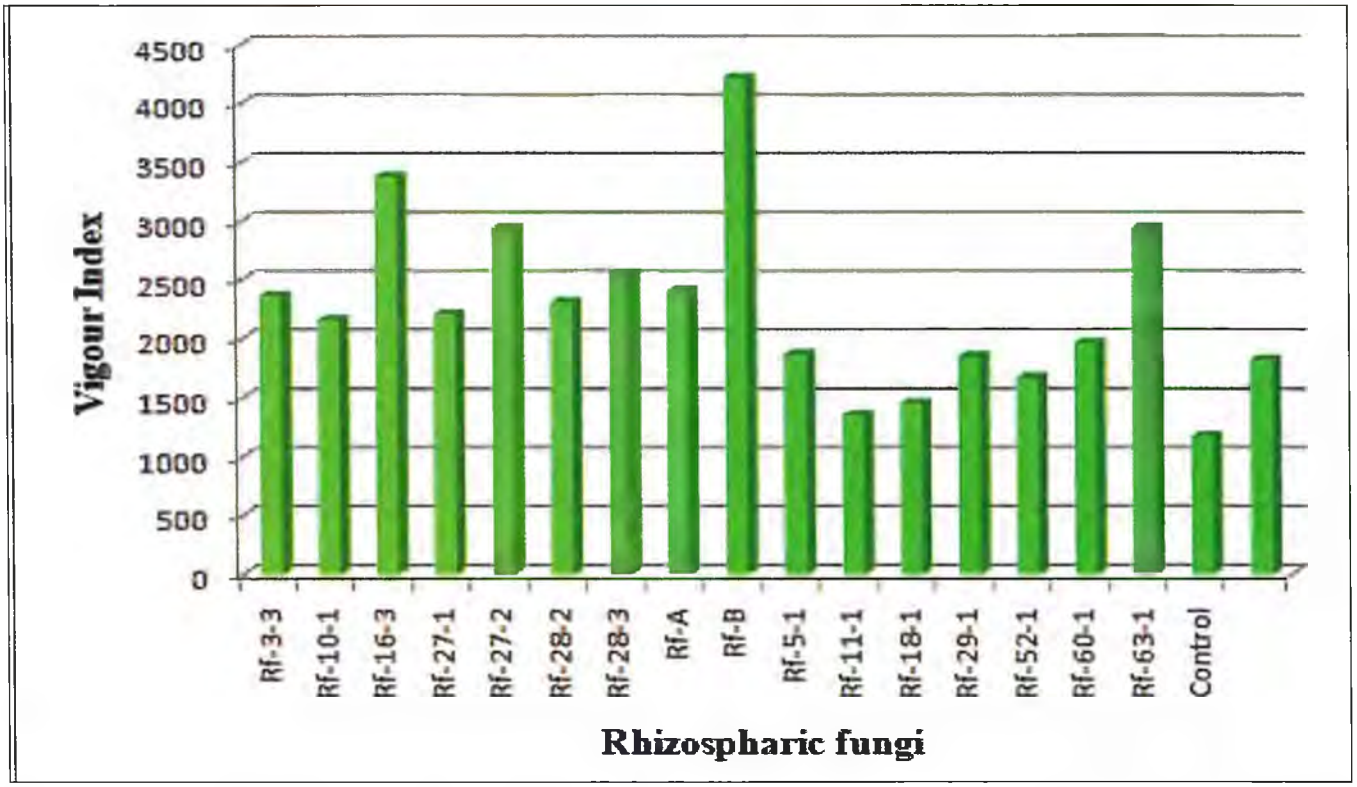


Fig. 3.71.2: Effect of selected cotton rhizospheric fungi (RFs) on cotton plant vigour index at 30 DAS. Rhizospheric fungiRF-3-*T. pleuroticola*, RF-10-1-*T. pleuroticola*, RF-16-3-*T. virens*, RF-27-1-*T. asperellum*, RF-27-2-*T. asperellum*, RF-28-2-*T. asperellum*, RF-28-3-*T. asperellum*, RF-A-Th-4-*T. asperellum*, RF-B-Th-11-*T. asperellum*, RF-5-1-*Mortierella sp.*, RF-11-3-*Mortierella* sp., RF-18-*Actinomortierellaambigua*, RF-29-1-*Fusarium fujikuroi*, RF-52-1-*Mortierella alpina*, RF-60-1-*A. ambigua*, RF-63-1-*A. wolfii*

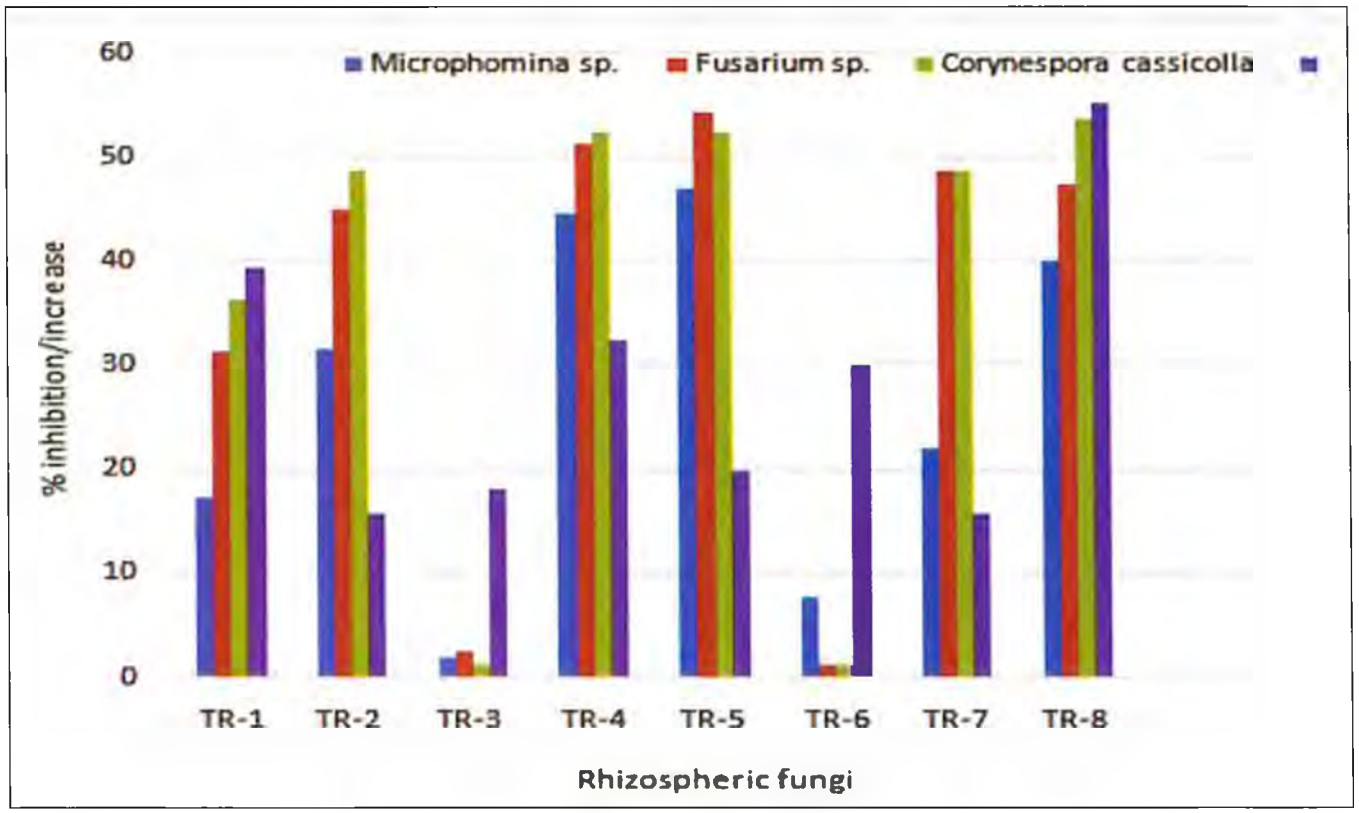


Fig. 3.71.3: Effect of selected cotton rhizospheric fungi (RFs) on invitro pathogen inhibition and cotton plant height at 70 DAS: *TR-1 (T. asperellum), TR-2 (Taleromyces sp.), TR-3 (Taleromyces sp.), TR-4 (T. harzianum), TR-5 (T. longibrachiatum), TR-6(T. longibrachiatum), TR-7 (Talaromycescellulolyticus), TR-8 (T. longibrachiatum)*

Cultivar Notifications in 2022

Gossypium arboreum

Cultivar: CICR-A Cotton 56 (CNA1031)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers:V.N.Waghmare, R V Salame Associates: S M Palve, M V Venugopalan, JaibhimKambe
Salient features: Medium staple and good fibre strength desi cotton variety *(Average Yield – 13.57 q/ha; GOT – 35.9%; Fibre length – 25.7 mm; Fibre strength – 27.8 g/tex)*
Recommended for: Rainfed Conditions of Central Zone (Maharashtra, Gujarat, Madhya Pradesh and Odisha

Cultivar: CICR-A Cotton 57 (CNA 1091)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: V.N .Waghmare, R V Salame
Salient features: Naturally Colour cotton (brown) variety with short staple and medium fibre strength *(Average Yield – 12.67q/ha; GOT – 32.9%; Fibre length – 23.8 mm; Fibre strength – 25.1 g/tex;Micronaire* - 4.1 µg/in)
Recommended for: Rainfed conditions of South Zone (Telangana, Andhra Pradesh, Karnataka and Tamil Nadu)

Cultivar:CICR-A Cotton 59 (CNA17522)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developer: Vinita Gotmare
Salient features: Light Brown linted naturally coloured cotton variety(*G. arboreum*) derived from wild species *(Average Yield – 11.15 q/ha; Fibre length – 23.3 mm; Fibre strength – 23.1 g/tex;, Micronaire–5.3 µg/in)*
Recommended for: Rainfed conditions of Central Zone (Maharashtra,Gujarat and Madhya Pradesh)

Gossypium hirsutum (Non Bt)

Cultivar: CICR-H Cotton 58 (CNH 17395)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developer: Vinita Gotmare
Salient features: Brown linted naturally coloured cotton variety*(Average Yield – 20.01q/ha; Potential yield – 33.61 q/ha; Fibre length – 23.7 mm; Fibre strength – 24.4 g/tex;, Micronaire–4.7 µg/in)*
Recommended for: Irrigated conditions of South Zone (Karnataka, Telangana, Andhra Pradesh and Tamil Nadu)

Cultivar: CICR-H Cotton 54 (Nano)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: S. Manickam, Collaborators: R. Raja, A. H. Prakash, J. GulsarBanu, J. W. Raja, R. Senthilkumar, K. Aravind
Salient features: A compact cotton variety with ideal plant type for HDPS *(Average Yield – 21.23 q/ha; Potential yield – 28.59 q/ha; Average boll weight – 4.7 g; Fibre length – 30.8 mm; Fibre strength – 30.8 g/texat south zone)(Aver age Yield – 18.15q/ha; Potential yield – 29.63 q/ha; Average boll weight – 3.4 g; Fibre length – 30.1 mm; Fibre strength – 30.2 g/texatcentral zone)*
Recommended for: Irrigated conditions of Central and South Zone (Andhra Pradesh, Telangana , Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Gujarat and Odisha)

Cultivar: CICR-H NC-Cotton-53 (ICAR_CICR_1630 DB)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: Dr Vinita Gotmare ; Contributors / Collaborators: ChetaliRodge, PrachiAkhare, Ashish Jaunjal, Krushna Gajghate, Suman Bala Singh, S M Palve, G Balasubramani, Santosh HB, M Saravanan,, N Chandrashekar, RachnaPande, NeelakanthHiremani, V N Waghmare, K R Kranthi

Salient features: Dark Brown linted naturally coloured cotton variety with with stable colour, *(Average Yield – 14.95 q/ha; GOT – 36.37%; Fibre length – 23.8 mm; Fibre strength – 25.1 g/tex;, Micronaire* - 4.1 µg/in)
Recommended for : Rainfed conditions of South Zone (Karnataka, Andhra Pradesh, Telangana and Tamil Nadu)

Gossypium hirsutum (Bt)

Cultivar: CICR- H Bt Cotton 60 (Yugank Bt / CICR-183059- 5)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: ICAR-CICR, Nagpur (HB Santosh, S Manickam, SumanBala Singh, VN Waghmare, KP Raghavendra, Vivek Shah, KunalGaikwad, KR Kranthi) in collaboration with UAS, Dharwad (SS Patil)
Salient features: An early maturing, medium staple Bt cotton variety amenable for high density planting *(Average Yield – 12.65 q/ha; Potential yield – 22.1 q/ha; Average boll weight – 3.4g; Plant height – 93.5 cm; GOT – 38.1%; Fibre length – 24.80mm; Fibre strength – 25.70 g/tex)*
Recommended for: Rainfed conditions of Central Zone (Maharashtra, Madhya Pradesh and Gujarat)

Cultivar: CICR- H Bt Cotton 61 (TejasBt / Bt- 183059-4)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: ICAR-CICR, Nagpur (HB Santosh, S Manickam, SumanBala Singh, VN Waghmare, KP Raghavendra, Vivek Shah, KunalGaikwad, KR Kranthi) in collaboration with UAS, Dharwad(SS Patil)
Salient features: An early maturing, medium staple Bt cotton variety amenable for high density planting *(Average Yield- 11.63 q/ha; Potential yield – 20.5 q/ha; Average boll weight – 3.3g; Plant height – 98.53cm; GOT – 36.37%; Fibre length – 25.47 mm; Fibre strength – 25.73 g/tex)*
Recommended for: Rainfed conditions of Central Zone (Maharashtra, Madhya Pradesh and Gujarat)

Cultivar: CICR- H Bt Cotton 62 (NamamiBt / CICR 19-32 Bt)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: ICAR-CICR, Nagpur (HB Santosh, S Manickam, SumanBala Singh, VN Waghmare, KP Raghavendra, Vivek Shah, KunalGaikwad, KR Kranthi) in collaboration with UAS, Dharwad (SS Patil)
Salient features: An early maturing, medium staple Bt cotton variety amenable for high density planting *(Average Yield – 11.49 q/ha; Potential yield – 20.72 q/ha; Plant height – 98.53cm; GOT – 38.17%; Fibre length – 24.67 mm; Fibre strength – 25.37 g/tex)*
Recommended for: Rainfed conditions of Central Zone (Maharashtra, Madhya Pradesh and Gujarat)

Cultivar: CICR- H Bt Cotton 63 (SamratBt / CICR- 183059-2)
Notification Number: S.O. 4065(E)., 31st August, 2022
Date of Notification: 31st August, 2022
Developers: ICAR-CICR, Nagpur(HB Santosh, S Manickam, SumanBala Singh, VN Waghmare, KP Raghavendra, Vivek Shah, KunalGaikwad, KR Kranthi) in collaboration with UAS, Dharwad(SS Patil)
Salient features: An early maturing, medium staple Bt cotton variety amenable for high density planting *(Average Yield – 13.73 q/ha; Potential yield – 24.14 q/ha; Average boll weight – 3.7g; Plant height – 105.83cm; GOT – 36.77%; Fibre length – 25.17 mm; Fibre strength – 25.1 g/tex)*
Recommended for: Rainfed conditions of South Zone (Karnataka, Tamil Nadu, Andhra Pradesh and Telangana)

Technologies Demonstrated on Institute Farm

1. Nutrient Expert

Nutrient Expert is a decision support system (DSS), which consists of the QUEFTS model for fertilizer prescriptions and developed with the principles of site-specific nutrient management (SSNM) and offers 4R (right source, right rate, right time and right place) nutrient prescriptions to farmers aimed at bridging yield gaps, improving the overall farmer profitability and minimizing environmental pollution.

Seed cotton yield of 34 q/ha (121 N: 64 P_2O_5:65 K_2O) and 40 q/ha (151 N: 68 P_2O_5:69 K_2O) were targeted in rainfed and irrigated system, respectively in deep black soil with Ajeet 155 BG II hybrid. Nutrient expert improved boll weight by 12% and 16% under rainfed and irrigated crop, respectively over RDF. Similarly, Nutrient expert based on-station demonstration had 24% and 32% more seed cotton under rainfed and irrigated conditions, respectively over RDF (Table 1). It ensures the balanced integrated nutrient management (INM) for cotton. Hence, nutrient expert is recommended as a potential nutrient management strategy to enhance cotton productivity.

RAC team visiting Nutrient Expert demonstration

2. Sunnhemp –Live Mulch

Sunnhempas live mulch is effective in controlling weeds, reducing up to 50% of weed density due to its allelopathic effect on weeds.

Allelopathic potential of Sunnhemp (*Crotalaria juncea* L.) was evaluated for their weed inhibition and improved profitability. Sunnhemp were planted 30 DAS in every rowof cotton (Cv.Ajeet 155 BG II)and it was grown as live mulch for up to 50 days. Sunnhemp initially grew faster and taller, reaching a plant height of one meter within 50 DAS. As intercrop, it generated substantial biomass and effectively suppressed the weeds. It also lowered the weed biomass to 43%. The above ground straw mulch of sunnhemp had higher allelochemicals like terpenoid and phenol which inhibited the weed germination as well as their growth. It improved boll weight by 6%. The seed cotton yield realized was 29.23 kg/ha. Similarly, live mulches reduce the intercultural operations and also act as a favorable host for natural enemy populations of sucking pests.

Sunnhemp- live mulch

Table 1: Fertilizer management through Nutrient Expert

Treatments	Boll/plant	Boll weight (g)	SCY (q/ha)
RDF	35	4.03	25.60
Sunnhemp -Live Mulch	38	4.28	29.23
Nutrient Expert rainfed	39	4.52	31.74
Nutrient Expert irrigated	40	4.68	33.80

RDF-Recommended dose of fertilizers

3. Land configuration

Land configuration modification like raised bed or ridge and furrow method play an important role at high rainfall areas or seasons in improving drainage, crop growth and seed cotton yield.

A demonstration was carried out to showcase raised bed and ridge and furrow method under rainfed condition in shallow soil. During the summer deep ploughing was done with mould board plough and land configuration was modified into i. raised beds and ii. ridge and furrow. Cotton hybrid RCH 659 BG II was sown on raised beds with spacing of 120 cm x 45 cm and on ridges with 90 cm x 60 cm. Pre-emergence herbicide (Pendimethalin 38.7 CS) was applied immediately after sowing which kept the field weed free for initial 40 days. During the crop season, 1230 mm rainfall was received. Both the land configuration modification helped in providing good drainage during the heavy downpour. Changing the flat land into beds or ridges, crop gained additional soil volume for better root expansion in shallow soil. Seed cotton yield data presented in Table 2.

Table 2: Land Configuration Modifications

Land configuration	Boll/plant	Boll weight (g)	SCY (q/ha)
Ridges and furrows	32.8	5.13	19.32
Raised beds	47.6	4.93	19.40

4. Insecticide Resistance Management-Pink Bollworm

In IRM plots distinct treatments imposed were installation of pheromone traps for monitoring pink bollworm moth activity, initial spray of Neem oil, ETL based spray of Profenofos, Emamectin benzoate and Fenvalerate; releases of biocontrol agent *Trichogramma bactrae* while in non IRM-insecticidal spray of Imidacloprid, Profenophos+Cypermethrin and Thiomethoxam+Emamectin benzoate. Seasonal mean infestation by pink bollworm in green bolls was 4%more in non-IRM over IRM pink bollworm strategies. Seed cotton yield was 14% higher in IRM pink bollworm strategies compared to non IRM.

EDUCATION, TRAINING AND CAPACITY BUILDING

05

5.1: Training and Capacity Building

5.1.1: Training Received

International

Scientist

S.No.	Name of Scientist	Name of the Training	Place/Organized by	Training Start Date	Training End Date
1.	Saravanan M	New Crop Breeding technologies	ICRISAT, Hyderabad	07.09.2022	28.09.2022
2.	Dr J Gulsar Banu	International workshop on Complementing current techniques with next generation technologies for crop health improvement (Online)	Aligarh Muslim University, Aligarh	14.11.2022	19.11.2022

National

Scientist

S.No	Name of Scientist	Name of the Training	Place/ Organized by	Training Start Date	Training End Date
1.	Dr Neelkanth Hiremani	Training Programme on Analysis of Experimental Data (Online)	ICAR-NAARM, Hyderabad	17.01.2022	22.01.2022
2.	Dr K Baghyalakshmi	Analysis of experimental data (Online)	ICAR-NAARM, Hyderabad	17.01.2022	22.01.2022
3.	Dr J H Meshram	MDP on Intellectual Property valuation and Technology Management (Online)	ICAR-NAARM, Hyderabad	18.01.2022	22.01.2022
4.	Dr Debashis Paul	Winter School on Artificial Intelligence in Agriculture (Online)	ICAR-IASRI, New Delhi	15.02.2022	07.03.2022
5.	Dr Neelkanth Hiremani	Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR (Online)	ICAR-NAARM, Hyderabad	21.02.2022	23.02.2022
6.	Dr Rahul Phuke, Rakesh Kumar	Advance ISO Quality Auditors training ISO 9001:2015	Quality consultant, Gurgaon at ICAR-CICR, Nagpur	23.03.2022	24.03.2022
7.	Dr J Gulsar Banu	Workshop on Resonance Surface Methodology (Online)	ICAR-NAARM, Hyderabad	18.08.2022	20.08.2022
8.	Dr Babasaheb Fand	Advances in simulation modelling and climate change research towards knowledge based agriculture	ICAR-IARI, New Delhi	17.09.2022	07.12.2022
9.	Dr KP Raghavendra	Hands on training program on CRISPR Cas9 Gene Editing Technologies in Plants	ICRISAT, Hyderabad	10.10.2022	14.10.2022
10.	Mr Rakesh Kumar	Hands on training program on CRISPR Cas9 Gene Editing Technologies in Plants	ICRISAT, Hyderabad	10.10.2022	14.10.2022
11.	Dr K Velmourougane	Metagenomic Data Analysis	ICAR-IASRI, New Delhi	18.10.2022	21.10.2022
12.	Dr K Baghyalakshmi, Dr A Manivanan, Dr N Chandrashe-khar	Genome editing in Agriculture	TNAU, Coimbatore & BCIL, New Delhi	29.11.2022	29.11.2022

Technical Staff

S.No	Name of Technical staff	Name of the Training	Place/ Organized by	Training Start Date	Training End Date
1.	Mr.Kunal R Gaikwad,	Analysis of experimental data (Online)	ICAR-NAARM, Hyderabad	17.01.2022	22.01.2022
2.	Dr .Harish Kumbhalkar, Dr Jimmy Vaidya, Mr.Rohit Katiyar, Mrs. Chetali Rodge Ms. Mithila Meshram, Mr. Krushna Gajghate, Mrs. Rachana Deshmukh, Mr. Eluka Sridhar	Advance ISO Quality Auditors training ISO 9001:2015	Quality consultant, Gurgaon at ICAR-CICR, Nagpur	23.03.2022	24.03.2022
3.	Mr.Akshay Barahate	National Training Programme on "Data visualization using R" (Online)	ICAR-NAARM, Hyderabad	09.03.2022	11.03.2022
4.	Dr Deepa Lal	Advanced Production Technologies of Citrus	ICAR-CCRI, Nagpur	12.07.2022	14.07.2022
5.	Mr.Chandrashekhar Mundafale, Mr.Rohit Katiyar	Appropriate sampling techniques including sample preparation and preservation of soil, water, plant and air samples for various analyses (Online)	Division of Environmental Science, ICAR-IARI, New Delhi	02.08.2022	07.08.2022
6.	A. Karthik	Motivation, positive thinking and communication skills	ICAR-NAARM, Hyderabad	13.09.2022	16.09.2022
7.	Mr.Homraj R. Mundafale	Statistical techniques for data analysis in agriculture (Online)	ICAR-IASRI, New Delhi	04.10.2022	13.10.2022
8.	Dr. Sachin Wankhede	National Training Programme on Recent Advances in Agricultural Meterology (Online)	Centre for Advanced Faculty Training (CAFT) in Agricultural Meterology and Department of Agricultural Meterology, College of Agriculture, Pune	01.12.2022	21.12.2022
9.	Dr Jimmy Vaidya	Training Programme on Analysis of Experimental data (Online)	ICAR-NAARM, Hyderabad	19.12.2022	28.12.2022

Administrative Staff

S.No.	Name of Administrative staff	Name of the Training	Place/Organized by	Training Start Date	Training End Date
1	Mrs. R P Deepa (UDC)	Training on Pension and Retirement Benefits through Virtual Mode	ICAR- NRRI, Cuttack, in Collaboration with HRM Unit, ICAR Headquarters	12.01.2022	14.01.2022
2	Mrs. Rama Iyer (Private Secreatry)	Two days Online Workshop on Noting and Drafting	ISTM, New Delhi	18.04.2022	19.04.2022

Student Research

Advisor

Sl. No	Name of Student	Name of Advisor	Thesis Title
1.	Ms.Anjali Baghel (MSc)	Dr. G. Balasubramani	Expression of Gus gene in tobacco plant with different green tissue specific promoters
2.	Ms.Harshada Suresh Ingle (MSc)	Dr. G. Balasubramani	Studies on molecular analysis of Cry1 Ac and Cry2 Ab genes segregation and tissue culture in cotton
3.	Ms.Yogita Waghe (MSc)	Dr.J.Amudha	Drought response gene study in cotton
4.	Ms.Dipti P Dhote, (MSc)	Dr.J.Amudha	SSR marker analysis in cotton genotypes

Sl. No	Name of Student	Name of Advisor	Thesis Title
5.	Ms.Pallavi Jibhkate (MSc)	Dr. K.P.Raghavendra	In silico analysis of Cis-acting elements of GaLIM family genes and isolation of anther specific promoter sequence from Asiatic Cotton, *Gossypium arboreum*
6.	Ms.Dnyaneshwari Meshram (MSc)	Dr.N.Chandrashekar	Molecular and biochemical studies in cotton genotypes
7.	Ms.Achal Raut (MSc)	Dr.J.H.Meshram	Isolation and Characterization of rhizospheric salt tolerant bacteria from *Gossypium herbaceum* with plant growth promotion properties
8.	Ms.Sanika Bhagawatrao Nasare (MSc)	Dr.K.Velmourougane	Deciphering soil biology, soil nutrients and soil volatile profiles of wild and cultivated cotton species

Co-Advisor

Sl. No	Name of Student	Name of Co-Advisor	Thesis Title
1.	Ravinder Kumar Giri (Ph.D)	Dr.SK.Verma	Maternal effects and generation mean analysis for economic yield and textile traits in cotton (*Gossypium hirsutum* L.)
2.	Ms. Priyanka Priyadarshini (M.Sc)	Dr.Shailesh Gawande	Studies on prevalence of leaf spot diseases of cotton and their characterization
3.	Ms. Swati Popat Shinde (M.Sc)	Dr.Nandini Gokte-Narkhedkar	Evaluation of entomo pathogenic nematode, Heterorhabditis indica against Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae)
4.	Mr.Arpan Bhagat (M.Sc)	Dr.V.S.Nagrare	Toxicity evaluation and resistance monitoring in the field population of cotton jassid Amrasca biguttala biguttala
	Ms.Amrithapriya B (M.Sc)	Dr.V.S.Nagrare	Identification and characterization at trehalase gene from Pink bollworm
5.	Mr.Malsawntluanga Hnialum (M.Sc)	Dr.Chinna Babu Naik	Ovicidal efficacy of insecticides against Pectinophora gossypiella (Saunders) in cotton
6.	Mr.Sham Supreet (Ph.D)	Dr.Chinna Babu Naik	Studies on genetic of resistance in Cry toxin resistance population of PBW and its management

List of Colleges and Universities signed MoU with ICAR-CICR, Nagpur during 2022

Sl No.	Name of University /College	Date
1.	Tamil Nadu Agricultural University (TNAU), Coimbatore	06th April 2022
2.	Punjab Agricultural University, Ludhiana	17th September 2022
3.	University of Agricultural Sciences, Dharwad, Karnataka	27th October 2022

5.1.2: Training Imparted

Student Training Imparted

Sl. No	Name of Student	Name of Training Coordinator	Duration	Title
1.	Ms.Akshata Nete (B.Sc) Economics 3rd Year MIT-World Peace University, Pune	Dr.A.R. Reddy Pr. Scientist (Agril. Economics	3 months	Agricultural Economics-Value Chain in Cotton
2.	Ms. Jagruti S.Bodele M.Sc (Molecular Biology and Genetic Engineering, RTMNU, Nagpur University	Mr Joy Das (Plant Biotechnology)	3 months	Basic molecular biology techniques cotton biotechnology
3.	Ms.Snehal C.Satpute, M.Sc (Mol.Biol & Genetic Engineering)	Mr Joy Das (Plant Biotechnology)	3 months	Basic molecular biology techniques cotton biotechnology
4.	Ms. Tanshree Raju Ganvir, B.Tech Biotechnology Final Year student	Dr.G.Balasubramani,	2 Months	Basic molecular biology techniques cotton biotechnology

5.2: Trainings organized

Name of the Training	Organized by	Place & Date	Participant Category	No. of participant		Scheme under training organised	Training Coordinator
				Male	Female		
Integrated Nutrient Management of cotton crop	ICAR-CICR Nagpur	ICAR-CICR, Nagpur 27 January 2022 (online)	Field facilitators and project managers of Ambuja Cement Foundation	92	52	Ambuja Cement Foundation	Dr. Ramkrushna G.I. and Dr. A. Manikandan
Soil sampling for regenerative Agriculture	ICAR-CICR, Nagpur	ICAR-CICR, Nagpur, 15 February 2022	Staff	8	2	WWF India	Dr. A. Manikandan
Mass Production of Lecanicillium lecanii	ICAR-CICR,RS Coimbatore and KVK MYRADA	KVK MYRADA, 23-24, February 2022	ARYA - Bio input youth group	13	12		Dr. J Gulsar Banu Dr. M. Sabesh
Kapas Mela and Training Camp	ICAR-CICR, RS, Sirsa	ICAR-CICR, RS, Sirsa, 26 February 2022	Farmers	248	13	Institute	Dr.S.K.Verma
HRD for capacity building to Skilled Supporting Staff	ICAR-CICR, RS, Coimbatore	ICAR-CICR, RS, Coimbatore 08-10 March 2022	SSS of CICR, RS, Coimbatore	5	4		Dr. M. Sabesh
Workshop on Cotton Production Technology	FPO Bani, Sirsa	Bani, Sirsa 28 March 2022	Farmers	70	6		Dr. S.K.Verma, Dr. Rishi Kumar, Dr. Amarpreet Singh and Dr. Debashis Paul
Crop residue management for Organic cotton	ICAR-CICR, Nagpur	Panjari Farm, ICAR-CICR, Nagpur, 29 March 2022	Staff & farmers	18	2	WWF, India	Dr. A Manikandan and Dr. Savitha Santosh
Soil and Plant Analysis	VANAMATI, Nagpur	VANAMATI, Nagpur, KVK and ICAR-CICR, Nagpur 16-21, April.2022	Staff	29	5	Govt. of Maharashtra	Dr. A Manikandan
Master Trainers Training for Cotton Crop	ICAR- CICR Nagpur and VANAMATI, Nagpur	ICAR-CICR, Nagpur, 25-29 April 2022	Officers of Dept. of Agriculture, Govt. of Maharashtra	35	1	VANAMATI, Nagpur	Dr. Ramkrushna, G. I., Dr. V. Chinna Babu Naik, Dr. D.T. Na grale
Soil Health and Fertility Management	VANAMATI, Nagpur	VANAMATI, Nagpur, KVK and ICAR-CICR, Nagpur, 04 May 2022	Officers (Class II)	29	5	Govt. of Maharashtra	Dr. A. Maniakndan

Name of the Training	Organized by	Place & Date	Participant Category	No. of participant		Scheme under training organised	Training Coordinator
				Male	Female		
Microbial dissolution technology	ICAR-CICR, Nagpur	Akola and Amaravati 14-15 May 2022	Farmers	35	15	Institute	Dr. Velmourougane and Dr. A. Manikandan
Enhancing Cotton Production in North zone	ICAR-CICR, RS, Sirsa and Better Cotton Initiative (BCI)	ICAR-CICR,RS, Sirsa 17 May 2022	Farmers	85	0	Institute	Dr. S. K. Verma
Promotion of Non-GM Varieties through Organic Cotton production	ICAR- CICR Nagpur	ICAR-CICR, Nagpur 18-19 May 2022	Field staff of NGOs	15	2	ICAR- CICR Nagpur	Dr.Ramkrushna, G.I., Dr.Shailesh P. Gawande
Integrated Cotton Management Practices	ICAR-CICR, RS, Coimbatore and State Department of Agriculture, Tamil Nadu	ICAR-CICR, RS,Coimbatore 06-08 June 2022	Cotton growers from Chinnasalem, Kallakurici Dt, Tamil Nadu	32	8	SSEPERS / ATMA	Dr. A.H. Prakash Dr. S. Usha Rani
Better crop management in Cotton	ICAR-CICR, RS, Sirsa	MGMG (Kheri & Chaharwala) 14 June 2022	Farmers	50	0	NFSM (CC)	Dr. RishiKumar, Dr. S. K. Sain, Dr. Amarpreet Singh,
Efficient and Balanced Use of Fertilizers	ICAR-CICR, Nagpur	Kondali, Katol, Nagpur 21 June 2022	Front line workers and Farmers	48	2	Instititute	Dr. A. Manikandan
ICM in Cotton	ICAR-CICR, RS, Sirsa	MGMG (Chadiwal & Hanzira) 29 June 2022	Farmers	30	0	NFSM (CC)	Dr. Rishi, Dr. S. K. Sain, Dr. Amarpreet Singh, Dr. Debashis Paul
Cotton Crop Protection with special emphasis on PBW, whitefly and CLCuD management	ICAR-CICR, RS, Sirsa	Villages (Kalanwali & Dabwali) 20 July 2022	Pesticide dealers	93	0	NFSM (CC)	Dr. S. K. Sain,
Parthenium Eradicati on	ICAR-CICR, Nagpur	23 August 2022	Staff	60	30	Institute	Dr. A. Manikandan
Improved cotton cultivation technologies	ICAR-CICR, Nagpur	29-30 August 2022, 6-7 September 2022, 20-21 September 2022	Staff	40	35	Ambuja Cement	Dr. A. Manikandan & Dr. Dipak Nagrale
Exposure Visit	ICAR- CICR Nagpur and VANAMATI, Nagpur	ICAR-CICR, Nagpur, 03 September 2022	Mandal Agriculture Officer and Taluka Agriculture Officer	72	28	VANAMATI, Nagpur	Dr.Ramkrushna, G.I. and Dr. V. Chinna Babu Naik.
IPM of pink boll worm, demonstration on use of sex pheromone traps and management of boll rot disease	ICAR-CICR, Nagpur	Tivsa, Amravati 05 September 2022	Cotton farmers	31	04	NFSM (CC): IRM-PBW Project	Dr. Babasaheb B. Fand, Dr Neelkanth Hiremani
Monitoring of pests and diseases of cotton	ICAR- CICR, Nagpur	Yavatmal 09 September 2022	Farmers and agriculture officers	25	10	NFSM (CC): IRM PBW Project	Dr V. S. Nagrare Dr. S. P. Gawande Dr. D. T. Nagrale,
Integrated Cotton Management Practices	ICAR-CICR, Coimbatore	Thamalerimuthur, Jolarpet block, Tirupathur district 13 September 2022	FLD cotton Farmers from Jolarpet block	35	15	NFSM-FLD	Dr. A.H. Prakash, Dr. S. Usha Rani, Dr. D. Kanjana

Name of the Training	Organized by	Place & Date	Participant Category	No. of participant		Scheme under training organised	Training Coordinator
				Male	Female		
Exposure Visit	ICAR- CICR Nagpur	ICAR-CICR, Nagpur, 22 September 2022	Agriculture Input Dealers (DAESI)	38	2	ICAR- CICR Nagpur	Dr.Ramkrushna, G.I. and Dr. A. Manikandan
Scientist farmer interaction and input distribution	ICAR-CICR, Nagpur	Nimbhi Village of Morshi Taluka, Amravati District on 29 September 2022	Farmers	160	40	(NFSM)-CC-FLD	Dr. A. Manikandan
Root rot and Root-knot nematode management in the cotton crops	ICAR-CICR, RS, Sirsa	MGMG (Chaharwala & Hanzira) 29 September 2022	Farmers	25	0	NFSM (CC)	Dr. Rishi, Dr. S. K. Sain, Dr. Amarpreet Singh, Dr. Debashis Paul
Field visits for monitoring of pests and diseases of cotton	ICAR- CICR, Nagpur	Aurangabad, Jalna and Buldhana districts of Maharashtra 29th September to 1st October 2022	Farmers and agriculture officers	15	3	NFSM (CC): IRM PBW Project	Dr.V.S.Nagrare, Dr J. H. Meshram
Sustainable laboratory practices and field experiments on cotton research	ICAR-CICR, Nagpur	ICAR-CICR, Nagpur World cotton Day 07 October 2022	Students	80	60	Institute	Dr. A. Manikandan & Dr. J.H. Meshram
Integrated Cotton Management Practices	ICAR-CICR, Coimbatore and State Department of Agriculture, Tamil Nadu	Nallur Block Cuddalore district 17 October 2022	Cotton growers from Nallur Block Cuddalore District	30	10	ATMA	Dr. S. Usha Rani
Diagnostic field visit cum training on management of pests and diseases of cotton	ICAR- CICR, Nagpur	Chhindwara, Khandwa, Barwani, Khargone and Dhar districts of Madhya Pradesh 10 -12 October 2022	Farmers and Agriculture officers	225	18	NFSM (CC): IRM-PBW Project	Dr V. S. Nagrare Dr. S. P. Gawande Dr. D. T. Nagrale, Dr. Babasaheb B. Fand
Organic Cotton Production Technology	ICAR- CICR Nagpur and Welpsun foundation, Wardha	ICAR-CICR, Nagpur, 30 November 2022	Farmers	38	8	Welpsun foundation, Wardha	Dr Ramkrushna G.I. and Dr RachnaPande
Microbes for sustainable soil and crop production	ICAR-CICR, Nagpur	17 November 2022	Students & Teachers	60	66	Institute	Dr. A. Manikandan, Dr. K. Velmourougane & Dr. J.H. Meshram
Soil health, and its sustainable management	ICAR-CICR, Nagpur	World Soil Day 05 December 2022	Students, Teachers & Farmers	63	56	Institute	Dr. A. Manikandan
One day training program on Pink Boll Worm management	ICAR-CICR, RS, Sirsa	ICAR-CICR,RS, Sirsa, 07 December 2022	Farmers	35	0	NFSM (CC): IRM-PBW Project	Dr. Rishi Kumar & Dr. S. K. Sain

AWARDS AND RECOGNITIONS

06

Name of the officer	Name of the Award/Recognition	Awarded by	Conferred on
Dr Babasaheb B Fand	"Associateship" of the National Academy of Agricultural Sciences	NAAS, New Delhi	1st January 2022
Dr V.Chinna Babu Naik	Young Scientist Award 2022	International Conference on Integrated Approach in S&T for Sustainable Future (ICIASTSF-2022)	24-26 February 2022
Dr S K Sain	Best Oral Paper Presentation Award 2022 at 8th International Conference Plant Pathology: Retrospect & Prospects	Indian Phytopathology Society, New Delhi	23-26 March 2022
Dr J Gulsar Banu	Research Excellence Award-2022	International Conference on "Recent Advances in Agricultural, Biological and Applied Sciences Research" held at Nowgong College , Assam (online)	08 August 2022
Dr V N Waghmare	Professional Excellence Award	Cotton Research and Development Association, Hisar	08-10 August 2022
Dr V N Waghmare	Diamond Achievers Award 2022	Council for Academic and Performance Appraisal, New Delhi	
Dr J Gulsar Banu	Excellence and Innovation Award-2022	Dr. B. Vasantharaj David Foundation	
Mr Joy Das	Young Scientist Award	Cotton Research and Development Association, Hisar	08-10 August 2022
Dr A.Manivannan	Outstanding Scientist award 2022	Society for Biotic and Environmental Research (SBER)	08 August 2022
Dr A.Manivannan	Best Poster Award	Cotton Research and Development Association, Hisar	10 August 2022
Dr K P Raghavendra	Best oral presentation Award at the National Symposium on "Paradigm shift in cotton cultivation"	Cotton Research and Development Association, Hisar	08-10 August 2022
Dr Rahul M Phuke	Outstanding Poster Award at the 2nd International Wheat Congress, Beijing, China		11-15 September 2022
Dr H B Santosh	Best oral presentation at the National Symposium On "100 Glorious Years Of Cotton Research And Way Forward"	TNAU, Coimbatore	18 – 19 October 2022
Dr. Vinita Gotmare	Best Poster Award at the First National Conference on Plant Genetic Resource Management (NCPGRM 2022)	Indian Society of Plant Genetic Resources (ISPGR), New Delhi	22-24 November 2022
Dr H B Santosh	Best oral presentation at the First International Conference Reimagining Rainfed Agro-ecosystems: Challenges & Opportunities	CRIDA, Hyderabad	22–24 December 2022
Dr V.Chinna Babu Naik	Avvaru Seethamma Memorial Award 2022	AZRA, Bhubaneshwar	10-12 November 2022
Dr MV Venugopalan	Elected as the Executive Committee member, to represent India in the International Cotton Researchers' Association (ICRA).	General Body Assembly of ICRA in Cairo, Egypt	6 October 2022
Dr Blaise D.	Fellow of the CRDA	Cotton Research and Development Association, Hisar, Haryana	8 August 2022
Dr A Manikandan	Second prize in oral paper presentation in the National Symposium on 100 glorious years of cotton research and way forward	Centre for Plant Breeding and Genetics, TNAU, Coimbatore	18-19 October 2022
Dr Baghyalakshmi K. and Dr S. Manickam	Best Article Award for article ID AGV02-I03-03 entitled 'Best Linear Unbiased Prediction (BLUP) Based Selection in Cotton for Low Heritability Complex Traits'	AgriGate – An International Multidisciplinary Monthly e-Magazine	

LINKAGES AND COLLABORATIONS

07

Areas of Linkages	Institution
Refinement of spindle type header prototype for development of a cotton picker	CSIR-CMERI-CoEFM, Ludhiana
Crop pest surveillance in Maharashtra.	CROPSAP, Maharashtra
Insecticide Resistance Management (IRM): Dissemination of Pink bollworm Management Strategies.	DAC, Govt of India and SAUs (Dr PDKV Akola, VNMKV Parbhani, MPKV Rahuri, NAU Surat, JAU Junagarh, RVSKVV Gwalior, UAS Dharwad, UAS Raichur, PITSAU Hyderabad and ANGRAU Guntur)
Genetic diversity of pink bollworm in India	DST-SERB, Ministry of Science And Technology, Govt of India
Implementation of PVP legislation 2001 and DUS testing of cotton.	Protection of Plant Varieties and Farmers' Rights Authority, Govt of India
Evaluation of insecticide combinations against insect pest complex of cotton	M/s Gharda Chemicals Ltd, Thane Mumbai
ICAR project on Seed Production in Agricultural Crops and Fisheries.	ICAR, New Delhi
Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem.	National Carbon Project, ISRO, Hyderabad
Transgenic research on plant protection	CSIR and NBRI, Lucknow
Pheromone technology	CSIR and IICT, Hyderabad
Value addition naturally colored cotton	Dr. PDKV, Akola and ICAR-CIRCOT, Mumbai
Student collaboration for research	RTMNU, Nagpur
Production and commercialization of Bt cotton varieties.	Maharashtra State Seeds Corporation Ltd. (Mahabeej), Akola
HRD of implementation partners of BCI programme in India	Better Cotton Initiative, New Delhi
Whitefly management	PAU, Ludhiana, HAU, Hisar RAU, Sriganganagar
Dissemination of weekly advisories and BMPs for cotton	State Agricultural Departments of cotton growing states
Strengthening Bt referral lab for Bt/HT tests	DAC, GoI
Digital landscape diagnostic survey in Maharashtra	Rajiv Gandhi Science and Technology Commission, Mumbai
Nectariless cotton genotypes evaluation for bollworm resistance	RASI Seeds
Breeding for cotton leaf curl virus	ATGC, Hyderabad
Evaluation of mating disruption technology for PBW	Rallis India (Pvt ltd), Bengaluru
Bio-efficacy of new Bt cry proteins against PBW populations	Bayer Crop Sciences
Variable Rate Technologies (VRTs) for site specific input (pesticide, water & Nitrogen) management	Network Program on Precision Agriculture (NePPA)
Promotion and commercialization of Bt cotton varieties	M/s Nairuthi Seeds Pvt Ltd., Hyderabad
Implementation of the Project Bandhan	Agrovision Foundation
Establishing sustainable organic cotton production ventures in selected farms located in Ghatanji of Yavatmal District, Kalmeshwar of Nagpur district and Dhamangaon of Amravati District	Cottonguru MahaFPC Limited

Areas of Linkages	Institution
Popularization of Long linted Desi cotton varieties	Better Cotton Initiative, India and VNMKV Parbhani
To Evaluate Nectariless Rasi Cotton hybrids against pink bollworm and American Bollworm on Cotton	Rasi Seeds Pvt Ltd
To develop recommendations for cotton High Density Planting System (HDPS) pertaining to canopy and nutrient management through collaborative agronomy TRIALS/DEMOS	Rasi Seeds Pvt Ltd, Nuziveedu Seeds Ltd
Soil Testing Services related to Regenerative Agriculture	World Wide Fund For Nature-India (WWF India)
Evaluation of mating disruption technology	ATGC Biotech Pvt Ltd
Seed production and commercialization of Bt cotton varieties developed by ICAR-CICR, Nagpur (ICAR-CICR 16 Bt and ICAR-CICR 23 Bt, ICAR-CICR PKV081 Bt (Bt 12), ICAR-CICR RS 2013 Bt (Bt 6), ICAR-CICR GJHV374 Bt (Bt 3)	ALP GIRI SEED Sciences Pvt Ltd
The response of potassium salt of active phosphorous (PSAP) fertilizer grade by foliar spray in Bt hybrid cotton	M/s. Isha Agro Sciences Pvt. Ltd., Pune
Multiplication and commercialization of Bt Cotton Varieties- ICAR-CICR 16 Bt and ICAR-CICR 23 Bt	M/s. Pinnacle Agri Sciences Pvt Ltd. Kurnool
Multiplication and commercialization of ICAR-CICR 23 Bt Cotton Variety	M/s. Nirupama Seeds Pvt Ltd. Hyderabad
Multiplication and commercialization of Bt Cotton Varieties- ICAR-CICR 16 Bt and ICAR-CICR 23 Bt	M/s. Sahaja Crop Sciences Pvt Ltd. Kurnool
MoU with M/s ITC Limited	M/s ITC Limited, Guntur
Promotion and commercialization of Bt cotton varieties ICAR CICR GJHV 374 Bt, ICAR-CICR PKV081 Bt and ICAR-CICR 23 Bt	M/s Dinkar Seeds Pvt Ltd. Himatnagar, Gujarat
Entomopathogenic fungi	ICAR- Central Plantation Crops Research Institute (ICAR CPCRI), Kasargod, Kerala
Non-GM cotton varieties to organic cotton growers in Central and Southern part of India	Welspun Foundation for Health and Knowledge (WFHK), Welspun, Kutch, Gujarat

ICAR-AICRP ON COTTON

08

The world's first commercial intra-hirsutum cotton Hybrid 4 (H4, or Sankar4) was developed by Dr C.T. PATEL at the Main Cotton Research Station, Surat (Gujrat) in 1970. This year we are celebrating the **"GOLDEN JUBILEE OF HYBRID COTTON TECHNOLOGY"** developed through AICRP on Cotton. The technology revolutionized cotton farming due to the genetic phenomena of HETEROSIS and breeding becoming popular as hybrid technology, with a phenominal increase in production from a meagre 47.63 lakh bales during 1970s to 370 lakh bales in the year 2021-22.

The Varietal Identification Committee meeting was held under the Chairmanship of Dr. R. K. Singh, Assistant Director General (Commercial Crops), ICAR, New Delhi on 7th April, 2022 and identified 18 non-Bt varieities, 6 Bt varieties and 38 Bt Hybrids.

List of notified varieties/ hybrids during 2022

S.No.	Variety	Identified for zones
1	**KR 136 (Pedigree:** GMS-1 x SVA-568)	North zone States of Punjab, Haryana and Rajasthan under Irrigated conditions
2	**GJHV 522 (Pedigree:** GP-129 x J-78)	Central zone States of Maharashtra, Madhya Pradesh and Gujarat under Irrigated conditions
3	**Phule-Shubhra (RHB-1623) (Pedigree:** RHC-0572/1-1 x Pima-84)	Central zone States of Maharashtra and Gujarat under Irrigated conditions
4	**GISV 312 (Pedigree:** GSH 2 x GISV 197)	Central zone States of Maharashtra, Madhya Pradesh and Gujarat under Irrigated conditions
5	**NDLH 2035-5 (Pedigree:** NDLH – 1905 × MCU 5)	Central zone States of Maharashtra, Madhya Pradesh, Odisha, South Rajasthan and Gujarat as well as South Zone States of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
6	**JLA 1207 (Pedigree:** JLA-794 x JLA-104)	Central zone states of Madhya Pradesh, Maharashtra, and Gujarat under rainfed conditions
7	**RAH 1075 (Pedigree:** GSHV 99/307 x PUSA 9127)	South Zone States of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under irrigated conditions
8	**LHDP 5 (Pedigree:** L 770 x L 2233**)**	South Zone States of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under irrigated conditions
9	**CCH 19-4 (Pedigree:** CCH 526612 X VNWH-1)	South Zone States of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under both irrigated and rainfed conditions as well as in Central zone States of Mahaashtra, Madhya Pradesh, Gujarat and Odisa, under Irrigated conditions
10	**CCB 51-2 (Pedigree:** Suvin x (ICB125 x Giza-70)**)**	South zone states of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu under Irrigated conditions
11	**DB 1801 (Pedigree:** Selection from a bulk population of breeding line BCS-23-18-7)	South zone states of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu under Irrigated conditions
12	**DHCC 1801 (Pedigree:** Selection in a variable medium brown linted bulk population)	South zone States of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu under rainfed conditions
13	**DWDa 1802 (Pedigree:** Selection from an arboreum population of ARBAS-131)	South zone states of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu under rainfed conditions
14	**CNA 1091 (Pedigree:** G. arboreum cv. KWAN-3 x G. herbaceum cv. Jaydhar)	South zone States of Andhra Pradesh, Telangana, Karnataka and Tamil Nadu under rainfed conditions
15	**CNA 1031 (Pedigree:** Selection from Random Mating Population)	Central zone states of Madhya Pradesh, Maharashtra, Gujarat, Southern Rajasthan and Odisa, under rainfed conditions
16	16301 DB **(Pedigree: Selection from cross involving *G. hirsutum, G. raimondii, G. barbadense* & *G. thurberi*)**	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under irrigated conditions
17	**CNH 17395 (Pedigree:** Interspecific hybridization between G.hirsutum, G. raimondii, G. barbadense & G. thurberi followed by pedigree method of selection)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under irrigated conditions
18	**CNA 17522 (Pedigree:** Interspecific hybridization between Gossypium arboreum race Burmanicum and G. raimondii and Selection)	Central zone states of Madhya Pradesh, Maharashtra, Gujarat, Sothern Rajasthan and Odisa, under rainfed conditions

List of Bt cotton varieties / hybrids identified during VIC 2022

S.No.	Bt hybrid	State/ Zone
1	**KCH 9323 BGII** (Pedigree: KC 19S001T X KC 19S002U)	North zone states of Punjab, Haryana and Rajasthan under irrigated conditions.
2	**KCH 9333 BGII** (Pedigree: KC 19S001T X KC 19S003U)	North zone states of Punjab, Haryana and Rajasthan under irrigated conditions.
3	**RCH 960 BGII** (Pedigree: RC 781 BGII X RC 876)	North zone states of Punjab, Haryana and Rajasthan under irrigated conditions
4	**ATCH-118 BG II**(Pedigree: AT 2007-1 x AT 2005-1)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
5	**GBCH 1801 BG II**(Pedigree: G 21 BG II X GCS 297 BG)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
6	**KCH9292 BG II**(Pedigree: KGPGH 7402 BG II X KGPGH 1142)	Central zone States of Madhya Pradesh, Maharashta and Gujarat under irrigated conditions
7	**MC5441 BGII**(Pedigree: COCD 131333 X COCC 141353B)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
8	**MC5444 BGII**(Pedigree: COCD 1104258 X COCX 150014Y)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
9	**NBC 2020 BGII**(Pedigree: C 6009 X C 2358)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
10	**RCH 971 BGII**(Pedigree: RC 880 X RC 878)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
11	**US 704 BGII**(Pedigree: US 65 HR16BGI X UC756H17BGII)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
12	**VSCH-369 BGII**(Pedigree: VCS 219 X VCS 220)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
13	**ARCH 3001 BG II**(Pedigree: D-4-25 X DC-15-1-1)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
14	**ARCH 3106 BG II**(Pedigree: ICR/NBTX18-6-1 X DC-2-2-15)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under irrigated conditions
15	**Daftari 3434 BG II**(Pedigree: Lata x R2-1)	Central zone States of Madhya Pradesh, Maharashta and Gujarat under irrigated conditions
16	**ACH-909-2 BG II**(Pedigree: ACG-1301 BGII x ACG-14 BGII)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
17	**Daftari 3434 BG II**(Pedigree: Lata X R2-2)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
18	**GBCH 1801 BG II** (Pedigree: G 21 BGII X GCS 297 BG)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
19	**MC5459 BGII** (Pedigree: COCD131333B X COCX141364B)	
20	**Neo 1656 BGII**(Pedigree: Neo 1656 F (1782-3-6-3) X Neo 1656 M (1735-3-2-1))	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
21	**US 704 BGII**(Pedigree: UC 65 HR16BGI X UC756H17BGII)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
22	**C 9392 BG II** (Pedigree: MTC3410 X MTC2675).	Central zone State of Gujarat under rainfed conditions
23	**ARCH 3001 BG II**(Pedigree: D-4-25 X DC-15-1-1)	Central zone States of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
24	**NCS 2778 Bt2** (Pedigree: NC 6134 Bt2 X NC 7027 Bt)	Central zone State of Maharashtra under rainfed conditions
25	**ARCH 3106 BGII** (Pedigree: ICR/NBTX18-6-1 X DC-2-2-15)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
26	**KCH9292 BG II**(Pedigree: KGPGH-7402 BGII X KGPGH-1142).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
27	**RCH 971 BGII**(Pedigree: RC880 X RC 878).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
28	**US 704 BGII**(Pedigree: US 65 HR16BGI X UC756H17BGII).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
29	**VSCH-369 BGII**(Pedigree: VCS 219 X VCS 220)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions

S.No.	Bt hybrid	State/ Zone
30	**C 376 BG II**(Pedigree: MTC3386 X MTC2681)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
31	**SP 7679 BG II**(Pedigree: C10345B2ms X 14Q2F0008)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
32	**Indam-1634 BG II**(Pedigree: 12H011 BGII X 416 NBt)	South zone states of Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
33	**US 704 BGII** (Pedigree: US 65 HR16BGI X UC756H17BGII)	South zone states of Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
34	**VSCH-369 BGII**(Pedigree: VCS 219 X VCS 220)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
35	**GBCH 1801 BG II** (Pedigree: G 21 BG II X GCS 297 BG).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
36	**MC5441 BGII** (Pedigree: COCD 131333 X COCC 141353B).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
37	**SP7686 BGII** (Pedigree:C10768B2ms X 14Q2D0407)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
38	**CCH-333 BG II** (Pedigree: 6070 X 7111).	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions

List of Bt cotton varieties / hybrids notified during VIC 2022

S.No.	Bt variety	State/ Zone
1	**Bt 183059-5** (Pedigree: (Bikaneri Narma Bt × RCRSC7) × (RCRSC2× RCRSC12))	Central zone states of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
2	**Bt 183059-4** (Pedigree: (Bikaneri Narma Bt × RCRSC7) × (RCRSC2 ×RCRSC12))	Central zone states of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
3	**CICR Bt 19-32** (Pedigree: (Bikaneri Narma Bt × RCRSC7) × (RCRSC2× RCRSC12))	Central zone states of Madhya Pradesh, Maharashtra and Gujarat under rainfed conditions
4	**ACH 52-2 BG II** (Pedigree: ACG-176-2 BGII X ACG-50-1 BGI)	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under Irrigated conditions
5	**Bt 183059-2** (Pedigree: (Bikaneri Narma Bt × RCRSC7) × (RCRSC2 × RCRSC12))	South zone states of Telangana, Andhra Pradesh, Karnataka and Tamil Nadu under rainfed conditions
6	**PBH Bt 21 (PAU Bt 5)** (Pedigree: LH 2298 X PAU Bt 1).	North zone states of Punjab, Haryana and Rajasthan under irrigated conditions.

Breeder seed production 2021-22

S. No.	Centre Name	Variety	DAC Indent (q)	Production (q)
1	PAU, Ludhiana	LD 1019	0.10	0.25
		LD 949	0.10	0.20
		F 2228	1.20	2.50
		F 2383	0.30	1.80
		FDK 124	0.10	1.00
		Total	**1.80**	**5.75**
2	CICR, Nagpur	Rajat Bt	0.01	0.50
		Suraj Bt	0.01	0.60
		CCH 4474 (Subiksha)	0.05	1.10
		CCH 12-2 (Suchitra)	0.05	0.00
		CCH-2623	0.10	0.00
		Suvin	0.00	0.90
		CCH 14-1 (Sunantha)	0.00	1.60
		CICR B Cotton 37	0.00	0.30
		Surabhi	0.00	1.70
		Total	**0.22**	**6.70**
3	JNKVV, Jabalpur	RVK-11	0.10	0.00
		Total	**0.10**	**0.00**
4	NAU, Navsari	G.Cot.20 (GSHV 97/59)	0.10	0.20
		Deviraj	0.00	0.30
		GN.Cot. 22	0.00	0.15

S. No.	Centre Name	Variety	DAC Indent (q)	Production (q)
		GN.Cot. 32	0.00	0.20
		G.Cot. 34	0.00	0.20
		G.Cot. 36	0.00	0.20
		G.Cot. 40	0.00	0.30
		G.Cot. 42	0.00	0.30
		G. Cot. 16	0.00	0.50
		G. Cot. 23	0.00	0.40
		GN. Cot. 25	0.00	0.75
		GN. Cot. 26	0.00	0.50
		GN. Cot. 29	0.00	0.40
		Total	**0.10**	**4.40**
5	VNMKV, Parbhani	PA 740	0.10	0.10
		Total	**0.10**	**0.10**
6	SKRAU, Bikaner	RS 2814	0.00	2.50
		Total	**0.00**	**2.50**
		Grand Total	**2.32**	**19.45**

Front Line Demonstrations (FLD) under National Food Security Mission (NFSM) (Commercial Crops)

During the year 2021-22 under NFSM - Commercial Crops, a total of 530 FLDs on Integrated Crop Management (ICM), 270 Front Line Demonstrations on Desi / ELS cotton / ELS cottonseed production and 165 Front Line Demonstrations on intercropping with cotton were allotted to ICAR-AICRP on Cotton with a budget outlay of INR 79.90 lakh. Out of the allotted FLDs, a total of 514 Front Line Demonstrations on Integrated Crop Management on cotton, 217 Front Line Demonstrations on Desi / ELS cotton / ELS cottonseed production, and 145 Front Line Demonstrations on intercropping with cotton were conducted by nineteen participating centers of ICAR – AICRP on Cotton.

Trainings

On campus and Off campus training

One twenty eight short duration (1 to 3 days) on-campus and off-campus training courses were conducted in different disciplines for practicing farmers, rural youth and extension functionaries. In all 5963 participants including 1592 SC/ST participants benefitted from the training programs (Table 9.1).

Table 9.1 : Details of training conducted

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	52	1349	961	2362
Rural youths	56	1498	1172	2726
Extension functionaries	12	362	128	502
Sponsored Training	8	261	104	373
Vocational Training	0	0	0	0
Total	128	3470	2365	5963

Sponsored training programme

Eight sponsored training programmes were organized in the field of Crop Production, Horticulture, Plant Protection, Veterinary Science and Home Science for farmers and extension functionaries, deputed by State Agriculture Department of Maharashtra, ATMA, CIPMC, Nagpur, RCF, MAFSU Nagpur, MCED & ICDS Nagpur, NGOs. In all 821 participants attended these courses.

Cluster Front Line Demonstrations on Oilseed and Pulses

Crop enterprises

Four CFLDs on oilseeds (i.e. Soybean (MAUS-158, Groundnut (TAG-24)) & pulses (i.e. Pigeonpea (BDN-716), Chickpea (PDKV, Kanchan) were conducted in the adopted villages of Nagpur district viz. Bhivgarh, Chirvaha, Khairi & Tambekhani. Several extension activities like field day, field visit of farmers and extension functionaries, group discussion and scientist farmers meet etc. were conducted for effective implementation of technologies. These demonstrations were conducted on 150 farmers field covering 80 ha. area.

Table 9.2: FLD on Plant Protection Integrated management of soybean defoliator

Crop	Variety	No. of farmers	Area	Yield			Check	% increase	Parameters of Demo		Assessment of Check	
				High	Low	Avg.			No. of defoliator /MRL	B:C Ratio	No. of defoliator / MRL	B:C Ratio
Soybean	MAUS-158	13	5.2	22.9	14.9	19.7	15.5	27.10	2.69	3.45	3.7	2.45

Table 9.3: FLD on Plant Protection Integrated management of Chickpea Pod Borer Complex

Crop	Variety	No. of farmers	Area	Yield			Check	% increase	Parameters of Demo		Assessment of Check	
				High	Low	Avg.			No. of defoliator /MRL	B:C Ratio	No. of defoliator / MRL	B:C Ratio
Chickpea	Digvijay	13	5.2	24.9	20.30	22.6	18	25.55	2.61	3.20	3.79	2.6

FLD on Livestock Production -

1) Scientific cultivation of Hybrid Napier variety DHN-10

Hybrid Napier variety DHN-10 was cultivated on 15 farmers field on 3 hectares of area. There was on increase of 7.2% in green fodder yield in demonstration plot (237.98 q/ha) as compared to local check variety CO4 (222.00 q/ha). Plant height, average number of tillers/clump, average number of leaves/tiller was observed as 2.81 m, 36, 7.2 and 2.50 m, 31, 6.8 in demonstration plot and local check, respectively.

On feeding greens, the average milk yield in demo group was observed as 8.54 lit/cow/day over local check i.e. 7.89 lit/cow/day with 8.24% change in parameters.

FLD on Hybrid Napier DHN-10

2) Supplementation of Probiotic to cross bred cows

Under this trial, 20 gm of Probiotic powder was supplemented in the daily diet of 15 crossbred cows of 15 farmers for 90 days. The result revealed that there was 10.77% increase in milk yield with avg. Daily milk yield of 6.58 lit/cow/day and 5.80 lit./cow/day in demonstration and local check, respectively. An increase of 15.38% was also observed in milk fat content in demonstration group (4.5%) over local check (3.9%).

FLD on Probiotic cross bred cows

FLD on Home-Science

FLD *Performance of Cole crops in Nutrition Garden through IPM Model with Organic input*

Cabbage and cauliflowers cultivated on 15 farm women *Nutrition Garden* on 1000 sq. ft area. There was of 28% more yield in demonstration plot (121 kg) as compared to local check (65 kg). Average weight of cabbage & cauliflower was observed as 760 g, & 515 g & 580g & 370g in demonstration plot and local check respectively. 90% excellent growth of curd without any infestation was observed due to alternate drenching and foliar application of 30 litre/1000 sq. ft. Jivamrutham,k Waste Decomposer, DGA (Milk Jaggary & Egg) at the interval of 15 days for nutrient management and spraying of Azadarachtin & Dashparni during the growth period.

T-3 Cultivation of Cole crops in Nutrition Garden through IPM Model with Organic input

On Farm Trials (OFT)

Horticulture Discipline

OFT-1:- Assessment on Short duration early high yielding variety of marigold

Technology	No. of Farmers	Yield (t/ha)	Net Return(Rs.)	B:C Ratio
T1 – Farmers Practice (Suman)	13	6.7	117770	3.6:1
T2 –Pusa Basanti	13	7.8	167770	6.2:1
T3- Arka Banagara	13	8.9	142770	5.4:1

Result: Production of both variety are higher as compared to local marigold with high price.

Marigold Variety- Pusa Basanti and Arka Banagara

Plant Protection

OFT 1- Integrated management of pink bollworm (*P. gossypiella*) in Bt cotton- Ankur - 3028

Treatment	% of Green Boll damage	% of Larval Boll damage	Average Yield (q/ha)	% increase yield
T1 – Farmers Practice 1 or 2 chemical pesticide sprays comprising of Chlorpyriphos 20 EC 30ml, Triazophos 40 EC 30 ml per 10 lit water	30.2	18.5	18.5	
T2 - Technology Assessed 1. 1st Spray profenophos 50 EC @ 20 ml per 10 lit water at 60 DAS. 2. 2nd Spray Emamectin benzoate 5 SG @ 4.4 g per 10 lit water at 80 DAS 3rd spray Lambda cyhalothrin 5 EC @ 10 ml per 10 lit water at 100 DAS	16.9	11.25	20.8	12.43
T3 - Technology Assessed 1. Installation of Pheromone Traps @2/acre for monitoring at square formation 2. Spray Azadiractin 300 ppm @ 50ml/10 lit at flower initiation 3. 6 to 7 inundative releases of Trichogramma chilonis 60,000 per acre 4. Plucking of rosette flowers. 5. ETL based application of Thiodicarb 75 WP 20 g per 10 lit water at boll formation followed by Deltamethrin 2.8 EC 10 ml per 10 lit water	15.55	9.5	23.00	24.32

OFT 2 : Management of pigeon pea pod borer complex

Treatment	Average podborer larvae/plant	Percent pod damage	Average Yield (q/ha)	% increase yield
T1 – Farmers Practice 3 to 4 chemical pesticide sprays comprising of Quinalphos 25 EC40 ml, Chlorpyriphos +cypermethrin 50 ml , Flubendiamide 20 WG 2 g or Trizoophos+Deltamethrin 50 ml in 15 litres of water.	3.10	10.30	11.95	
T2 - Technology Assessed: 1st spray - Clorantraniliprole 18.5 SC @3 ml per 10 lit water at 50 per cent flowering 2nd spray- Flubendiamide 39.35 SC @2 ml per 10 lit water at pod filling stage.	1.75	4.3	13.10	9.62
T3 - Technology Assessed 1st spray Azadirachtin 300 ppm 50 ml /10 lit water 2nd Spray Emamectin Benzoate 5 SG 3 g/10 lit water 15 days after 1st spray . 3rd spray Lamda cyhalothrin 5 EC 10 ml/10 lit water based on ETL	1.5	1.6	14.9	24.69

Veterinary Science

OFT 1 Assessment of performance of new breeds of Chicken – CARI-NIRBHEEK and GIRIRAJA under Back Yard System of rearing in farmer's field

There is a great demand for indigenous/desi chicken and the current production is not able to meet the demand. Hence the trial was conducted on improved breeds of chicken to evaluate their performance which resembles to indigenous/desi chicken.

Total 130 birds (6 weeks) of each improved varieties i.e. CARI-Nirbheek and Giriraja were distributed to 13 farmers of Nagpur Tahsil. These birds were reared under free range system with minimum inputs.

The study revealed that body weights of local chicken, CARI-Nirbheek and Giriraja birds at 20 weeks of age were 1.150 (TO1), 1.890 (TO2) & 1.82 (TO3) kg, respectively. Giriraja birds showed early sexual maturity at 162 days as compared to CARI-Nirbheek (172 days) and indigenous/desi chicken (186 days). CARI-Nirbheek birds found more active and pungacious than Giriraja. CARI-Nirbheek variety fetched more prices due to its resemblance with fighter Aseel breed. The details of the parameter of evaluation were as follows.

Sr. No.	Parameters	Farmer's Practice (TO1) Local chicken	Technology Option (TO2) CARI-NIRBHEEK	Technology Option (TO3) GIRIRAJA
1	Mean body weight of chicken kg/bird	1.15	1.89	1.81
2	Age at sexual maturity days	186	172	162
3	Gross cost (Rs/bird	325.00	325.00	325.00
4	Gross return (Rs/bird)	710.00	1050.00	820.00

Major Observation / Feedback : CARI-Nirbheek birds may be recommended for rural back yard poultry system instead of local breed to fetch more income.

OFT on Poultry

OFT 2 Evaluation of fodder hybrid Napier varieties under scientific management in Nagpur district

In order to ensure the supply of quality green fodder to the dairy cows throughout the year, a trial was conducted at Umred Tahsil on 'Evaluation of fodder hybrid Napier varieties under scientific cultivation' during. Two multi-cut perennial varieties of hybrid Napier i.e. Super Napier and BNH-10 were compared with local prevalent variety CO4 on 4.68 ha area on 13 farmer's field. Both the varieties i.e. Super Napier and BNH-10 showed better performance in terms of green fodder yield, number of tillers, number of leaves and milk yield on feeding of greens than locally grown CO4 variety. As per the feedback of farmer green fodder intake was more in TO2, in which Super Napier was fed to the cows. That might be due to less serration, high succulence and good palatability of Super Napier. The details of the parameter of assessment were as follows.

S. No.	Parameters of Assessment	Farmer's practice (TO1): CO4	Technology option (TO2): Super Napier (Packchong-1)	Technology option (TO3): BNH-10
1	Plant Height (m)	2.42	3.41	2.73
2	No. of tillers/clump	32	46	41
3	No. of leaves/tiller	6.01	7.88	6.23
4	Green fodder yield in 1st cutting (q/ha	219.70	276.65	252.5
5	Cost(Rs/acre)	49450	49450	49450
6	Average Milk yield of cows on feeding greens (l/day)	6.80	8.55	7.70

Home Science Discipline

OFT-1:- Assessment of different models of Nutrition Garden for small land holders for nutritional sustainability

Technology	Area of garden (meter)	Parameters			Quantity of Vegetables produced in three months	Saving of money per family in three months (Rs.)
		Quantity of vegetables produced (October-December-2021) (kg)				
		GLV	Cucurbitaceous	Other Vegetables		
T1 – Farmers Practice Growing vegetable Tomato, Brinjal, Cow-pea, Bottle Guard	6 mtr	00	16	13	29	580 /family
T2 – Nutrition Garden GLV: Spinach, Methi, Amaronthus, Coriander Other vegetables: Brinjal, Tomato, Cowpea, Okra, Cluster Beans (source: IIHR, Bangalore)	6mtr	33	08	45	86	1390 /family
T3 – Nutrition Garden Sat Din Sat Kyari GLV: Spinach, Methi, Amaronthus, Coriander Other vegetables: Brinjal, Tomato, Cowpea, Cluster Beans Cucurbitaceous: Bottle Guard, Spong Guard, (source: ICAR-IIVR, Varanasi and IIHR, Bangalore)	6mtr	44	30	37	111	1780/family

Result : Area under production of vegetables in Nutrition Garden in all trials is 6meter for four family members. Quantity of Green leafy vegetables (GLV) & cucurbitaceous vegetables & other vegetable produced through emproved practice in T3 is 111 kg in Rabi season which is higher and better as compared to T1 (29 kg) & T2 (86 kg). This is by adapting T3 practice of cultivation which saves Rs. 1200/family in three months

Attracting and retaining rural youth in Agriculture (ARYA)

Under ARYA, KVK-CICR, Nagpur is one of the centre operating two enterprises for lively-hood of rural youth. 1) Developments of disease free sampling Nagpur mandarin 2) Fruits and vegetable processing. Project ARYA (Attracting & Retaining Rural Youth in Agriculture) is focusing on creating awareness and capacity building training programmes for youths in rural areas to take up various agriculture, allied and service sector enterprises for sustainable income and gainful employment. During the year 2022, KVK trained 625 rural youths for production of disease free seedlings of Nagpur mandarin and different self help groups for custard apple processing, its value addition, preparation of pickles, citrus juice, Potato chips ,preparation of Mixed Fruit Jam, Tomato Ketchup and solar drying of vegetables. Additionally, KVK provided technical support to rural youth of Katol block for multiplication of Nagpur mandarin seedlings. 15 rural youth beneficiaries developed

their nursery on Nagpur mandarin and are generating significant income. Sugarcane juicer,citrus juicer,Potato chips machines and Greavy machines are distributed to 6 self help groups as Critical Inputs for establishing processing enterprises. Three units of processing of pickles and two units of sugarcane, one unit of custard apple pulper, solar drying unit of chilli processing 3 chilly processing and 2 potato chips unit, 2 mix fruit jam units and 2 orange juice processing units are running successfully at Besa, Beltarodi, Chichbhuvan, Gondbori, Wakodi, Bhiwapur, Nagalwadi and Jamtha. 1000 Nursery citrus plants are ready for budding process at KVK, Nagpur and 2000 new slot is in process. Ten rural youths from Ladgoan, Kukadipanjara village, Tahsil Katol also established their disease free nursery of citrus and Nagpur mandarin after acquiring training under ARYA.

Potato Slicer Machine Installation to Samyak SHG, Besa, Nagpur

Mixed fruit Jam Gravy Installation to Abhiruchi SHG, Nagalwadi, Hingna, Nagpur

KVK GKMS ACROSS

Inauguration of Agro Automatic Weather Station

Agro Automatic Weather Station was inaugurated by Dr. C.D. Mayee, Former Chairman, ASRB, New Delhi.

Impact based forecast and advisory for Nagpur district

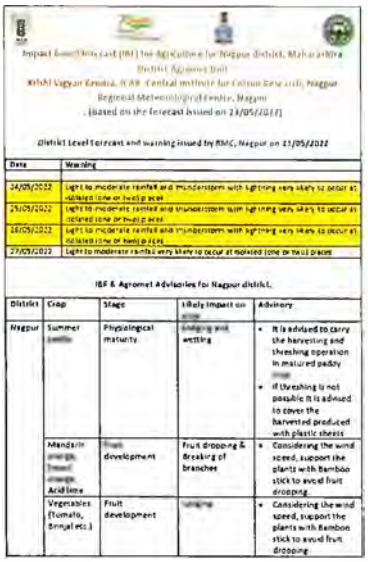
The impact-based forecast and advisory were prepared and disseminated to the different stalkholder in the district before and after occurrence of adverse weather event through email and social media groups. A total of 17 IBF bulletins were

Inauguration of Agro Automatic Weather station at Agromet Observatory of ICAR-CICR, Nagpur

prepared and disseminated to the concern district agriculture department and others stalkholder during 2022.

Nowcast warning-

The nowcast warning and forecast are received from time to time by Regional Meteorological Centre, Nagpur is disseminated to the farmers on priority on their registered mobile number through different social media platform. The nowcast warning includes warning on heavy rainfall, hail, thunderstorm, lightning as well as gusty winds valid for next 3 hours from the nowcast forecast issued.

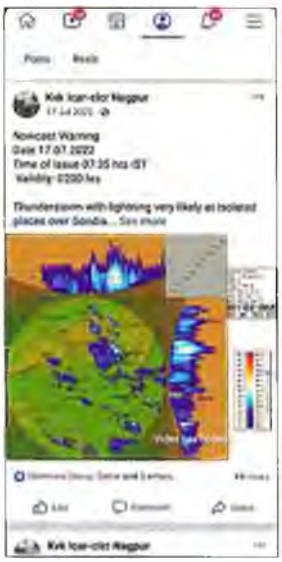


District Level forecast and warning issued by RMC, Nagpur on 23/05/2022

Date	Warning
24/05/2022	Light to moderate rainfall and thunderstorm with lightning very likely to occur at isolated one or two places
25/05/2022	Light to moderate rainfall and thunderstorm with lightning very likely to occur at isolated one or two places
26/05/2022	Light to moderate rainfall and thunderstorm with lightning very likely to occur at isolated one or two places
27/05/2022	Light to moderate rainfall very likely to occur at isolated one or two places

IBF & Agromet Advisories for Nagpur district.

District	Crop	Stage	Likely Impact on	Advisory
Nagpur	Summer paddy	Physiological maturity	Lodging and wetting	• It is advised to carry the harvesting and threshing operation in matured paddy • If threshing is not possible it is advised to cover the harvested produced with plastic sheets
	Mandarin orange, Sweet orange, Acid lime	Fruit development	Fruit dropping & breaking of branches	• Considering the wind speed, support the plants with Bamboo stick to avoid fruit dropping
	Vegetables (Tomato, Brinjal etc.)	Fruit development	Lodging	• Considering the wind speed, support the plants with Bamboo stick to avoid fruit dropping



Impact based forecast and advisory bulletins

Farmers Awareness Programme

A total of 8 farmer awareness programme were conducted at KVK and Villages to aware the farmer for use and application of agromet advisory services in the farm management and use of mobile application like, Meghdoot, Damini, Mausam and Public observation to reduce the risk of adverse weather in the agriculture.

Exposure visit of DAESI participants to Agromet Observatory of ICAR- CICR, Nagpur 30.03.2022

World meteorological day celebrated at KVK and Agromet Observatory on 23.03.2022

Awareness programme on Agromet Advisory Services at RAMETI, Nagpur on 19.03.2022

Awareness programme on Agromet Advisory Services at KVK on 07.02.2022

Dissemination of Agromet Advisory Services

On time Agromet Advisory Services bulletins are currently disseminated to the all block of the district benefitting the farmers, State Agriculture Department, Agricultural Research Station, NGO, SAUs, FPO through different suitable medium.

The following social media platform were created and used for dissemination of Agromet Advisory service.

Sr. No.	Social media platform	No. of farmers
1.	Whats app (214 group)	28676
2.	Whats app community group (1)	2325
3.	mKisan portal (1)	169607
4.	Kisan Sarathi portal (1)	8648
5.	Telegram (3)	1899
6.	Facebook (1)	4946
Total		**216401**

Dissemination of Agromet Advisory Bulletins through facebook and whats app group

mKisan portal

A total of 14 text messages sent to the 2036160 farmer through mKisan portal.

Kisan Sarathi portal

A total of 151 text messages sent to the 8917 farmers through Kisan Sarathi portal.

Integrated farming system for doubling farmer's income

Krishi Vigyan Kendra, Nagpur has developed Integrated Cotton based Farming System module in 2021 covering one hectare area. This IFS is having three component T1 Cotton + Soybean, T2 -T1+ Horticulture and T3 all these components and all animal components of Vidarbha region.

In Horticulture Component all seasonal vegetables of Kharif and Rabi crop is grown organically in three forth acre This is planned in such a way that it start yielding after every 25 days that not only full fill family requirement of vegetables but also fetches price too. This vegetable growing area is maintained by Two women labour manually and women friendly tools. Organic waste is also converted into manure using waste Decomposer. Covering cultivable land with Agri residue is key component of IFS. Cow dung, Jivamrut and fruit fermented juice other liquid juices are applied quarterly for micronutrients. Spraying schedule of Dashparni and Azadirachtin is also maintained which result no infestation of any worms, aphid and Jassid .

Sixty four Guava of L-49 variety are planted in June 2021 on mulch in IFS whereas 179 Mango plants of Amrapali was planted in 4th March2021 in hi-density method.

Till date, nearly 750 Dignitaries, Tribal & Schedule Caste farmers, Farm Women, RAWE students, SHG visited. Skill training on Nursery raising, Seedling transplanting on mulch, Operation of drudgery reduction tools were conducted.

A model of attractive Cole Crops was demonstrated and it is managed with Biological inputs and Bio-pesticides. Vegetable, Mushroom, Eggs, Chicken, Flowers produced in IFS model was sold to CICR Staff by first come first serve basis in Kharif & Rabi season. A low cost, Outdoor, Mobile Oyster Mushroom

Unit is also established in November 2021 for getting vegetable protein source. This unit yielded 11 kg of mushroom in 45 days. Continuous batch of oyster mushroom is planted after every 45 days where Tribal Women farmers were trained in growing Oyster Mushroom. Revenue of Rs. 31765/- was generated from August 2022 to December 2022 This Horticulture Component is designed and maintained by Smt Sunita Chauhan , SMS, KVK, ICAR -CICR, Nagpur

A low cost small model shade for a family 0f 2-4 person for care

and maintenance is also established Cotton, Soybean production in IFS as well as low cost poultry, duck rearing was started in IFS. Goat shade and Desi Cow are also established for training purpose and rearing. A Fish Pond having Rohu, Katla, Mrigal were also put for rearing by Dr Nandankar and Dr. U.V. Galkate. SMS, KVK, ICAR -CICR, Nagpur .

This project is dream project of Dr. Y. G. Prasad, Director ICAR-CICR, Nagpur, Dr S. N. Rokade, Head KVK, ICAR-CICR, Nagpur for doubling farmers income.

Workshop cum training Natural Farming

Krishi Vigyan Kendra conducted workshop cum training on Natural farming under Home Science discipline for farmers, farm women, students and Farmers Producing Organization (FPO) on 17 September 2022. In the inaugural address Dr. S. N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur emphasized the need for popularization efforts for "Natural Farming" and stressed the role to be played by the farmers producing organization. In the technical session demonstration on preparation of Biological inputs viz. Jivamrutham, Panchagavya, Saptdhanankur and preparation of Bio-pesticides viz. Dashparni, LAMIT Ark and Botanicals for the use of Natural Farming by Smt. Sunita Chauhan, SMS, Home Science, KVK, ICAR-CICR, Nagpur. 163 farmers 215 students, FPO Nagpur, Saoner, Hingna were benefited during 2022.

Swachhta Pakhawada was observed from December 16 to December 31, 2022

Krishi Vigyan Kendra, ICAR-CICR, Nagpur Conducted Swachhata Pakhwada from 16/12/2022 to 31/12/2022. Under this program various activities related to cleanliness were carried out.

Meetings/ Workshop/Conference/Training attended

Name of the officials	Name of event	Location	Date
Dr. S. N. Rokde	Action Plan Workshop of KVKs	Dr. PDKV, Akola	05.02.2022
Dr. S. N. Rokde	"Oilseeds, Pulses and Bio-fortified Crops	Webinar	28.04.2022
Dr. S. Y. Wankhede	Implementation of Kisan Sarathi	Online	17.05.2022
Dr. S. N. Rokde	National Workshop of KVKs in India	Dr. PUA, Solan, (HP)	1to2.06.2022
Dr. U. V. Galkate	Review meeting of All KVKs of Maharashtra	ICAR-ATARI, Pune	17.06.2022
Dr. S. N. Rokde & All KVK	SAC Meeting of KVK	KVK, Nagpur	22.06.2022
Dr. S. N. Rokde	Attended Meeting	Nagpur	14.07.2022
Dr. S. N. Rokde	National Workshop of KVKs in India	Anand Agriculture University, Gujarat	7to9.07.2022
Dr. S. N. Rokde & Dr. Deepa Lal	ARYA Meeting	Online	25.07.2022
Dr. S. Y. Wankhed e	Operational and banking issues under KVK GKMS ACROSS	Online	02.08.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	12.08.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	19.08.2022

Name of the officials	Name of event	Location	Date
Dr. S. N. Rokde & All KVK	SAC Meeting of KVK	KVK, Nagpur	22.06.2022
Dr. S. N. Rokde	Attended Meeting	Nagpur	14.07.2022
Dr. S. N. Rokde	National Workshop of KVKs in India	Anand Agriculture University, Gujarat	7to9.07.2022
Dr. S. N. Rokde & Dr. Deepa Lal	ARYA Meeting	Online	25.07.2022
Dr. S. Y. Wankhed e	Operational and banking issues under KVK GKMS ACROSS	Online	02.08.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	12.08.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	19.08.2022
Dr. S. N. Wankhede	District Skill Development Executive Meeting	Collector office, Nagpur	05.09.2022
Dr. S. N. Rokde	Attended Meeting	ATMA, Nagpur	20.09.2022
Smt. Sunita Chauhan	Team Meeting of Gender Nutrition Research Project	Online	06.09.2022
Smt. Sunita Chauhan	Zhilla Committee Member for Input distribution under Chief Minister Food Processing Enterprises	SAO Office, Nagpur	27.09.2022
Dr. S. Y. Wankhede	Fund flow under KVK GKMS ACROSS	Online	29.09.2022
Dr. S. Y. Wankhede	Cluster Facilitation Cell Committee Meeting	Collector office, Nagpur	03.10.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	21.10.2022
Dr. S. Y. Wankhede	CROPSAP	DDA, Plant protection (Online)	04.11.2022
Dr. S. Y. Wankhede	IMD services through CSCs	Online	15.11.2022
Smt. Sunita Chauhan	Revive Meeting of Gender Nutrition Research Project	Online	10.11.2022
Smt. Sunita Chauhan	Revive Meeting of Gender Nutrition Research Project	Online	13.12.2022

Publication/Research Paper

i. Avijit Ghosh, S.K. Mahanta, M.C. Manna, Sultan Singh, Ranjan Bhattacharyya, V.C. Tyagi, J.B. Singh, S.N. Ram, R. Srinivasan, A.K. Singh, Ajita Gupta, Prabhu Govindasamy & S.N. Rokde (2022) "Long Term Grazing Mediates Soil Organic Carbon Dynamics by Reorienting Enzyme Activities and Elemental Stoichiometry in Semi-arid Tropical Inceptisol Journal of Soil Science and Plant Nutrition published online.

Published popular articles

i. Smt. Sunita Chauhan, Dr. S.N. Rokde (2022) "Nutritional products from Soybean" ICAR Kheti Journal in Poshan Visheshank October 2022 pp 15-17

ii. Dr. Deepa Lal, Dr. S.N. Rokde & Jayshree Khobragade (2022) "Value added products on Papaya" ICAR Kheti Journal in Poshan Visheshank October 2022 pp 28-29

Awards received

i. Smt. Sunita Chauhan, SMS, Home Science, KVK, ICAR-CICR, Nagpur has received best oral paper award for presentation on "Organic Olericulture: An approach for soil health management" at 3rd National Conference on Natural, Organic Farming and Chemical Farming in Agriculture – Present scenario and way forward held during 17-19 October 2022 at KVK, Ujjain (M.P.) conducted by society of Krishi Vigyan.

ii. Dr. S.N. Rokde, bagged 1st Prize in Hindi Shuddhalekhan Competition, Hindi Essay Competition & English to Hind Translation Competition, 2nd Prize in Photobased Story Competition and 3rd Prize in Self composed Hindi Poem Competition.

iii. SY. Wankhede, SM. Wasnik, SN. Rokade, JH. Meshram, PS. Gayakwad has received Second best paper presentation award for paper entitled "Farmer Feedback on Weather Based Agromet Advisory Services to Improve Rural Livelihoods - A Way of Making Farmers Self-Reliant in Decision Making in Farm Operations" at National Conference AGRESAR 2022 held at Shri Ramdeobaba College of Engineering & Management, Nagpur during 11th & 12th March, 2022.

Radio Talks (AIR, Nagpur):

i. Smt. Sunita Chauhan, SMS (Home Sci.), KVK, ICAR-CICR, Nagpur on "Cottage level Enterprises for Economic Empowerment" which was broadcasted in All India Radio on dated 14.11.2022

ii. Dr. S. N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur on "Answers to the queries of livestock owners" on All India Radio on dated 04.11.2022

iii. Dr. S. N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur on "Management of hens in winter" on All India Radio on dated 28.12. 2022

iv. Dr. U.V. Galkate, SMS, KVK, ICAR-CICR, Nagpur participated in a Phone in Programe in a series Hello Annadata broadcasted by All India Radio on dated 23.08.2022, 30.08.2022 & 06.09.2022 at 7.30 PM.

TV Talks

i. Dr. Ulhas Galkate, SMS (Veterinary Science), KCK, ICAR-CICR, Nagpur on "Improved breeds of Poultry for Backyard Poultry Farming" in a Krishi Darshan programme telecasted by DDKs Sahyadri channel on 06.04.2022 at 6:00 PM.

ii. Dr. S.N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur on "Doubling farmers income on Rajwade Television Channel, Nagpur on 04.01.2022

iii. Dr. S.N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur on "Management at Milch Animals" in winter on Doordarshan Kendra, Nagpur on 07.01.2022

iv. Smt. Sunita Chauhan, SMS (Home Science) KVK, ICAR-CICR, Nagpur on "Nutrition Garden for Nutrition Sustainability" on Doordarshan Kendra, Nagpur on 01.09.2022

v. Dr. Sachin Wankhede, SMS, Agrometeorology, KVK, CICR, Nagpur Krushi Darshan programme of Doordarshan on the "Hawaman Aadharit Krushi Salla Seva-Shetkaryansathi Wardaan" on dated 16th, March, 2022.

Events conducted by KVK, ICAR-CICR, Nagpur Under Azadi ka Amrut Mahotsav campaign, KVK, ICAR-CICR, Nagpur conducted several programmes to sensitize to the participants including farmers, womens, students and other related stakeholders about the various schemes and relevance of the programme. The programmes or Kisan melas conducted during the year is given in below table:

S.No.	Event/Programme/Kisan Mela	Date	Theme	Participants
1.	National Girl Child Day	24.01.2022	"Empowering girls for a bright future"	
2.	World Pulses Day	10.02.2022	"Atmanirbhar Bharat- Harnessing potential pulses for import substitution"	110
3.	International Women's Day	08.03.2022	"Gender equality today for a sustainable tomorrow"	100
4.	World Water Day	22.03.2022	"Groundwater, making the invisible visible"	100
5.	Kisan Mela in collaboration with ATMA and Directorate of Cotton Development	26.04.2022	"Kisan ki Bhagidari – Parathmikta hamari Abhiyan "	360
6.	Kisan Mela in collaboration with ICAR-CICR, Nagpur	31.05.2022	"Garib Kalyan Sammelan"	1200
7.	International Yoga Day	21.06.2022	"Yoga for Humanity"	60
8.	World Soil Day on 5th December, 2022	05.12.2022	Soils : Where Food Begins	101

10.1: Publications

10.1.1 Research papers (NAAS rating> 6)

1. Alam, Md Shahid, Sharma Monica, Rakesh Kumar, Das Joy, Rode Surabhi, Pravindra Kumar, Ramasare Prasad and Sharma Ashwani Kumar. (2022). In silico identification of potential phytochemical inhibitors targeting farnesyl diphosphate synthase of cotton bollworm (*Helicoverpa armigera*). *Journal of Biomolecular Structure and Dynamics*. (2022): 1-10. (NAAS rating: 10.15)
2. Amutha M, Sankaranarayanan K, Anisha V. (2022). Performance Assessment of Intercrops as Trap Crop for the Management of Thrips in Cotton (*Gossypium hirsutum* L.). Suitable Intercrops for the Management of Thrips in Cotton. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.* 92(4):897–905 https://doi.org/10.1007/s40011-022-01378-8. (NAAS rating: 6.95)
3. Blaise D, Kranthi K, Saxena Sujata, Venugopalan M V and Mohan Punit. (2022). Productivity and fibre attributes of absorbent Asiatic cotton (*Gossypium arboreum*) cultivars in rainfed central India. *Indian Journal of Agricultural Sciences*. 92 (3): 300 -4, March 2022. (NAAS rating: 6.37)
4. Blaise D., Majumdar G., Manikandan A., Santosh S., Velmourougane K. (2022). Subsoiling and crop rotation improve root growth of Bt-cotton in Vertisols. *Current Science*. 123(7), 874-880. (NAAS rating: 7.1)
5. Chakraborty, A., Venugopalan, M.V., Mani, J.K., Bagadkar, A.J. and Manikandan, A. (2022). Rainfed cotton crop in central India is a strong net CO2 sink: An eddy covariance-based analysis of ecosystem fluxes. *Field Crops Research*. 286, p.108595. (NAAS rating: 11.22)
6. Das Joy, Rakesh Kumar, Sharma Ashwani Kumar. (2022). Functional characterization of chitin synthesis pathway genes, HaAGM and HaUAP, reveal their crucial roles in ecdysis and survival of *Helicoverpa armigera* (Hubner) *Pesticide Biochemistry and Physiology*. 188:105273 https://doi.org/10.1016/j.pestbp.2022.105273. (NAAS rating: 9.96)
7. Kumar H., Verma P., John S. A. and Blaise D. (2022). Physiological, biochemical and molecular manifestations in response to seed priming with elicitors under drought in cotton. *Current Science*. 123(5), 658-666. (NAAS rating: 7.1)
8. Kumar, S.; Ahmad, K.; Behera, S.K.; Nagrale, D.T.; Chaurasia, A.; Yadav, M.K.; Murmu, S.; Jha, Y.; Rajawat, M.V.S.; Malviya, D.; Singh, U.B.; Shankar, R.; Tripathy, M.; Singh, H.V. (2022). Biocomputational Assessment of Natural Compounds as a Potent Inhibitor to Quorum Sensors in *Ralstonia solanacearum*. *Molecules* 27: 3034. ttps://doi.org/10.3390/molecules27093034. (NAAS rating: 10.41)
9. Layek, J., Das, A., Ghosh, P.K., Krishnappa, R., Lal, R., Ramkrushna, G.I., Nath, C.P., and Dey, U. (2022). Double no-till and rice straw retention in terraced sloping lands improves water content, soil health and productivity of lentil in Himalayan foothills. *Soil and Tillage Research*. https://doi.org/10.1016/j.still.2022.105381. (NAAS rating: 11.37)
10. Layek, J., Narzari, R., Hazarika, S., Das, A., Krishnappa, R., Devi, S., Balusamy, A., Saha, S., Mandal, S., Ramkrushna G.I., Babu S., Choudhury, B.U., and Mishra, V.K. (2022). Prospects of Biochar for Sustainable Agriculture and Carbon Sequestration: An Overview for Eastern Himalayas. *Sustainability*. 14, 6684. https://doi.org/10.3390/su14116684. (NAAS rating: 9.25)
11. Madhu TN, Rishi Kumar, V ChinnaBabu Naik,Prabhulinga, T., Santosh Savitha, Chandrashekar, N., & Verma, P. (2022). Attraction of leaf hopper, Amrascabiguttullabiguttulla, and whitefly, Bemisiatabaci, toward natural essential oils in Cotton. *Animal Biology*. doi: https://doi.org/10.1163/15707563-bja10095. (NAAS rating: 7.2)
12. Manikandan A and Blaise D. (2022). Customized Complex Fertilizers for Transgenic Bt-Cotton Hybrids Grown on Rainfed Vertisols. *Communications in Soil Science and Plant Analysis*. 53:20, 2789-2796, DOI: 10.1080/00103624.2022.2094395. (NAAS rating: 7.33)
13. Manu D.G, Ramchander S, Sai Rekha K, Aiyswaraya S, Vishnu Varthini N, Manonmani S, Ramanathan A, Devasena N, Saraswathi R, Dhivyapriya D, Subashini G, Baghyalakshmi K, Raveendran M, Jeyaprakash and Robin S. (2022). Genetic dissection of false smut resistance in rice through Genome Wide Association Mapping. *Journal of Phytopathology*. 00:1–18. (NAAS rating: 7.79)
14. Mathyam Prabhakar, Sengottaiyan Vennila, Prasad Y G, G. Srasvan Kumar, Paul RK, S.K. Yadav. (2022). ARIMAX—Artificial neural network hybrid model for predicting semilooper (*Chrysodeixis acuta*) incidence on soybean. *International Journal of Tropical Insect Science*. https://doi.org/10.1007/s42690-022-00887-3 Received: 1 January 2020 / Accepted: 8 September 2022 Published online 28 september 2022. (NAAS rating: 6.77)
15. Md Shahid Alam, Sharma Monica, Rakesh Kumar, Das Joy, Rode Surabhi, Pravindra Kumar, Prasad Ramasare & Sharma Ashwani Kumar. (2022). In silico identification of potential phytochemical inhibitors targeting farnesyl diphosphate synthase of cotton bollworm (*Helicoverpa armigera*). *Journal of Biomolecular Structure and Dynamics* https://doi.org/10.1080/07391102.2022.2025904. (NAAS rating: 9.392)
16. Nagrale, D.T., Gawande, S.P., Shah, V., Verma, P., Hiremani, N.S., Gokte-Narkhedkar, N. & Waghmare, V.N. (2022). Biocontrol potential of volatile organic compounds (VOCs) produced by cotton endophytic rhizobacteria against Macrophomina phaseolina. *European Journal of Plant Pathology*. https://doi.org/10.1007/s10658-022-02490-1. (NAAS rating: 7.91)
17. Pande, R., Shah, V, Verma, P.Gokte-Narkhedkar N. and Waghmare V.N. (2022). Improved bioassay method for

evaluation of oviposition deterrents against Old World bollworm, *Helicoverpa armigera* (Hubner). *Indian Journal of Experimental Biology*. 60, pp. 851-857. (NAAS rating: 6.82)

18. Pandirwar Ashutosh P, Khadatkar Abhijit, Mehta C R, Majumdar Gautam, Idapuganti Ramkrushna Mageshwaran Vellaichamy, Shirale Abhay O. (2022). Technological Advancement in Harvesting of Cotton Stalks to Establish. Sustainable Raw Material Supply Chain for Industrial Applications: a Review *Bio Energy Research*. (NAAS rating: 8.81)
19. Patil Balanagouda, Hegde Vinayaka, Sridhara Shankarappa, Pandian R T P, Thube Shivaji H, Palliath Gangaraj K, Gangurde Sunil S, Jha Prakash Kumar. (2022). Multigene pylogeny and halotype analysis reveals predominance of oomycetous fungus Phytophthora meadii (McRae) associated with fruit rot disease of arecanut in *India Saudi Journal of Biological Sciences*. 29 (2022) 103341 https://doi.org/10.1016/j.sibs.2022.103341 (NAAS rating: 10.22)
20. Patil Balanagouda, Narayanaswamy Hanumappa, Hegde Vinayaka, Sridhara S, Pandian R T P, Thube Shivaji H. (2022). Development and evaluation of fungicide-amended urea briquettes (FAUB's) to combat fruit rot disease of arecanut: A farmers-friendly approooach. *Crop Protection*. 165 (2023) 106155htts://doi.org/10.1016/j.cropro.2022.106155 (NAAS rating: 8.57)
21. Phuke Rahul M, He Xinyao , Juliana Philomin, Kabir Muhammad R, Roy Krishna K, Marza Felix, Roy Chandan, Singh Gyanendra P, Chawade Aakash , Joshi Arun K and Singh Pawan K. (2022). Identification of Genomic Regions and Sources for Wheat Blast. Resistance through GWAS in *Indian Wheat Genotypes Genes*. 2022, March 27, 13, 596.https://doi.org/10.3390/genes13040596. (NAAS rating: 10.1)
22. Rachana R R, Roselin P, Amutha M, Sireesha K and Narasimma Reddy G. (2022). Invasive pest, Thripsparvispinus (Karny) (Thysanoptera:Thripidae) - a looming threat to Indian agriculture. *Current Science*. 122 (2), 211-213. (NAAS rating: 7.1)
23. Rakesh Kumar, Das Joy, Mahto Jai Krishna, Sharma Monica, Shah Vivek, Pravindra Kumar, Sharma Ashwani Kumar. (2022). Crystal structure and molecular characterization of NADP+-farnesol dehydrogenase from cotton bollworm, *Helicoverpa armigera. Insect Biochemistry and Molecular Biology*. 147 (2022) 103812 Received 23 May 2022; Received in revised form 30 June 2022; https://doi.org/10.1016/j.ibmb.2022.103812. (NAAS rating: 10.71)
24. S.P. Gawande, K.P. Raghavendra, D. Monga, D.T. Nagrale, T. Prabhulinga, N. Hiremani, M. Meshram, Sandhya Kranthi, Nandini Gokte-Narkhedkar and Waghmare V N. (2022). Development of loop mediated isothermal amplification (LAMP): A new tool for rapid diagnosis of cotton leaf curl viral disease. *Journal of Virological Method*.306. https://doi.org/10.1016/j.jviromet.2022.114541. (NAAS rating: 8.01)
25. Sain Satish K, Singh Amarpreet, Paul Debashis, Monga D, Rishi Kumar, Verma S K and Tuteja O P. (2022). Plant stands and gap-filling methods affect the productivity of bt cotton hybrid in north western India. *Scientist*. 2023; 2(1):47-57.DOI:https://doi.org/10.5281/zenodo.7536187 (NAAS rating: 6.85)
26. Sain, S.K., Monga, D., Kranthi, S. Hiremani N.S., Nagrale, D.T., Kumar, R.,Verma, S.K. and Prasad, Y.G. (2022). Evaluation of the Bioefficacy and Insecticide Compatibility of Entomopathogens for Management of Whitefly (Hemiptera: Aleyrodidae) on Upland Cotton Under Laboratory and Polyhouse Conditions. NeotropEntomol. 51, 600–612. https://doi.org/10.1007/s13744-022-00964-9. (NAAS rating: 7.43)
27. Savitha S., Velmourougane K., Ramkrushna GI., Manikandan., Blaise D. (2022). Potassium Solubilizing Potential of Native Bacterial Isolates from Cotton Rhizosphere of Rainfed Vertisols. *National Academy Science Letters* 45, 209–212. 2022, 10.1007/s40009-022-01113-x. (NAAS rating: 6.79)
28. Shah Vivek, Pande Rachna, Verma Pooja, Gokte-Narkhedkar Nandini and Prasad Y G. (2022). Oviposition preference of pink bollworm, *Pectinophora gossypiella* (Saunders) on cotton. *Animal Biology*. 72(4), 353-366. doi: https://doi.org/10.1163/15707563-bja10088. (NAAS rating: 7.48)
29. Shinde Swati P, Ingole D B, Biradar V K, Gokte-Narkhedkar Nandini, Lavhe N V, Thube Shivaji H, Shah Vivek and Prasad Y.G. (2022). Efficacy of native strains of entomopathogenic nematode, *Heterorhabditis indica* against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) from India. *Egyptian Journal of Biological Pest Control*. 32, 141. https://doi.org/10.1186/s41938-022-00638-z. (NAAS rating: 8.0)
30 Tenguri Prabhulinga, Chander Subhash, Ellur Ranjith K., Arya P S ., Yele Yogesh. (2022). Deciphering host plant resistance mechanisms of rice genotypes resistant against Brown Planthopper. *Euphytica*.219:8, https://doi.org/10.1007/s10681-022-03136-3. (NAAS rating: 7.9)
31 Thube S.H, Pandian R.T.P, Josephrajkumar A, Bhavishya A, Nirmal Kumar B.J, Firake D.M, Shah, V. Madhu, T.N. Ruzzier, E. (2022). Xylosandrus crassiusculus (Motschulsky) on Cocoa Pods (*Theobroma cacao* L.): Matter of Bugs and Fungi Insects. 13,809. https://doi.org/10.3390/insects13090809. (NAAS rating: 8.77)
32. V ChinnaBabu Naik, Saonerkar Tejaswini D, Chandrashekar N, Pusadkar Pratik P, Kranthi Sandhya , Verma Pooja, Kumbhare Sujit H, Gokte Narkhedkar Nandini and Prasad Y.G. (2022). Biochemical characterization of alkaline phosphatase in midgut of Cry2Ab dosed, pink bollworm, *Pectinophoragossypiella* (Saunders). *Journal of Environmental Biology*. 43(4) (2022). (NAAS rating: 7.5)
33. V ChinnaBabu Naik, Gillesugur Sham Supreeth, Gokte-Narkhedkar N and Prasad Y G. (2022). In vitro rearing protocol for pink bollworm, Pectinophoragossypiella (Saunders) (Gelechiidae: Lepidoptera) on semi-synthetic diet. *Animal Biology*. (72) (2022) 217–225. (NAAS rating: 7.2)
34. Velmourougane K., Manikandan A., Blaise D., Mageshwaran V. (2022). Cotton stalk compost as a substitution to farmyard manure along with mineral fertilizers and microbials enhanced Bt cotton productivity and fibre quality in rainfed Vertisols. *Waste and Biomass Valorization*. 13, 2847-2860. (NAAS rating: 9.7)

35. Velmourougane K., Thapa S., Prasanna R. (2022). Prospecting microbial biofilms as climate smart strategies for improving plant and soil health: A review. Pedosphere. https://doi.org/ 10.1016/j.pedsph.2022.06.037. (NAAS rating: 9.91)

10.1.2 Research papers published by the Institute's scientists NAAS rating < 6

1. Agarwal Isabella, Reddy A R and Singh Amarpreet(2022). Impact assessment of COVID 19 on cotton economy of *India Journal of Cotton Research and Development* 36(2), 244-251, July 2022 (NAAS Rating:4.78)
2. Amutha M(2022).Population dynamics of thrips infesting Bt cotton in relation to weather factors. *Research Biotica* 4(1): 29-32.
3. Amutha M. and Rachana R.R. (2022).Species diversity of thrips on cotton. *Indian Journal of Entomology* 83. Online published Ref. No. e21262. Doi.:10.55446/IJE.2022.522.(NAAS Rating: 5.08)
4. Arude V.G, Sukla S.K and V Chinna Babu Naik (2022). Mechanical gin trash treatments system to prevent transmission of Pink bollworm from Cotton ginneries. *Journal of Cotton Research and Development* 36(1), 111-119. (NAAS Rating:4.78)
5. Avinash,P., Ramathilaga, A. and Valarmathi, P. (2022).Hyperspectral remote sensing for discrimination for plant disease forecasting: Review. *Journal of Pharmacognosy and Phytochemistry* 11(4): 208-215.(NAAS Rating: 5.21)
6. Banu J.G. and Prakash A.H(2022).Compatibility of selective insecticides with Metarhiziumanisopliae (Metchnikoff) (Sorokin,1883).*Journal of Cotton Research and Development* 36(1): 88 - 94 (NAAS Rating:4.78)
7. Divya K., Kaleeswari R K , Jeyanthi D, Amirtham D and Sankaranarayanan K(2022).Evolution of Liquid Multinutrient Fertilizer for Hybrid Cotton. *International Journal of Plant & Soil Science* 34(20): 666-671, 2022 DOI: 10.9734/IJPSS/2022/v34i2031202 (NAAS Rating:5.07)
8. Hatzade, Radhesham V., Mahajan, Sunil S., Lal, Eugenia P., John, S. A. and Shukla, P. K.(2022).Seed viability and vigour assessment of different seed lots of tetraploid and diploid cotton. *Journal of Soils and Crops* 32(1): 212-216. (NAAS Rating:4.5)
9. Hatzade, Radhesham V., Mahajan, Sunil S., Lal, Eugenia P., John, S. A. and Shukla, P. K. (2022).Correlation and regression analysis of standard germination and field emergence with various viability and vigour tests in tetraploid and diploid cotton Journal of Soils and Crops 32(2): 305-311. (NAAS Rating:4.5)
10. Kumbhalkar H B, Gawande V L, Gotmare Vinita, Waghmare V N(2022).Physico-morphological and biochemical studies related to sucking pests in upland cotton (Gossypium hirsutum L.) *Emergent Life Sciences Research* (2022) 8(2): 41-51 (NAAS Rating: 5.41)
11. Manikandan A., K.S. Subramainan, K. Arulmozhiselvan, N. Natarajan, M. Amanullah, Deshmukh Rachana and D. Blaise.(2022).Nanofertilizer Nitrogen Formulations for Enhancing Use Efficiency: A Review. *Agropedology* 32(01), 13-32. doi.org/10.47114/j.agroped.2022.Jun2. (NAAS Rating:3.21)
12. Nagrare, V.S., Fand, B.B., Kumar, R., V ChinnaBabu Naik., Bhure, K., Naikwadi, B., Gokte-Narkhedkar, N and Waghmare, V.N (2022). Arthropod Pests and Their Natural Enemies Associated with Cotton in India: A Review *Indian Journal of Entomology* pp.1-36 (NAAS Rating:5.08)
13. Pande R, Ramkrushna G I, Hiremani, N and Chauhan S(2022).Laboratory evaluation of Dashparni extract against bollworm complex of cotton Pantnagar *Journal of Research* Vol. 20(2), 216-220 (NAAS Rating:3.71)
14. Patra, S., Pande, R. RrumkiHh. Sangma, Ch., BaisSwar, P. and Bhattacharjee, B(2022).Management of ChilopartellusSwinhoe and Stenachroiaelongella Hampson in midhills of Meghalaya. *Indian Journal of Entomology* Online published Ref. No. e21221 Dol.: 10.55446/IJE.2022.430 (NAAS Rating: 5.08)
15. Ramkrushna, G.I., Das, A., Layek, J., Verma, B.C., Babu, S., Mohapatra, K.P. and Shahane, A.A(2022). Assessing maize based cropping systems for higher productivity and income under shifting cultivation in eastern Indian Himalayas. *Indian Journal of Soil Conservation* 50(2): 101-106.(NAAS Rating: 5.28)
16. Ramkrushna, G.I., Layek, J., Das, A., Verma, B.C., Das, S., Mohapatra, K.P. and Ngachan, S.V. (2022).Nutrient management in maize (Zea mays) under shifting cultivation for higher productivity and sustainability in North-East India. *Indian Journal of Agronomy* 67(4): 386-391. (NAAS Rating: 5.55)
17. Rathinavel K, Priyadharshini C and Kavitha H(2022).Use of image based pollen morphology of cultivated cotton species (Gossypium sp) for the establishment of distinctiveness. *Journal of Cotton Research & Development* 36 (1) , 1-8 (January 2022) ISSN No. 0972-8619 (NAAS Rating:4.78)
18. Sabesh M and Prakash A H(2022).Window of opportunity in Natural Fiber for Atmanirbhar Bharat. *Journal of Cotton Research and Development* 36(1): 9-18 (NAAS Rating:4.78)
19. Santhy, V., Mahajan Sunil, Vijayakumari, P.R. and Chaudhary Vaibhav (2022). Effect of Foliar Supplementation on Enhancing Seed Yield and Final Recovery of Processed Seeds in Cotton. *Seed Research* 49(1): 0-0, June, 2021 (NAAS Rating:4.3)
20. Santosh H. B, Ashwini, Santhy V, Raghavendra K P, Kranthi K R and Waghmare V N (2022). Microsatellite marker based DNA fingerprinting of cotton (Gossypium spp.) hybrids and their parents. *Electronic Journal of Plant Breeding* 13 (3) (NAAS Rating: 5.14)
21. Saonerkar Tejaswini D , V ChinnaBabu Naik , Pusadkar Pratik P, Chandrashekar N and Ghongade Dilip Shriram. (2022). In-silico Determination of Insecticidal Potential in Lepidopteron Specific Crystal Toxins with Midgut Alkaline Phosphatase Using Molecular Docking. *Indian Journal of Ecology* 49(2): 520-525. (NAAS Rating: 5.79)
22. Saravanan M, Amudha J, Singh Suman Bala and Tuteja O P(2022).SNP marker evaluation in Genetic Male sterile lines of cotton (*Gossypium hirsutum L*). *Journal of Cotton Research and Development* 36(2).162-165 (NAAS Rating:4.78)
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25. Suhail Ashraf , Nakkeeran S., Saranya N., Jothi G., Banu,J.G., Mohankumar,S., Saravanan R., Mahendra K. and Krishna Nayana R.U (2022).Computational analysis reveals 10-Acetyl-9,10-dihydroacridine as a novel biomolecule from *Bacillus licheniformis*(MW301654) possessing nematicidal property against banana root knot nematode Meloidogyne incognitaBiological Forum14(3): 363-370 (NAAS Rating: 5.11)
26. T. Prabhulinga, Chander Subhash , Arya P S, Bhoi Tanmaya Kumar and Yele Yogesh. (2022) . Mechanism and modifications associated with mimicry and camouflage in butterfly. *Journal of Entomological Research*. 46(3): 667-672(2022) DOI : 10.5958/0974-4576.2022.00115.3 (NAAS Rating: 5.89)
27. Tenguri Prabhulinga, Chander Subhash , Nebapure Suresh, Arya P S, Madhu T N and Yele Yogesh(2022).Effect of silicon amendment on herbivore induced plant volatiles of rice plant infested by brown planthopper Nilaparvata Lugens (Stal) *Indian Journal of Entomology* Online published Ref. No. e22487 Dol.: 10.55446/IJE.2022.595 (NAAS Rating: 5.08)
28. Upendhar S, Vani Sree K and V ChinnaBabu Naik (2022). Molecular Characterization of South Indian Insecticides Resistance, *H. armigera* (Hubner). *Biological Forum- An International Journal* 14(2): 638-644. (NAAS Rating: 5.11)
29. Veeraputhiran R and Sankaranarayanan K(2022).Productivity, nutrient uptake and water use efficiency of irrigated Bt cotton based intercropping systems. *Journal of Cotton Research and Development* 36 (2) 202-207, July 2022 (NAAS Rating:4.78)
30. Venugopalan M V and Abdullah Khalid(2022).Key highlights from papers presented in WCRC-7 (World Cotton Research Conference-7 Cairo, Egypt, 4-6 October 2023)*The ICAC Recorder* December 2022, 19-25
31. Venugopalan M V and Prasad Y G(2022).Scalable Climate Smart Technologies for Sustainable Rainfed Cotton Production In India. *The ICAC Recorder*. Volume XL, No. 2 ISSN 1022-6303
32. Verma Pooja, Hiremani Neelkanth S, Gawande Shailesh P, Sain Satish K, Nagrale Dipak T , Narkhedkar Nandini G, Prasad Y G(2022).Modulation of plant growth and antioxidative defense system through endophyte biopriming in cotton (*Gossypium spp*.) and non-host crops Heliyon 8 e09487 https://doi.org/10.1016/j.heliyon.2022.e09487.
33. Verma S K, Paul Debashis, Goyal Shaifali, Singh Amarpreet, Sain S K, Rishi Kumar and Hamid Hassan(2022).Prediction of Gene Action, Heterosis and Combining Ability to Identify Superior GMS Based Hybrids in Asiatic Cotton (G. arboreum L.).*International Journal of Plant & Soil Science* 34(19): 161-174. (NAAS Rating:5.07)
34. Verma S K, Paul Debashis, Singh Amarpreet , Sain S K(2022). Stability Analysis of Asiatic Cotton (Gossypium arboreum L.) Genotypes with Respect to Seed Cotton Yield, GOT and Boll Weight under Multi Environmental Trials through GGE Biplot Analysis. *Environment and Ecology* 40(4A): 2282-2289 (NAAS Rating: 5.25)

10.1.3 Other Publications

10.1.3.1 Book Chapters

1. Prakash A.H., Baghyalakshmi K., Manickam S., Sabesh M., Sathyakumar, Prasad, Y,G., Singh R.K. (2022). A Journey of AICRP on Cotton- Compendium of Indian Cotton Varieties and Hybrids. All India Coordinated Research Project on Cotton, ICAR-Central Institute for Cotton Research, Regional Station, Coimbatore, 404. p.
2. Prakash A.H., Baghyalakshmi K., Manickam S., Sabesh M., Sathyakumar, Prasad, Y,G., Singh R.K. (2022). Compendium of Indian Cotton Varieties and Hybrids.A Journey of AICRP on Cotton edited by Prakash A.H., Baghyalakshmi K., Manickam S., Sabesh M., Sathyakumar, Prasad, Y,G., Singh R.K. ICAR-Central Institute for Cotton Research, Regional Station, Coimbatore, 404. p.
3. Sarala, K. K. Prabhakara Rao, C. Nanda, K. Baghyalakshmi, Reza Darvishzadeh, K. Gangadhara & J. J. Rajappa (2022). Abiotic Stress Resistance in Tobacco: Advances and Strategies Genomic Designing for Abiotic Stress Resistant Technical Crops edited by Kole, C. Springer, Cham. https://doi.org/10.1007/978-3-031-05706-9_10
4. Singandhupe, R.B., Manikandan, A., Blaise, D. and Chattaraj, S., (2022). Assessment of Climate Reactive Strategies for Improving Cotton Yield in Gujarat, India. Research Highlights in Agricultural Sciences edited by George P. Laliotis, BP International, 978-93-5547-787-3 .eBookISBN:978-93-5547-78 0.10.9734/bpi/rhas/v2/7493F.Vol. 1, Chapter 3.pp.38-61
5. T D Nidheesh, K S Jagadish, C Preethi, C G Arunkumar, T Prabhulinga (2022). Recent genetic tools for the management of stored product pests. Genetic methods and tools for managing crop pests edited by A K Chakravarthy Springer Nature 559-567
6. V.N. Waghmare, M.V. Venugopalan, V.S. Nagrare, S.P. Gawande and D.T. Nagrale (2022). Cotton Growing in India Pest management in cotton : a global perspective LCCN 2021023836 (print) | LCCN 2021023837 (ebook) | ISBN 9781800620216 (hardback) | ISBN 9781800620223 (ebook) | ISBN 9781800620230 (epub) edited by G. A. Matthews, T Miller30-52

10.1.2.2 Training Manuals

1. A H Prakash, J Gulsar Banu and M. Sabesh (2022). Training manual on Cotton production and protection technologies. ICAR-CICR pp01 to 81 (Tamil)
2. Banu,J.G., Sabesh,M. and Prakash, A.H. (2022)Training manual on Mass production of Lecanicillium lecanii. ICAR-CICR pp27 (Tamil)

10.1.2.3 Popular Articles

1. Satish Kumar Sain and Dilip Monga (2022). Proper bioassay method, most virulent and insecticide compatible entomopathogens can help reduce chemical pesticide load to control whitefly in cotton. ICRA- *Cotton Innovations* 2022, 1(12) 7-12
2. Nalayini,P., Sankaranarayanan, K and AH.Prakash (2022). Water smart hi-tech agrotechniques for cotton cultivation in changing climate. *Cotton Innovations* (ICRA) 2022, 1(2)
3. M V Venugopalan, Y G Prasad, Vandana Satish (2022). Game Changing Landmarks and Achievements in Cotton

R&D in Independent India. *Cotton Statistics and News* 2022-23 No. 21 -23rd August, 2022

4. Velmourougane K, Savitha Santosh, Rachna Pande, Dipak Nagrale, P. Nalayini, A. Manikandan, D. Blaise. (2022) Microbial biofilms: An eco-friendly agri-input to enhance soil and cotton productivity. *Cotton Innovate* 1(2), 1-2.
5. Valarmathi, P. (2022) History of root rot fungus in cotton. *AGROBIOS Newsletter*. Vol. XX (11):44-45.
6. Avinash, P. and Valarmathi, P. (2022)Disease resistance in stressed plants *AGROBIOS Newsletter*. Vol. XX (11):48-49.
7. Avinash, P. and Valarmathi, P. (2022) Postharvest diseases of citrus. *AGROBIOS Newsletter*. Vol. XX (12): 56-57
8. Avinash, P. and Valarmathi, P. (2022) Effect of Disease Incidence on the Modification of Nutrient Status of Plant. *AGROBIOS Newsletter*. Vol. XIX (1): 31-33.
9. Avinash, P. and Valarmathi, P (2022) Types of IP protection and patents for microbes *AGROBIOS NewsletterVol*. XXI (3): 74-75.
10. M. Amutha and S. Usha Rani (2022)Tea Mosquito Bug - A New Threat to Cotton crop. *Biotica Research Today* 4(1):023-025.
11. M. Amutha and S. Suriya. (2022) Climate change and cotton insect pests *Agrobios Newsletter* 21(6):54-56.
12. M. Amutha and S. Suriya (2022) Negative externalities of Insecticides. *Agrobios Newsletter* 21(7):64-65
13. V. ChinnaBabu Naik, Dipak T. Nagrale, Y. G. Prasad, Banka Kanda Kishore Reddy and M. Venkataramulu (2022) PrathiloGulabirangupurugunumariyuKayakulluteguluyaza maniaym. (Telugu), *ANGRAU Vyavsayam* monthly Magazine, November, 2022 page No:25-27
14. Rajasekhar. M,Reddy.T.P., V.Chinna Babu Naik, Rajasekhar.B, Satyanarayana.E, Ramakrishna.K, Adi sankar , Asifajahan, Lavanya.M and Gnaneswar.K. (2022) Bottupettu - Gulabirangupurugunupattu (Telugu), *PJTSAU Vyavsayam* monthly Magazine, October, 2022 page No:32-33.
15. V.ChinnaBabu Naik, Sham Supreeth and Banka Kanda Kishore Reddy (2022) Homologises in Pests of Cotton. *Agrobios Newsletter* vol no.XXI, issue no.06, pp-58
16. Banka Kanda Kishore Reddy, SN Malleswari and V,ChinnaBabu Naik (2022) Intercropping -An effective tool to combat pests and pathogens in Cotton. Trends in *Agriculture Science*. Vol.1 (9), December, 2022, pp:385-388
17. Manikandan, A., and Blaise, D. (2022)Contingency measure for cotton during heavy rain at Vidharbha. *Sakal - Agrowon*. Published on 14th July 2022.
18. B. Bhargavi, A. Manikandan and D. Blaise. (2022)Cotton irrigation scheduling using remotely sensed evapotranspiration (ET).*Cotton Innovate*. Volume: 03 (02), pp-15, available at http://www.cicr.org.in/cotton_innovate.htm
19. K. Velmourougane, A. Manikandan, D. Blaise (2022)Microbial dissolution of calcium carbonate: A novel ecofriendly approach to ease soil sodicity. *Cotton Innovate* 03 (02), pp-15, available at http://www.cicr.org.in/cotton_innovate.htm.
20. Baghyalakshmi K. and S. Manickam (2022)Best Linear Unbiased Prediction (BLUP) Based Selection in Cotton for Low Heritability Complex Traits. *'AgriGate* e-Magazine. 2 (3): 4-6.
21. Baghyalakshmi K. (2022)Base editing in crop improvement and a way for cotton genetic enhancement. *AgriGate* e-Magazine. 2 (7): 1-4.
22. Baghyalakshmi K. (2022)Unravelling the functional genomics of stress tolerance of crops using virus-induced gene silencing and its application in Cotton. *AgriGate* e-Magazine. 2 (12): 118-123.
23. Reddy, A.R., Ramkrusha, G.I. and Sundaramoorthy, C (2022)Cotton Marketing in Maharashtra – Issues and Way Forward. *Cotton Statistics and News* 38 (2022-23): 1-6 (20th December, 2022).
24. Prakash. A.H., and Sabesh. M (2022)Contribution of AICRP on Cotton in Changing Indian Cotton Scenario Cotton Innovations - *International Cotton Researchers Association* (ICRA)2022, 1(11)

25 Banu,J.G (2022)Bionematicides in India: Opportunities and Challenges. *Biotica Research* Today4:687-691.

10.2 : List of on-going projects

Programme 1. Accelerating genetic gains for productivity enhancement, fibre quality, stress tolerance and climate resilience using transgenics, genome editing and pre-breeding technologies

Nagpur			
Sl. No.	**Project title and investigators**	**Project type**	**Duration**
1.1	Development of elite Bt cotton varieties using potential non-deregulated transgenic events. VN Waghmare (PI), Vinita Gotmare, G Balasubramani, J Amudha, Saravanan M, Rishi Kumar, V.S. Nagrare	Institute	2018-2023
1.2	Harnessing the potential of wild and unadapted germplasm in cotton improvement- A pre-breeding approach. Vinita Gotmare (PI), SK.Verma, Santosh HB, Chandrashekar N, Rachna Pande, Neelkanth Hiremani, A.H. Prakash, M. Amutha, A. Sampathkumar K. Baghyalakshmi	Institute	2018-2023
1.3	Collection, conservation, evaluation, documentation and maintenance of germplasm of cultivated species of Gossypium. Vinita Gotmare (PI), Sunil S. Mahajan, M. Saravanan, Neelakanth S. Hiremani, Manickam, A.H. Prakash, A. Manivannan, SK. Verma, Debashis Paul, Anjali Kak	Institute	2018-2023
1.4	Development of heterotic pools in *hirsutum* cotton. D.V. Patil (PI), Rahul M Phuke	Institute	2020-2025
1.5	Development of elite Bt cotton varieties using deregulated transgenic events. Santosh HB (PI), V.N. Waghmare, D.V. Patil, V. Santhy, Raghavendra KP, Rakesh Kumar, MV Venugopalan, Ramkrushna GI, Shah Vivek, Neelakanth S. Hiremani, Manickam, K. Baghyalakshmi, A. Sampath kumar, S.K. Verma, Rishi Kumar, S.K. Sain	Institute	2018-2023
1.6	Development of *Bt* hybids in tetraploid cotton with high yield, superior fibre quality and tolerance to jassids. M. Saravanan (PI), Rahul M Phuke, Chandrashekar N, Prabhulinga T	Institute	2022-2027
1.7	Advancement of MAGIC population to development of core set for genetic mapping and identification of potential inbred lines. Rahul M. Phuke (PI), YG. Prasad	Institute	2022-2026
1.8	ICAR project on Seed Production in Agricultural Crops and Fisheries. P. R.Vijayakumari, (Nd Officer), V. Santhy, Sunil Mahajan, K. Santosh HB, Rathinavel, Debashis Paul	MSP, ICAR	2007-2023
1.9	Seed priming through Nano particles to induce early seed germination and enhanced seedling vigor in cotton. V. Santhy (PI), K. Rathinavel	Ad-hoc	2022-2023
1.10	Development of Quality Seed Production Protocol in Cotton. Sunil S. Mahajan (PI), V. Santhy, P.R. Vijayakumari, G. I. Ramkrushna	Institute	2022-2024
1.11	An efficient regeneration system for transformation studies with *ClCRcry2Ab1Ac* and fiber strength genes in Cotton (*G. hirsutum*). G. Balasubramani (PI), J. Amudha, K.P Raghavendra, Chandrashekar N, Joy Das, Rakesh Kumar	Institute	2017-2023
1.12	Validation of molecular markers and genes linked to drought tolerance in cotton. J. Amudha (PI), Suman Bala Singh, Jayant Meshram, M. Saravanan	Institute	2021-2024
1.13	Exploration of genomic resources for identification of candidate genes and promoters for cotton improvement. Raghavendra KP (PI), Chandrashekar N, Pooja Verma, Joy Das, Rakesh Kumar	Institute	2020-2025
1.14	Targeted mutagenesis of ghPHYA1 through CRISPR/Cas9 in Cotton. Chandrashekar N. (PI)	Institute	2017-2023
1.15	Molecular Characterization of EPSPS Gene in Cotton Germplasm for the Development of Herbicide Resistant Cotton Through CRISPR/Cas9. Chandrashekar. N (PI), M. Saravanan	Institute	2021-2024
1.16	Identification, Cloning, and functional validation of genes/enzymes involved in chitin biosynthesis pathway of Cotton Pink Bollworm (*Pectinophora gossypiella*). Joy Das (PI), Raghavendra KP, Rakesh Kumar	Institute	2021-2024
1.17	Study on hormonal regulation of Bt toxin resistance in Pink bollworm. Rakesh Kumar (PI), Joy Das	Ad-hoc	2022-2023
1.18	Precise base editing in Acetolactate synthase gene (*ALS* Gene) for herbicide tolerance in Cotton. Rakesh Kumar (PI), Joy Das	Institute	2022-2027
Coimbatore			
1.19	Development of high strength cotton genotypes by reducing the short fiber content.S. Manickam (PI), A. H. Prakash, Gulsar Banu	Institute	2017-2025
1.20	National Seed Project (Crops). K. Rathinavel (PI), P.R.Vijayakumari	NSP, ICAR	1999-2023

Sl. No.	Project title and investigators	Project type	Duration
1.21	Implementation of PVP legislation 2001 and DUS testing of cotton under ICAR-SAU system. K. Rathinavel (PI), P.R.Vijayakumari, V. Santhy	DUS, ICAR	2003-2023
Sirsa			
1.22	Development of varieties of upland cotton having better fibre traits and tolerance to CLCuD. S. K. Verma (PI), V. N. Waghmare	Institute	2017-2025
1.23	Physiochemical traits determining genotypic response towards Accelerated Ageing process in Cotton. Debashis Paul (PI), V Santhy, Sunil Mahajan	Institute	2021-2024
Programme 2. Development of ecologically compatible integrated pest management strategies for existing and emerging pests under conventional and niche area cotton production systems			
Nagpur			
Sl. No.	**Project title and investigators**	**Project type**	**Duration**
2.1	Investigations on bioefficacy of entomopathogens against cotton Pink bollworm, *Pectinophora gossypiella* Saunders. V. S. Nagrare (PI), Chinna Babu Naik, Shailesh P. Gawande, Dipak T. Nagrale, J. Gulzar Banu	Institute	2020-2023
2.2	Crop pest surveillance and advisory project (CROPSAP) in Maharashtra. V. S. Nagrare (PI)	CROPSAP	2010-2023
2.3	Insecticide Resistance Management (IRM): Dissemination of Pink bollworm Management Strategies. V.S. Nagrare (PI), CoPIs: V. Chinna Babu Naik, Rachana Pande, Neelkanth Hiremani, S.P. Gawande, B.B. Fand, D.T. Nagrale, S.S. Patil, K. Rameash, Rishi Kumar, S. K. Sain, J. H. Meshram, K. Shankarganesh, Prabhulinga T.	IRM-DAC	2018-2023
2.4	Multi-pronged bio-rational management of Pink bollworm (PBW), *Pectinophora gossypiella* (Saunders) on cotton in India. V. Chinna Babu Naik (PI), YG Prasad, BB Fand, Rishi Kumar, K Rameash	Institute	2021-2024
2.5	Monitoring for shifts in susceptibility in populations of cotton bollworms to Bt cry toxins. MAHYCO I: *Helicoverpa armigera* and *Pectinophora gossypiella* against Cry 1Ac protein in various cotton growing regions of the country. Vivek Shah (PI), V. Chinna Babu Naik (Co-PI) MAHYCO II: *Helicoverpa armigera* and *Pectinophora gossypiella* and leaf eating caterpillar (*Spodoptera litura*) against Cry 2Ab and Cry 1Ac+ Cry 2Ab protein in various cotton growing regions of the country. V. Chinna Babu Naik (PI), Vivek Shah (Co-PI)	MAHYCO -BCS	
2.6	Evaluation of nectariless Rasi cotton hybrids against bollworms. Chinna Babu Naik (PI)	Rasi seed	2021-2022
2.7	Identification of Host Cues from Cotton (*Gossypium hirsutum*) to elicit behaviour of female Pink bollworm (*Pectinophora gossypiella*). Rachna Pande (PI), Prabhulinga T, Pooja Verma	Institute	2022-2025
2.8	Revisiting the ETLs and yield loss assessment for cotton pink bollworm. Babasaheb B Fand (PI), Vivek Shah, Dipak Nagrale	Institute	2021-2024
2.9	Monitoring insecticide resistance in American bollworm, *Helicoverpa armigera* Hubner populations from cotton growing regions of Maharashtra and Gujarat. Shah Vivek (PI), Rachna Pande	Institute	2021-2026
2.10	Investigations on host plant resistance mechanisms in cotton genotypes against thrips. Prabhulinga T (PI), Shivaji Thube, Pooja Verma	Institute	2022-2025
2.11	Development of EPF (*Beauveria bassiana* and *Metarhizium anisopliae*) & EPN based bio-formulation for sustainable management of pink bollworm and sucking pest complex in cotton. Shivaji Hausrao Thube (PI), Nandini Gokte-Narkhedkar, Prabhulinga T.	Institute	2022-2025
2.12	Studies on Boll rot in cotton - Etiology and Management. Dipak T. Nagrale (PI), B.B.Fand	Institute	2020-2025
2.13	Studies on target leaf spot of cotton caused by *Corynespora cassiicola*. S.P. Gawande (PI), S.K.Sain, Chandrashekhar N.	Institute	2020-2025
2.14	Studies on grey mildew disease of cotton caused by *Ramularia areola*. Neelkanth Hiremani (PI), P. Valarmathi	Institute	2020-2025
2.15	Bioprospecting microbial volatiles for plant growth promotion and sucking pest (Whitefly and Jassids) management in Bt cotton. K. Velmourougane (PI)	SERB-DST	2019-2023
Coimbatore			
2.16	Unraveling the Differential Expressed Proteins (DEP) in cotton genotypes with contrasting resistance to leafhopper and development of the protein biomarkers/functional markers for leafhopper resistance. A Manivannan (PI), K Shankarganesh	DST-CRG	2021-2024

Sl. No.	Project title and investigators	Project type	Duration
2.17	Development of AI enabled pheromone trap for lepidopteran pests and multi-fin glue trap for sucking pests on cotton. K. Rameash (PI), M. Sabesh	Institute	2022-2025
2.18	Biology and holistic management strategies for emerging pest Tea mosquito Bug (*Helopeltis*) in Cotton. M. Amutha (PI)	Institute	2020-2023
2.19	Development of sociochemical based attractants for sustainable management of cotton stem weevil *Pempherulus affinis* (Faust) Curculionidae: Coleoptera). Shankarganesh (PI)	SERB-DST	2022-2025
2.20	Identification and genetic variability of Alternaria and Cercospora isolates of cotton using molecular markers. A. Sampathkumar (PI)	Institute	2021-2024
2.21	Studies on rust disease of cotton caused by *Phakopsora gossypii* and *cotton* necrosis *disease* caused by TSV, its management. P. Valarmathi (PI)	Institute	2021-2024
2.22	Studies on plant parasitic nematodes of cotton. J. Gulzar Banu (PI), Nandini Gokte Narkhedkar	Institute	2020-2025
Sirsa			
2.23	Whitefly: Studies on ecology and host plant resistance. Rishi Kumar (PI), S.K. Sain, Prabhulinga. T	Institute	2020-2023
2.24	Thermal stress induced effect on insecticide susceptibility and fitness traits in whitefly, *Bemisia tabaci, a* serious pest of worldwide concern. Rishi Kumar (PI), Debashis Paul, Baba Saheb Fand	DST-CRG	2022-2025
Programme 3. Development of efficient resource management technologies for precision farming, smart cotton production, mechanical harvesting and high-density planting			
Nagpur			
Sl. No.	**Project title and investigators**	**Project type**	**Duration**
3.1	ICAR-Network Project on Precision Agriculture. Y.G. Prasad (PI), Director, CICR, Blaise Desouza, Gautam Majumdar, R. Raja, Amarpreet Singh, K. Rameash, C.B. Naik, B. Fand, Shailesh Gawande, Dipak Nagrale, N. Hiremani, B. Bhargavi, P. Nalayini, A. Manikandan, D. Kanjana, J.H. Meshram, Pooja Verma	NePPA	2022-2027
3.2	Long-term impacts of sub-soiling and cover crop rotation on soil properties and N requirement of cotton. D. Blaise (PI), Co-PIs: G. Majumdar, B. Bhargavi, K. Velmourougane, J. Somasundaram (IISS)	Institute	2022-2024
3.3	Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem: Integrating ground observations, satellite data and modelling. M.V. Venugopalan (PI), A. Manikandan	NCP	2017-2023
3.4	Evaluation and validation of enriched pressmud cake, nano seed inoculants, soil and foliar nutrient formulations for rainfed cotton. A.R. Raju (PI), Amarpreet Singh	Institute	2022-2025
3.5	Estimating water footprint in cotton production system. B. Bhargavi (PI), Blaise D, P. Nalayini	Institute	2019-2023
3.6	Evaluation of chemical defoliants augmenting leaf senescence for mechanical picking in Bt Cotton. J.H. Meshram (PI)	DST-SERB	2022-2025
3.7	Nutrient profile-based fertilizer management in rainfed Bt-Cotton – A. Manikandan (PI), B. Bhargavi	Institute	2022-2025
3.8	Evaluation of biochar nutrient composites to improve nutrient use efficiency for cotton grown at calcareous soils. A. Manikandan (PI), D. Blaise, K.M. Manjaiah, KA Chobhe	Adhoc	2022-2023
3.9	Efficacy evaluation of ICAR-CIRCOT Nano-ZnO as Nano-fertilizer in field crops. CCPIs: A. Manikandan, D. Kanjana	CIRCOT	2021-2023
3.10	Phytohormone profiling by targeted metabolomics in cotton. Pooja Verma (PI), Joy Das	Institute	2021-2024
3.11	Microbial dissolution of carbonate to ameliorate soil sodicity in Black Soil Regions of Maharashtra. K. Velmourougane (PI), A. Manikandan, D. Vasu (NBSS & LUP)	Institute	2019-2023
3.12	Land resource inventory of Pench National Park for ecological restoration (NBSS & LUP, Pench Tiger Reserve Project). K. Velmourougane (Co -PI)	Maharashtra Forest Dept.	2020-2023
3.13	Evaluation of genotypes, defoliants, and growth regulators for different hybrids/varieties under HDPS for machine picking of cotton. G. Majumdar (PI), J.H.Meshram, Blaise D, Ramkrushna GI, R. Raja, Amarpreet Singh	Institute	2019-2023
3.14	Development of tractor operated brush type cotton harvester. Dr AP Pandirwar, ICAR-CIAE, Bhopal, G. Majumdar (Co-PI), Ramkrushna GI	Collaborative project	2021-2023

Sl. No.	Project title and investigators	Project type	Duration
Coimbatore			
3.15	Crop-weed interaction under ambient and elevated CO_2 conditions. P. Nalayini (PI), A.H.Prakash, M. Amutha	Institute	2020-2023
3.16	Evaluation of agro techniques to overcome the impact of weather aberrations (drought, water logging) in ELS cotton. K Sankarnarayanan (PI), M. Amutha, J. Annie Sheeba, P. Vala rmathi, J.H.Meshram, B. Bhargavi	Institute	2020-2023
3.17	Active Optical Sensors based Nitrogen Management and Yield Prediction in Cotton using Unmanned Aerial System. R. Raja (PI), D. Kanjana, T. Arumuganathan (SBI, Coimbatore)	Institute	2021-2024
3.18	Effect of long-term application of organic and inorganic sources of nutrients on continuous cultivation of Bt and non Bt cotton with maize and wheat cropping system under irrigated conditions. D. Kanjana (PI), K. Sankaranarayanan, Amarpreet Singh	Institute	2017-2023
3.19	Formulation of Customized fertilizers for Cotton. D Kanjana (PI), R. Raja, Usha Rani	Institute	2021-2025
3.20	Development of a nutrient and plant hormone- enriched foliar formulation for cotton. J. Annie Sheeba (PI), D Kanjana	Institute	2021-2024
Sirsa			
3.21	Conservation agriculture practices for cotton-wheat system. Amarpreet Singh (PI), G. Majumdar	Institute	2022-2027
3.22	Management options for poor root development in Hybrid Bt cotton. Amarpreet Singh (PI)	Adhoc	2022-2023
Programme 4. Genetic improvement and development of production and protection technologies for desi, organic, ELS and naturally coloured cotton			
Sl. No.	Project title and investigators	Project type	Duration
Nagpur			
4.1	Development of broad based high yielding varieties of diploid and tetraploid cotton through recurrent selection. V.N. Waghmare (PI), S. K Verma	Institute	2020-2026
4.2	Development of Asiatic cotton (*G. arboreum*) genotypes with high yield and improved fibre quality traits. M. Saravanan (PI), V.N. Waghmare	Institute	2015-2023
4.3	Validation and refinement of organic cotton production technology. Ramkrushna G.I (PI), Rachna Pande, Neelakath S. Hiremani, Savitha Santosh	Institute	2021-2027
Coimbatore			
4.4.	Breeding for high yielding, early maturing sucking pest tolerant extra-long staple G. barbadense genotypes with improved fibre properties. A. Manivannan (PI), K. Rameash	Institute	2017-2025
4.5	Induced Mutagenesis for Improvement of ELS (*G. barbadense*) cotton. A. Manivannan (PI), S. Manickam, K. Rathinavel, K. Shankarganesh, A. Sampathkumar	Institute	2020-2025
4.6	Development and Evaluation of ELS interspecific hybrids with better yield and fiber quality. K. Baghyalakshmi (PI), M. Amutha, A. Sampathkumar	Institute	2019-2024
4.7	Sustainable Intensification of Extra Long Staple Cotton Production in South Zone. R. Raja (PI), J Annie Sheeba, K. Rathinavel	Institute	2019-2023
4.8	Development of biocontrol consortia with multifaceted fungi for the management of important pests and nematodes of cotton. Gulzar Banu (PI), M. Amutha, Shivaji Thube	Institute	2020-2025
Sirsa			
4.9	Collection, characterization and evaluation of beneficial fungal microorganisms from North, Central and South Cotton growing zones. S.K. Sain (PI), Nandini Gokte Narkhedkar, S.P. Gawande, P. Valarmathi, Savitha Santosh	Institute	2020-2025
Programme 5. Socio-economic dimension of cotton production system, technology dissemination, outreach, impact assessment and industrial linkages			
Sl. No.	Project title and investigators	Project type	Duration
Nagpur			
5.1	Landscape Diagnostic Survey (LDS) of cotton production practices and crop performance in Maharashtra. YG. Prasad, Director, CICR (PI), A.R.Reddy, M.V. Venugopalan, Ramkrushna GI, Shailesh Gawande, M. Sabesh	RGTC	2022-2024

Sl. No.	Project title and investigators	Project type	Duration
Coimbatore			
5.2	Technology Impact and Need Assessment to Address Productivity, Sustainability and Climate Change Challenges of Indian Cotton. S. Usha Rani (PI), K. Sankaranarayanan, J. Annie Sheeba, M. Amutha	Institute	2022-2024
5.3	ICT Dissemination of Cotton Technologies for Production Augmentation and Knowledge Empowerment S. Usha Rani (PI), M. Sabesh, JH. Meshram, SK. Sain	Institute	2022-2025
5.4	Economic Analysis of Value Chain of the Cotton Market in Tamilnadu. Isabella (PI)	Institute	2020-2023
5.5	Development of web-based Cotton data query system. M. Sabesh (PI), AR Reddy, Sunil Mahajan, Isabella	Institute	2021-2026

10.3: Consultancy, Patents, Commercialization of Technology

10.3.1 Contract Research / Revenue generation

Items	Amount (Rs. in Lakhs)
Commercialization of varieties	30,00,000
Seed/ planting material sale	40,000
Sale of other products	

10.3.2 MoU Signed:

Sl. No	ICAR-CICR signed MoU/ MTA with Institutions	Date	Area of work
1.	World Wide Fund For Nature-India (WWF India), New Delhi.	1 January 2022	Soil Testing Services related to Regenerative Agriculture
2.	Rasi Seeds Pvt. Ltd, Coimbatore.	1 April 2022	Evaluate Nectariless Rasi Cotton hybrids against pink bollworm and American Bollworm on Cotton
3.	Nuziveedu Seeds Ltd. Telangana	18 May 2022	High Density Panting System pertaining to canopy and nutrient management through consultancy agronomy Trails/ Demos.
4.	Dinkar Seeds Pvt. Ltd., Gujarat	14 June 2022	Seed production and commercialization of Bt cotton varieties developed by ICAR-CICR, Nagpur.
5.	ATGC Biotech Pvt. Ltd., Hyderabad	27 June 2022	Evaluate "Wax based Gossyplure 4 % (RTU), slow-release mating disruption formulation for effective pest management for Pink bollworm in cotton"
6.	Bombay Super Hybrid Seeds Ltd., Rajkot	27 June 2022	Multiplication and commercialization of Bt cotton varieties.
7.	AlpGiri Seed Sciences Private Ltd., Gujarat	29 June 2022	Multiplication and Commercialization of Bt Cottonvarieties.
8.	Isha Agro Sciences Pvt. Ltd , Pune	16 July 2022	"Test Cotton Pro-Phite (potassium salt of active phosphorus) PSAP product trial in 2022-23".
9.	ITC Limited, Kolkata	19 July 2022	Advisories to the farmers associated with the eChoupal network.
10.	Pinnacle Agri Sciences Pvt. Ltd , Andhra Pradesh	29 July 2022	Seed production and commercialization of "Bt cotton varieties" developed by ICAR-CICR.
11.	Nirupama Seeds Pvt. Ltd, Hyderabad	29 July 2022	Seed production and commercialization of "Bt cotton varieties" developed by ICAR-CICR.
12.	Sahaja crop sciences Pvt. Ltd., Andhra Pradesh	29 July 2022	Seed production and commercialization of "Bt cotton varieties" developed by ICAR-CICR.
13.	Welspun Foundation For Health and Knowledge, Gujarat.	30 September 2022	Non GM Cotton varieties to organic cotton growers in Central Southern part of India.
14.	Rallis India Ltd, Bangalore.	30 November 2022	Evaluate Cr Protein provided by Rallis against population of Pink bollworm, Pectinophora Gossypiella (Saunders)

10.4: Research Advisory Committee (RAC) meeting

The third meeting of the current Research Advisory Committee (RAC) of ICAR-Central Institute for Cotton Research (CICR), Nagpur was held on 7th and 8th December 2022 under the Chairmanship of Dr. S.A. Patil, Former Chairman, Farmers' Commission of Karnataka, Former Director ICAR-IARI, New Delhi and Former Vice Chancellor UAS, Dharwad.

Dr. O M Bambawale, Dr. A. J. Shaikh, Sh. Srirang Devaba Lad attended in physical mode and Dr. R.K. Singh, Prof. S S Siwach, Dr. A R Sharma attended through virtual mode. Dr. Y. G. Prasad, Director; Dr. V.N. Waghmare, Dr. D. Blaise, Dr. Nandini Gokte Narkhedkar, Dr. AH Prakash, Dr. S.K.Verma, Dr. M.V. Venugopalan, Dr. S N Rokde, Dr. K.P. Raghavendra and Dr. K. Velmourougane also participated in the meeting.

Dr. M. V. Venugopalan, Member Secretary, welcomed the Chairman and the other members of the RAC. Dr. Y.G. Prasad, Director, ICAR-CICR also extended a formal welcome and appraised the RAC on the salient achievements of the Institute and new initiatives at ICAR-CICR.

The Chairman Dr. S.A. Patil in his introductory remarks briefed about the current national cotton scenario and the global dynamics in the cotton economy. He added that there is a need to keep a balance among the different categories of cotton produced. He exhorted ICAR-CICR to take up the challenge of improving the cotton productivity of India to the global average. Innovative technologies developed by the institute need to be up-scaled.

Dr. M. V. Venugopalan presented the Action Taken Report on the recommendations of the previous RAC meeting held on 17th & 18th November, 2021. Dr. Y.G. Prasad appraised the RAC about the salient research achievements for the period during 2021-22 and highlighted the recent R&D initiatives. The Heads of the Divisions and Regional stations presented the salient achievements of the research undertaken by their divisions/stations. The Chairman and Members of the RAC also visited the experimental fields, polyhouse and laboratories. The scientists interacted with the experts and explained the objectives of the work being undertaken and the research findings that are emerging.

Dr. S. A. Patil addressed all the scientists through hybrid mode (physical and virtual). He appreciated the research achievements of ICAR-CICR and urged the institute to work on popularization of CICR Bt varieties and integrate all the available technologies to achieve at least 50 quintals yield/ha. He appreciated the conduct of RAC meeting and urged the institute to include the valuable suggestions been made by the members during the meeting in the research programmes of the institute. The RAC meeting was concluded with the vote of thanks proposed by Dr. Y.G. Prasad, Director, ICAR-CICR, Nagpur.

The committee proposed the following recommendations and the same were subsequently approved by the Council.

1. Bt cotton seed production should be done in participatory mode on a large scale. Participatory breeding programme can be conducted in collaboration with other centres to avoid the burden and shortage of scientists.
2. Breeding programme can be redesigned and re-oreintated based on market demand and supply competitors. Targeted breeding programme by integrating different disciplines to design ideal plant type for different growing situations, suitable agronomy for different ecologies, and plant protection to achieve potential target of 100 Q/ha may be initiated. Different groups of scientists to be identified to work on specific traits on a project mode with time frame, milestones and deliverables
3. Targeted genome editing work for enhancing stress tolerance, yield and fibre quality traits to be fast tracked. Cotton biotechnology should be further strengthened through collaborations for the identification of newer genes and development of transgenic events (*cry1D*) for pink boll worm management
4. Under the flagship programme on "*Smart cotton production for yield maximization in cotton*" one popular Bt hybrid and Bt variety of the institute must be demonstrated in the Technology Park. Mechanization of cotton cultivation to be included in the smart cotton project. CICR should concentrate on work related to canopy management, defoliants and boll openers to facilitate mechanical harvesting.
5. A status paper on the success story of conservation agriculture in cotton and cotton-wheat systems in North-West India should be brought out
6. Work on the use of AI, robotics and drones may be intensified. Sensor-based applications may be developed and validated in PPP mode for precision crop protection and production. Such technologies are to be demonstrated in the research farms.
7. Studies on effect of salicylic acid, melatonin etc to alleviate abiotic stresses including water-logging should be intensified and physiological mechanisms behind their effect should be investigated. Cost benefit ratio of their application in field must be quantified.
8. Best management practices- raised bed, drip-fertigation, canopy management showcased in the Technology Park may be demonstrated on farmers field for maximizing yield
9. Causal agent for external and internal boll rot of cotton has to be identified and confirmed. The pre-disposing factors may be established.
10. Microbial volatiles are being evaluated for insect pest management. These volatiles may be evaluated for their efficacy on different cotton pathogens (*Rhizoctonia, Macrophomina, Fusarium, Myrothecium, Corynespora, Ramularia*)

10.5 : Other Important Meetings/Events

10.5.1: Meetings

Annual Institute Research Committee (IRC) meeting - 2022

The Annual Institute Research Committee (IRC) - 2022 meeting of ICAR-CICR was conducted as a combined IRC for ICAR-CICR, Nagpur, ICAR-CICR, RS, Coimbatore, and ICAR-ICAR, RS, Sirsa from 15-17, 22-26 March, and 18-April 19, 2022, at ICAR-CICR, Nagpur in both physical and virtual mode. Dr. Y.G. Prasad, Director and Chairman, IRC chaired the meetings. All the Heads of Divisions, Heads of Regional Stations, Head, PME Cell, Secretary, IRC, and all the Scientists of ICAR-CICR participated in the deliberations. Director presented the details of EFC 2021-26 under the five major research programs. He also presented the RAC action points, action points from DDG, CS review. The Director also discussed the progress of technology park initiation, status of collaborating institutes, MOU proposals, new research proposals, notable initiatives from the institute, workshop, interface meetings, publications, etc. Dr. K. Velmourougane, Secretary, IRC, presented the Action Taken Report (ATR) of the previous IRC (2021), and the IRC confirmed the ATR of the last IRC meeting. In the IRC-2022, 24 projects were approved for closure on completion and 24 new projects were approved. After the project matrix finalization, 83 projects (67 institute and 16 externally funded projects) are listed as ongoing projects. During the IRC 2022, Dr. OM. Bambawale (Member, RAC), Dr. M. Nagesh (Director, NBAIR), and Dr. Rabi Narayan Sahoo (Project leader NePPA project) visited ICAR-CICR, took part in some of the deliberations, and offered their ideas and suggestions. Dr. K. Velmourougane, Secretary IRC and Dr. Chinnababu Naik, Joint Secretary IRC coordinated the meeting.

Stakeholders Interface Workshop Pre-Kharif consultation on Technologies and best practices for enhancing cotton productivity

ICAR-Central Institute for Cotton Research (CICR), organized a "Stakeholders Interface workshop- Pre-Kharif consultation on technologies and best practices for enhancing cotton productivity" on 7th May, 2022 at VANAMATI, Nagpur. Shri. Sunil Chhatrapal Kedar, Hon'ble Minister of Animal Husbandry, Dairy Development, Sports & Youth Welfare, (Cabinet Minister Govt. of Maharashtra) graced the event as Chief Guest. Dr.C. D. Mayee, Ex-Chairman (ASRB) & Ex-Director (ICAR-CICR), Dr. V.M Bhale, Hon'ble Vice Chancellor, Dr PDKV, Akola, Maharashtra also grace the workshop. Three hundred and sixty farmers participated in the workshop.

Orientation Workshop of IRM

The Orientation Workshop of Insecticide Resistance Management (IRM): Dissemination of Pink Bollworm Management Strategies 2022-23 was held on 19thJuly, 2022 through video conferencing. During 2022-23, the project was approved for implementation across north, central and south India covering 41 districts of 11 major cotton growing states.

Dr YG Prasad, Director, ICAR-CICR, Nagpur chaired the meeting. Dr AL Waghmare, Director, Directorate of Cotton Development (DCD), Government of India, Nagpur and other officials of ICAR-CICR, Nagpur were prominently present. Dr Y. G. Prasad in his opening remarks updated the cotton scenario in India in the current season. He stressed the implementation of the project in all the cotton growing states with special emphasis on pink bollworm management strategies involving SAUs, ATARIs and KVKs located in 41districts. Dr AL Waghmare appraised the implementation of National Food Security Mission (NFSM) in India. Dr VS Nagrare presented project details including objective, budget and manpower allocation, technology interventions, outreach activities to be carried out, technical backstopping, Annual Action Plan 2022-23, and points of impact assessment at the end of the financial year, etc. Coordinators from 41 districts of 11 states ICAR-CICR, DCD, 10SAUs, 6 ATARIs and 20 KVKs participated in the workshop.

3rd Interface Meeting on prevailing Cotton issues in North Zone

3rd Interface Meeting on prevailing Cotton issues in North Zone" was organized at ICAR-Central Research Institute for Cotton Research, Regional Station, Sirsa, on September 16, 2022 on the occasion of "Azadi Ka Amrit Mahotsav" under the Chairmanship of Hon'ble Vice Chancellor, Prof. B. R. Kamboj, CCS HAU, Hissar, Haryana, Dr. R. K. Singh, ADG (Commercial Crops), ICAR, New Delhi and Dr. Sumita Misra, Additional Chief Secretary (Agriculture & Farmers Welfare), Govt. of Haryana were the special guests. Dr. S. K. Verma, Head (I/c), ICAR-CICR Regional Station, Sirsa, Haryana welcomed the Dignitaries including Dr. Y. G. Prasad, Director, ICAR-Central Research Institute for Cotton Research, Nagpur, Maharashtra; Dr. A. H. Prakash, PC-AICRP on Cotton& Head, ICAR-CICR Regional Station, Coimbatore; Dr. A. S. Dhatt, Director of Research, PAU, Ludhiana; Dr. P. S. Shekhawat, Director of Research, SKRAU, Bikaner; Dr. Rajbir Singh, Director ICAR-ATARI, Ludhiana (Zone-I); Dr. S. K. Singh, Director, ICAR-ATARI, (Zone- II), Joint Director(s) of Cotton of Punjab, Haryana and Rajasthan, and the stakeholders from SAUs, KVKs, State Agriculture Departments, ICAR institutes, private seed companies and progressive farmers of the North Zone. He also presented the 'Overview of Cotton Crop in North Zone'. A total of 75 participants in person and 25 participants online joined the meeting from various stakeholders like SAUs, Joint Directors of State Agriculture Departments of Punjab, Haryana and Rajasthan, Progressive farmers, Seed and Fertilizer Dealers, Representatives from Cotton ginning mills and Seed companies have attended the programme in physical as well as online mode, respectively.

10.5.2: Events

46th Foundation Day Celebration of ICAR-CICR, Nagpur

ICAR-Central Institute for Cotton Research (CICR), Nagpur celebrated its 46th Foundation day on 1st April 2022 in the presence of Dr. C. D. Mayee, Ex-Chairman (ASRB) & Ex-Director (ICAR-CICR), Dr. Velchala Praveen Rao, Hon'ble Vice Chancellor, PJTSAU, Telangana, Dr. B. S. Dwivedi, Director, ICAR-NBSS&LUP, Nagpur and Dr. D. K. Ghosh, Director, ICAR-CCRI, Nagpur. Dr. Y. G. Prasad, Director, ICAR-CICR in his welcome address mentioned that genome editing, transgenic cotton and precision agriculture are major thrust areas of future research in cotton and briefed the achievements of the institute. Dr. Praveen Rao, Hon'ble Vice Chancellor, PJTSAU, Telangana, in his foundation day lecture as Chief Guest spoke about the promotion of High Density Planting System (HDPS) in Cotton as a key for enhancing cotton productivity and resource use efficiency. He stated that this method helps in tackling pink boll worm menace in cotton due to early maturity of crop within 150 days. He also stressed that location specific canopy management and defoliants aid in upscaling of HDPS towards mechanisation of cotton cultivation and harvesting. A journey of ICAR-CICR since its inception (1976) was presented by the Director. Institute publications "CICR at a Glance" and "CICR Technologies" were also released by the dignitaries during the occasion.

Workshop for organic cotton growers

ICAR - Central Institute for Cotton Research, Nagpur organized a one-day workshop on organic cotton production on 23rd April 2022 at Sevagram in association with Gram Seva Mandal, Wardha and Mission Samruddhi, Chennai as part of 'Annadata Devo Bhava' campaign in commemoration of Azadi ka Amrit Mahotsav. Ninety participants representing different NGOs including forty four farmers participated. Dr. Y. G. Prasad, Director, CICR highlighted the revival in demand for organic cotton and the need for establishing robust supply chain from production to marketing. Dr. MV Venugopalan, Principal Scientist, ICAR-CICR, Nagpur, Mr. Atul Sharma Secretary, Gram Seva Mandal, Wardha, Dr. Vidya Mankar Project Director ATMA, Wardha, Mr Kishore Jagtap, program officer, Mission Samruddhi, Dr. Suhas Podar, Principal, Anand Niketan Agricultural College, Warora explained & guided the participating farmers on organic cotton production initiative. Dr. Sunil Mahajan, Principal Scientist (Seed Technology) provided detailed information to the farmers about the properties of non-GM varieties promoting for organic farming developed by CICR.

Dr. V. Chinna Babu Naik, Senior Scientist (Agricultural Entomology), Dr. Ramkrushna, G.I., and Dr. Shailesh Gawande, Senior Scientist (Plant Pathology) acted as course coordinators for the training program.

Live webcast of Hon'ble PM's interaction with beneficiaries of PM Kisan Samman Nidhi-"Garib Kalyan Sammelan-Shath Pratishath Shasakthikaran"

ICAR-CICR Nagpur showcased the country's largest ever event, "Garib Kalyan Sammelan-Shath Pratishath Shasakthikaran"

commemorating Azadi ka Amrit Mahotsav on 31st May 2022. The Hon'ble Prime Minister interacted live from Shimla with rural beneficiaries spanning all districts, about the wide-ranging schemes/programmes. The programme at KVK-ICAR-CICR, Nagpur was presided over by Dr. N. Vijayalakshmi, IAS, Joint Secretary(Agriculture), Govt. Of India, New Delhi, Dr. B.S. Dwivedi, Director, NBSS& LUP, Nagpur and Dr. S.K. Shukla, I/c., Ginning Training Center, Nagpur. A total of 1200 farmers participant s benefitted from the event.

World Cotton Day 2022

ICAR-CICR celebrates World Cotton Day on 07th October, 2022, with Gusto & Fervour by distributing inputs to cotton farmers and training the B.Sc (Agri.) students in Clean Cotton Production techniques.

Live webcast of "Agri-Startup Conclave and Kisan Sammelan organized at ICAR-CICR, Nagpur

ICAR-CICR, Nagpur organized the live web telecasting of "Agri-Startup Conclave and Kisan Sammelan" organized by Ministry of Agriculture and Farmers' Welfare, New Delhi to over 200 farmers. PM inaugurated "One Nation-One Fertilizer" Programme under which farmers' will get quality fertilizer at economic rates with a single brand name "Bharat". The web telecast arranged at ICAR-CICR, Nagpur was inaugurated by Hon'ble Shri Krupal Tumane Ji, Member of Parliament, Ramtek, Dr. Y. G. Prasad, Director, ICAR-CICR, Nagpur, Heads of Divisions, Head KVK, SCSP Nodal officer of ICAR-CICR, Nagpur were present on the dias. In his address, Hon'ble Shri Tumane ji urged farmers to take up additional small-scale occupation in addition to farming. He emphasized the need to generate new generation farmers with application of technology in farming and taking up agri-business. Dr. Y. G. Prasad informed that farmers across India participated in the Hon'ble PM Kisan Samman Sammelan event. He also informed that CICR, Nagpur is implementing technology interventions for cotton pink bollworm management in 14 districts of Maharashtra and issuing weekly voice messages to registered farmers on crop and pest management. A technical session was conducted for farmers which comprised interactive lectures on cotton nutrient and pest management as well as Lumpy Skin Disease in cattle. Kits containing seeds for up-coming rabi season and vermi-compost were distributed to the participating farmers under Scheduled Caste Sub Plan (SCSP).

Kapas Mela 2022

ICAR-CICR, Nagpur organized Kapas Mela 2022 on 24 Nov. 2022 to showcase improved cotton technologies and facilitate farmer-scientist interaction. Dr. C.D. Mayee, Former Chairman, ASRB & Agriculture Commissioner, GoI was the Chief Guest. During the technical session of Kapas Mela organized by ICAR-CICR, Nagpur on 24 November 2022, Mrs. Pragati Gokhale, Advisor, Rajiv Gandhi Science & Technology Commission conducted an interactive session on "Mission: Mera Mobile Mera Marketing" through Market Mirchi app. A total of 500 farmers participated during the Mela.

10.6: Participation of Scientists in Symposia/ Conference/Seminars/ Webinar

Name of Scientist	Name of Seminar/Webinar/Conference/Symposia/	Place/Organized by/Date
Symposia		
Dr K P Raghavendra	International Symposium on Advances in Plant Biotechnology and Nutritional Security (APBNS-2022)	ICAR-NIPB, New Delhi 28-30 April, 2022
Dr.V.N Waghmare ,Dr S Manickasm Dr. Blaise Desouza, Dr S. Usha Rani, Dr P.Nalayini, Dr K. Sankaranarayanan ,Dr Rishi Kumar, Dr SK Sain, K. Velmourougane, Dr Amarpreet Singh, Dr V.Chinna Babu Naik, Dr.G. Balasubramani, Dr J Amudha, Dr Vinita Gotmare, Dr. Saravanan, M,	National Symposium on Paradigm Shift in Cotton Cultivation	MPUAT and Cotton Research and Development Association at MPUAT, Udaipur. 08 -10 August 2022

Name of Scientist	Name of Seminar/Webinar/Conference/Symposia/	Place/Organized by/Date
Dr V.Santhy, Dr.K P Raghavendra, Mr.Rakesh Kumar,Mr. Joy Das, Dr K. Baghyalakshmi, Dr A. Sampathkumar, Dr P Valarmathi, Dr A Manivannan		
Dr S Manickam,Dr K. Sankaranarayanan , Dr S. Usha Rani, Dr Rishi Kumar, Dr SK Sain, Dr. G. Balasubramani, Dr P Valarmathi, Dr A Manikandan, Dr A Manivannan	National Symposium "100 glorious years of cotton research and way forward"	TNAU, Coimbatore, 18-19 October 2022
Conference		
Dr Saravanan M	International conference on "Biotechnological Initiative for Climate Resilient Agriculture"	Dr. Rajendra Prasad Agricultural University, Pusa, Samastipur 07-09, January 2022
Dr S K Sain, Dr D T Nagrale, Dr P Valarmathi	8th International Conference on Plant Pathology: Retrospect & Prospects	SKNAU, Jobner - Jaipur, Rajasthan, 23-26 March 2022
Dr Rishi Kumar, Dr S K Sain, Dr Amarpret Singh, Dr S Manickam, Dr S Usha Rani	Annual Group Meeting of AICRP on Cotton, 2022 & Fifty Years (Golden Jubilee) of Cotton Hybrid Technology	TNAU, Coimbatore 06-08 April 2022
Dr S Manickam	CITI-CDRA Golden Jubilee Celebration	Vigyan Bhawan, New Delhi, 12 April 2022
Dr Amarpreet Singh	National conference on "Promotion of Kisan Drones: Issues, Challenges and Way Forward"	NASC Complex, New Delhi 02 May 2022
Dr M Amutha	Biotech Innovation Ignition School -12 conducted by BIRACs-SRISTI	Ahmedabad (SRISTI) 13 June - 3 July, 2022 (Online)
Dr K P Raghavendra	International Conference in Hybrid mode on Innovative and Current Advances in Agriculture and Allied Sciences (ICAAAS-2022),	Himachal Pradesh University Summer Hill, Shimla 12-14, June 2022
Dr M Amutha	International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research	Assam, 8-9 August, 2022 (Online)
Dr K Velmourougane, Dr K P Raghavendra	International Conference on Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS2022)	UAS Bengaluru 22-24 August 2022
Dr A. Sampathkumar, Dr A Manivannan	International Conference on "Biotechnology Trends and Future Prospects"	Department of Plant Biotechnology, UAS, GKVK, Bengaluru. 13 th – 15th
Dr Y G Prasad, Dr M V Venugopalan, Dr Rishi Kumar, Dr V Chinna Babu Naik, Dr D V Patil, Dr G Balasubramani, Dr J Amudha, Dr K P Raghavendra, Dr S Usha Rani, Dr K Sankaranarayanan, Dr J Gulsar Banu, Dr M Sabesh	WCRC-7 organized by International Cotton Researchers Association (ICRA) in collaboration with International Cotton Advisory Committee (ICAC)	Cairo, Egypt 04-07 October 2022
Dr S K Sain	National Conference on Natural Farming for Sustainable Agriculture and National Prosperity	SDAU, Sardarkrushinagar 11-13 October 2022
Dr V.Chinna Babu Naik , Dr M Amutha	18th AZRA International Conference on "Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment"	ICAR-CIWA, Bhubaneswar. 10-12, November 2022

Name of Scientist	Name of Seminar/Webinar/Conference/Symposia/	Place/Organized by/Date
Dr Vinita Gotmare Dr Debashis Paul	1st National Congress on Plant Genetic resource management.	NASC Complex, New Delhi. 22-24, November 2022
Dr A Manikandan	National Conference on Innovative Technologies in Agriculture	Priyadharshini Bhagwati College of Engineering, Nagpur. 24-25 March 2022
Webinar		
Dr MV Venugopalan	Better Cotton Implementing Partners' Webinar, London, United Kingdom (on-line)	Jan 18-19, 2022 (on-line)
Seminar		
Dr MV Venugopalan	State workshop on Sustainability of Cotton - GIZ India and Cotton Corporation of India (CCI)	Mumbai, 20 April, 2022

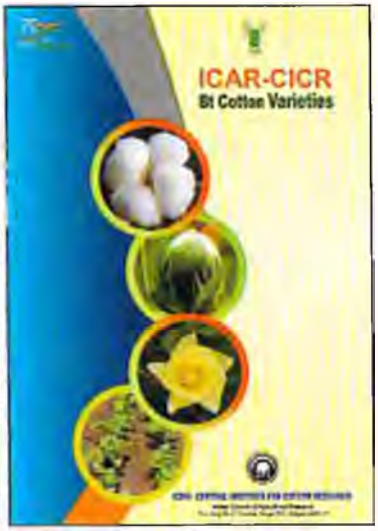
10.7: Distinguished Visitors

Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR on 26 June 2022

Dr. Trilochan Mohapatr, Secretary, Department of Agricultural Research and Education & Director General, ICAR and Dr. S.K. Chaudhari, DDG(NRM), ICAR visited ICAR-CICR, Nagpur on 26 June 2022 alongwith Dr. CD Mayee, Ex-Chairman, ASRB; Dr. B.S. Dwivedi, Director, ICAR-NBSS & LUP, Nagpur; Dr. Dilip Ghosh, Director, ICAR-CCRI, Nagpur. After tree plantation, DG, ICAR inaugurated the Multi-purpose Hall. The DG, ICAR also interacted with the scientists during the poster exhibition. During the interaction session in hybrid mode with the scientists, he appreciated the recent R&D efforts of the institute and exhorted to strengthen partnerships for faster and effective technology dissemination and up-scaling. Earlier during a National Workshop on "Production of disease-free citrus planting material through PPP mode" organized by ICAR-CCRI, Nagpur, an ICAR-CICR publication entitled "ICAR-CICR Bt Cotton varieties" was released by Shri Nitin Gadkari ji, Hon'ble Union Minister of Road Transport and Highways, GoI.

Name & Designation	Organization	Date
Sirsa		
Dr. R. K. Singh, ADG (Commercial Crops)	ICAR, Ministry of Agriculture and farmers' Welfare, GOI	September 16, 2022
Dr. A. S. Dhatt, Director of Research	PAU, Ludhiana;	September 16, 2022
Dr. P. S. Shekhawat, Director of Research	SKRAU, Bikaner	September 16, 2022
Dr. Jeet Ram Sharma, Director of Research	CCS-HAU, Hisar	October 17, 2022
Coimbatore		
Sri M.V.S Nagi Reddy, Hon'ble Vice Chairman	Andhra Pradesh State Agriculture Mission	March 11, 2022
Dr. T.R. Sharma, Hon'ble Deputy Director General (Crop Science) and Dr. R K Singh, Assistant Director General (Commercial Crops)	ICAR	April 07, 2022
Dr Indra mani Vice Chancellor	Vasantrao Naik Marathwada Krishi Vidyapeet, Nanded	November 10, 2022






10.8: Personnel

Director
Dr. Y. G. Prasad Director
Project Coordinator (Cotton)
Dr. AH Prakash, PC (Cotton) & Head (Acting)

CROP IMPROVEMENT DIVISION

Genetics& Plant Breeding
Nagpur
Dr. VN Waghmare, Acting head
Dr. (Mrs.) SB Singh, Pr. Scientist **(Retired on 30.04.2022)**
Dr. SM Palve, Pr. Scientist **(Retired on 31.05.2022)**
Dr. (Mrs.) Vinita Gotmare, Pr. Scientist
Dr. DV Patil, Pr. Scientist
Dr. M Saravanan, Sr. Scientist
Dr. HB Santosh, Sr. Scientist **(Transferred to ICAR-CRIDA, Hyderabad, relieved on 08.07.2022)**
Dr. RM Phuke , Scientist
Coimbatore
Dr. S Manickam, Pr. Scientist
Dr. Manivannan A, Sr. Scientist
Dr. (Mrs.) K Baghyalakshmi, Scientist
Sirsa
Dr. SK Verma, Pr. Scientist
Dr. Subhash Chandra, Scientist **(Joined on 07.11.2022)**

Agril. Biotechnology
Dr. G Balasubramani, Pr. Scientist
Dr. (Mrs.) J Amudha, Pr. Scientist
Dr. KP Raghavendra, Sr. Scientist
Mr. Joy Das, Scientist
Mr. Rakesh Kumar, Scientist
Coimbatore
Dr. Chandrashekar N, Scientist

Seed Science &Technology
Nagpur
Dr. (Mrs.) PR Vijayakumari, Pr. Scientist **(Expd on 17.08.2022)**
Dr. (Mrs.) V Santhy, Pr. Scientist
Dr. SS Mahajan, Pr. Scientist
Coimbatore
Dr. K Rathinavel, Pr. Scientist
Sirsa
Dr. Debashis Paul, Scientist

CROP PRODUCTION DIVISION

Agronomy
Nagpur
Dr. Blaise Desouza, Pr. Scientist& Head (Incharge)
Dr. MV Venugopalan, Pr. Scientist
Dr. AR Raju, Pr. Scientist
Dr. Ramkrushna I Gandhiji, Sr. Scientist
Dr. B. Bhargavi, Scientist **(Transferred to ICAR-CRIDA, Hyderabad, relieved on 11.08.2022)**
Coimbatore
Dr. (Mrs.) P Nalayini, Pr. Scientist
Dr. K Sankaranarayanan, Pr. Scientist
Dr. R Raja, Pr. Scientist
Sirsa
Dr. Amarpreet Singh, Scientist

Soil Science
Nagpur
Dr. A Manikandan, Sr. Scientist
Coimbatore
Dr. (Mrs.) D Kanjana, Sr. Scientist

Farm Machinery & Power
Nagpur
Er. G Majumdar, Scientist (SG)

Plant Physiology
Nagpur
Dr. JH Meshram, Pr. Scientist
Coimbatore
Dr. AH Prakash, Pr. Scientist & Head (Acting) RS Coimbatore
Dr.(Mrs.) Annie Sheeba, Sr. Scientist

Plant Biochemistry
Dr. (Mrs.) Pooja Verma, Scientist

Agricultural Microbiology
Nagpur
Dr. K Velmourougane, Senior Scientist
Dr. (Mrs.) Savitha Santosh, Scientist **(Transferred to ICAR-CRIDA, Hyderabad, relieved on 08.07.2022)**

Agricultural Extension
Nagpur
Dr. SM Wasnik, Pr. Scientist **(Retired on 31.05.2022)**
Coimbatore
Dr. (Mrs.) Usha Rani, Pr. Scientist

Agricultural Economics
Nagpur
Dr. AR Reddy, Pr. Scientist **(Transferred to ICAR-ATARI, Hyderabad, relieved on 12.07.2022)**
Coimbatore
Dr. (Mrs.) Isabella Agarwal, Pr. Scientist

Computer Application in Agriculture
Coimbatore
Dr.M Sabesh, Sr.Scientist

CROP PROTECTION DIVISION

Agricultural Entomology
Nagpur
Dr. V S Nagrare, Pr. Scientist
Dr. Chinna Babu Naik V, Sr. Scientist
Dr. (Mrs.) Rachna Pande, Sr.Scientist
Dr. Babasaheb Fand, Sr. Scientist
Mr. Prabhulinga Tenguri, Sr. Scientist
Mr. Madhu TN, Scientist **(Transferred to ICAR-CPCRI, RS, Vittal, relieved on 31.03.2022)**
Dr. Shah Vivek Hanskumar, Scientist
Dr. Shivaji Thube, Scientist **(Joined on 28.03.2022)**
Coimbatore
Dr. K Rameash, Pr. Scientist
Dr. (Mrs.) M Amutha, Sr. Scientist
Dr. K Shankarganesh, Sr. Scientist
Sirsa
Dr. Rishi Kumar, Pr. Scientist

Plant Pathology
Nagpur
Dr. SP Gawande, Sr. Scientist
Dr. DT Nagrale, Sr. Scientist
Dr. Neelakanth Hiremani, Scientist
Coimbatore
Dr. A Sampath Kumar, Sr. Scientist
Dr. P Valarmathi, Scientist
Sirsa
Dr. Satish Kumar Sain, Pr. Scientist

Nemotology
Nagpur
Dr. (Mrs.) N Narkhedkar, Pr. Scientist & Head (Incharge)

Coimbatore
Dr. (Mrs.) J Gulsar Banu, Pr. Scientist

KVK
Dr. S. N Rokde, Head KVK

ADMINISTRATION
Sh. A. A. Goswami, Chief Administrative Officer
Sh. Ashwani Garg, Senior Finance & Accounts Officer (Additional Charge from 16.10.2021)
Sh. Sanjay Kumar Singh, FAO

10.9: Other Information

10.9.1: Mera Gaon Mera Gaurav

Mera Gaon Mera Gaurav (MGMG) program has been implemented by ICAR- CICR Nagpur and itsRegional Stations CICR, Coimbatore and CICR, Sirsa as per the guidelines during 2022. The program was implemented in 62 adopted villages in 13 clusters by 48 Scientists. A total of 11687 farmers were benefited out of 156 extension activities conducted during the year.

Details of Scientists involved and Villages adopted under MGMG during 2022

Team	Name of the Team Leader and Members	Villages / Clusters / Districts adopted
1	1. Dr. V.Santhy(Seed Technology) 2. Dr. Dipak Nagrale (Plant Pathology), 3. Dr.PrabhulingaTengudi(Entomology) 4. Dr. Rakesh Kumar (Biotechnology)	District: Nagpur Cluster: Hingna Villages: Metaumari, Nildoh, Khari, Kinhi and Dhanoli
2	5. Dr.SunilS.Mahajan(SeedTechnology) 6. Dr. Neelkanth Hiremani (Plant Pathology) 7. Dr. Pooja Verma (Plant Biochemistry) 8. Dr.RachanaPande (Entomology)	District: Nagpur Cluster: Umred Villages:Godhani, Dhurkheda, Thombra Dodmaand Welsakhra
3	9. Dr.RamkrushnaGI(Agronomy) 10. Dr. Shailesh Gawande (Pathology) 11. Dr.BabasahebFand(Entomology) 12. Dr.RahulFuke (Plant Breeding)	District: Nagpur Cluster: Kalmeshwar Villages:Bhadangi, Ardoli,Sonapar,Varoda and Adasa
4	13. Dr A.R. Raju (Agronomy) 14. Dr.D.V.Patil(PlantBreeding) 15. Dr Joy Das (Biotechnology) 16. Dr.ShivajiThube (Entomology)	District: Wardha Cluster: Seloo Villages:Aakoli,Madani, Tamaswada,Jamni,Aamgaon and Masala
5	17. Dr.VishleshNagrare,(Entomology) 18. Dr. J. H. Meshrm (Plant Physiology) 19. Er. G. Majumdar (Agril. Engg) 20. Dr.Manikandan(Soil Science)	District: Nagpur Cluster: Kuhi Villages:Wadegaon(Kale),Mohadi, Kuchadi, DongargaonHetameti

Team	Name of the Team Leader and Members	Villages / Clusters / Districts adopted
6	21. Dr.K.P.Raghvendra (Biotechnology) 22. Dr.MSarvanan(PlantBreeding) 23. Dr. Vivek Shah (Entomology)	District: Nagpur Cluster: Parsheoni Villages:Ghatkukda, Salai, Dhwalapur, Ambazari,Saleghat, Ghatphendri
7	24. Dr.VinitaGotmare(Genetics&Cytogenetics) 25. Dr.J.Amudha (Biotechnology) 26. Dr.ChinnaBabuNaik (Entomology	District: Nagpur Cluster: Umred Villages:Bhivgad, Deori, Jamdapani,Bothliand Bendoli
8	27. Dr. K. Rathinavel 28. Dr. J. Gulsar Banu 29. Dr. M. Sabesh 30. Dr. J. Annie Sheeba	District: Coimbatore Cluster: Annur Villages: Allikulam, Pogalur Thokkupalayam, Lakeepalayam and Sellampalayam
9	31. Dr. P. Nalayini 32. Dr. M. Amutha 33. Dr. A. Manivannan 34. Dr. Sampath Kumar	District: Coimbatore Cluster: Karamadai Villages:Tholampalayam, Neelampathy, Colony Pudur and Uggayanur,
10	35. Dr. K. Sankaranarayanan 36. Dr. K. Ramaesh 37. Dr. D. Kanjana	District: Coimbatore Cluster: Annur Villages:Ettimadai, Malumichampatti, Mavuthampathy and Chettipalayam
11	38. Dr. S. Manickam 39. Dr. S. Usha Rani 40. Dr. Shankar Ganesh 41. Dr. Baghyalakshmi	District: Coimbatore Cluster: Annur Villages:Devarayapuram, Kuppepalayam, Selambanur Zakinayakanpalayam and Thondamuthur
12	42. Dr. Isabella Agarwal 43. Dr. R. Raja 44. Dr. P. Valarmathi	District: Coimbatore Cluster: Annur Villages:Govindapuram, Devarayapuram, Muthur and Nallattipalayam
13	45. Dr Rishi Kumar 46. Dr. S.K. Sain 47. Dr. Amarpreet Singh 48. Dr. Debashis Paul	District: Sirsa Villages:Khedi, Chaharwala, Hanjira and Chadiwal:

Activities conducted under MGMG in the adopted villages

Farmers training cum distribution of vegetable seeds kit to tribal farmers under TSP in Hingna MGMG cluster

Distribution of vegetabkle seed kits to tribal farmers in the cluster villages

Field visit and on farm guidance on cotton production and protection technologies in cluster villages

On-farm diagnosis of cotton insect pests and diseases with integrated management practices

Distribution of critical inputs to tribal farmers under NSP-TSP to tribal farmers

Field demonstration of hand-held mechanical cotton picker along with scientists from ICAR-CIRCOT, Mumbai at Village Adasa of Kalmeshwar Tahsil

Critical input distribution cum interface meeting to SC farmers of MGMG villages of Kalmeshwar cluster by team of scientist

Distribution of Arhar (TUR) seed to MGMG farmers at Godhani

Kishangosthi, training and demonstrations at MGMG villages(Chaharwala and Khedi) for 50 farmers on 14.06.2022

KishanGosthi, training and demonstrations at MGMG villages for 30 farmers (Chadiwal and Hanzira) on 29.06.2022

Training cum FLD demonstrations at village Chaharwala and Hanzinra to 25 farmers on root rot and root-knot nematode management in Cotton

10.9.2: Development Action Plan for Scheduled Caste

The central government sponsored and funded scheme, "Development Action Plan for Scheduled Caste (DAPSC) (formerly Scheduled Caste Sub Plan SCSP)" was implemented by the ICAR-CICR, Nagpur. The objective of the scheme was to increase the income levels of the targeted population through various income generating schemes, skill development and infrastructure development. The scheme was implemented in the selected PMAGY and other Non- PMAGY villages in Five Districts of Maharashtra namely Nagpur, Wardha, Chandrapur, Amaravati and Bhandara where the Scheduled Caste population is 50% or more by identifying the beneficiary families with the help of State Government Agencies. The program planning was done at the institute level and executed by the committee members in the adopted villages. The poor families were targeted to directly use the various agricultural related inputs provided by the Institute. The scientific inputs in terms of technology dissemination, technological interventions, capacity building, showcasing technologies, exposure visits, interface meetings and trainings, skill up gradation, timely solutions of the farmers problems, cleanliness of public premises, sanitization and providing information of various schemes implemented by state agricultural departments.

Various activities were carried out in the adopted villages to provide direct benefit to the scheduled caste beneficiaries under the SCSP Scheme. These includes, organization of skill development programmes, trainings and workshops, distribution of Goat & Goat Feed, improved Cotton cultivation practices, Paddy seed, Red Gram seed, Soyabean seed, Gram seed (Chickpea), Wheat seed, Crop protection Kit (Pesticide Kit), Pusa bio-fertilizer kit, Tarpaulin, Vermicompost bed, Vegetable plant based kit, Citrus plant based kit, Sickle, Pesticide Protection Kit, Pheromone Traps & lure, Cotton picking bags and printed cotton cultivation practices. The farmers were sensitized on round the year for Cotton production and its scientific cultivation, with complete package of practices and seeds.

Details of various Training programme carried out

Sr. No.	Details of Training Programmes	Date	Venue	No of SC beneficiaries
1.	Training cum Demonstration of Cotton Stalk Shredder on Cotton field to SC farmers.	02 March 2022.	ICAR- CICR, Nagpur.	50
2.	Training program on Scientific Goat Farming & livestock management for SC beneficiaries.	29 March 2022	Punyashlok Ahilyadevi Maharashtra Mendhi va Sheli Vikas Prakshetra, Bondri, Ta. Ramtek, Dist. Nagpur.	50
3.	Stakeholders Interface Farmers Meeting for Pre-Kharif season (Interface Farmers Meeting cum Training for Pre - Kharif season to increase Cotton Production using better cultivation and improved technologies.)	07 May 2022	VANAMATI, Nagpur	40
4.	Training program on 'Improved Cotton Production Technology' on the occasion of "Garib Kalyan Sammelan".	31 May 2022	ICAR- CICR, Nagpur.	482
5.	Training program on 'Scientific Soybean Cultivation' to SC farmers.	14 June 2022	KVK, ICAR- CICR, Nagpur.	57
6.	Training on Tur Cultivati on	15 June 2022	Welsakhara, Godhani and Dhurkheda Ta. Umred, Dist. Nagpur.	157
7.	Training program on 'Scientific Soybean Cultivation' to SC farmers	17 June 2022	KVK, VNMKV, Aurangabad.	64
8.	Training program on Kharif crop (Paddy and Tur) Cultivation to SC farmers.	20 June 2022	Khobna, Bodakhipeth, Sawarkhanda Amti Ta. Kuhi, Dist. Nagpur.	113
9.	Training on usages of PUSA Bio-fertilizers for SC farmers of Nagpur district.	17 August 2022	Welsakhara, Godhani, Pipardol, Amboli, Ta. Umred Dist. Nagpur	234
		23 August 2022	Khobna and Bodakhipeth Ta. Kuhi, Dist. Nagpur	
10.	Training on Integrated pest Management and Cotton field visit to SC farmers at MGMG village.	08 September 2022	Dongargaon, Ta. Kuhi, Dist. Nagpur.	26
11.	Training on 'Integrated Cotton managem ent' on the occasion of "World Cotton Day"	07 October 2022	ICAR- CICR, Nagpur.	85
12.	Training on "Cotton technology outreach and interventions for improving ELS cotton" for Cotton growing farmer's livelihoods	12 October 2022	Venue: ICAR- KVK, Hans Roever campus, Valikandapuram, Perambalur, Beneficiary village: Tharani in Perambalur District, Tamil Nadu.)	50
13.	Farmers training on Cotton cultivation cum exposure visit at CICR Cotton fields on the occasion of "PM KISAN SAMMAN SAMMELAN"	17 October 2022	ICAR- CICR, Nagpur.	132
14.	Farmers Training on PBW management in cotton field and usages of Pheromone Trap.	02 November 2022	Wadegaon, Pipardol, Ta. Umred, Dist. Nagpur.	74
15.	Training programme on "Integrated Cotton Cultivation", Exposure visit and Exhibition on the occasion of "Kapas Mela 2022"	24 November 2022	ICAR- CICR, Nagpur.	400
16.	Workshop and Training on "Soil Health Management" on the occasion of "World Soil Day -2022"	05 December 2022	ICAR- CICR, Nagpur.	45

Details of Critical input distributed

Sr. No.	Details of Input	Date	Venue / Beneficiary Village	No of SC beneficiaries
1.	Tarpaulin (Standard size Tarpaulins to protect the crop/seed from rain.)	02 March 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Bodakhipeth, Khobna, Sonapar, Pipardol Amboli, Tirkhura	435
		17 October 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Chikhali Maina, Wadvihara, Khadaki, Parsodi, Khairi Punjab	
		20 October 2022	Durgada	
		28 October 2022	Amboli, Tirkhura, Welsakhara	
		02 November 2022	Pipardol	
		09 November 2022	Chikhali Maina	
2.	Sickle (Distributed 2 Sickle to each SC beneficiary)	02 March 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Bodakhipeth, Khobna, Pipardol, Amboli, Tirkhura, Sonapar	283
		28 October 2022	Welsakhara	
		01 November 2022	Khapri	
		09 November 2022	Khairi Punjab, Chikhali Maina	
		27 December 2022	Mendhepathar, Palwadi	
3.	Female Goat (Vaccinated Two female goats & 50 Kg Goat Feed distributed to each Scheduled caste Beneficiary from Nagpur district.)	29 March 2022	Venue: Punyashlok Ahilyadevi Maharashtra Mendhi va Sheli Vikas Prakshetra, Bondri, Ta. Ramtek, Dist. Nagpur. Beneficiary Villages: Kinhi Khurd, Khapri, Wakeshwar, Welsakhara	50
4.	Crop Protection Kit (containing Fungicides, Insecticides and Bio -Fertilizers namely Neem Oil, Nano Urea, Liquid Consortia (NPK), Flonicamid, Chlorantraniliprole, Propiconazole, Metiram & Pyraclostrobin, Tricoderma Poweder, Boron Fertilizer, Zinc Fertilizer)	31 May 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Welsakhara, Godhani, Dhurkheda, Amboli, Wadegaon, Pipardol, Thombra, Tirkhura, Pavani, Sillori, Sonapar, Amti, Khobna, Bodakhipeth, Sawarkhanada, Khapari, Durgada	784
		22 June 2022	Pavani	
		08 September 2022	Dongargaon	
		07 October 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Waadvihara, Khadki, Parsodi, Khairi Punjab, Chikhali Maina, Hingna	
		09 November 2022	Khairi Punjab, Chikhali Maina	
		10 November 2022	Waadvihara	
		05 December 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Khadki, Parsodi	
		27 December 2022	Mendhepathar, Palwadi	
5.	Soybean (Soybean JS -2069 for front line demonstration (FLDs) On 57 acres of farmer's field in Nagpur district.)	14 June 2022	Venue: KVK, ICAR- CICR, Nagpur. Farmers from Kamptee, Kuhi, Mauda, Nagpur, Narkhed and Umred Taluka, district Nagpur	57
6.	Soybean (Soybean (NRC -130) for front line demonstration (FLDs). On 64 acres of farmer's field in Aurangabad district.)	17 June 2022	KVK, VNMKV, Aurangabad	64
7.	Tur Seed (Variety PKV – TARA having 2 kg packing (4 Kg to each) distributed for Cotton intercropping to Scheduled caste farmers for Kharif	15 June 2022	Welsakhara, Godhani, Dhurkheda	871
		16 June 2022	Amboli, Wadegaon, Pipardol, Thombara, Tirkhura	
		17 June 2022	Sillori, Sonapar	
		18 June 2022	Durgada, Tekari, Dhamangaon Chak	

Sr. No.	Details of Input	Date	Venue / Beneficiary Village	No of SC beneficiaries
	season.)	20 June 2022	Amti, Khobna, Bodakhipeth, Kuhi, Sawarkhanda	
		22 June 2022	Pavani	
		24 June 2022	Dawadipar Bazar	
8.	Paddy (PDKV–Tilak variety of Paddy distributed to Scheduled caste farmers for Kharif season.)	16 June 2022	Tirkhura	200
		18 June 2022	Dhamangaon Chak, Tekari	
		20 June 2022	Khobna, Bodakhipeth	
		24 June 2022	Dawadipar Bazar	
9.	PUSA Bio-Fertilizer (Bio-Fertilizer kit having powder based and liquid based fertilizers namely Bio Azatobacter Powder, Rhizobium Powder, Biophas Powder, Biopotash Powder, Biozinc Powder, Bioiron Powder, Mycorhiza Powder, Azatobacter Liquid, Biophos Liquid, Biopotash Liquid, Biozinc Liquid Bio-iron Liquid, Smpoorn Liquid)	17 August 2022	Amboli, Godhani, Pipardol, Welsakhara	241
		23 August 2022	Khobna, Bodakhipeth	
10.	Pesticide Protection Kit (Pesticide protection kits including Safety jackets, goggle, hand gloves, face mask, gum boots, safety helmet etc. Useful for safe handling of pesticides in agriculture field.)	29 August 2022	Wadvihara	215
		30 August 2022	Khadki	
		15 September 2022	Parsodi, Khairi Punjab	
		17 September 2022	Chikhali Maina	
		09 November 2022	Khairi Punjab, Chikhali Maina	
		27 December 2022	Mendhepathar, Palwadi	
		27 December 2022	Rampuri	
11.	Cotton Picking Bag (KVK-CICR innovated Cotton Picking bag distributed among SC beneficiary. Useful in clean and easy way of cotton picking.)	15 September 2022	Parsodi, Khairi Punjab	302
		17 September 2022	Chikhali Maina	
		07 October 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village: Parsodi, Hingna,Wadvihara, Khadki,	
		09 November 2022	Khairi Punjab, Chikhali Maina	
		10 November 2022	Wadvihara	
		05 December 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village :Parsodi, Khadki	
		27 December 2022	Mendhepathar, Palwadi	
		28 December 2022	Rampuri	
12.	Gram Seed (Chickpea) (Gram seed Variety, Jaki -9218 having packing 30 Kg bag. one bag to each farmer distributed to Scheduled caste farmers for Rabi season.)	17 October 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Wadvihara, Khadaki, Parsodi, Khairi Punjab,	500
		19 October 2022	Amti, Khobna, Bodakhipeth, Sawarkhanda,	
		20 October 2022	Durgada.	
		21 October 2022	Tekari	
		28 October 2022	Amboli, Welsakhara, Godhani, Tirkhura	
		01 November 2022	Khapari	
		02 November 2022	Wadegaon, Pipardol	
		09 November 2022	Chikhali Maina	
13.	Wheat Seed (Wheat variety Phule Samadhan having packing 40 Kg bag. one bag to each farmer distributed to Scheduled caste farme rs for Rabi season.)	17 October 2022	Venue : ICAR-CICR, Nagpur Beneficiary Village : Wadvihara, Khadaki,Chikhali Maina, Parsodi,	250
		19 October 2022	Khobna, Bodakhipeth, Sawarkhanda,	
		20 October 2022	Durgada.	
		21 October 2022	Tekari	

Sr. No.	Details of Input	Date	Venue / Beneficiary Village	No of SC beneficiaries
		28 October 2022	Amboli, Welsakhara, Tirkhura	
		02 November 2022	Wadegaon	
		09 November 2022	Khairi Punjab	
		10 November 2022	Mendhepathar	
14.	Vermicompost Bed (Standard size 12"4"2" beds of Vermicompost bed provided to turn waste into organic compost to promote organic farming. Were distributed to SC farmers.)	17 October 2022	Venue: ICAR-CICR, Nagpur Beneficiary Villages: Wadvihara, Chikhali maina, Khadaki, Khairi Punjab, Parsodi	774
		19 October 2022	Khobna, Bodakhipeth, Amti, Sawarkhanda	
		20 October 2022	Durgada	
		21 October 2022	Tekari	
		28 October 2022	Amboli, Tirkhura, Welsakhara	
		01 November 2022	Khapari	
		02 November 2022	Wadegaon, Pipardol	
		09 November 2022	Khairi Punjab, Chikhali Maina	
		27 December 2022	Mendhepathar, Palwadi	
		27 December 2022	Rampuri	
15.	Pheromone Trap & PBW Lure (Distributed Pheromone traps & Lures for Pink Bollworm Management on Cotton crop. Farmers were given demonstration on usages of Pheromone traps.)	19 October 2022	Khobna, Bodakhipeth, Amti, Sawarkhanda	538
		20 October 2022	Durgada	
		28 October 2022	Amboli, Tirkhura, Welsakhara	
		01 November 2022	Khapri	
		02 November 2022	Wadegaon, Pipardol	
		09 November 2022	Khairi Punjab, Chikhali Maina	
16.	Vegetable Plant-Based Kit (Vegetable Plant -Based Kit procured from ICAR -IIHR Bangalore was distributed to vegetable growing SC farmers.)	02 November 2022	Pipardol	150
		09 November 2022	Khairi Punjab, Chikhali Maina	
		10 November 2022	Khadaki, Wadvihara Mendhepathar	
		27 December 2022	Palwadi	
17.	Citrus Plant-Based Kit (Citrus Plant -Based Kit procured from ICAR -IIHR Bangalore distributed to Citrus growing SC farmers.)	02 November 2022	Pipardol	75
		09 November 2022	Khairi Punjab, Chikhali Maina	
		10 November 2022	Khadaki, Wadvihara Mendhepathar,	
		28 December 2022	Rampuri	
18.	Crop Protection kit *containing Fungicides, Insecticides and Bio -Fertilizers namely* Ullala 60g, Emamectin Benzoate 100g, Cabrio top 300g, Planifix 100ml, All19 - 4kg, PN- 4kg, Westa boran - 2kg, MAP - 2kg, NSKE 1L, Pseudomonas 1 kg, Imidacloprid 17.8 % SL 250ml, Lambdacyhalothrin 5% EC 500ml, Profenofos 50 % EC 500ml, Carbendazim 50 % WP 1 kg, Pheromone trap with lure.	12 October 2022	ICAR- KVK, Hans Roever campus, Valikandapuram, Perambalur, 621115, Tamil Nadu.	50

Glimpses of various activities undertaken in SCSP Scheme, ICAR-CICR Nagpur & Regional Station Coimbatore

10.9.3: Tribal Sub Plan

The Centrally sponsored Development Action Plan for Scheduled Tribes, DAPST (formerly Tribal Sub Plan) scheme runs by the Government of India with the main objective to promote Scheduled tribes socio-economic development through family-oriented schemes by providing resources to the Scheduled tribe families.The main objective of the scheme is to enhance the income of the target population by way of various income generating schemes, technical-know how, skill development and infrastructure development. During the interfaces, the farmers were sensitized on various issues they confront in their day to day work due to their involvement in agricultural and allied activities, especially in the field of cotton cultivation and agro ecological zone wise crops. Some of their queries and problems were taken up during the interfaces organized and were met through technological interventions.The activities carried out during 2022 include, capacity building on improved production and protection techniques of cotton, paddy, green gram, chickpea, groundnut and vegetable cultivation. Exposure visits, awareness trainings and on field demonstrations about new technologies in agriculture and allied activities were also organized. Similarly, vocational trainings on agribusiness, skill up gradation, integrated pest management (IPM), reduced tillage or conservation tillage farming, animal husbandry, integrated farming system (IFS) and created awareness on personal protection while spraying and use of agrochemicals among scheduled tribe (ST) farmers.Project also focusing on tribal women empowerment through awareness programmes, provide them technical assistance through capacity building and motivated them to generate income round the year through vegetable cultivation,plant nurseryand other various activities. As part of the TSP programmes, inputs like improved seeds of cotton, paddy, green gram, chick pea and groundnut varieties, vegetable seeds (kit), fungicides & pesticides (IPM in cotton kit), CICR KVK cotton picking bags, pink bollworm pheromone traps and yellow sticky traps for sucking pests management were distributed totribal beneficiaries from villages of Nagpur, Wardha, Yawatmal& Bhandara district of Maharashtra and Adilabad and Nagarkurnool district of Telangana.

Glimpses of various activities undertaken in TSP Scheme, ICAR-CICR Nagpur

Details of various programmes carried out under the TSP scheme, ICAR-CICR, Nagpur:

SN	Name of training	Place and date	Participant Category	No. of participants		Name of Coordinator
				Male	Female	
1.	Farmer's field training-cum workshop and Trichocards distribution program	Thorana, Chandrapur 07.01.2022	Farmers	50	0	Dr. V. Chinna Babu Naik
2.	Farmer's training-cum-Exposure visit and summer groundnut seed bags	ICAR -CICR, Nagpur 07.02.2022	Farmers	50	0	Dr. V. Chinna Babu Naik
3.	Farmer's training on cultivation technique of oyster mushroom	KVK, ICAR-CICR, Nagpur 15.02.2022	Farmers	0	15	Dr. V. Chinna Babu Naik
4.	Farmer's training-cum-input distribution program	KVK, Sonapur, Gadchiroli 03.03.2022	Farmers	96	04	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
5.	Distribution of inputs during training program for cotton growing farmers at VANAMATI organised by ICAR-CICR, Nagpur	At-VANAMATI, Nagpur 06.05.2022	Farmers	20	0	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
6.	Farmers training cum distribution of vegetable seeds kit	At-Khairi (Pannase), Taluka Hingna, Nagpur. 8.06.2022	Farmers	13	0	Dr. Dipak T. Nagrale
7.	One day farmers training cum workshop programme and input distribution programme for paddy growing tribal farmers	At. Khapa (khurd), Taluka-Tumsar, Dist. Bhandara. 16.06.2022	Farmers	90	10	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
8.	One day farmers training cum workshop programme and input distribution programme for paddy growing tribal farmers	KVK, Sonapur, Gadchiroli 27.06.2022	Farmers	94	06	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
9.	Farmers training cum exposure visit and input distribution for vegetable growing	ICAR-CICR Nagpur 29.06.2022	Farmers	30	0	Dr. Chinna Babu Naik, Dr. Dipak T. Nagrale Dr.N. Chandrashekar
10.	Farmers training cum workshop programme and input distribution	At-Burakpalli, Ta-Bheempur, Dist-Adilabad (TS) 04.08.2022	Farmers	18	16	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
11.	Farmers training and input distribution program for tribal farmers organised	At-Tiwsala, Taluka-Ghatanji, Dist.-Yawatmal 01.09.2022	Farmers	95	5	Dr. V. Chinna Babu Naik

SN	Name of training	Place and date	Participant Category	No. of participants		Name of Coordinator
				Male	Female	
12.	Distribution and installation of Pheromone traps in farmers field for mass trapping of pink bollworm	At-MasalaK Taluka--Bela Dist-Adilabad (TS) 02.09.2022	Farmers	50	0	Dr. V. Chinna Babu Naik
13.	One day farmers training cum method demonstration of mass trapping of Pink Bollworm and input distribution program	At-Laxmapur Tanda, Amrabad, Nagar Kurnool (TS) 22.09.2022	Farmers	75	12	Dr. V. Chinna Babu Naik
14	Distribution of chickpea seeds as critical inputs in Wardha district	Wardha, Arvi Karanja, Wardha 21.10.2022	Farmers	13	2	Dr. V. Chinna Babu Naik Dr. Ramkrushna G.I.
15	One day "Farmer's training -cum-Exposure visit and critical input distribution" program	ICAR-CICR, Nagpur 03.11.2022	Farmers	33	2	Dr. V. Chinna Babu Naik Dr. Dipak T. Nagrale
16	One day "Farmer's training, pest awareness camp cum seed distribution" program	KVK, Sonapur, Dist-Gadchiroli 04.11.2022	Farmers	50	10	Dr. Chinna Babu Naik; Dr. Dipak T. Nagrale
17	One day farmers training cum exposure visit for vegetable growing tribal farmers	ICAR-CICR, Nagpur 30.12.2022	Farmers	20	0	Dr. V. Chinna Babu Naik
18	Farmers training cum input distribution	Village-Khairi (Pannase), Hingna, Nagpur (M.S.) 14.10. 2022	Farmers	18	2	Dr. Dipak Nagrale and Dr. V. Santhy

10.9.4: Library

In the year 2022, the Library purchased 23 new books . The Library also procured the *E-book series of Advances in Agronomy 2022*. 26 Hindi books were procured. The Library also subscribed to 11 Indian Journals. Annual Report 2021 was distributed to ICAR Institutes and dignitaries.

DOCUMENTATION SERVICES

1. *The Library has started a monthly documentation service to highlight the worldwide ongoing research and development in Cotton science by the name "Gleanings in Cotton Research". 12 issues of this monthly publication were compiled for the year 2022 and e-mailed to all scientists.*
2. Library has developed computerized bibliographic database on Cotton to provide comprehensive and updated information on cotton. About 5400 bibliographic references along with abstracts have been stored in it. Based on this bibliographic database the Library publishes a current awareness bulletin namely "*COTTON RESEARCH ABSTRACTS*". The Bulletin is emailed to all the scientists of the Institute and to all AICCIP Centers in India. In the reported period, two issues of *COTTON RESEARCH ABSTRACTS (V36, January – December 2022)* were e-mailed.
3. Articles appearing in newspapers on Cotton are digitally scanned and the copy is emailed to all scientists for information. A collection of all news items appearing in 2022 was compiled and published by the name "CICR in News 2022" .
4. The Library is actively participating in the E-Journal Consortium by responding regularly through E-mails and thus also receiving updates. More than 2000 on-line journals on agriculture and crop science are made available over the network through this consortium. Library provides E-Reference Service by virtue of which, important information vital for research such as, alerts, bulletins, articles and circulars received by the Library in electronic format are immediately circulated to all scientists by sending regular E-mails.
5. Four User Terminals installed in the Library have facilitated the library users to access the databases uploaded in the Library Server. Users can also access the Internet on these terminals. Similarly the entire catalog of the library has been downloaded on these terminals for ease of use.
6. KOHA Library software was installed in the Library and the data comprising the entire Library collection that includes books, bound volumes, Annual Reports, Hindi books and Gratis publications was migrated on the new platform.
7. The Library catalog is available on LAN terminals of the Institute .

10.9.5: Progressive Use of Hindi

राजभाषा (हिंदी) : प्रचार- प्रसार

भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में वर्ष 2022 के अंतर्गत भारत सरकार, गृह मंत्रालय, राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद, नई दिल्ली से प्राप्त निर्देशानुसार संस्थान में राजभाषा (हिंदी) के सक्रिय प्रचार–प्रसार हेतु राजभाषा (हिंदी) संबंधित विभिन्न गतिविधियों का आयोजन किया गया, जिसका संक्षिप्त विवरण निम्नानुसार हैं :

राजभाषा कार्यान्वयन समिति की बैठकों की तिथि :

क्र.	दिनांक	विषय
1	26 मार्च, 2022	वर्ष–2022 की राजभाषा कार्यान्वयन समिति की प्रथम बैठक
2	22 अप्रैल, 2022	वर्ष–2022 की राजभाषा कार्यान्वयन समिति की द्वितीय बैठक
3	15 जुलाई, 2022	वर्ष–2022 की राजभाषा कार्यान्वयन समिति की तृतीय बैठक
4	25 नवम्बर, 2022	वर्ष–2022 की राजभाषा कार्यान्वयन समिति की चतुर्थ बैठक

हिंदी सप्ताह 2022

हिंदी सप्ताह : उदघाटन समारोह का आयोजन :

भा...अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में बड़े ही उत्साह पूर्ण वातावरण में 'हिंदी सप्ताह (दिनांक : 07 – 14 सितंबर, 2022) समारोह' का विधिवत उद्घाटन दिनांक : 07 सितम्बर, 2022 को डॉ. वाय.जी. प्रसाद, निदेशक, भा...अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर के शुभहस्त दीप प्रज्ज्वलित कर किया गया।

कार्यक्रम का संचालन करते हुए डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.) ने इस सुअवसर पर उपस्थित अधिकारियों एवं कर्मचारियों का संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक स्वागत करते हुए उन्हें 'हिंदी सप्ताह (दिनांक : 07–14 सितंबर, 2022) समारोह' के अंतर्गत आयोजित किए जाने वाली विभिन्न हिंदी प्रतियोगिताओं (हिंदी गीत गायन, चित्र आधारित कहानी लेखन प्रतियोगिता, हिंदी शुद्ध लेखन प्रतियोगिताए प्रतियोगिता, शब्दानुवाद प्रतियोगिता, सामान्य ज्ञान / हिंदी बहुविकल्पी पश्नोत्तरी प्रतियोगिता, हिंदी निबध प्रतियोगिता एवं हिंदी काव्य पाठ प्रतियोगिता) की जानकारी

अधिकारियों एवं कर्मचारियो को देते हुए उनसे यह आग्रह किया कि वे इन विभिन्न हिंदी प्रतियोगिताओं में अधिक–से–अधिक की संख्या में भाग लेकर इस आयोजन को सफल बनाएँ ।

डॉ. वाय. जी. प्रसाद ने अपने स्वागत संबोधन में संस्थान की ओर से मुख्य अतिथि के रूप में सादर आमंत्रित डॉ. एस. एन. तिवारी, सेवानिवृत्त प्रोफेसर एवं पूर्व निदेशक (अनुसंधान), गोविंद वल्लभ पंत कृषि एवं प्रोद्योगिकी विश्वविद्यालय एवं मंचासीन महानुभवों तथा सभागार में उपस्थित समस्त हिंदी प्रेमी अधिकारियों का हार्दिक स्वागत करते हुए कहा की हिंदी से राष्ट्रीय एकता को बल मिलता है और संवैधानिक रूप से इस राजभाषा का दर्जा प्राप्त होने के कारणवश हमारा यह नैतिक उत्तरदायित्व बन पड़ता है कि इसे हम अपने दैनिक कार्यालयीन कार्यों में अपनाकर इसका मान बढ़ाये।

हिंदी सप्ताह : समापन समारोह का आयोजन :

भा...अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में बड़े ही उत्साह पूर्ण वातावरण में 'हिंदी सप्ताह : समापन समारोह' का आयोजन दिनांक : 14 सितम्बर, 2022 को किया गया। इस कार्यक्रम की अध्यक्षता का पदभार संस्थान की राजभाषा कार्यान्वयन समिति के अध्यक्ष डॉ. वाय. जी. प्रसाद, निदेशक, भा...अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ने संभाला और साथ ही इस अवसर पर डॉ. सुनील रोकडे, प्रधान वैज्ञानिक एवं प्रमुख, .षि विज्ञान केंद्र, श्री अ. अं. गोस्वामी, मुख्य प्रशासनिक अधिकारी एवं डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.) प्रमुख वक्ता के रूप में सादर मंचासीन थे।

तदोपरांत इस समारोह के कार्यक्रमाध्यक्ष डॉ. वाय. जी. प्रसाद, एवं मंचासीन मान्यवरों के शुभहस्ते संस्थान में हिंदी सप्ताह समारोह –2022 के अंतर्गत आयोजित हिंदी संबंधित विभिन्न प्रतियोगिताओं के विजयी प्रतिस्पर्धी अधिकारियो एवं कर्मचारियों को नकद पुरस्कार वितरित किए गए।

(डॉ. वाय. जी. प्रसाद विजेता अधिकारियो एवं कर्मचारियों को पुरस्कार प्रदान करते हुए)

इस कार्यक्रम का कुशल संचालन डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.) ने किया एवं आभार डॉ. सूनिल रोकडे, प्रधान वैज्ञानिक एवं प्रमुख, .षि विज्ञान केंद्र वैज्ञानिक, भा...अनु.प. –केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ने माना।

कार्यशालाए : 2022

केन्द्रीय कपास अनुसंधान संस्थान, नागपुर कार्यालय में वैज्ञानिक / प्रशासनिक / तकनीकी अधिकारी संवर्ग हेतु एक दिवसीय कार्यशालो का आयोजन किया गया। संस्थान में इस वर्ष निम्नलिखित विषयों पर कार्याशालाओं का प्रस्तुतीकरण किया गया।

क	दिनांक	विषय	वक्ता
1	11 मार्च, 2022	किसानो की आय दोगुनी करने हेतु उपाय	डॉ. सुनील रोकड़े, प्रमुख, कृषि विज्ञान केन्द्र
2	24 मई, 2022	योग मिटाए रोग	डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा),
3	08 सितंबर, 2022	हमारा जीवन और जिदगी सारा दिमाग का खेल है विभाग	डॉ. जी. बालासुब्रमणी, प्रधान वैज्ञानिक, फसल सुधार
4	30 दिसंबर, 2022	संतुष्ट रहना सीखे : यह जीवन वास्तव में बहुत सुंदर है	डॉ. बाबासाहेब फंड, वरिष्ठ वैज्ञानिक, फसल संरक्षण विभाग

10.9.5: Sports

ICAR-CICR participated in the ICAR zonal sports tournament (West Zone) at ICAR-NRCC, Bikaner, Rajsthan during 22-25 November, 2022. Shri Eluka Sridher, Technician won gold medal in chess and Shri Samir Chalkhure, Dr. S. S. Patil, Shri Dilip Mundharikar, Dr. UV Galkate & Shri Sujit Kumbhare bagged Runner Tropy in Table-tennis event by the hands of the Chief Guest Shri Arjun Ram Meghwal, Union Minister State, Ministry of Parliamentary Affairs, Government of India.

10.10: Weather

Nagpur

Month	Temperature (°C)		Relative Humidity (%)		Rain fall (mm)	No. of Rainy Days
	Max	Min	Max	Min		
January, 2022	26.6	13.0	87	54	17.00	4
February, 2022	30.7	14.3	81	37	6.7	2
March, 2022	38.0	20.6	61.3	28.0	1.2	1
April, 2022	42.3	26.2	51.4	27.3	4.9	1
May, 2022	42.4	28.9	49.1	27.3	8.4	2
June, 2022	38.4	27.7	67.6	45.6	123.2	11
July, 2022	29.8	24.4	88.0	79.7	695.10	27
August, 2022	31.9	24.8	82.9	70.1	362.3	17
September, 2022	31.7	23.8	79.9	71.4	408.5	21
October, 2022	31.6	20.5	80.3	66.6	114.2	9
November, 2022	30.1	14.1	69.8	44.4	0	0
December, 2022	29.8	14.7	73.5	44.3	9.2	2
Total					**1750.7**	**97**

Coimbatore

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sun shine hours
	Max	Min	Morning	Evening		
January, 2022	30.2	20.7	85	49	16.6	7.1
February, 2022	32.1	21.1	84	41	0	7
March, 2022	34.5	21.7	81	38	9.2	7.9
April, 2022	34.6	24.6	84	48	41.2	7.2
May, 2022	32.9	23.9	82	56	19	5.9
June, 2022	32.9	23.7	81	51	9.5	6.9
July, 2022	30.1	23.1	83	61	86.8	4.6
August, 2022	30.5	22.9	84	61	131.2	5.6
September, 2022	31.2	22.5	84	54	32.5	6.9
October, 2022	30.6	22.4	85	58	93	5.1
November, 2022	29.4	21.8	86	58	138	5.5
December, 2022	28.9	20.6	85	53	103	5.8
Total					**680**	

Sirsa

Month	Temperature (°C)		Relative Humidity (%)		Rain fall (mm)	No. of Rainy Days
	Maximum	Minimum	Maximum	Minimum		
January, 2022	16.8	6.7	89.1	70.0	33.8	4
February, 2022	23.0	8.9	71.0	42.0	16.6	3
March, 2022	32.0	16.2	65.6	35.3	0	0
April, 2022	40.9	24.7	43.6	28.0	1.4	1
May, 2022	42.2	27.2	59.3	36.9	16.2	3
June, 2022	41.0	27.2	58.2	39.4	52.4	2
July, 2022	34.4	26.7	81.3	70.9	304.7	10
August, 2022	34.6	26.2	87.0	67.3	27	2
September, 2022	34.4	24.9	85.3	62.1	37	5
October, 2022	32.5	18.5	82.6	45.7	1	1
November, 2022	28.0	11.5	89.2	40.8	0	0
December, 2022	20.7	5.4	91.8	54.8	0	0
Total					**490.1**	**31**

10.11: Cotton Scenario

Area: in Lakh Hectares
Production: in Lakh bales of 170 kg.
Yield: Kg per hectare

State	Area		Production		Yield	
	2021-22(P)*	2022-23(P)*	2021-22(P)*	2022-23(P)*	2021-22(P)*	2022-23(P)*
Punjab	2.51	2.41	6.46	4.54	437.53	320.25
Haryana	6.36	6.47	13.16	17.20	351.76	451.93
Rajasthan	7.56	7.77	24.81	25.51	557.90	558.13
Total North Zone	***16.43***	***16.65***	***44.43***	***47.25***	***459.71***	***482.43***
Gujarat	22.84	25.49	75.09	87.12	558.90	581.03
Maharashtra	44.10	42.29	82.49	81.85	317.99	329.03
Madhya Pradesh	5.60	5.99	14.20	15.19	431.07	431.10
Total Central Zone	***72.54***	***73.77***	***171.78***	***184.16***	***402.57***	***424.39***
Telangana	18.89	20.24	48.78	54.41	438.99	457.00
Andhra Pradesh	5.54	6.95	17.08	18.85	524.12	461.08
Karnataka	6.74	8.97	19.55	21.48	493.10	407.09
Tamil Nadu	1.48	1.56	3.02	3.56	346.89	387.95
Total South Zone	***32.65***	***37.72***	***88.43***	***98.30***	***460.43***	***443.03***
Odisha	1.93	2.16	6.26	7.23	551.40	569.03
Others	0.16	0.19	0.27	0.29	286.88	259.47
All-India	***123.71***	***130.49***	***311.17***	***337.23***	***427.60***	***439.34***

Source: Cotton Advisory Board, Ministry of Textile, Govt. of India.
P-Provisional; * - As estimated by Committee on Cotton Production and Consumption (COCPC) in its meeting held on 20.02.2023

NOTES

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