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ICAR-CENTRAL INSTITUTE FOR COTTON RESEARCH

NAGPUR

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ANNUAL REPORT

2019

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

ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR

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PREFACE

Cotton, popularly referred as `white gold', is an economically important natural fibre crop of India. For the past eight years, decline in cotton production and productivity has been observed on account of biotic and abiotic stresses. In 2015-16, cotton growing states of North-India faced an epidemic of whitefly and subsequently, during the period from 2016 to 2018, cotton growing states of Central and South Indian faced challenge of pink bollworm due to breakdown of resistance of BG II cotton. During 2018-19, in the beginning of crop season, the crop was exceptionally good and farmers were expecting bumper yield. However, the terminal moisture stress at critical stage of boll development from mid-October onwards resulted in drastic reduction in production to recent lowest of 33.7 m. bales from an area of 12.6 m. hectares. During 2019-20, the area under cotton was almost static (12.584 m.ha.).

This year, several significant events were organized by the Institute. The foremost important event being a `Brainstorming on Relevance of Cotton Breeding by Public Sector in India' under the Chairmanship of Dr. Trilochan Mohapatra, Hon'ble Secretary (DARE) & Director General (ICAR) on April 3, 2019. The Chairman reemphasized the relevance and role of public institutions and urged to strengthen public-private partnership with more focus on reciprocal sharing of genetic resources, understanding each other's capabilities and strengths collectively so as to break yield plateau and enhance cotton production. On this occasion, the ICAR-CICR Cotton App was launched by the Hon'ble Director General which is serving as a platform to disseminate cotton production and protection technologies. The final report of Quinquennial Review Team of the Institute and ICAR-AICRP on Cotton was also submitted by Dr. S.A.Nimbalkar, Chairman (QRT) to the Hon'ble Director General.

A collaboration between ICAR & CSIR was launched in a joint meeting on `Next Generation Insect Resistance in Cotton' under the chairmanship of Hon'ble Director General, ICAR. This joint collaboration paved way for evaluation of indigenously developed transgenic events (CSIR-NBRI), evaluation of pheromone technology (CSIR-IICT) and initiatives on refinement of cotton picker (CSIR-CMERI). As a follow-up of Cotton Brainstorming, the Institute-Industry Interface Meeting was held under the chairmanship of Dr. A.K. Singh, Hon'ble DDG (CS) seeking broad collaboration in development of parental / inbred lines, widening of genetic base of cotton through pre-breeding and sharing of germplasm / segregating genetic material and quality seed production of public sector varieties / hybrids. An Institute-Industry Interface Germplasm Field Day was also organized to showcase the genetic resources available with the Institute and across the ICAR-AICRP on Cotton centres.

The Institute has made several noteworthy achievements which includes identification of *G. arboreum variety CNA 1028 (Ravi)* for commercial cultivation in rainfed conditions of central zone; a long staple *G. hirsutum* genotype CCH 14-1 (Sunantha) for irrigated conditions of South zone; two medium staple Bt varieties viz. ICAR-CICR 16 Bt and ICAR-CICR 23 Bt for irrigated conditions of central zone and rainfed conditions of south zone, respectively. Two entries viz. CNA 1032 and CCB 51 were promoted to agronomy trial and several cultures are under evaluation across different ICAR-AICRP trials. Cotton production technologies for shallow calcareous soils were validated and demonstrated on farmers fields. Under rainfed conditions, short duration Black gram, Green gram and Soybean were found promising for intercropping. Individual and combined traps with separate or combined lures were found to be more effective than the mixed lures for management of lepidopteran pests. Degree-day based phenology models for predicting the developmental events of pink bollworm was developed which would be handy to predict adult moth

emergence, oviposition and egg hatch, thus in undertaking timely management strategies.

In continuation to the previous year, outreach activities of the Institute further strengthened. '*Mera Gaon Mera Gaurav*' (MGMG), Tribal Sub Plan (TSP), Scheduled Caste Sub-Plan (SCSP) and IRM Pink Bollworm Management Project sponsored by GEAC under National Food Security Mission – Commercial Crops (NFSM-CC) were vigorously implemented by the Institute. *ICAR*-CICR has carried out monitoring of pink bollworm throughout the crop season across all cotton growing states and has through its intense awareness, farmers training activities and dissemination of weekly advisories made its presence felt in the cotton farming community. Under e-Kapas, 68,92,298 voice messages were uploaded.

This season witnessed commercial cultivation of straight Bt varieties developed by the Institute on farmers' fields. A beginning has also been made for collaborative seed production and marketing of Institute's Bt varieties through MSSC, Akola. Linkages were fostered with sister ICAR institutes, SAUs, other public sector institutions, private seed companies, NGOs and farmers to commercialize and upscale varieties and technologies developed by the Institute. Seven MoUs were inked during April to December 2019.

Research apart, progress in implementation of the Official Language (Hindi) has made ICAR-CICR proud by bagging the ICAR's prestigious "Rajarshi Tandon Rajbhasha Puraskar 2018-19" (First) for the best Official language implementation in 'B' Region for successive year. Exemplary skills were shown by the Institute's staff in ICAR Western Zone Tournament-2019 held at Avikanagar and bagged 5 Gold, 1 Silver and 4 Bronze Medals in Athletics.

I owe my gratitude to Dr Trilochan Mohapatra, Hon'ble Secretary, DARE & Director General, ICAR for his constant encouragement and guidance in organizing Brainstorming Session on Cotton Breeding, Joint ICAR-CSIR Collaboration and Institute-Industry Interface which is making a big headway in bringing the Institute to visibility. I am grateful to Dr. A.K. Singh, Hon'ble DDG (CS) and Dr R.K. Singh, ADG (CC) for their constant encouragement, guidance and support throughout. Contribution of Dr A.H. Prakash, PC and Head I/c, Regional Station, Coimbatore; Dr. D. Monga, Head, Regional Station, Sirsa; I/c Heads of Divisions - Dr Blaise D'souza, Dr (Mrs) Sandhya Kranthi, Dr Nandini Gokte Narkhedkar and Dr. S.M.Wasnik, I/c (KVK) in the execution of research programmes and outreach activities is gratefully acknowledged. Dr M.V. Venugopalan, Principal Scientist & I/c PME Cell has immensely contributed in making of this report and needs special acknowledgement. Thanks are also due to the Editorial Committee members for their sincere and dedicated efforts in bringing out this Annual Report-2019. Mrs. Rama Iyer, Sh. Sameer Chalkhure and Dr. Jimmy Vaidya deserve special appreciation for their strenuous effort and commitment in bringing out this Annual Report to a beautiful shape.

(V. N. Waghmare)
Director

CONTENTS

1. EXECUTIVE SUMMARY

CROP IMPROVEMENT

- A *G. arboreum* genotype 'CNA 1028 (Ravi)' was identified for release and commercial cultivation in rainfed conditions of central zone. A long staple *G. hirsutum* genotype 'CCH 14-1 (Sunantha)' was identified for release for irrigated conditions of south zone. Two medium staple Bt genotypes *viz.,* 'ICAR-CICR 16 Bt' and 'ICAR-CICR 23 Bt' were identified for cultivation under irrigated conditions of central zone and rainfed conditions of south zone, respectively.
- Two entries *viz., G. arboreum* genotype CNA1032 (rainfed conditions of central zone) and *G. barbadense* genotype CCB51 (irrigated conditions of south zone) were promoted to agronomy trial.
- Seventeen non-Bt entries were promoted in different trials of ICAR-AICRP on Cotton while, 16 entries were retained in their respective trial for further evaluation.
- Seven Bt entries (CICR 17 Bt in North Zone; CICR 20 Bt, CICR 21Bt, CICR 22 Bt in Central Zone; CICR 24 Bt, CICR 25 Bt, CICR 26 Bt in South Zone) were promoted and three entries were retained for evaluation in Bt varietal trial of ICAR-AICRP on Cotton.
- Breeder seed (207.7kg) of ICAR-CICR released non-Bt varieties [Suraj, Surabhi, LRA 5166, LRK 516, CNA 1003 (Roja)] was produced. TFL seed (20.5q) of ICAR-CICR Bt varieties (Suraj Bt, PKV Rajat Bt, PKV 081 Bt and GJHV 374 Bt) was also produced during the year.
- Exotic accessions (674) were procured and the National Cotton Gene Bank was enriched to 12,335 accessions covering all the cultivated and wild species of *Gossypium* including perennials, landraces and inter-specific derivatives. A total of 3830 germplasm lines of base collection were evaluated and multiplied and 39 germplasm accessions were distributed.
- A new wild species, *G. nelsonii* Fryx was procured from MPKV, Rahuri to enrich the existing wild species collections (24 wild species of *Gossypium*) of ICAR-CICR, Nagpur.
- In order to develop a mini-core, 780 geographically and genetically diverse upland cotton accessions of core collections were phenotyped for DUS traits and genotyped using 52 polymorphic SSR markers.
- The field trial of five RIL mapping populations (two inter-specific populations of *G. arboreum* × *G.hirsutum*, two intra-*hirsutum* and one inter-specific *G. hirsutum* × *G. barbadense* was conducted at ICAR-CICR, Nagpur to phenotype and to develop consensus genetic linkage map of *Gossypium*.
- Fourteen cultures of spinnable *G. arboreum*, 14 high yielding *G. arboreum* genotypes, 4 GMS based *G. arboreum* hybrids were evaluated for traits of economic importance. Twenty two GMS lines were maintained through sib-mating and 18 were submitted to ICAR-NBPGR, New Delhi for long term storage.
- A total of 208 *G. hirsutum* entries were evaluated in eight different trials and promising entries (CNH 1196, CNH 5816, CNH 1246, CNH 2215, CNH 7615, CNH 1015, CNH 6215, CNH 1806, CNH 2616 and CNH 5916) were identified for plant type, boll weight and earliness.
- Six genotypes with comparatively higher colour strength were identified upon lint analysis of 16 naturally brown colour cotton genotypes. Crosses were attempted between cleistogamous MSH-345 and dark brown linted genotype Vaidehi-95 to introduce cleistogamy trait in colour cotton.
- Fifty *G. barbadense* genotypes were evaluated and the identified promising lines for early maturity (CCB 11A), leaf trichome density (ICB 124), gossypol gland density (ICB 46) and epicuticular wax (CCB 25) were utilized in hybridization programme for development of superior *G. hirsutum* × *G. barbadense* hybrids.
- Bio-efficacy of different non-deregulated transgenic events *viz.,* Tg2E13 (*cry1Ac*), UASD78 (*cry1Ac*), CH12 (*cry2Ax1*) was confirmed against American bollworm. Zygosity PCR for Tg2E-13 event was standardized and plants homozygous for Tg2E13 event in BC_4F_2 population of three crosses *viz.,* Suraj × Coker 310 (Tg2E13), NH615 × Coker 310 (Tg2E13) and CISH 3178 × Coker 310 (Tg2E13) were identified for further evaluation and multiplication. Third backcrossing (BC_3) was attempted for introgression of CH12 event and event UASD No. 78 was characterized.
- *Agro-bacterium* mediated transformation of

CICRcry2Ab1Ac::*chitinase* in *G.hirsutum* Cv. Coker 312 followed by subculture on kanamycin (25mg/L) selection medium resulted in regeneration of 41 putative t

- Three CRISPR/Cas9 gene targeting constructs for the targeted mutagenesis of *GhPHYA1 viz.,* sgRNA1 *GhPHYA1*::CRISPR/Cas9, sgRNA2 *GhPHYA1*:: CRISPR/Cas9 and sgRNA3 *GhPHYA1*:: CRISPR/ Cas9 were generated.
- To elucidate the potential role of Wnt3A like gene in embryogenesis, *Agrobacterium tumefaciens* mediated transformation of pBI121::*Wnt* 3A::*UidA* gene construct in *G. hirsutum* Cv. Suraj was attempted and putative transgenic callus cultures were confirmed for β-glucuronidase activity.
- Freshly harvested seeds were evaluated for storability in different packaging materials and storage conditions. Storing seeds under cold conditions in vacuum containers and modified Argon gas revealed better seed germination.

CROP PRODUCTION

- Field trials at institute as well as in the farmer's field proved that fertilizer recommendation based on Nutrient Expert system was superior in enhancing seed cotton yield as compared to other fertilizer management systems. The Nutrient Expert recorded a seed cotton yield of 3149 kg ha^{-1} (32% increase as compared to farmer practice).
- There found to be no added advantage with application of Sulphate of Potash (SOP) based complex fertilizer over the Muriate of Potash (MOP) based complex fertilizer
- Based on legume compatibility under rainfed conditions, short duration Blackgram, Greengram and Soybean in the ratio of 1:1 cotton intercropping systems were found to perform better even under erratic rainfall conditions. *Desmanthus virgatus* was most amenable for 4:2 cotton intercropping systems under irrigated conditions.
- The total rainfall received during cropping season (2019-20) at ICAR-CICR, Nagpur was 1240.07 mm, out of which, effective rainfall (662.8 mm) was 53.44 % and ineffective rainfall (577.27 mm) was 46.56%. Based on the ineffective rainfall calculation according to USDA Soil Conservation method and soil moisture changes, the runoff estimated during June to December was 57.72 lakh litres from one hectare area.
- Under winter irrigated conditions of Coimbatore, higher values of water use efficiency (WUE) were consistently observed across irrigations scheduled at 1.0, 0.8, 0.6 or 0.4 ETc, where the source was structured water as compared to bore well water. When irrigated at 0.8 ETc the values of WUE were 60.2 and 52.8 $kgha^{-1}$ cm in case of structured water and bore-well water respectively.
- Radish-cotton and Pigeon pea-cotton rotations were found to give lesser inter-row soil penetration resistance as compared to deep sub soiling and shallow sub-soiling. Dhaincha and sunnhemp offered least soil penetration resistance inter-row as well as between row than soybean and sub-soiling every and alternate rows. At Coimbatore, on mixed red and black soils, compared to farmers practice, adoption of Conservation Agriculture system with 100% residue recycling significantly reduced the soil penetration resistance upto 9" soil depth.
- A total of 325 native bacterial strains were tested for their biocontrol potential against pink bollworm, American bollworm and fall army worms through replicated insect diet bioassay. The maximum larval mortality of *Pectinophora gossypiella*, *Helicoverpa armigera,* and *Spodoptera frugiperda* were recorded with the bacterial strains 188 (94%), 219 (85%) and 304 (91%) respectively.
- Among the four cotton spp., *G. arboreum*: (Phule Dhanwantary and PA 255) had more oxalate oxidase enzyme expression. Water stressed leaf samples were observed to possess more oxalate oxidase activity than control. Overall, expression of oxalate oxidase in cotton leaves at gene and protein level confirms the existence of "Alarm photosynthesis" pathway in cotton.
- Tissue specific expression of *ACS* (1-aminocyclopropane-1-carboxylic acid synthase) and *ACO* (1-aminocyclopropane-1-carboxylic acid oxidase) in six medium long to long-linted *Gossypium arboreum* L. genotypes showed their higher expression in ovules as compared to subtending leaves and bolls. Temporal expression analysis of the same revealed their involvement in early fiber elongation stage. A positive correlation was established between the amount of ethylene and fiber length of respective genotypes. Further, role of two candidate genes; *BONZAI* and *PEX1* involved in H_2O_2 and other ROS homeostasis during fibre development was confirmed and re-validated in *G. arboreum.*

- Epigenetic regulating chemicals contributed to drought tolerance in cotton plants, and the effect was inherited till the third generation of seed treated plants. 5 Azacytidine (40 µM) and Epigallocatechin gallate (100 µM) improved the SPAD values, Peroxidase activity, Epicuticular wax content, Proline and relative water contents, while decreased the excised leaf water loss in first generation plants of Suraj and LRA 5166 subjected to drought stress, the stress memory of which was inherited till the third generation. In addition, LRA 5166 plants treated with 5 Azacytidine 10 µM and 40 µM exhibited early flowering (6-7 days) in all three replications, however, it was not evident in Suraj.
- Under e-Communication programme, cotton production technologies were disseminated among farmers through voice message services covering 1.5 lakh farmers of Nagpur, Coimbatore and Sirsa regions. During the reporting period 58,81,315; 3,14,035 and 10773 noise-free voice messages were uploaded from Nagpur, Coimbatore and Sirsa centres, respectively.
- The study on impact of Institutional Credit on Cotton Farming in Maharashtra indicated that the mean of Technical Efficiency at 0.60 for the credit using farmers as against 0.57 for their non-credit using counterparts. Further, agriculture credit itself cannot play any direct role in enhancing the output, rather it indirectly helps through facilitating the purchase of various modern inputs.
- The seed cotton yield of Bt cotton hybrid was significantly superior over SCY of both Bt as well as non-Bt cotton varieties under irrigated cotton-wheat cropping system at Sirsa, but was at par with SCY under non-Bt cotton hybrid-wheat cropping system. Significantly higher SCY was observed with application of NPK (RDF) + Secondary nutrients ($MgSO_4$) + Micro nutrients ($ZnSO_4$ + Borax) + FYM (5 t/ha) once in two years.
- Early sowing of Bt cotton variety (CICR Bt-6) at Sirsa with a plant spacing at 67.5 cm x 45 cm significantly improved the seed cotton yield. Application of Mepiquat chloride 20g a.i./ha at 60 and 75 DAS significantly improved the seed cotton yield.
- The seed cotton yield was significantly higher under Zero tillage - permanent narrow raised bed with residue retention on surface. Amongst the cropping systems, the significantly higher values of seed cotton yield were recorded under Cotton - Chickpea as compared to all other cropping systems.

CROP PROTECTION

- Field efficacy of sex pheromones as individual lures, combinations and as mixtures were tested against the major lepidopterous bollworms and leaf worms of cotton. Trap catch of *Pectinophora gossypiella* and *Spodoptera litura* was found to be at par in Individual traps, combined traps & combined lure, while in the mixed lure experiment a reduction in trap catch was noticed.
- Chemical profiling of ethyl acetate fractions of a new wax degrading fungus, *Aspergillus fumigatus* isolated from striped mealybug, *Ferritia virgata* yielded alkaloids as major component which included 5-Chlorobenzimidazole-2-carboxylic acid (7.06 %), 1,4-Diaza-2, 5-dioxo-3-isobutyl bicyclo [4.3.0] nonane (18.97%), 3,6-Bis (2-methylpropyl) piperazine-2,5-dione (7.13%) and 3-Benzylhexahydropyrrolo [1,2-a]pyrazine-1,4-dione (9.94 %).
- The genotype BB-6-1-2 was found to be resistant against Reniform nematode, *Rotylenculus reniformis* among the 29 genotypes of *G. hirsutum* screened.
- Out of nine insecticides tested, cotton leafhopper *A. biguttula biguttula* was most susceptible to thiamethoxam. The level of detoxification enzymes *viz*., esterase and mixed function oxidases were higher in insecticide exposed leafhoppers.
- Cotton intercropped with marigold recorded lowest population of thrips. Insecticide spinetoram followed by fipronil recorded highest efficacy against thrips.
- A retrospective study on weather parameters triggering whitefly infestation using ICAR-AICRP on Cotton data for the past 15 years for three North Zone locations showed that maximum temperature had more influence in decreasing whitefly infestation while minimum temperature influenced in increasing whitefly infestation. Other weather parameters did not show any pattern or consistency over the years.
- The label claimed insecticides screened under laboratory conditions against leafhopper recorded mortality ranging from 26.67 to 72 percent. The maximum mortality (%) was observed in flonicamid (72), followed by dinotefuran (70), thiacloprid (57.33), acephate (55.33) and imidacloprid (56.67).
- The per cent infestation of pink bollworm in Flowers of BG-II cotton at 60-70 days after sowing was observed at 0 to 22.6% in all cotton growing districts of Maharashtra. Per cent infestation in green bolls at 160-165 days after sowing was observed at 0 to82%.

- Infestation of pink bollworm on BG II cotton in Gujarat was in range of 0 to 8.00 per cent at 80-90 DAS.
- Pink bollworm infestation in North India (Punjab, Haryana and Rajasthan) at 140-150 DAS was recorded nil on BG-II hybrids except in Jind district of Haryana and Bhatinda district of Punjab with 6.90 % and 1.00% of incidence respectively. At 180 DAS PBW incidence at 69.60 % and 28.00 % was observed in Jind district of Haryana and Bhatinda district of Punjab respectively.
- PBW larvae resistant to Cry2Ab toxins have higher alkaline phosphatase activity than the susceptible population collected from infested non-*Bt* cotton bolls.
- *Burkholderia* strains were recorded as endosymbionts in pink bollworm larvae collected from different locations. Other bacteria recorded were *Pluralibacter gergoviae*, *Enterobacter sp.*and *Citrobacter youngae* .
- Laboratory evaluation of six vegetable oils (groundnut, sunflower, safflower, soybean, sesame and ricebran) showed promising results as oviposition deterrant for pink bollworm with respect to avoidance index (Ai) and percent effective deterrence (PED).
- The major putative attractants for pink bollworm identified from squares and bolls were α/β pinene, carene, γ terpinene, α copaene, caryophyllene and humulene.
- Degree-day based phenology model for predicting the developmental events of cotton pink bollworm *Pectinophora gossypiella* in field was developed. Validation of model provided closer estimates across the tested locations.
- The Bio module-1 (2 sprays each of neem+*Isaria javanica* CICR-RSS -0102) followed by existing IPM module (2 sprays each of neem+ flonicamid + spiromecifen), IPM module-3 (2 spray of neem+ Flonicamid @ 1 ml/L + *Metarhizium anisopliae*-1299) and Bio module-2 (2 sprays each of neem+ *Beauveria bassiana*-4511 showed higher nymphal mortality of whitefly than untreated control and other modules.
- PGPR *Bacillus aryabhattai* (CICR-D5) + *B. tequilensis* (CICR-H3) combination followed by strains *B. tequilensis* (CICR-H3) and *B. aryabhattai* (CICR-D5) singly were found most effective against seed and soil borne fungal pathogens (*Macrophomina phaseolina*, *Rhizoctonia solani* and *Fusarium oxysporum* f.sp. *vasinfectum*) and leaf spot diseases of upland cotton Cv. Suraj.
- Cotton endophyte *Nigrospora sphaerica* (CEL 19) effective against *Fusarium solani* and *Corynespora cassiicola* was recorded to produce antimicrobial VOCs namely 1, 3-diethyl benzene, 1, 4-diethyl benzene, cymene-7-ol and m-ethylacetophenone .
- Sap transmission studies with *Tobacco streak virus* showed transmission as evidenced by development of symptoms in greengram, black gram, *Chenopodium amaranticolor, C.quinoa, Nicotiana rustica and N. tabacum* and soybean.

General

- During the period 38 research papers and 37 popular articles were published; 16 training programmes were organized in which 1660 farmers and extension functionaries participated.
- Linkages were fostered with sister ICAR institutes, SAUs, other public sector institutes, private companies, NGO's and farmer producer groups to commercialize and upscale varieties and technologies developed. Seven MoUs were linked during April to December, 2019.

2. INTRODUCTION

2.1 : Brief History

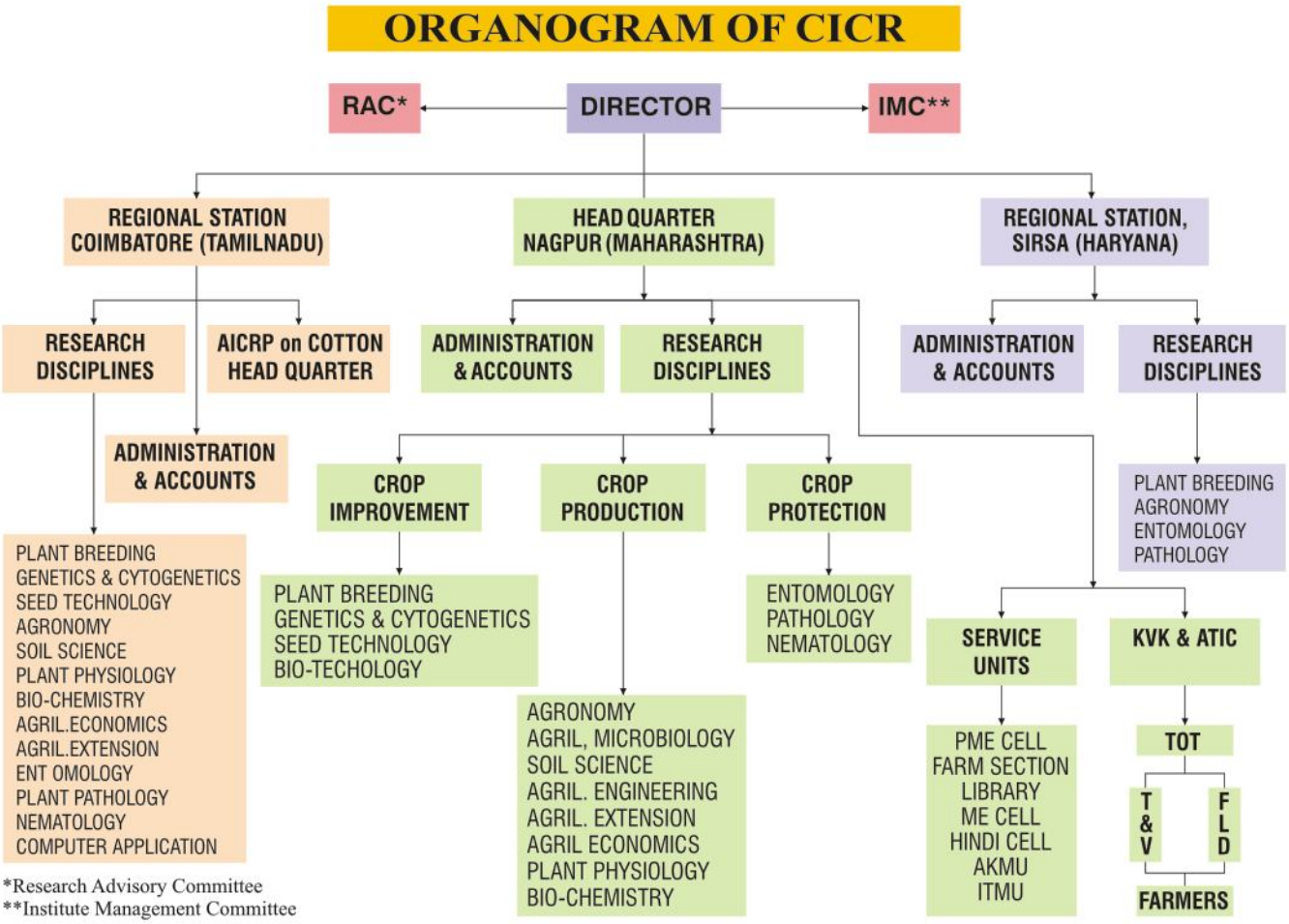
The ICAR-Central Institute for Cotton Research was established at Nagpur, in 1976. The two regional stations of IARI at Sirsa (Haryana) and Coimbatore (Tamil Nadu) were transferred to CICR to cater to the needs of north and south India, respectively.

Location of the of ICAR-CICR Institute

Center	Latitude	Longitude
ICAR-CICR, Head Quarters, Nagpur, Maharashtra	21.037	79.056
ICAR-CICR, Regional Station, Coimbatore, Tamil Nadu	11.014	76.929
ICAR-CICR, Reg ional Station, Sirsa, Haryana	29.543	75.038

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



2.3 : Staff Position (as on 31st December, 2019)

Name of the Post	Sanctioned Cadre Strength				Post Filled Up			
	NGP	CBE	Sirsa	Total	NGP	CBE	Sirsa	Total
Director (RMP)	1	--	--	**1**	--	--	--	**--**
Scientific	49	22	6	**77**	42	22	6	**70**
Technical	46	16	10	**72**	37	15	9	**61**
Administrative	34	9	5	**48**	20	5	5	**30**
Skilled Support Staff	23	12	9	**44**	23	12	9	**44**
Krishi Vigyan Kendra								
Training Organizer	1	--	--	1	--	--	--	--
Technical	11	--	--	11	9	--	--	9
Administrative	2	--	--	2	1	--	--	1
Skilled Support Staff	2	--	--	2	2	--	--	2

NGP – Nagpur; CBE - Coimbatore

2.4 : Financial Statement

The budget grant and actual expenditure for the year 2019 are furnished below:

(Rs. in Lakhs)

Name of Scheme	2018-19	
	Sanction	Expenditure
Plan Scheme	1505.05	1479.57
Deposit Scheme	2631.51	2284.92
Revolving Fund	21.96	8.06
Govt. Grants (Non-Plan & Plan merged from 2017-18)	3785.08	3608.77
Total (in lakhs)	**7943.6**	**7381.32**
Revenue Generation (Revenue Receipts)	40.52	37.94

3. RESEARCH ACHIEVEMENTS

3.1 Consolidation and characterization of genetic diversity

Cotton germplasm resources

ICAR-CICR, Nagpur maintains one of the largest cotton germplasm collections of the world with 12,335 accessions covering all the cultivated and wild species of *Gossypium* including perennials, landraces and interspecific derivatives (Table 3.1.1).

Species	Base Collection
G. hirsutum	8851
G. barbadense	536
G. arboreum	2053
G. herbaceum	565
Wild species	24
Inter-specific derivatives	40
Perennials and land races	254
Races and derivatives of all 4 species	12
Total Collection	**12335**

Table 3.1.1: Germplasm collections at ICAR-CICR, Nagpur

Quarantine evaluation of imported accessions:

Six hundred seventy-four (674) exotic accessions (346 *G. hirsutum*, 211*G. barbadense* and 117 G. *arboreum*) were procured from USA and evaluated in glass house for quarantine pest, *Xanthomonas campestris* var. *malvacearum.*

Maintenance and evaluation of germplasm:

***G. hirsutum*:** Seeds of 56 exotic accessions and 36 Coker lines including two CLCuD resistant accessions were multiplied. Eight exotic varieties of *G. hirsutum* were evaluated for yield and fibre quality traits.

***G. barbadense*:** Three hundred and twenty-seven (327) accessions and eleven new germplasm lines are being maintained at ICAR-CICR Regional Station, Coimbatore. Eighty-nine accessions have been deposited in MTS at ICAR-CICR, Nagpur.

***G. herbaceum*:** Seeds of 66 accessions received from ICAR-NBPGR, New Delhi are being multiplied and characterized at Main Cotton Research Station (NAU), Surat.

A total of 3830 base collection comprising of 3602 accessions of *G. hirsutum,* registered lines (49), exotic varieties (08), ICAR-NBPGR accessions (67-*G. hirsutum and* 69- *G. arboreum*), West Bengal Culture (32- *G.hirsutum*), and colour cotton accessions (03-*G. arboreum*) were multiplied and evaluated.

In order to develop a mini-core, seeds of 780 geographically and genetically diverse upland cotton accessions of core collections were multiplied and characterized for DUS traits. They were also profiled to assess the DNA polymorphisms using 52 polymorphic SSR markers.

Distribution of cotton germplasm: Thirty-nine (39) germplasm accessions consisting of *G. hirsutum, G. arboreum* and wild species were distributed to breeders/scientists of ICAR-CICR, State Agricultural Universities (SAUs) and private seed companies for utilization.

Exploration of wild species for cotton improvement

Seeds and cuttings of *G. anomalum*, *G. triphyllum*, *G. capitis viridis*, *G. thuberi*, *G. armourianum*, *G. davidsonii, G. raimondii*, *G. trilobum, G. stocksii, G. somalense, G. longicalyx*, *G.nelsonii* Fryx, and *G. barbasonum* from MPKV, Rahuri were collected. Seeds of *G. nelsonii* Fryx were germinated in MS media in the tissue culture laboratory, hardened and established in a pot while, the cuttings of *G. somalense, G. raimondii* and *G. barbosanum* have been established in pots.

***G. nelsonii* grown on MS medium, hardened in a paper cup and transplanted in pot**

***G. somalense* and *G. raimondii* cuttings from MPKV, Rahuri established in pots**

Six BC_1F_1 cuttings of *G. hirsutum* × *G armourianum* have been established in pots. Progenies of crosses between *G. arboreum* × *G. longicalyx, G. arboreum* race indicum × *G. davidsonii, G. arboreum* × *G. thurberi* and

G. arboreum Cv. AKA 8401 x *G. davidsonii* were advanced from F_4 to F_5 generation. New crosses were attempted using wild species namely *G. australe, G. thurberi, G. raimondii, G. barbosanum, G. anomalum, G. capitis virides, G. triphyllum, G. klotzchianum, G. longicalyx, G. somalense* and *G. mexicanum.*

3.2 Breeding for premium fibre quality and high yield

Genetic improvement of *G. herbaceum*

Nagpur

The F_3 population of five inter-specific crosses *viz.,* IC–371437 × PA-785, Jayadhar × PA-785, Baluchistan-2 × PA-785, IC-371560 × PA-785, IC-371437 × PA-812 and their reciprocals were evaluated. F_4 population of six intra specific crosses (IC-371587×Baluchistan-2, IC-371437×IC-371602, IC-371437×IC-371560, IC-371602×C-371560, Jayadhar×GVHV-655, IC-371136×IC-371437) and five back cross (BC_2) population of inter-specific crosses along with parents were also evaluated.

Genetic improvement of G. *arboreum*

Nagpur

For improvement of fibre quality traits of *G. arboreum*, backcrossing and generation advancement were done for crosses involving long linted genotypes *viz.*, PA255, PA812, PA740, PA785 and KWAN3. Based on morphological and fibre quality trait data, superior progenies were identified and utilized in the backcrossing (BC_3F_1 and BC_2F_2) and generation advancement programme (F_4) (Table 3.2.1.)

Table 3.2.1. Range for fibre quality traits in advance selections of *G. arboreum*

Particulars	Range in *G. arboreum* selections
Fibre length (mm)	16.2-29.5
Fibre strength (g/tex)	21.5-33.1
Micronaire value (µg/in)	4.4-6.8
Uniformity Index (%)	70-81

Promising single plant selections and progenies of *G. arboreum*

Evaluation of introgressed derivatives

500 introgressed derivatives (*G. arboreum* and *G. hirsutum*) were evaluated for fibre and economic traits. Seeds of lines with unique traits and identified high strength introgressed lines *viz.,* CICR 16301 (DB), CICR 16315 (LB), CICR 16337 (LB), CICR 16377 (LB-A) and CICR 16378 (LB-A) sponsored for testing under AICRP on Cotton were multiplied.

Coimbatore

G. arboreum accessions screened for high yield and early maturity were selected for producing F_1's in diallel fashion. The crosses and their parents were evaluated for specific combining ability (SCA) effects and standard heterosis (SH) along with *per se* performance. Seven F_2 populations with white lint *viz.,* AC 3265× PBS1127–SP1, AKA 496 × H 509, AKA 496×AC 3097, PBS 1127-SP1×N 11-54-31-32, AC 3216×AKA 13-SP1, H 503×N 11-54-31-32, H 509×AKA 13-SP1 were selected. A set of 12 F_2 brown linted (coloured) progenies are being evaluated (indicum 12-Sp1×H 480, NA 48×H 483, AC 514×AC 3066, AC 514×Desi 56, H 480× indicum 12-SP1, 30814×AC 3066, 1422×indicum 12-SP1, H 492×30839, Desi 77×Arboreum 12, indicum 12-SP1×H 502, Desi 56×indicum 12-SP, G 725-SP1× indicum 12).

F_2 population of cross from AC 3216 × AKA 13-SP1

F_2 population of cross Desi 56 × indicum 12-SP (brown linted)

Sirsa

Evaluation of spinnable *G. arboreum* cultures: Fourteen cultures were tested in RBD along with two checks CISA 614 (3070 kg/ha) and PA255 (2577 kg/ha). None of the genotypes showed significantly higher yield than the high yielding check (CISA-614). However, two genotypes namely, CISA 6-350 (3171 kg/ha) and CISA 6-295 (3217 kg/ha) recorded numerically higher seed cotton yield than the high yielding check (CISA-614). Three genotypes, namely, CISA 6-350 (3172 kg/ha), CISA 6-295 (3217 kg/ha) and CISA 33-1 (2988 kg/ha) recorded significantly higher yield than the quality check, PA-255 (2577 kg/ha). Genotype CISA 6-295 recorded fiber length of 25.8mm on par to PA 255 (25.5mm) and is also numerically superior to higher yielding check CISA-614. Genotypes CISA-6-350 and CISA-6-295 recorded more than 30q/ha of seed cotton yield and have promise for spinning. Three genotypes CISA-6-295, CISA-33-4 and CISA 33-8 were having UHML >25.0mm and strength >25.0 g/tex in HVI mode during 2019-20.

Evaluation of high yielding *G. arboreum* genotypes: Fourteen genotypes were evaluated in RBD design with two check varieties CISA 614 and CISA 310. Four genotypes CISA 405 (3739 kg/ha), CISA 9 (3531 kg/ha), CISA 294 (3638 kg/ha) and CISA 33-5 (3617 kg/ha) gave significantly higher seed cotton yield than both the check varieties CISA 614 (3102 kg/ha) and CISA 310 (2461 kg/ha).

Evaluation of GMS based *G. arboreum* hybrids: Four GMS based hybrids were evaluated for seed cotton yield with two check hybrids AAH1 and CICR2. Two hybrids CISAA19-1 (3449 kg/ha) and CISAA19-3 (3498 kg/ha) recorded significantly higher seed cotton yield than the highest yielding check hybrid CICR 2 (3106 kg/ha). Fiber quality of CISAA19-1 parameters were also superior (UHML-27.6 mm, strength-27.9 g/tex, mic-5.4 µg/in) to check hybrid (UHML- 21.1 mm, strength-22.3 g/tex, mic-6.3 µg/in). One GMS based hybrid namely CISAA19-2 (3348 kg/ha) recorded numerically higher seed cotton yield than highest yielding check hybrid CICR2.

Maintenance of GMS lines: Four GMS lines (DS5, CISA 2, GAK 413A, CISG-20) and 18 newly identified GMS lines, (CISG-1, CISG-2, CISG-4, CISG-8, CISG-9, CISG-10, CISG-11, CISG-13, CISG-14, CISG-15, CISG-16, CISG-17, CISG-18 (narrow leaf), CISG-18 (broad leaf), CISG-19, CISG-21, CISG-22 (narrow leaf) and CISG-22 (broad leaf)) were maintained through sib-mating. GMS lines CISG 8, CISG-9, CISG-10, CISG-13 and CISG-14 posses red flower colour. The proposal for registration of CISG 20 has been submitted to ICAR-NBPGR, New Delhi.

Genetic improvement of *G. hirsutum*

Nagpur

A total of 440, 850 and 260 single plant selection progenies belonging to F_4, F_5 and F_6 generations respectively are being evaluated. Single plants were selected based on quality traits, early maturity (140-150 days), compact plant type and tolerance to jassids. Eight trials comprising 208 entries were evaluated for seed cotton yield and fibre properties. Promising entries (CNH 1196, CNH 5816, CNH 5916, CNH 1246, CNH 2215, CNH 7615, CNH 1015, CNH 6215, CNH 1806, CNH 2616 and CNH 5916) were identified based on plant type, boll weight and earliness.

From interspecific crosses of *G. hirsutum* × *G. barbadense*, promising introgressed lines were developed using backcrosses, three-way and double crosses. Amongst 73 introgressed lines (F_5) evaluated, CNHB34-53-1, CNHB 34-53-3, CNHB 34-53-4, CNHB 44-50-3, CNHB 44-2-1, CNHB 44-2-2 and CNHB 44-5-1 were promising for fibre length and seed cotton yield. Introgressed lines derived from backcross progenies of cross (Suraj × Suvin) × Suraj recorded significant variation for ginning outturn varying from 29.0% (CNHB 32-3) to 45.9 % (CNHB 33-7). The fibre properties of these lines CNHB 32-3 and CNHB 33-7 had upper half mean length of 28.4 and 27.6 mm and fibre strength of 27.1 and 29.1 g/tex, respectively. These lines possess longer internode distance. Amongst 56 extra long staple lines, 10 lines namely (CNH 1196, CNH 5816, CNH 5916, CNH 1246, CNH 2215, CNH 7615, CNH 1015, CNH 6215, CNH 1806, CNH 2616, CNH 5916) were promising for seed cotton yield.

Colour cotton

Lint samples of 16 naturally brown colour cotton were analyzed for colour parameters and fibre properties at ICAR-CIRCOT, Mumbai. Six samples with comparatively higher colour strength were also the darkest, with L* values (Lightness- darkness scale with 0 being most dark and 90 most light respectively) below 75. Wavelength of maximum absorption (λ_{max}) for all the samples in the visible region was 420 nm. Evaluation of colour fastness of these samples revealed no/least fading. Wash fastness was tested and it was observed that instead of fading, colour became darker after washing indicating stability of colour. Fifty colour cotton entries were evaluated for their fibre traits.

Crosses were attempted between cleistogamous MSH-345 and dark brown linted genotype Vaidehi-95 to introduce cleistogamy trait in colour cotton. Seed multiplication of dark brown linted Vaidehi-95 has been taken up in the institute as well as in Dr PDKV Akola farm under a tripartite agreement signed between ICAR-

CICR, ICAR-CIRCOT and Dr PDKV. Sixty kilograms of delinted seeds of Vaidehi-95 (MSH-53) was supplied to Dr. PDKV Akola for multiplication at Vani Rambhapur, Akola.

Seed production plot at Vani Rambhapur, Akola

Sirsa

Evaluation of advance cultures of *G. hirsutum*

Trial 1: Fourteen *G. hirsutum* cultures were evaluated against the check varieties RS 2013, LH 2076, CSH 3129 and CLCuD susceptible check F1861 in RBD with three replications. The highest seed cotton yield was recorded in the culture CSH 2902 (2103 kg/ha) followed by CSH 2924 (2096 kg/ha) as against the check variety LH 2076 (1832 kg/ha). Maximum ginning outturn of 35.3 per cent was recorded in the culture CSH 2916 as compared to local check varieties CSH 3129 (34.2%) and LH 2076 (34.7%). CSH 1604 recorded fibre length of 28.8 mm whereas CSH 2931 recorded fibre strength of 33.2 g/tex. Six cultures *viz.,* CSH 2932, CSH 1601, CSH 1602, CSH 1604, CSH 1606 and CSH 1607 showed resistant reaction against CLCuD as compared to local check varieties with MS reaction.

Trial 2: Fifteen *G. hirsutum* cultures were evaluated against the check varieties RS 2013, LH 2076, CSH 3129 and CLCuD susceptible check F1861 in RBD with three replications. The culture CSH 1622, CSH 1713 and check variety CSH 3129 recorded the highest length of 29.0 mm whereas CSH 1615 recorded the strength of 31.2 g/tex. Cultures CSH 1615, CSH 1616, CSH 1711, CSH 1712, CSH 1714 and CSH 1604 showed resistant reaction against CLCuD.

Trial 3: Sixteen *G. hirsutum* cultures were evaluated against the check varieties CSH 3075 in RBD with three replications. The highest seed cotton yield was recorded in the culture CSH 49 (2399 kg/ha) followed by CSH 50 (2345 kg/ha) as against the check variety CSH 3075 (1781 kg/ha). Maximum ginning outturn of 35.0 per cent was recorded in the culture CSH 53 as compared to local check variety in CSH 3075 (32.0%). All the advance cultures except CSH 46 and check variety CSH 3075 showed resistant reaction against CLCuD.

Trial 4: Eleven compact cultures of *G. hirsutum* were evaluated against the check CSH 3129 in RBD with three replications. Highest seed cotton yield was recorded in compact culture CSH 92 (2563 kg/ha) followed by CSH 111 (2437 kg/ha) as against the check CSH 3129 (2563 kg/ha). Maximum ginning outturn of 35.3 per cent was recorded in the culture CSH 2916 as compared to local check varieties CSH 3129 (34.2%) Three cultures CSH 109, CSH 114, CSH 116 and the check variety CSH 3129 showed resistant reaction against CLCuD.

Trial 5: Eighteen *G. hirsutum* cultures were evaluated against the check variety CSH 3075 in RBD with three replications. The highest seed cotton yield was recorded in culture CSH 89 (3143 kg/ha) followed by CSH 90 (2926 kg/ha) as against the check variety CSH 3075 (2416 kg/ha). Maximum ginning outturn of 34.5 per cent was recorded in the culture CSH 95. Three cultures CSH 107, CSH 115 and CSH 117 showed resistant reaction against CLCuD.

Population improvement

Nagpur

Evaluation of single plant selection: A total of 1508 superior single plants selected from random mating population (897 of *G. arboreum* and 611 of *G. hirsutum*) were evaluated as plant to row progenies. These were monitored for segregation, if any, and also evaluated for uniformity, economic and fibre quality traits.

Evaluation of advance cultures: *G. arboreum* 111 cultures and 72 of *G. hirsutum* were evaluated in 7 replicated trials (4 rows in 2 replications). In all, 4 trials of *G. arboreum* and 3 of *G. hirsutum* were conducted following spacing of 60 x 45 cm.

Evaluation of sterile plants: A total of 3269 single sterile plants from random mating population (1244 of *G. arboreum* and 2054 of *G. hirsutum*) were evaluated as plant to row progenies to access its superiority for specific trait. All the single plant progenies were monitored for segregation and sterile and fertile plants were tagged. Fertile plants shall be evaluated for economic and quality traits to identify progenies for specific superior traits.

Sirsa

GMS based random mating population

Individual plants in the population were monitored for sterility/fertility at anthesis and sterile plants were

tagged. Out-crossed bolls from the sterile plants in the population were bulk harvested and ginned to constitute the next cycle of GMS based random mating population. After 8th cycle of random mating, 75 fertile plants having high yield potential and tolerance against CLCuV were selected for evaluation in progeny row trial.

Evaluation of advance cultures selected through random mating of *G. hirsutum*

Trial 1: 24 cultures were evaluated against the check varieties CSH 3129 and CSH 3075 in RBD with 3 replications. Highest seed cotton yield was recorded for culture CSH 70-15 (2238 kg/ha) followed by CSH 71-16 (2210 kg/ha) as against the check variety CSH 3129 (2050 kg/ha).

Trial 2: Thirty-two cultures were evaluated against the check varieties CSH 3129 and CSH 3075 in RBD with 2 replications. The highest seed cotton yield was recorded for culture CSH 223-10 (2859kg/ha) followed by CSH 99-02 (2734 kg/ha) as against the check variety CSH 3129 (2050 kg/ha).

Genetic improvement of *G. barbadense*

Coimbatore

Cleistogamy in *G. barbadense* : A stable complete cleistogamous progeny was obtained in the segregating population from an intra *barbadense* cross (Giza -45 × Suvin- 3-7-2). This cleistogamous trait is highly useful in seed production and pure line breeding. Fifty grams of cleistogamous plant seeds was sent to ICAR-CICR, Nagpur and MPKV, Rahuri for multilocation evaluation. Mass multiplication of seed was done for sending to ICAR-NBPGR, New Delhi for registration.

Seed multiplication of the promising genotypes : Seed multiplication of advance cultures for the station as well as ICAR-AICRP trials was taken up. These include advance cultures (CCB-141, CCB-142 and CCB-64b for the initial evaluation trial) and eight cultures (CCB-26, CCB-28, CCB-29, CCB-51, CCB-51-2, CCB-64, CCB-129, CCB-143B) entered in three breeding trials (Br.12a, Br13a and Br.14a) of AICRP-2019-20.

3.3. Breeding for climate resilience and biotic stress tolerance

Drought tolerance

Three sets of experiments were conducted. In the first set, advance generation of thirteen crosses were tested in replicated trial with LRA 5166, Rajat and Suraj as checks. In second set, 15 crosses in advance generation along with parents and checks were tested. The same material was tested for drought tolerance under rainfed and irrigated condition. The third set of experiment comprising of F_3 and F_4 generation of three-way and single crosses are being tested for developing compact genotypes for high density planting.

Single plant progenies (672) evaluated for seed cotton yield and fibre quality. Sixteen inter-cross lines with zero monopodia, seed cotton yield and fibre quality and 129 single plant progenies of 28I × Suvin were raised for developing genotypes with compact plant type, high yield and good fibre quality.

Single plant progenies (2972) were raised for ten parental cross for developing MAGIC RILs. Out of these, 250 MAGIC lines were subjected for proline estimation and Polyethylene glycol (PEG) treatment. The leaf discs of drought tolerant plants were subjected to stress in half MS media with different PEG concentration gradient at 0.2, 0.4, 0.6 and 0.8 MPa for 15 days which showed higher proline accumulation. Another set of 3031 single plant progenies have been raised from eight parental cross for developing MAGIC RILs. These are being evaluated for yield and other economic traits.

Breeding for early maturity, compact plant type and jassid tolerance

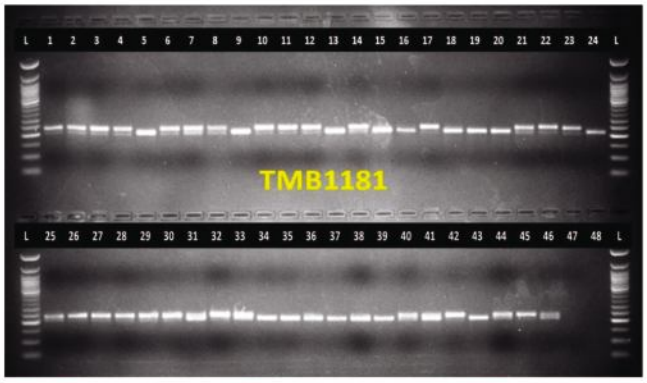
Single plant progenies and selections promising for earliness, jassid tolerance, compact plant architecture, yield and fibre quality were identified from the segregating populations (Table 3.3.1). Crop duration and plant architecture were severely impacted by the incessant rains resulting in heavy infestation of sucking pests. Taking advantage of pest pressure, material was thoroughly screened for jassid tolerance and promising lines/progenies were identified.

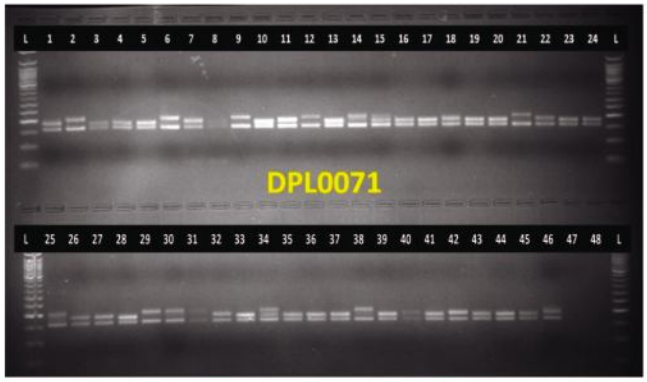
Table 3.3.1. Single Plant Selections having early maturity, jassid tolerance, compact plant architecture along with better yield and fibre quality

Single Plant Selection	Plant Height (cm)	Width at Mid height (cm)	Monopodia	Sympodia	Percent boll bursting at 150 DAS	Av. boll weight (g)	Plant yield (g)	UHML (mm)	Mic (µg/in)	Str. (g/tex)
SPS18-08	112	51	1	12	100	4.50	127	27.6	4.4	29.3
SPS18-10	98	42	0	13	100	3.83	81	28.1	3.5	27.4

Single Plant Selection	Plant Height (cm)	Width at Mid height (cm)	Monopodia	Sympodia	Percent boll bursting at 150 DAS	Av. boll weight (g)	Plant yield (g)	UHML (mm)	Mic (µg/in)	Str. (g/tex)
SPS18-11	100	38	0	16	100	3.83	120.5	27.9	4.4	29.0
SPS18-18	84	38	2	16	100	3.50	124	26.9	4.4	28.4
SPS18-25	86	37	1	18	100	2.50	96.5	28.0	4.1	29.0
SPS18-27	78	28	1	11	100	4.17	89	27.1	4.7	28.4
SPS18-32	88	38	1	14	100	3.83	97.5	26.7	4.2	27.7
SPS18-34	82	32	0	14	100	3.83	88	26.6	3.8	26.5
SPS18-35	108	52	1	12	100	4.00	106.5	26.8	4.1	27.9
SPS18-36	88	38	0	11	100	4.00	80.5	26.3	4.3	27.1
SPS18-40	84	40	0	12	100	5.17	85	26.5	4.8	27.0
SPS18-42	92	30	0	15	100	3.50	78.5	26.5	4.6	28.4

In order to assess the molecular divergence among jassid tolerant (16) and susceptible (30) entries, 50 polymorphic markers were identified and utilized for molecular characterization. Out of 50 polymorphic SSR markers screened, 18 of them have been reported to be associated with QTL for jassid tolerant traits as per the information available from Cotton QTL database (www.cottonqtldb.org)



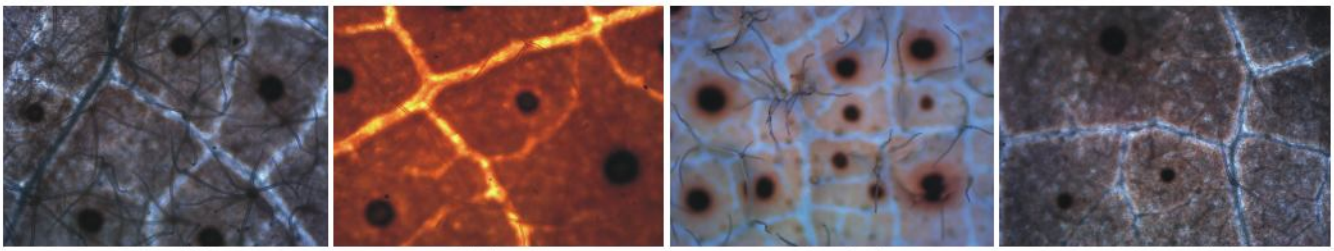


SN.	Genotype	SN.	Genotype	SN.	Genotype	SN.	Genotype	SN.	Genotype	SN.	Genotype
1	G-COT16	9	EC343591	17	CNH2035	25	AKH8828	33	NISC44	41	CNH2034
2	Narasimha	10	AKH081	18	RS875	26	CNHO7-34	34	N170	42	Phule688
3	RCH Non-Bt	11	EC344804(S)	19	HS6	27	NISC-40	35	GCot12	43	NISC-43
4	CNH2026	12	CNH2025	20	SurbhiXMM2-4BK	28	NH545	36	IC359478	44	CSH3178
5	Anjali	13	SurbhiXM532-4-2	21	IC357857	29	Khandwa-2	37	IC359691	45	NH615
6	CINHTi-1	14	LRA5166	22	CNH09-7	30	Supriya	38	Sahana	46	MCU12
7	Arogya	15	F1378	23	RS2013	31	DSC99	39	Suraj	47	NTC
8	EC344092	16	CNHO12	24	Sumangala	32	KC-3	40	Sikandar Ageti	48	NTC

Molecular diversity analysis for jassid tolerance in cotton

***G. hirsutum* × *G. barbadense* hybrids**

Fifty *G. barbadense* genotypes comprising of 40 germplasms and 10 advance cultures were sown in two replications along with four *G. hirsutum* lines namely Suraj, Surabhi, MCU5 VT, CCH 15-1 during Kharif 2019. The *barbadense* lines were evaluated for various morphological characters to select diverse parents for further crossing programme. ICB 28 and CCB 141 were found to be early in flowering and boll bursting. The genotype ICB 124 had higher leaf trichome density (135 no./sq. cm), ICB 264 had maximum gossypol glands per sq. cm (126/sq.cm) and the genotype ICB 1 showed higher epicuticular wax (29.63 µg/sq.cm). The genotypes ICB 264, CCB 26 and ICB 73 showed lesser sucking pest incidence. About 28 crosses were attempted with seven *barbadense* lines namely ICB 161 (Compact type), CCB 11 A (early maturing), CCB 29 (advance culture for yield), Suvin (Quality), ICB 124 (hairs), CCB 25 (Epicuticular waxy lines), ICB 46 (high gossypol glands) with four *hirsutum* genotypes.



ICB 124 (135 trichomes/sq.cm) | **CCB 64** (10 trichomes /sq.cm) | **ICB 264** (126 gossypol glands/sq.cm) | **CCB 64** (6 gossypol glands /sq.cm

Genotypes with maximum and minimum trichome density and gossypol glands

Development of Bt cotton varieties using deregulated transgenic event (Mon531)

Nagpur

Two Bt genotypes *viz.,* ICAR-CICR 16 Bt and ICAR - CICR 23 Bt were identified for release in irrigated conditions of central zone and rainfed conditions of south zone, respectively by Variety Identification Committee, ICAR-AICRP on Cotton under the Chairmanship of Dr. A.K. Singh, DDG (Hort. & CS), ICAR.

Seven Bt entries are in second year of testing while four entries are in first year of testing in ICAR-AICRP Bt trial. Work on development of Bt hybrids was initiated and 109 Bt hybrids are being tested in institute common trial. Few hybrids were identified which showed reasonable promise during flowering and boll development stage. Promising hybrids will be carried forward for seed production and further testing in AICRP multilocation trial. New crosses were attempted between Bt varieties (Suraj Bt, Rajat Bt, PKV 081 Bt and GJHV 374 Bt) and GMS lines and introgressed derivatives for development of Bt hybrids. Promising single plant selections and progenies carrying *cry1Ac* gene (Mon531 event) were evaluated for early maturity, compact plant architecture, jassid tolerance, yield and fibre quality traits.

Coimbatore

cry1Ac positive plants in different BC_1F_1 populations (in background of Suraj, Surabhi, Supriya, Anjali, Sumangala, MCU 5-VT, LRA 5166, CCH 2623, Subiksha, Sunantha, CCH 15-1, BB 6 and BB 7) were backcrossed with recurrent parent. F_2 population from different crosses were raised, Cry1Ac positive plants were identified and selfed to produce F_3 population. H×B crosses were attempted between four Bt varieties and 7 *barbadense* lines.

Development of Bt cotton varieties using non-deregulated transgenic events

Nagpur

Effectiveness of different non-deregulated transgenic events against bollworms : Different non-deregulated transgenic events *viz.,* Tg2E13 (*cry1Ac*), UASD78 (*cry1Ac*), CH12 (*cry2Ax1*) were assessed for their bio-efficacy against pink bollworm and American bollworm along with checks BGII hybrid (*cry1Ac+cry2Ab*), Suraj Bt variety (Mon531), Non-Bt (Coker 310). For pink bollworm Tg2E13 was found to be comparable to single and dual Bt checks. The event Tg2E13 has good bio-efficacy against American bollworm as assessed in previous two years. Event UASD No. 78 and CH12 tested for their bio-efficacy against American bollworm showed good response.

Introgression of non-deregulated events into elite cotton varieties: In order to introgress Tg2E13 event, BC_4F_1 populations of three crosses *viz.,* Suraj × Coker310 (Tg2E13), NH615 × Coker310 (Tg2E13) and CISH3178×Coker310 (Tg2E13) were raised in seedling trays. ELISA was conducted at 20-30 DAS and non-Bt plants from the segregating backcross populations were roughed out. Event (Tg2E13) positive plants were transplanted to bigger pots on which ELISA was conducted at 60DAS and event positive plants having high toxin expression were identified and selfed. Generation was advanced using embryo culture technique. BC_4F_2 populations thus derived were evaluated for cry toxin expression at 30 days and non-Bt plants were roughed out. Event positive plants (BC_4F_2) were transplanted and using standardized zygosity PCR, plants homozygous for Tg2E13 event (*cry1Ac* gene) in BC_4F_2 population of three crosses were identified for further evaluation and multiplication. CISH3178 based BC_4F_1 plants having Tg2E13 and Mon531, alone and in combination have been identified. Characterization of UASD No. 78 event has been completed. Third backcross (BC_3) for introgression of CH12 event (*cry2Ax1* gene) into elite cotton genotypes (Suraj, NH615 and CISH3178) was successfully attempted (Fig.3.3.1). The presence of gene was confirmed by using *cry2Ax1* and Actin primers.

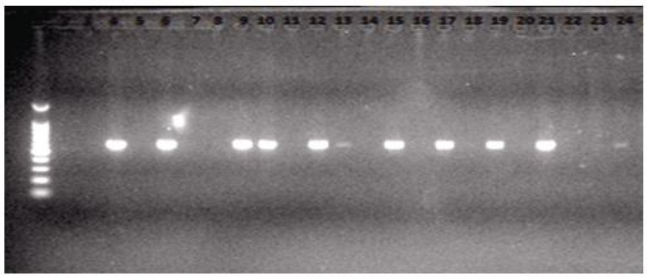


Fig. 3.3.1.: **Foreground selection for CH12 event using *cry2Ax1* gene specific primer** (Lane 1-100bp Ladder, 2-23 CH12 samples, 24- Positive control)

Evaluation trials for varietal identification and release

Institute Common Trial of *G hirsutum and G. arboreum*

G. hirsutum (18 entries) and *G. arboreum* (10 entries) were evaluated for seed cotton yield and fibre properties to identify promising entries for sponsoring in coordinated trials.

State Multi Varietal Trial (SMVT) at ICAR-CICR, Nagpur

An SMVT trial of *G. arboreum* (16 entries and 7 checks) and *G. hirsutum* 19 entries and 4 checks) was conducted with three replications following recommended package of practices at ICAR-CICR, Nagpur. The crop duration was prolonged due to intermittent rains during the crop season.

ICAR – AICRP on Cotton trials

The entries of ICAR-CICR, Nagpur sponsored, promoted and retained for different trials of ICAR – AICRP on Cotton trials during 2019-20 are summarized in as follows :

Table 3.3.2. : Entries sponsored in ICAR-AICRP on Cotton trials 2019-20

Trial	AICRP trial code	Name of Entry
National trials		
IET of *G. hirsutum*	Br 02 (a)	CCH 19-1, CCH 19-2
IET of *G. hirsutum*	Br 02 (b)	CNH 17393, CNDTS 283, CNH 2077, CNH 09-119, CNH 1134, CCH 19-2, CCH 19-3
IET of *G. hirsutum* -Colour cotton trial	Br 02 (a/b) CC	CNH 18528, CNH 18529, CCHC 19-1, CCHC 19-2
IET of *G. arboreum*	Br 22 (a/b)	CNA 1042, CNA 2035, CNA 2036, CNA 2037
IET of *G. arboreum* Long linted	Br 22 (a/b)LL	CNA1067, CNA 1068, CNA 1069, CISA 6-256, CISA 6-295
IET of *G. arboretum* -Colour cotton	Br 22 (a/b) CC	CNA18562, CNA18563
PHT - Desi Hybrid	Br 25 (a/b)	CISA 18-3, CISA 18-4
IET of compact *G. hirsutum*	Br 06 (a)	CCH 15-1, CCH 19-2, CCH 19-4
IET of compact *G. hirsutum*	Br 06 (b)	CNH 1132, CNH 1133, CNDTS 44, CNH 09-77, CNH 09-45, CNH 2046, CCH 15-1, CCH 19-4, CCH 19-5
IET of *G. barbadense*	Br 12(a)	CCB 141, CCB 142, CCB 64B

Table 3.3.3. : Entries promoted and retained in ICAR-AICRP on Cotton during 2019-20

AICRP trial	Entries promoted	Entries retained
North Zone		
Br-03 a	CSH 1721, CSH 3012	
Br 25 (a/b)	CISA-18-1	
Br 06 (a)	CSH 3158	
Br 24 (a)	CISA 10	
Central Zone		
Br 04 (b)		CNH11-11
Br 13 (a)	CCB 26	CCB 143b, CCB 51-2
Br-24 (b) CVT – *G. arboreum*		CNA1031, CNA1054

AICRP trial	Entries promoted	Entries retained
Br-24 (b) LL: CVT – *G. arboreum*	CNA 1065	
Colour cotton-*hirsutum*	CNH 17395	
Colour cotton - *arboreum*	CNA1091, CNA17522	
South Zone		
Br 13 a	CCB 26, CCB 28	CCB64, CCB 51, CCB 29
Br 14 (a)	CCB 143B, CCB 129, CCB 51-2	
Br06 b	-	CNH 1128
Br-24 b: CVT – *G. arboreum*		CNA 1054, CNA1031
Br-24 (b) LL: CVT – *G. arboreum*	CNA 1065	
Coloured Cotton Trial *G. hirsutum*	CNH 17395	16315 LB, 16301 DB, 16337 LB
Coloured Cotton Trial *G. arboreum*	CNA 1091, CNA 17522	CNA 407 SLP, CNA 405, CNA 407, 16377 LB-A

Table 3.3.4. : Entries sponsored, promoted and retained in ICAR-AICRP Bt varietal trials 2019-20

Name of the Zone	Entries sponsored	Entries promoted	Entries retained
North zone			
Irrigated	CICR 86 Bt, CICR 902 Bt	CICR 17 Bt	-
Central zone			
Irrigated	-	CICR 20 Bt, CICR 21Bt, CICR 22 Bt	-
Rainfed	CICR Bt.19-32, CICR Bt.19-33	CICR 20 Bt, CICR 21Bt, CICR 22 Bt	Bt 183059-4, Bt 183059-5
South zone			
Irrigated	-	CICR 24 Bt, CICR 25 Bt, CICR 26 Bt	-
Rainfed	CICR Bt.19-31	CICR 24 Bt, CICR 25 Bt, CICR 26 Bt	Bt 183059-2

Entries for agronomy trial		
G. *arboreum* (Variety, Rainfed)	CNA1032	Central zone
G. *barbadense* (Variety, Irrigated)	CCB 51	South zone

Varieties identified for release

CNA 1028 (RAVI) : A *G. arboreum* variety CNA 1028 tested in 18 AICRP trials for three years, 2015-18 and in agronomy trial in 2018-19 was identified for release and commercial cultivation in central zone rainfed conditions. It recorded an overall mean seed cotton yield of 1325 kg/ha with an yield advantage of 15.32 percent and 6.05 percent over the zonal check AKA 7 and local checks. It topped in 9 out of 18 AICRP trials and is identified as Jassid tolerant entry. The variety recorded ginning outturn of 34.23 per cent and lint yield of 452 kg/ha. In the agronomy trial conducted at Nagpur it recorded seed cotton yield (4633 kg/ha) at 125% RDF and 60 x 15 spacing despite terminal stress situation during the end of the crop season. The fibre quality characteristics of the variety are - 2.5% span length (25.5 – 29.6mm), micronaire (4.0-6.0 ug/inch), fibre strength (24.7 - 31.5 g/tex) with strength/length ratio of 1.154. The full-scale spinning test data from ICAR-CIRCOT indicates that the variety spun well at 30.6s counts with CSP of 2220 and at 40.7s counts with CSP of 1929.

CCH 14-1 (Sunantha): The good quality long staple variety of *G. hirsutum* CCH 14-1 (Sunantha) has been released for commercial cultivation in South Zone States of Karnataka, Andhra Pradesh, Telengana and Tamil Nadu under irrigated conditions. The variety recorded a mean seed cotton yield of 1688 kg/ha under irrigated condition in AICRP multi location trial and has an yield potential of 3675 kg/ha. The variety registered ginning outturn of 34.2 per cent and posses excellent fibre quality parameters *viz*., Upper Half Mean length of 32.0 mm, micronaire of 3.7 µg/in and tenacity of 32.7 g/tex in HVI mode, 2.5 % Span length of 32.8 mm, micronaire of 3.6 µg/in and tenacity of 24.1 g/tex in ICC Mode matching the CIRCOT norm for 50s count yarn. The variety recorded a mean boll weight of 4.5 g/boll. It is resistant to bacterial leaf blight, grey mildew and

tobacco streak virus and immune to root rot. The variety is tolerant / resistant to jassids, white fly, thrips, aphids and stem weevil.

ICAR-CICR 16 Bt: The medium staple Bt genotype 'ICAR-CICR 16 Bt' was identified for cultivation under irrigated condition of central zone. It recorded seed cotton yield of 1221 and 1471 kg/ha during the year 2017-18 and 2018-19 in central zone comprising states of Maharashtra, Gujarat and Madhya Pradesh respectively while the local BG II hybrid recorded seed cotton yield of 980 and 1264 kg/ha, respectively. It showed overall yield superiority of

15.23% over local check. It recorded lint index of 4.45 (g), GOT of 34.5%, UHML of 25.3 mm, micronaire of 4.3 µg/in, bundle strength of 26.1g/tex and uniformity index 81.5% which is at par to the local and zonal checks. ICAR-CICR 16 Bt recorded Cry protein expression of 6.79 ppm in leaves at 60 days crop duration during 2018-19. Mortality of 97% was recorded for *Helicoverpa armigera* in leaf bioassay at 90 days stage.

ICAR-CICR 23 Bt: The medium staple Bt genotype 'ICAR-CICR 23 Bt' was identified for cultivation under rainfed condition of south zone. It recorded average (over five locations in two years) seed cotton yield of 1459 kg/ha during its testing in ICAR-AICRP on Cotton in south zone comprising states of Tamil Nadu, Karnataka, Telangana and Andhra Pradesh respectively and ranked first in both the years. The zonal non-Bt check and local check recorded mean seed cotton yield of 1302 kg/ha and 1307 kg/ha, respectively. It recorded increase seed cotton yield of 26.39, 20.21 and 6.61% in 2017-18 and 0.76, 4.26 and 8.59% in 2018-19, respectively over zonal non-Bt check, local check and qualifying variety 1. ICAR-CICR 23 Bt recorded lint index of 4.35 (g), GOT of 35.0%, lint yield of 497.52 kg/ha, UHML of 27.6 mm, micronaire of 3.7 µg/in, bundle strength of 26.8 g/tex and uniformity index 83.0% which is at par to the local and zonal checks. ICAR-CICR 23 Bt recorded Cry protein expression of 4.7 ppm in leaves at 120 days crop duration and 4.46 ppm in boll at 90 and 120 days of crop during 2018-19. Mortality of 100% was recorded for *Helicoverpa armigera* on leaves upto 120 days.

3.4 Gene discovery, genomics and trait improvement

Nagpur

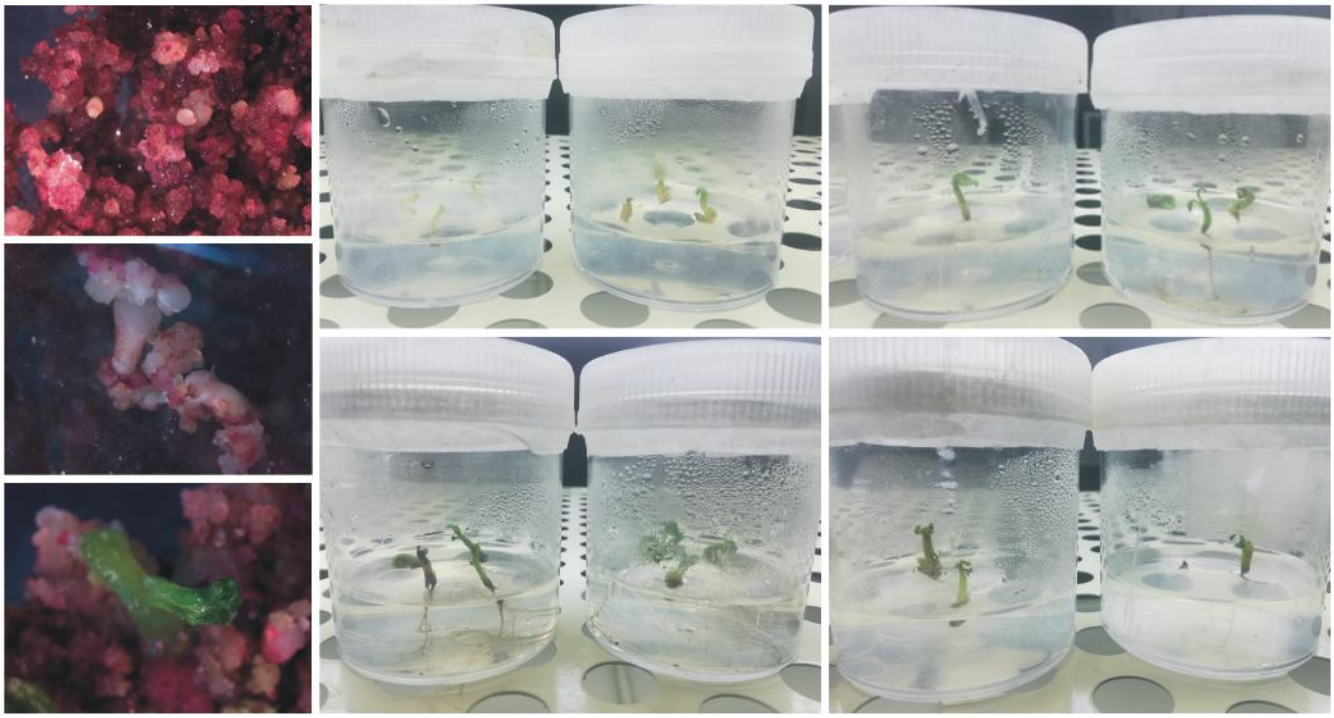
Development of consensus genetic linkage map of *Gossypium*

The field trial of five RIL mapping populations (two inter specific populations of *G. arboreum* × *G. hirsutum*, two intra-*hirsutum* and one interspecific *G. hirsutum* × *G. barbadense*) in two replications conducted to phenotype for morphological, yield and fibre quality traits at ICAR-CICR Nagpur. Phenotyping for economic

traits continued beyond December 2019 due to prolonged crop duration.

Transformation studies with *CICRcry2Ab1Ac*: :chitinase:

Hypocotyl and cotyledanary explants derived from seven to ten days old seedlings were either (A) incubated in Pre Induction Medium (PIM) for 30 minutes with *A. tumefaciens* suspension containing gene cassettes CICR- *cry2Ab1Ac::chitinase* (OD600 0.3-1.0) or (B) applied with pre-induced *Agrobacterium* suspension (OD600 0.3-1.0) of 5 & 10 µl to the cut side of the cotyledonary and hypocotyl explants followed by co-cultivation and subculture in to MS medium supplemented with 2,4-D (0.1mg/l) and kinetin (0.5mg/l), and selection on kanamycin 25mg/L. Total 41 putative transformants comprising 21 and 20 from method A and B respectively, were regenerated through somatic embryogenesis. Eleven out of the 21 putative transformants regenerated from method A produced good rooting but only 3 out of 20 are showing proper rooting in matured embryos regenerated from method B.



Construction of CRISPR/Cas9 gene targeting vectors for the targeted mutagenesis of *GhPHYA1*:

Four sgRNAs have been designed to target *GhPHYA1* gene using CRISPR/Cas9. Construction of gene targeting vector sgRNA1*GhPHYA1*::CRISPR/Cas9, sgRNA2*GhPHYA1*::CRISPR/Cas9 and sgRNA3*GhPHYA1*::CRISPR/Cas9 has been completed and confirmed. Putative recombinant colonies were analyzed for the presence of these gene targeting vector constructs through plasmid PCR. Presently, preparation of sgRNA4*GhPHYA1*::CRISPR/Cas9 gene targeting vector is in progress (Fig.3.4.1).

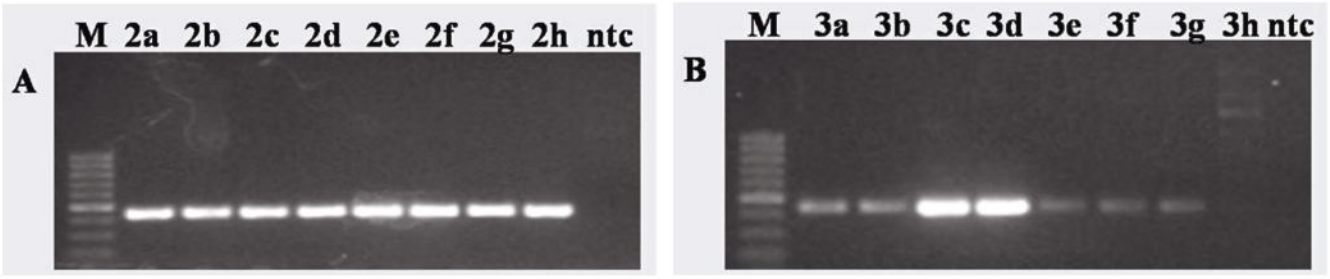


Fig.3.4.1: Plasmid PCR confirmation of sgRNA2*GhPHYA1*::CRISPR/Cas9 (A) and sgRNA3*GhPHYA1*::CRISPR/Cas9 gene targeting vectors (B)

Confirmatory GUS assay of putative transgenic callus cultures for the presence of pBI121::*Wnt 3A* gene construct:

The pBI121::*Wnt 3A* gene construct was utilized for *Agrobacterium tumefaciens* mediated transformation of non responsive cotton genotype for somatic embryogenetic (suraj variety) using hypocotyls as an explants. Pure cultures of hypocotyl explants specific calli have been maintained and after six sub cultures of the putative callus cultures with pBI121::*Wnt 3A* gene construct. GUS assays have been performed and it has been confirmed that many of the calli derived from specific hypocotyls were found to be positive for β-glucuronidase activity (Fig.3.4.2). All the GUS positive callus cultures along with controls are being maintained on appropriate tissue culture media from time to time for evaluating potential role of Wnt 3A like gene.

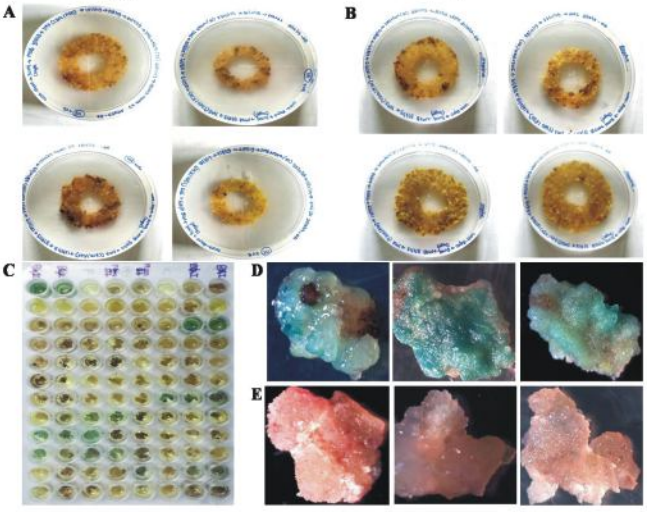


Fig.3.4.2 : Confirmatory GUS assay of putative transgenic callus cultures. A) GUS-positive callus cultures B) GUS-negative callus cultures C) GUS assay of putative calli with pBI121::*Wnt 3A* gene construct D) Microscopic photographs of GUS positive calli E) Microscopic photographs of GUS negative calli

Standardization of Zygosity PCR for Tg2E-13 event

Genomic sequence information of the T-DNA Right border junction sequence of the Tg2E-13 event was utilized for In-silico genome walking and identified the upstream cotton genomic sequences of T-DNA Left border of the transgenic event. Primers for detection of homozygous and hemizygous transgenic plants were designed, synthesized and PCR conditions was standardized (Fig. 3.4.3). The standardized PCR method is being utilized for identification of homozygous and hemizygous transgenic plants in BC4F2 progenies of three cross viz., Coker310Tg2E-13 × Suraj, Coker310Tg2E-13 × NH615, and Coker310Tg2E-13 × CISH3178.

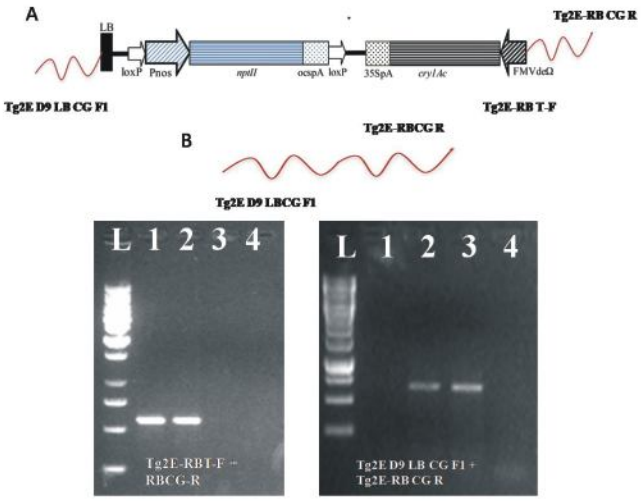


Fig. 3.4.3: Zygosity PCR for detection of homozygous and hemizygous plants of Tg2E13 event. L=1kb ladder; 1= Tg2E13 Homozygous sample; 2= Tg2E13 Hemizygous sample; 3= Azygous non-transgenic sample; 4= No template Control.

3.5 Seed Production and Quality improvement

Nagpur

Storability of cotton seed

Freshly harvested seeds in *kharif* 2018 were stored in different packaging materials, under different storage conditions. The seeds stored under cold conditions in vacuum containers and modified Argon gas indicated encouraging results in terms of higher germination.

Seed protein characterization

Quantification as well as profiling of seed storage protein was undertaken in varieties of four cultivated species as well as F_1 hybrids and their parents. The total seed protein content determined by Bradford method in 22 *G. hirsutum* cultivars of varying seed index ranged from 28µg/g (Supriya) to 51µg/g (Suraj). No correlation was observed between seed index and soluble seed protein content. The SDS PAGE profiling of varieties as well as 4 CICR hybrids along with their parents did not show major variations. The four cultivated species (*G. hirsutum; G. arboreum; G. barbadense and G. herbaceum*) were characterized for seed storage protein profiling by SDS PAGE. Unique polypeptide fragments with high intensity were distinct for *G. hirsutum* compared to other three.

The seed protein content was highest in *G. hirsutum* (50µg/g of seed tissue) and lowest in *G. barbadense*

(22µg/g seed tissue). The seeds of ten *G. hirustum* varieties were artificially aged/deteriorated in a desiccator placed at 40°C and 100% RH. The total protein content was found to be higher in fresh seeds with good germination compared to deteriorated seeds with poor germination as observed in 10 different varieties. The SDS PAGE profile of total seed proteins in aged and fresh seed lots of three varieties showed distinct 2 polypeptide fragments in fresh seeds compared to deteriorated seeds (Fig.3.5.1).

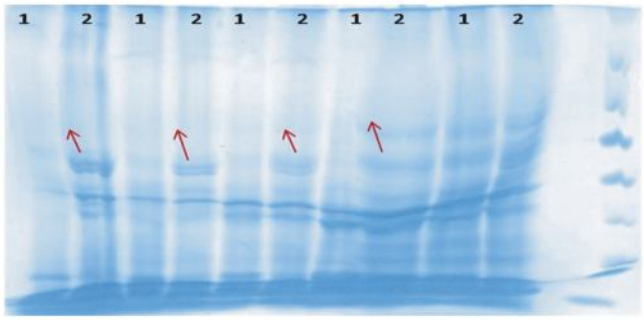


Fig.3.5.1: SDS PAGE profile of deteriorated low viable seed (1) and fresh viable seed (2)

Distinctiveness Uniformity and Stability (DUS) testing

Nagpur:

Five trials were laid out for DUS testing which includes New/First Year Trial (1 genotype); Varieties under Common Knowledge (1genotype); Essentially Derived Varieties and Initial Variety (1 each); Second Year Trial (3 genotypes) and reference variety trial (15 genotypes). The monitoring of trial was held at Nagpur on 28th November 2019 under the chairmanship of Dr. S.A. Patil, former Director, IARI, New Delhi.

Coimbatore

Data base on extant cotton varieties and notified cotton varieties has been updated. Data base of registered tetraploid and diploid cotton varieties was acquired from PPV&FRA, New Delhi. Maintenance breeding and characterization of 185 extant cotton varieties were carried out *viz.*, 140 in *G. hirsutum*, 35 in *G. arboreum,* 5 in *G.herbaceum* and 5 in *G. barbadense.*

Field trials of new candidate varieties for the establishment of DUS have been conducted. This trial consists of 7 new candidate varieties for second year of testing, 4 candidate varieties for first year of testing along with 10 reference varieties. Germination count at 12 DAS. Morphological characters were recorded on 10 plants of all varieties. The data received from participating centers were compiled and submitted to PPV & FRA for issue of registration certificate. Monitoring of DUS trials at the participating centres was done under the chairmanship of Dr. S.A. Patil, former Director, IARI, New Delhi.

Seed Production

Breeder seed production was taken up for non Bt varieties [Suraj, Surabhi, LRA 5166, LRK 516, MCU5VT, Subiksha, Suvin, CNA 1028, CNA 1003 (Roja)] and TFL seed for Bt varieties (Suraj Bt, PKV Rajat Bt, PKV 081 Bt, GJHV 374 Bt & Bt 6 in all three centres of ICAR-CICR (Table 3.5.1).

Stock seed production of 75 varieties (*G. hirsutum, G. arboreum, G. barbadense)*, parents of 18 hybrids, variable traits (12) of *G. arboreum* race cernuum was taken up. In Farmers Participatory mode, 7 tribal farmers had taken up TFL seed production of 4 Non-Bt varieties in 20 acres and one farmer taken up seed production of 4 Bt varieties in 4 acres. Certified seed production of red gram Cv. BSMR-736 was taken up in 32 acres, gram Cv. Jaki 9218 in 8 acres and foundation seed production of linseed Cv. NL 260 in 1.0 acre at the Institute farm.

Table 3.5.1. Quantity of Bt and non-Bt cotton seeds produced in 2019

S. No	Variety	Quantity (Kg)
Cotton Bt varieties		
1	Suraj Bt	714.4
2	Rajat Bt	901.1
3	GJHV 374 Bt	156.7
4	PKV 081 Bt	277.9
	Grand Total	**2050.2**
Non-Bt varieties		
1	Suraj (BS)	70.9
2	Surabhi (BS)	27.0
3	LRK 516 (BS)	12.0
4	LRA-5166 (BS)	15.3
5	NH 615(TFL)	46.7

S. No	Variety	Quantity (Kg)
6	Roja (BS)	82.5
7	Phule Dhanwantri(TFL)	10.5
	Grand Total	**264.9**

Coimbatore

Nucleus and Breeder Seed Production

Nucleus and Breeder seed production was undertaken for Suvin, Suraj, Subiksha, Surabhi and MCU 5-VT. During the year 2019, a total of 8 kg of breeder seed of Suvin was distributed to various seed producers.

Under AICRP-NSP (Crops), an experiment was laid out for redefining isolation distance of IMSCS 2013 for foundation and certified seed production of cotton. One male fertile (HD1-10-151) and one male sterile (GAK 433) received from PDKV, Akola was used for the experiment. To assess the efficiency of molecular markers in hybrid purity testing in comparison to the grow-out test (GOT) in various field crops. PDKV Akola, AAU Anand, NAU Navsari and UAS Dharwad were identified for cotton. Accordingly, ICAR-CICR had supplied the seeds of male and female parents of 5 hybrids CSHG 1862, CSH 198, CSH 243, CSH 238 and CICR-2 to all the four centres. All parents were grown for sufficient seed production for further testing.

To validate the validity period of certified seeds of field crops (as per the IMSCS regulations) at ICAR-CICR Regional Station, Coimbatore, seeds of NH 615 (*G. hirsutum*), Roja (CNA1003 *G. arboreum*) about 2.5 kg seeds of each variety were supplied to ICAR-CICR Regional Station, Coimbatore, PDKV, Akola, PJTSAU, Hyderabad and UAS, Dharwad for providing observations on 10 seed quality parameters on bi-monthly basis.

In another experiment on physiology studies and development of priming technologies for enhancing planting value of seed in field crops under optimal and sub-optimal conditions. Two seed lots i.e. seed lot I (2017-18) and seed lot II (2018-19) of varieties Surabhi and LRA-5166, were taken for the experimentation. Seeds were subjected to 12 treatments and 2 controls (untreated & Imidacloprid treatment). Observations are being recorded on 10 seed quality parameters. Field performance and productivity of Surabhi of 2017-18 (low vigor) and 2018-19 (high vigor) lots were taken for the study.

At Coimbatore, freshly harvested seed lot of cotton variety NH 615 and Roja (CNA1003) received from ICAR-CICR, Nagpur was used. Seed lots were assessed for initial viability and moisture content and stored in polythene and gunny bag under ambient condition. Bimonthly observations on seed moisture content (ISTA), germination % (ISTA), Vigour index-I and II (Abdul Baki and Anderson, 1973) and dry matter production of seedlings revealed that the performance of seed lots are well above the minimum seed certification standards. Two cotton varieties Surabhi (V1) with two seed lots produced during 2017-18 (L1) and 2018-19 (L2) and LRA 5166 (V2) with two lots of 2016-17 produced (L1) and 2018-19 (L2) were subjected to 14 treatments under laboratory conditions. The following parameters were estimated at laboratory moisture content (ISTA) before and after treatment i.e. before sowing, germination % (ISTA), vigour index-I and II in field, emergence (%) and final plant stand establishment (%). The positive response of seed treatments was observed in low vigour cotton seeds.

3.6 : Enhancing Resource Use Efficiency through climate smart agro-techniques

Nagpur:

Exploring the productivity potential of long-linted *G. arboreum* cotton

Six potential long linted genotypes (PA 812, PA 760, PA 528, PA 402, DLSa 17,CNA 1041) and a short staple check- Phule Dhanwantary were evaluated under HDPS and normal spacing on 2 dates of sowing (normal and 15 days delay) on an Inceptisol and a Vertisol under rainfed conditions at Nagpur and under winter irrigated conditions at Coimbatore.

Across sowing dates, year of experimentation, within row spacings and soil types -

- the date for the appearance of first square and first flower was the earliest in genotype DLSa 17 and farthest in the genotype Phule Dhanwantary
- the duration from flowering to boll opening was least in Phule Dhanwantary and hence it was the earliest in maturity
- the fibre quality parameters of PA 812 and PA 760 were distinctly superior to the rest

Role of the enzymes involved in ethylene biosynthesis pathway in *G. arboreum* genotypes in fibre elongation

An attempt was made to correlate the fibre length with ethylene in six varieties of long linted *arboreum* cotton and short staple check (Phule Dhanwantary). Relative quantification of ethylene (gaseous form) was done in young cotton bolls of approximately uniform size using ethylene monitor/sensor. The maximum ethylene release was observed in PA812 followed by PA 528, whereas minimum ethylene was registered in Phule Dhanwantary followed by PA402 (Table 3.6.1).

Table 3.6.1: Estimation of ethylene in young cotton bolls

Genotype	Ethylene (ppm)
DLSA-17	0.95
PA-528	1.12
PA-402	0.58
PA-812	1.27
PA-760	1.03
CNA1041	0.97
Phule Dhanwantari	0.55

Expression analysis of two genes of ethylene biosynthesis pathway, coding for key enzymes ACCS (1-aminocyclopropane-1-carboxylic acid synthase) and ACCO (1-aminocyclopropane-1-carboxylic acid oxidase) was performed in seven *arboreum* cotton genotypes to correlate their expression with fibre length. The expression of *ACCS* was maximum in PA812 followed by PA528, where as PA402 had minimum expression of *ACCS* among all seven genotypes when compared (Fig 3.6.1). In continuation, there was also significant difference for *ACCO* transcript level among the seven genotypes where PA812 showed maximum expression followed by PA760 while minimum ACCO level was observed in PA 402 among all desi genotypes (Fig 3.6.2).

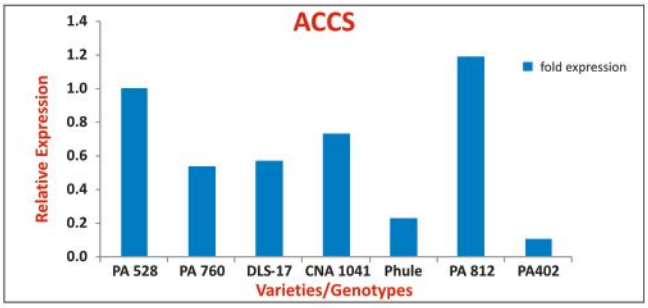


Fig 3.6.1: Expression of ACCS gene in subtending leaf of cotton boll

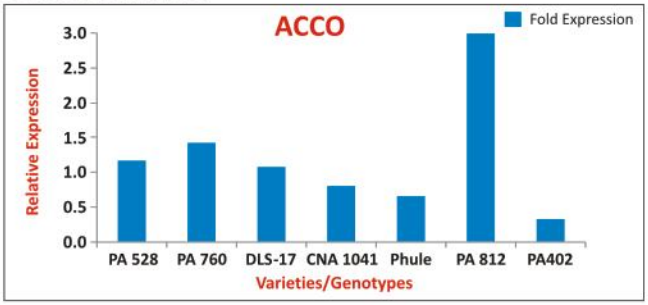


Fig 3.6.2: Expression of ACCO gene in subtending leaf of cotton boll

To relate the ethylene release and expression of genes involved in ethylene biosynthesis with fibre length, a correlation analysis was done and a positive correlation was observed between ethylene and fibre length of different long linted *arboreum* cotton genotypes.

In an effort to establish a correlation between few already known genes involved in cell elongation (*Bonzai*, *Myb25* and *Pex1*) and ethylene expression, transcript level of these selected genes were measured in 0, 7 & 14 DPA ovules of PA812 and Phule. At all stages, PA812 had more expression of all these genes compared to Phule Dhanwantary. *Myb 25* was found to be involved specifically in fibre elongation (7DPA), whereas *Bonzai* and *Pex1* were more at fibre initiation stage (0DPA).

On-station water foot print estimation of cotton production system

Cotton being a rainfed crop in India, a major emphasis needs to be given to improve its water productivity. Priority needs to be given for the development of indices those indicate appropriation of fresh water resources from a particular management system. In this regard water footprint estimation of cotton can be used to indicate both direct and indirect appropriation of fresh water resources.

On-station experiment was conducted at ICAR-CICR, Nagpur to estimate water footprint of cotton production under three water management practices (T_1: Rainfed condition with runoff collection, T_2: Furrow irrigated, T_3: Drip irrigated). The total rainfall received during cropping season 2019-2020 is 1240.07 mm, out of which effective rainfall (662.8 mm) is 53.44 % and ineffective rainfall (577.27 mm) is 46.56%. Considering ineffective rainfall according to USDA Soil Conservation method and soil moisture changes, the runoff estimated during June to December was 49.46 lakh litres from one hectare area. (Fig 3.6.3).

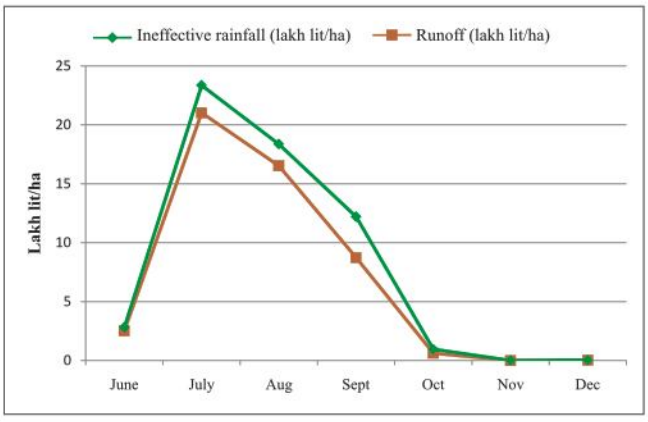


Fig 3.6.3 : **Ineffective rainfall (lakh lit/ha) and runoff (lakh lit/ha) during cotton growing season**

New complex fertilizer for Bt hybrid cotton

Replicated field experiments with Bt hybrid cotton were conducted using the complex fertilizers (Muriate of Potash (MOP) and Sulphate of Potash (SOP) supplied by Smartchem Technologies, along with MOP and SOP based complex fertilizers. Equivalent to recommended dose of fertilizer, 10% more, 10% less, which were compared with the ICAR-CICR recommended dose of fertilizers (RDF) and farmers practice under rainfed conditions. The results showed that all the treatments showed significant increased in the cotton yield as compared to farmers practice. Seed cotton yield was the highest with the 10% more MOP based complex grade fertilizer treatment. There was no additional advantage with SOP based complex fertilizer over the MOP based complex fertilizer.

Coimbatore

Use of structured water for Irrigation

A field experiment was conducted in a split plot design during summer 2018-19 and 2019-20 to study the benefits of irrigation under drip system using structured water.The results revealed that water saving due to drip ranged from 390.7 mm to 633.3 mm over conventional irrigation. The structured water irrigation recorded higher water use efficiency ranging from 23.5 to 62.6 kg/ha cm as against 20.2 to 55.2 kg/ha cm with bore well irrigation. The structured water irrigation resulted in enhanced water use efficiency of 5.7 kg/ha cm across irrigation scheduling over two years of experimentation. The structured water irrigation and moisture regimes significantly influenced the seed cotton yield of BG II hybrid. Among the irrigation scheduling, 0.8 ETc recorded the highest seed cotton yield and was on par with 1.0 ETc but significantly different from rest of the treatments. Water use efficiency was the highest in drip irrigation given at 0.4 ETc irrespective of the source of water (Fig 3.6.4).

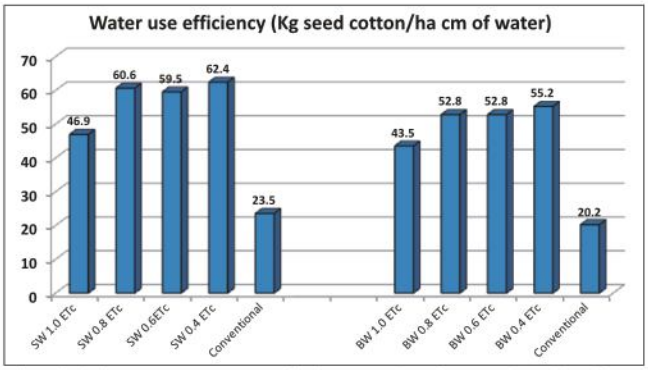


Fig 3.6.4: **Water use efficiency (kg/ha cm) of BG II cotton irrigated with structured water (SW) and borewell water (BW) irrigation pooled mean of 2018-19 and 2019-20**

Sirsa

Long Term Fertilizer Experiment

- A long term fertilizer experiment involving 5 cropping systems and five nutrient regimes is being conducted. During 2019-20 cropping season:-
- Among the cropping systems, seed cotton yield was in the order; Bt cotton hybrid – fallow > Bt cotton hybrid – wheat > non-Bt cotton hybrid – wheat > Bt cotton variety – wheat > non Bt cotton variety – wheat.
- Among the nutrient regimes, recommended dose of NPK + secondary nutrients ($MgSO_4$) + Micronutrients ($ZnSO_4$ + Borax) and FYM @ 5 t/ha once in two years out yielded other nutrient regimes with respect to seed cotton yield.
- Interaction between nutrient regimes and cropping systems was not significant for seed cotton yield

Enhancement in productivity of cotton through improvement in agrotechniques under North-Western Indian conditions:

(a) Bt cotton variety (CICR Bt-6) and non-Bt cotton variety (CSH 3075):

- Early sowing of Bt cotton variety (CICR Bt-6) and non-Bt cotton variety (CSH 3075) during [2nd week of May] gave significantly higher seed cotton yield than sowing at later dates.
- Spacing of 67.5 cm x 45 cm was superior to closer spacing at 67.5 cm x 10 cm.
- Response to the application of growth regulator (Mepiquat chloride) was significant.
- Spraying of Mepiquat chloride twice @ 20 g ai / ha at 60 and 75 DAS was superior to a single spray at the same rate at 60 DAS.
- Interaction between sowing date and spacing was significant indicating when sowing was delayed till first week of June, closer spacing (67.5 cm X 10 cm) gave higher yield than wider spacing (67.5 cm x 10/30 cm).

(b) Bt cotton hybrid (SP-7172):

- Early sowing of Bt cotton hybrid (SP-7172) during [2nd week of May] gave significantly higher seed cotton yield than sowing at later dates.
- The optimum spacing was 67.5 cm x 60 cm.
- Application of Mepiquat chloride @ 20 g ai / ha at 60 and 75 DAS significantly improved the seed cotton yield.
- Spacing x sowing date effect was significant. When sowing was delayed to the first week of June, planting

at closer spacing (67.5 cm X 30 cm) gave higher yields than planting at wider spacings (67.5 cm x 60 cm or 67.5 cm x 45 cm).

Nutrient expert system for hybrid cotton

The "Nutrient Expert" a decision support system for site specific nutrient management (SSNM) was developed and evaluated in hybrid cotton. The system was validated at ICAR-CICR farm as well as in ten farmers' fields. During 2018-19, the seed cotton yield (SCY) was found to be highest in "Nutrient Expert" as compared to other treatments in both institute as well as the farmers' field trials. The results reinforce the need for balanced fertilizer application based on site specific nutrient management especially for rainfed cotton.

3.7. Sustainable farming systems through conservation agriculture and precision techniques

Alleviating soil compaction – a production constraint in cotton

Replicated trials were laid out to study the effect of different sub soiling, crop rotations and deep rooted crops on soil penetration resistance in order to devise a suitable plan for ameliorating soil compaction. Radish-cotton (1450 KPa) and Pigeon pea-cotton (1333 KPa) rotations were found to give lesser inter-row soil penetration resistance as compared to deep sub soiling (2067 KPa) and shallow sub soiling (2000 KPa). Dhaincha (1000 KPa) and sunhemp (1033 KPa) offered least soil penetration resistance inter-row as well as between row than soybean (1233 KPa) and sub soiling every (2800 KPa) and alternate rows (2433 KPa).

Identification of suitable nitrogen fixing legumes for cotton intercropping under rainfed cultivation

Higher N was recorded in initial soils samples of short duration legumes. During kharif 2019 characterized by high rainfall, intercropping cotton with black gram, green gram and soybean were better than intercropping with groundnut. Cowpea and cluster bean. Post-harvest analysis shows enhancement in soil nitrogen in Cotton + Soybean, Cotton + Cowpea and Cotton + blackgram intercropping system.

Evaluation of PGPR and microbial inoculants to alleviate drought stress in cotton (*G.hirsutum*)

Nine bacterial strains (*Solibacillius isronenesis*, *Acinetobacter pitti I*, *Acinetobacter pitti II*, *Acinetobacter pitti III*, *Pseudomona sp.*, *Sphingomonas sp.I*, *Sphingomonas sp.II*, *Acinotobacter pitti*, *Acinotobacter sp.*) isolated from *G.hirsutum* and *G. arboreum* rhizosphere were shortlisted for drought stress studies. Talcum based formulation of these isolates were inoculated to variety Suraj as seed treatment, and evaluated for its plant growth promotion attributes. In general, the microbial treated seedlings showed increased leaf chlorophyll content (SPAD value in the range of 35 to 45) and leaf temperature 24-26 ºC.

Microbial interventions for potassium nutrition in cotton

Native Potassium Solubilizing Microbes (KSM) were isolated from different cotton growing regions and forest areas of Vidarbha using Alexandrov medium. The efficient K solubilizing microbes were screened qualitatively using bromothymol blue @ 0.5% in the Alexandrow medium (Fig 3.7.1). The shortlisted KSM were evaluated for potassium solubilization quantitatively (Flame photometry) through soil incubation studies. Significant difference was observed between the isolates on solubilization of potassium. The available potassium in the treatments ranged from 0.92-1.20 ppm and 0.98-1.35 ppm on 7 DAI and 14 DAI, respectively (Fig 3.7.2).

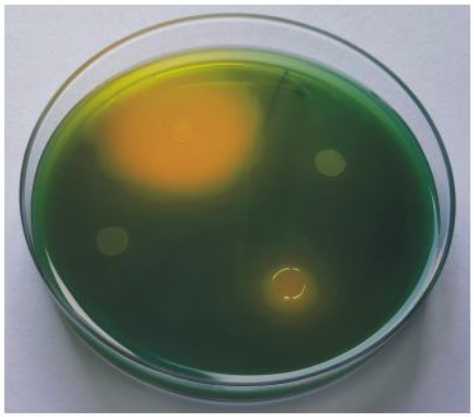


Fig 3.7.1. Rapid screening of K solubilizing microbes using bromothymol blue

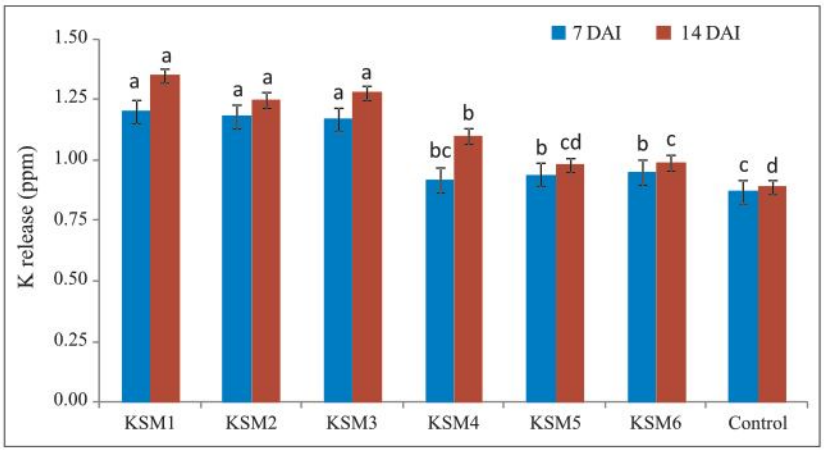


Fig 3.7. 2: Potassium release by KSM's at 7 and 14 DAI

Remunerative cotton based cropping systems using conservation agriculture principles under irrigated condition

Coimbatore

Field experiments based on conservation agriculture principles were conducted by combining land shaping with residue retention coupled with location specific remunerative cropping systems from 2015 to 2019 for enhancing system productivity and soil quality under irrigated condition. The salient findings are as follows :

- Cotton - Black gram - Maize (for grain purpose) is identified as a candidate cropping system to implement conservation agricultural practices under irrigated conditions as it produced significantly higher Cotton Equivalent Yield (CEY) of 4577, 4174, 4247 and 4408 kg ha^{-1}, respectively during first (2015-16), second (2016-17), third (2017-18) and fourth (2018-19) cropping sequences than the conventional Cotton - Fallow system (CEY of 3400, 1223, 1996 and 2609 kg ha^{-1}, respectively).

Cotton - Black gram - Maize cropping system

- Beds and furrows system is found suitable for raising cotton and other component crops under conservation agricultural practices *viz*., minimum tillage and residue recycling
- CA system with 100% residue recycling significantly reduced the soil penetration resistance upto 9" soil depth vis-à-vis Farmer's practice

Field demonstration of remunerative cotton based cropping systems using conservation agriculture principles under irrigated condition to the farmers

Sirsa

The seed cotton yield was significantly higher under M_6 (Zero tillage - permanent narrow raised bed with residue retention on surface) amongst the all other treatments. The lowest seed cotton yield was obtained under M_1 (Conventional Tillage - Flat Bed without residue incorporation) i.e. farmers' practice. However, it was at par with M_3 (Zero Tillage - Flat Bed without residue retention on surface). Amongst the cropping systems, the significantly higher seed cotton yield were recorded under (S_3) [Cotton - Chickpea (Bengal gram)] as compared to all other cropping systems. Second best cropping system with respect to the seed cotton yield was (S_2) [Cotton - Mustard (Raya)] which was at par with (S_7) [Cotton - Berseem (Fodder)] and (S_1) Cotton - Wheat cropping system. Seed cotton yields under (S_1) Cotton - Wheat and (S_4) Cotton - Barley cropping systems were at par with each other. Lowest seed cotton yield were obtained under (S_5) [Cotton - Winter Maize (Spring Maize)] cropping system.

Exploiting the epigenetic transgenerational inheritance of stress responsive traits for imparting abiotic stress tolerance in cotton

The epigenetic regulating chemicals (ERC) treated Suraj and LRA 5166 cotton plants is being screened for drought tolerance in the third generation. The plants were subjected to drought stress during pin head stage of squaring by withholding irrigation for 10 days. Control plants were maintained for each treatment. Chlorophyll content was numerically higher (23.1) in plants treated with epigallocatechin gallate 100µM in suraj (29.0) and in LRA 5166 it was numerically higher in plants treated with 5 Azacytidine 40µM. Relative water content is numerically higher in plants treated with Nicotinamide 35 µM and control (73%) in LRA 5166 and it was numerically higher in plants treated with 5 Azacytidine 40µM (77.8 % in Suraj). In LRA 5166 plants that received seed treatment of 5 Azacytidine 10µM, the epicuticular wax content was higher (104.9 µg/cm^2) when compared to control (17 µg/cm^2). However in Suraj, plants treated with epigallocatechin gallate (100 µM) recorded higher epicuticular wax content(105.8 µg/cm^2) followed by 5 Azacytidine 40µM (105.6 µg/cm^2) as against control (51.3 µg/cm^2). Among the treatments, 5 Azacytidine 40µM was found to be effective in imparting drought tolerance to cotton plants.

Metabolite exploration of drought stress in cotton

A new metabolic pathway "Alarm photosynthesis" has been explored in some of the model plants, which support them in sustaining under drought stress conditions. To explore this pathway in cotton, all the four cultivated *Gossypium* spp. (*G hirsutum*: DTS-44, DTS-155 and DTS-108 as drought tolerant and IC-357637, IC-359834 and IC-357055 as drought susceptible; *G. arboreum*: Phule Dhanwantary and PA 255; *G. barbadense*: Suvin; *G. herbaceum*: G-cot 25) were subjected to drought stress. Expression analysis (qPCR) of GLP1/oxalate oxidase gene in leaves of all the four cultivated cotton spp. as well as in different tissue [leaves, cotyledon, 10DPA (Days Post-anthesis) and 25 DPA ovule] confirmed its presence at gene level. Significant day night variation in oxalate content and oxalate oxidase (OxO) activity was also observed in cotton leaves. Further, to confirm at protein level, In-gel activity of oxalate oxidase was performed in cotton leaves. A combination of different extraction and staining buffers were tested and the method was standardized with some modifications. Proteins extracted in PBST (Phosphate Buffered Saline with Tween 20) buffer showed only the bands of oxalate oxidase (Fig 3.7.3) in the gel. Among the four cotton spp., desi cotton had more oxalate oxidase expression, where in water stressed leaf samples were observed to possess more oxalate oxidase activity than control (Fig 3.7.4). Overall, expression of oxalate oxidase in cotton leaves at gene and protein level confirms the existence of "Alarm photosynthesis" pathway in cotton.

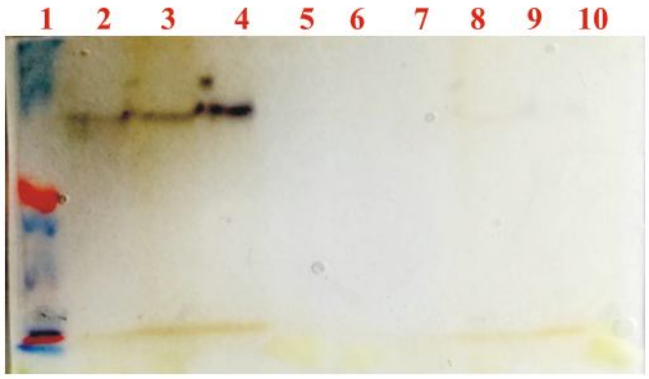


Fig 3.7.3: ***In-gel* activity of OxO in cotton leaves, in different buffers.** 1. Protein ladder(10-180 KDa), 2-4. PBST buffer, 5-7. Phosphate buffer, pH 7.2 + EDTA, 8-10. Tris buffer, pH 8.0

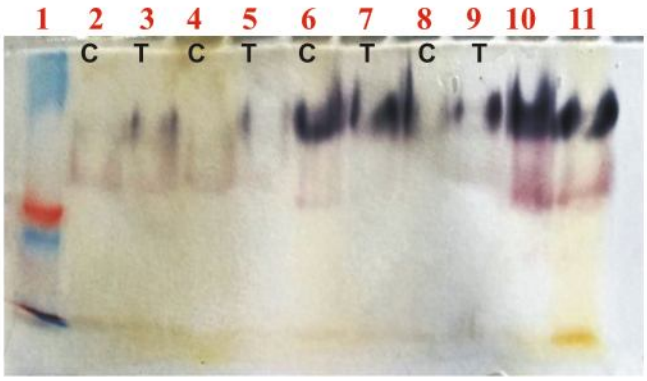


Fig 3.7.4: ***In-gel* activity of OxO in cotton leaves.** C: Control; T: Water stressed. 1. Protein ladder (10-180 KDa), 2-5: *G. hirsutum*, 6-7:*G. arboreum*, 8-9: *G. herbaceum, 10-11: G. arboreum infested with Grey mildew*

3.8. Economics and extension research and e- communication tools

e-Communication: dissemination of cotton production technology

The ICAR-Central Institute for Cotton Research, Nagpur has continued its efforts on strengthening *e-Kapas* as a model to disseminate cotton production technologies among farmers through voice message services covering 1.5 lakh farmers of Nagpur, Coimbatore and Sirsa regions. During the period, IT Tube light Communications Ltd, Mumbai served as a service provider. During this period, 16884 new farmers from Nagpur centre were registered. At Nagpur, 58,81,315 noise free voice messages uploaded on to 1,24481 farmers mobile numbers. From Coimbatore centre, 3,14,035 were uploaded voice messages on to 10773 farmers mobile. From Sirsa, 191008 messages were uploaded on to 21301 registered farmers' mobile numbers. The overall successful delivery of messages was only 42.40 percent.

Success stories of e-Kapas beneficiary farmers were documented. Few farmers shared their experiences and benefits of timely receipt of messages during the Kapas Mela organized at ICAR-CICR Nagpur on November 29 2019. Advisory services are, therefore, playing a crucial role in promoting cotton production, protection technologies, increasing productivity and improving rural livelihoods. During the period, farmers belong to Schedule Caste were also motivated under SCSP towards adoption of cotton production/protection technologies. An integrated ICAR-CICR Cotton App provides information about the latest cotton production, protection and improvement technologies, farmers outreach programmes, weekly advisories, etc. The App can be downloaded from Google Play Store for targeted end users including farmers, students, researchers, state department, agriculture officials, KVK officials, policy makers, etc

Impact of Institutional Credit on Cotton Farming in Maharashtra

Indian Society of Agricultural Economics (2015) and Parliamentary Committee on Agriculture has recently emphasized requirement of concrete evidence of efficacy of credit on farm profitability and productivity. Based on the above recommendations, a study was conducted to investigate the impact of institutional credit on technical efficiency of cotton production in Vidarbha region of Maharashtra, and to suggest policy measures to enhance and improve the efficiency of rural financial sector using primary data and purposive random sampling (720 cotton farmers) covering both credit users (Borrowers) and non-users of credit (Non-Borrowers). Sampling was done from 18 talukas two each from Amaravati, Wardha, Nagpur, Yavatmal, Aurangabad, Beed, Buldhana, Jalna and Jalgoan. Based on the stochastic frontier analysis, it was found that the credit use cotton farmers are more efficient than non credit user farmers except in Buldhana and Jalgaon. The ranges of technical efficiency were 0.30 to 0.91 with mean 0.60 for the credit user farmers and 0.25 to 0.89 with mean 0.57 for their non-credit user counterparts (Table 3.8.1). Further, the Maximum likelihood estimation results of the stochastic frontier production function shows a positive and significant coefficient of irrigation, bullock labour and credit dummy variables that indicate the overall cotton production can be enhanced by exploiting irrigation, bullock labour and expansion of credit (Table 3.8.2).

The study concludes that agriculture credit itself cannot play any direct role in enhancing the output rather indirectly helps through buying various modern inputs. Hence agriculture credit should be enhanced to large proportion of rural population. The financial institutions provided credit to the marginal and small farmers in limited quantity based on the size of holding, this study recommends subsidized credit should be given more to the farmers of small size holdings. Imparting training to borrower regarding procedural formalities of financial institutions could be helpful on increasing their access to institutional credit. The sample respondents opined that up to five lakh rupees crop loan limit must be with no interest and repayment of crop loan amount should be based on the price received for their produce. Increase in irrigation facilities such as drip, sprinkler tube well and tractor plays important role in enhancing the productivity, therefore special loans should be given directly to farmers on easy installments.

Table 3.8.1. Distribution of Technical Efficiency of Borrowers and non-Borrowers (Stochastic Frontier Analysis)

Efficiency Class	Amaravati		Aurangabad		Beed		Buldhana		Jalgoan		Jalna		Nagpur		Wardha		Yavatmal		All	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
<0.60	4	7	-	-		-	20	24	-	-	6	4	5	10	5	-	-	6	22	35
0.61-0.80	5	10	24	42	18	29	34	28	48	47	52	72	64	59	11	20	21	13	56	50
0.80-1.00	91	83	76	58	82	71	46	48	52	53	42	24	31	30	84	80	79	81	22	15
Maximum (TE)	0.99	0.98	0.97	0.90	0.98	0.91	1	0.99	0.98	0.94	0.96	0.92	0.99	0.96	0.99	0.97	0.85	0.87	0.30	0.25
Minimum (TE)	0.51	0.46	0.65	0.63	0.89	0.66	0.41	0.49	0.60	0.72	0.34	0.33	041	0.39	0.35	0.65	0.29	0.31	0.91	0.89

C= Credit; NC= Non Credit

Table 3.8.2: Maximum Likelihood Estimates of the Cobb Douglas Stochastic Frontier Function

Variables	Coefficients	t- statistics	Variables	Coefficients	t- statistics
Constant	4.244***	3.86	Animal labour	0.262**	2.25
Seeds	0.276	0.18	Machine labour	-0.035	-1.87
No. of. Irrigations	0.198**	2.48	Dummy of credit	0.163*	2.40
Fertilizers	0.093	1.8	Sigma-squared	0.129***	3.61
Pesticides	-0.033	-1.24	Gamma	0.746***	6.80
Human labour	-0.211	-1.23			

*** Significant at 1%, ** significant at 5%, * significant 10%

Socio-technological analysis of drip irrigation in cotton cultivation

Field survey was conducted in two districts viz., Sabarkantha and Rajkot of Gujarat state. Major research observations made about drip irrigation from the study area are; a) In Gujarat state adoption rate for drip irrigation in cotton cultivation was estimated at 18.60 %. Hence, there is a lot of scope for drip irrigation in cotton cultivation. b) Major cropping system followed in the area is Cotton – Wheat / Cotton-Potato / Cotton-Groundnut / Groundnut-Wheat-Groundnut / Maize-Wheat-Green gram. c) Majority of the farmers are cultivating cotton crop and where ever water is available farmers are going for second crop wheat or other crops. d) Most of the lands are unfragmented and it suits for drip irrigation well. e) drippers spacing mostly adopted by 1.5 and 2.0 feet. f) last three years the area was affected by Pink bollworm, hence there is a significant shift in area under cotton to other crops like groundnut. g). Average self-life of drip system is 6-7 years. Further, Constraint analysis revealed that lesser amount of subsidy by state government, rat menace, crop specific subsidy for drip irrigation for the specific year, clogging and increased price in the GST regime were some of the constraints reported by respondents.

Further analysis revealed that in the cotton based intercrop yielded additional profit. Shri. Bhurubheri Samjibheri Oobuniya, a farmer of Haripur village, Jetpur (Taluk), Rajkot district of Gujarat state cultivated Bt cotton in row spacing of 4.5 feet to 5 feet. He adopted Sesame and maize as intercrops for the season. He adopted drip fertigation for entire 5 acres of land. Maize was ready for harvest within two months and it was mainly used for fodder purposes. intercropped sesame was harvested at third month. The intercrop sesame realised the significant yield. He sold the sesame at the rate of Rs. 8500 / Q. He reported that the net profit was Rs One Lakh from Sesame cultivation from the five acres of land. The farmer realised Rs.1.5 Lakh as net profit from his five acres of cotton. In the duration of six months his net income from cotton based intercropping system was 2.5 lakhs. He reported that he was happy with the adoption of the technology "Cotton based intercropping system with Sesame and maize under drip fertigation". Thus, this case reveals that the present Central Government's Vision of "More Crop Per Drop" and "Doubling the Farmers Income" are not a distant *dream* but achievable one.

Field Survey in Gujarat Districts

Cotton marketing in Maharashtra

The study aims to assess the existing market mechanism for cotton in Maharashtra for its sustainability and profitability to study the price quality relations, harvesting and post harvesting practices and to examine the utilization pattern of cotton by-products. Data was collected from farmers and various market functionaries of four cotton growing districts Aurangabad, Amravati, Jalgaon and Yavatmal. Preliminary analysis revealed that the cotton farmers are incurring an amount of Rs. 77000 per ha towards production costs and producing about 18 q/ha of seed cotton. Five marketing channels were identified through which farmers are selling cotton in the study area. Cotton farmers most preferred point of sale is village merchants followed by traders and ginners. Highest price is realized by the cotton farmers when they sold their produce to ginners directly and the lowest price when they sold in the village to the merchants. Transport cost, delays in payment, waiting period, fear of rejection due to low quality and complicated price procedures deter the farmers to take their produce to the ginners or CCI. Procurement by CCI is observed whenever the prices are below MSP. Immediate cash payment, no transportation cost and small quantity of the produce make the farmers to prefer sale in the village itself. The practice of quality wise separate storage as well as selling is not practiced. All the cotton is stored at a single place and sold as per the requirement of the farmer. Harvesting of cotton is done in three or four pickings. Quality of the cotton harvested in first two /three pickings is superior when compared with that of last picking. As per the farmers price difference between different qualities of cotton is nominal. Hence they do not separate and sell each quality separately. Moisture content, trash and colour are the major factors considered by the traders while fixing price.

There is no commercial utilization of the cotton stalks in the study area. About 70-80 percent of the stalks are burned in the field and 10-15 percent are used as household fuel, while, very few farmers incorporate the cotton stalks in the field with the help of rotavator.

3.9 : New eco-compatible pest management strategies

3.9.1 : Bollworms

Nagpur

Push-Pull strategy for management of pink bollworm *Pectinophora gossypiella* (Saunders) in cotton

The 'push-pull' approach is an ecological based novel pest management tool that relies on the manipulation of pest behavior by utilizing attractant and repellent (deterrent) components in combination.

Identification and evaluation of vegetable oils as oviposition deterrents:

In this study, oils containing fatty acids that have proven role as oviposition deterrent in previous years were evaluated both under lab and field conditions. The crude vegetable oil samples - groundnut, sunflower, safflower, soybean, sesame and rice bran were subjected to GC-MS analysis for presence of deterrent components. Bioassays were carried out under laboratory conditions (65 ± 5% relative humidity; 14L:10 D photoperiod; 27 ± 1^{0}C temperature) in insectary using individual oils. Moths were allowed to mate for two days and allowed to lay eggs on treated cotton twigs. Cotton twigs were dipped in eppendroff tubes provided with water and covered with parafilm to keep twigs fresh for long time. Bioassays were performed for each oil using six different concentrations (0.5%, 1.0%, 1.5%, 2.0%, 2.5% and 3.0%) prepared in methanol. Field evaluation of crude vegetable oils under field conditions at three different concentrations (1.0%, 2.0% and 4.0%) is continued beyond December 2019.

Identification and evaluation of plant based volatiles:

Identification of relative proportion of various components and evaluation of their role as attractants was initiated. The major compounds identified were α/β

pinene, carene, γ terpinene, α copaene, caryophyllene and humulene. The evaluation of these compounds as attractant towards pink bollworm is in progress.

Identification of oviposition deterrent for ethological management of Cotton Boll worm (*Helicoverpa armigera*)

Semiochemicals are the acceptable alternative for the management of insects as it alter the behavior of insect particularly as oviposition deterrent. Analysis of feacal pellets of cotton boll worm showed the presence of four major fatty acids *viz.,* linoleic acid (9,12-octadecadienoic acid), palmitic acid (hexadecanoic acid), myristic (Tetradecanoic acid) and stearic acid (Octadecanoic acid) and were found promising (in pure form) with a significant reduction in egg laying over control under laboratory condition. In all the compounds, deterrence was higher than 68 per cent. For this study eight oils namely, palm, groundnut, sunflower, safflower, soybean, sesame, rice bran, and shea butter were selected based on the compounds identified in previous year through GC-MS and evaluated both under lab and field conditions (on cotton and chick pea). Laboratory and field evaluation of oils is in progress.

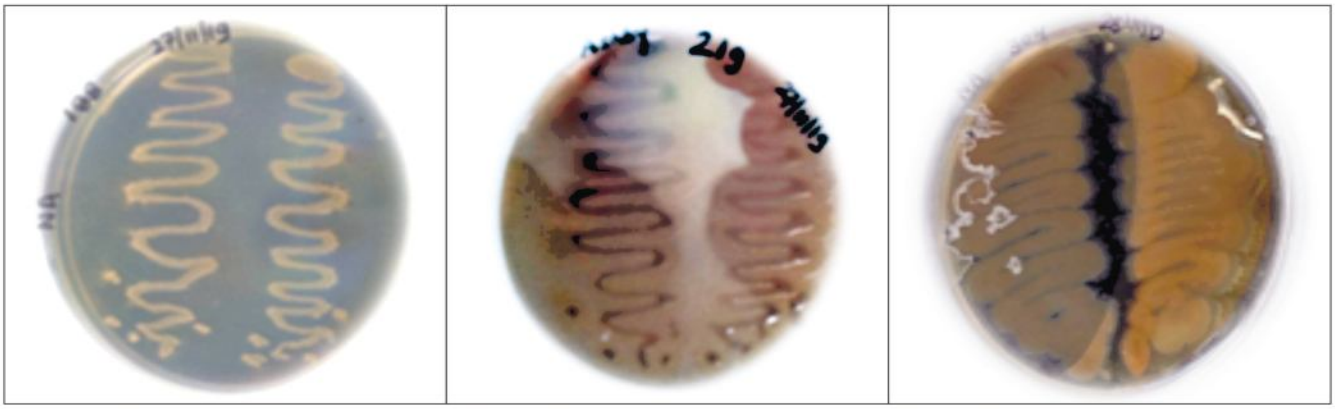
Development of microbial biofilm formulations for cotton pest management

Screening of native bacterial isolates for biofilm preparation was continued and 325 native bacterial strains were tested on major pests such as *Pectinophora gossypiella, Helicoverpa armigera,* and *Spodoptera frugiperda* of cotton through diet based insect bioassay. Out of 325 native bacterial isolates, best 20 isolates, which have shown maximum mortality on *Pectinophora gossypiella* (>80% mortality), *Helicoverpa armigera* (>70% mortality), and *Spodoptera frugiperda* (>70 mortality) were selected for further biochemical studies (Table 3.9.1.1). The best performing and unidentified bacterial isolates were submitted for identification through 16S rRNA sequencing.

Table 3.9.1.1: Top ranking isolates based on mortality of target pest

S.N.	Pink bollworm			American bollworm			Fall army worm		
	B*	S*	M*	B*	S*	M*	B*	S*	M*
1	Not identified	188	94	Not identified	219	85	Not identified	304	91
2	*Delftia acidovorans*	148	89	*Bacillus subtilis*	3	80	Not identified	276	86
3	Not identified	313	89	*Pseudomonas spp*	174	75	Not identified	Bt 25	81
4	*Ralstonia spp*	80	89	*Pseudomonas spp*	155	75	Not identified	Bt 27	81
5	Not identified	Bt 11	83	*Pseudomonas*	165	75	Not identified	29	81
6	Not identified	Bt 20	83	*Enterobacter cloacae*	116	75	*Enterobacter spp*	23	76
7	Not identified	68	83	Not identified	261	75	Not identified	310	76
8	Not identified	198	83	Not identified	Bt 2	70	Not identified	Bt 16	71
9	Not identified	275	83	Extensimonas	150	70	Not identified	167	71
10	Not identified	315	83	Not identified	157	70	*Pseudomonas spp*	12	71

*** B=Bacteria, *S=Strain code, *M=Mortality %,**



Strain 188- *Pectinophora gossypiella* mortality rate 94%

Strain 219- *Helicoverpa armiger* mortality rate 84%

Strain 304- *Spodoptera frugiperda* mortality rate 91%

Coimbatore

Field evaluation on the efficacy of the combination lures and mixed lures against major lepidopterous pests in cotton

Field efficacy of sex pheromones *viz.*,7,11-hexadecadienyl acetate (Pink bollworm, *Pectinophora gossypiella*); (Z,E)- 9,11- tetradecadienyl acetate (Cotton leaf worm, *Spodoptera litura*); (Z)-9 - hexadecenal (American bollworm, *Helicoverpa armigera*) and (E, E) - 10, 12- hexadecadienyl (Spotted bollworm, *Earias vitella*) as individual lures, combinations and as mixtures were tested against the major lepidopterous bollworms and leaf worms of cotton. Trap catch of *Pectinophora gossypiella* and *Spodoptera litura* was found to be identical in Individual traps, combined traps & combined lure, while in the mixed lure experiment a reduction in trap catch was noticed.

Chemical profiling of a wax degrading fungus

Chemical profiling of ethyl acetate fractions of a new wax degrading fungus, *Aspergillus* fumigatus isolated from striped mealybug, *Ferritiavirgata* Cockerell was carried out. From the GC/MS analysis of extract, 43.1 % of the composition of compounds are identified and rest of them are unidentified (56.9%). The mass spectrum of each compound was compared with the NIST 05 library. All the identified major constituents are alkaloids which includes 5-Chlorobenzimidazole-2-carboxylic acid (7.06%), 1,4-Diaza-2,5-dioxo-3-isobutyl bicyclo[4.3.0]nonane (18.97%), 3,6-Bis(2-methylpropyl) piperazine-2,5-dione (7.13%), 3-Benzylhexahydropyrrolo[1,2-a]pyrazine-1,4-dione (9.94 %) (Table 3.9.1.2 .) It was found that this fraction is rich in secondary metabolites.

Table 3.9.1.**2 : Composition of major compounds analyzed through GC-MS**

Compounds	RT	Molecular Formula	Molecular Weight	% Peak Area
5-Chlorobenzimidazole-2-carboxylic acid	20.18	$C_8H_5ClN_2O_2$	196	7.06
1,4-Diaza-2,5-dioxo-3-isobutyl bicyclo[4.3.0]nonane	22.09	$C_{11}H_{18}N_2O_2$	210	7.14
1,4-Diaza-2,5-dioxo-3-isobutyl bicyclo[4.3.0]nonane	22.46	$C_{11}H_{18}N_2O_2$	210	11.83
3,6-Bis(2-methylpropyl)piperazine-2,5-dione	27.14	$C_{12}H_{22}N_2O_2$	226	7.13
3-Benzylhexahydropyrrolo[1,2-a]pyrazine-1,4-dione	30.12	$C_{14}H_{16}N_2O_2$	244	9.94

3.9.2 : Sucking pests

Nagpur

Studies on chemical cues mediating natural enemy and sucking pest interaction in cotton

This study explores identification of volatiles emitting from the sucking pests that attract natural enemies and evaluation of their effect in enhancing natural enemies and reduction in sucking pests load.

Sucking pests (jassids and whitefly) were collected from the cotton field. For isolation of kairomones compounds whole body wash of insect was performed using methanol, with solvent volume of 5 µl whitefly and 25 µl of solvent/jassids. The compounds reconfirmed as observed in previous year with 9-Octadecenoic acid esters were major compounds in both sucking pests followed by 9,12-Octadecadienoic acid (Z,Z)-, methyl ester, hexadecanoic acid, methyl ester and methyl stearate. As the vegetable oils like groundnut, sunflower, safflower, soybean, sesame and ricebran contain these components, the field application of these oils in three different concentrations, 1.0%, 2.0% and 4.0% was taken up and observations on occurrence of natural enemies like coccinellids, *Cheilomenes sexmaculata* was recorded.

Coimbatore

Different intercrops in cotton against thrips

Summer Cotton grown with different intercrops *viz.*, marigold, vegetable cowpea, onion, french bean and groundnut was evaluated against thrips. Among these, cotton intercropped with marigold recorded reduced population of thrips. Cotton + vegetable cowpea system registered the significantly higher nitrogen (150.3 kg/ha) and phosphorus uptake (29.5 kg/ha). Cotton + marigold intercropping showed higher potassium uptake (136.5kg/ha).

Different group of insecticides against thrips in cotton

Efficacy of 10 different insecticides was evaluated against thrips in summer cotton. Among insecticides, Spinetoram followed by fipronil showed highest efficacy against thrips. The similar trend was observed in 2018-19 trial.

3.9.3 : Diseases

Nagpur

Evaluation of cotton PGPR for broad spectrum disease resistance

PGPR *Bacillus aryabhattai* (CICR-D5) + *B. tequilensis* (CICR-H3) combination followed by strains *B.*

tequilensis (CICR-H3) and *B. aryabhattai* (CICR-D5) singly were found most effective at 10^8 CFU/ml against seed and soil borne fungal pathogens (*Macrophomina phaseolina*, *Rhizoctonia solani* and *Fusarium oxysporum* f.sp. *vasinfectum*) and leaf spot diseases of cotton Cv. Suraj (*G. hirsutum*) as compared to control plots. No wilt and root rot incidence was noticed in *B. aryabhattai* (CICR-D5) + *B. tequilensis* (CICR-H3) treated plots. Minimum PDI (1.67) was recorded for *Myrothecium* leaf spot, *Corynespora* leaf spot and bacterial leaf blight in PGPR treated plots as compared to control at 60 DAS. Least PDI was recorded 120 DAS for grey mildew, *Corynespora* leaf spot and bacterial leaf blight diseases in PGPR formulation applied plots. Similarly, *B. tequilensis* (CICR-H3) strain was also found effective under *in vitro* bioassay against root knot nematode, *Melidogyne incognita*.

a) Field application of PGPR strains, b) Effect of PGPR strains treated plots Antifungal, nematicidal and insect repellent VOC's from CICR-H3 and CICR-D5 stains

Identification, characterization and antagonistic activity of cotton endophytes

About 48 endophytic fungi have been identified through ITS sequence analysis and the sequences were submitted to NCBI GenBank (Acc No. MN180847-MN180857 and MN173112-MN173148). Based on the mycelium inhibition percentage (>50 to 66%) in dual culture against *Fusarium solani* and *Corynespora cassiicola*, nine promising endophytes were selected for *in vivo* evaluation and is being carried out in pots by using different inoculation methods

An endophyte *Nigrospora sphaerica* (CEL 19) was tested for production of antimicrobial VOCs through GC/MS using methanol as solvent wherein, four compounds namely 1, 3-diethyl benzene, 1, 4-diethyl benzene, cymene-7-ol and m-ethyl acetophenone were identified, further confirming the previous results when DCM was used as a solvent (Fig.3.9.3.1.a&b) Table No. 3.9.3.1.

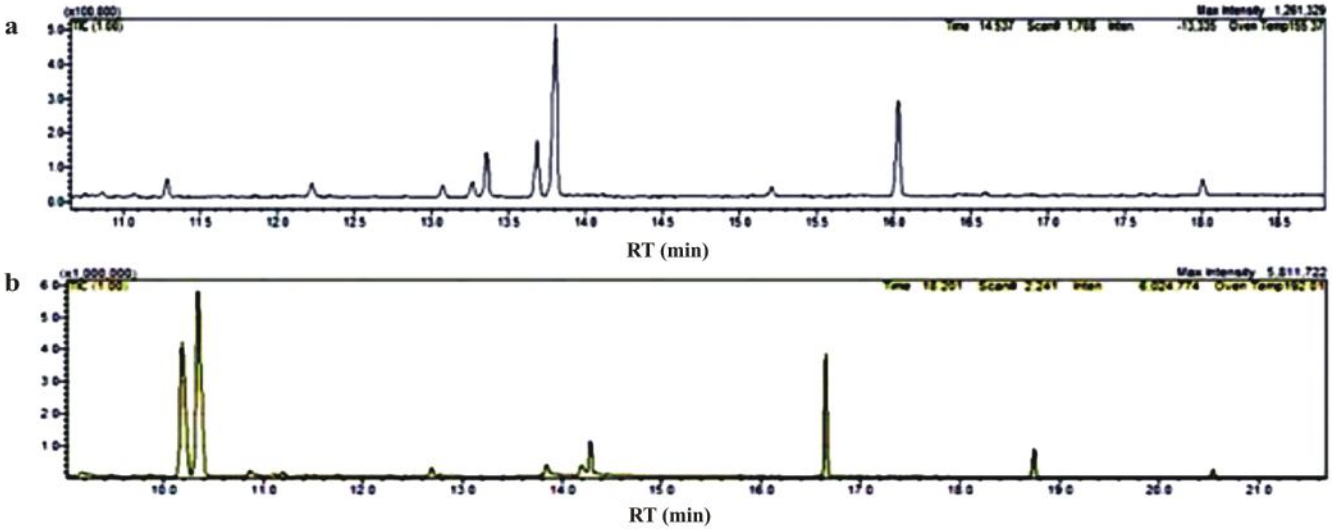


Fig.3.9.3.1 a & b: Total ion chromatogram (TIC) of endophytic Nigrospora sphaerica (CEL-19) for VOCs identification through GC-MS using DCM (a) and Methanol (b) as solvents

Table No. 3.9.3.1: List of VOCs of endophytic Nigrospora sphaerica (CEL-19) identified through GC-MS using DCM (a) and Methanol (b) as solvents

S.No.	Name of Compound	Relative abundance in DCM (%)	Relative abundance in Methanol (%)
1.	Benzene 1,3 diethyl	39.8	38.8
2.	Benzene 1,4 diethyl	46.4	51.5
3.	Naphthalene	1.37	1.62
4.	p-cymen-7-ol	2.51	---
5.	m- Ethyl acetophenone	4.16	5.1
6.	Ethanone, 1-(4-ethylphenyl) or p- ethyl acetophenone	5.69	---
7.	Nonanal	---	1.02
8.	Benzene 1,2,3 trimethyl	---	0.77

3.10: Bio-diversity of pests and natural enemies in cotton ecosystem

Seasonal Dynamics of Insect Pests and Diseases and their natural enemies

3.10.1: Sucking pests

Nagpur

Sucking pests *viz.,* jassid (*Amrasca biguttula biguttula* Ishida), aphids (*Aphis gossypii* Glover), mirid bug (*Campylomma livida Reuter)*, thrips (*Thrips spp.*), whitefly (*Bemisia tabaci* Genn.), mealybug (*Phenacoccus solenopsis* Tinsley*)*, red cotton bug (*Dysdercus cingulatus* Fab) and dusky cotton bug (*Oxycarenus hyalinipennis* Costa) were recorded on cotton in central India. Infestation of m*ealybugs (Phenacoccus solenopsis* Tinsley, *Paracoccus marginatus* Williams and Granara de Willink) was in traces.

Population dynamics of sucking pests

All the sucking pests were higher in number with onset of growing season and later decreased in late season. Jassid was the most prominent pest. (Fig. 3.10.1.1). All the sucking pests were least during third week of October coinciding with heavy rain. Natural enemies *viz.,* spider and Coccinellids were recorded in good number during the season.

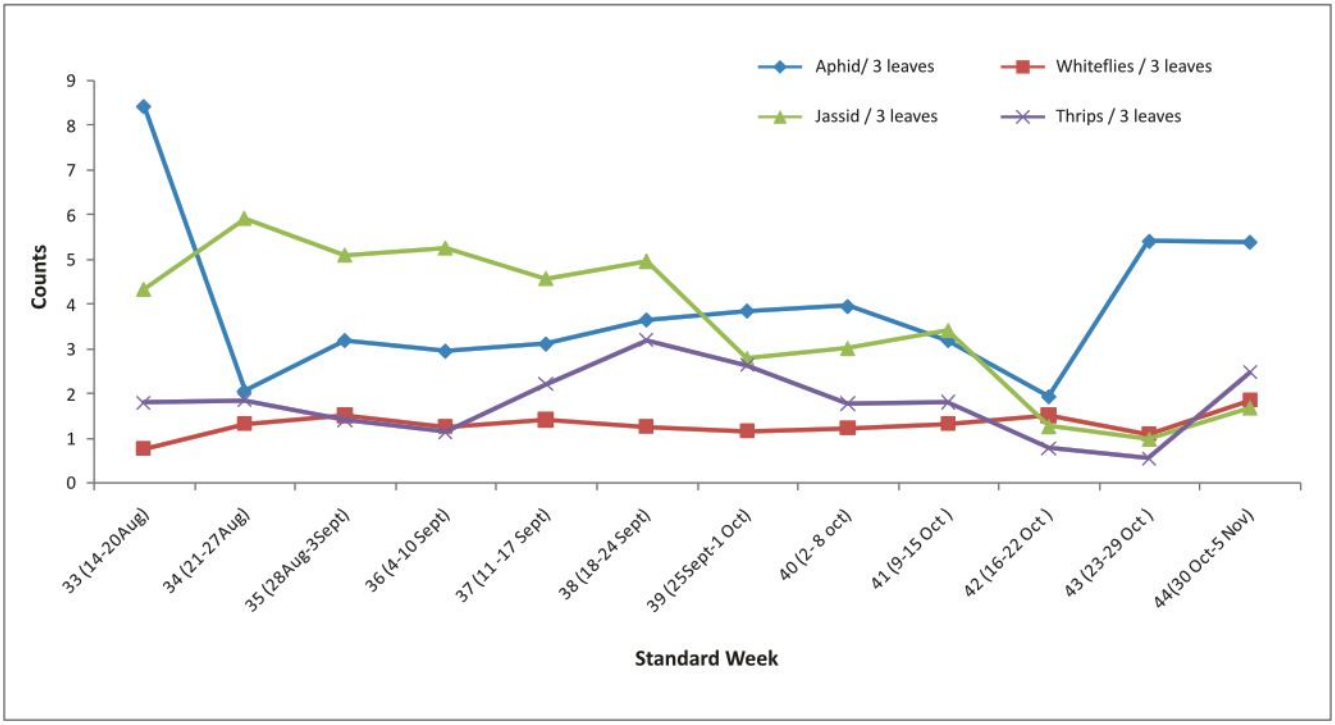


Fig.3.10.1.1: Population dynamics of cotton pests over the season in RCH 2 during 2019-20

Yellow sticky trap catches

Under protected conditions maximum jassid population 578 jassid/trap/week was trapped during 34 SMW (21-27Aug), whereas, under unprotected conditions, maximum trapped were 718 jassid/ trap/week during 35 SMW (28Aug-3Sept). Over the season, average trap catches recorded were 237 and 287 jassid/trap/week under protected and unprotected conditions, respectively. Maximum whitefly populations 225 whitefly/ trap/week and 381 were trapped during 48 (27 Nov - 3 Dec) and 35 SMW (28 Aug - 3 Sept), under protected and unprotected conditions respectively. The overall average population recorded 125 and 156 whitefly/ trap/week under protected and unprotected condition, respectively (Fig.3.10.1.2).

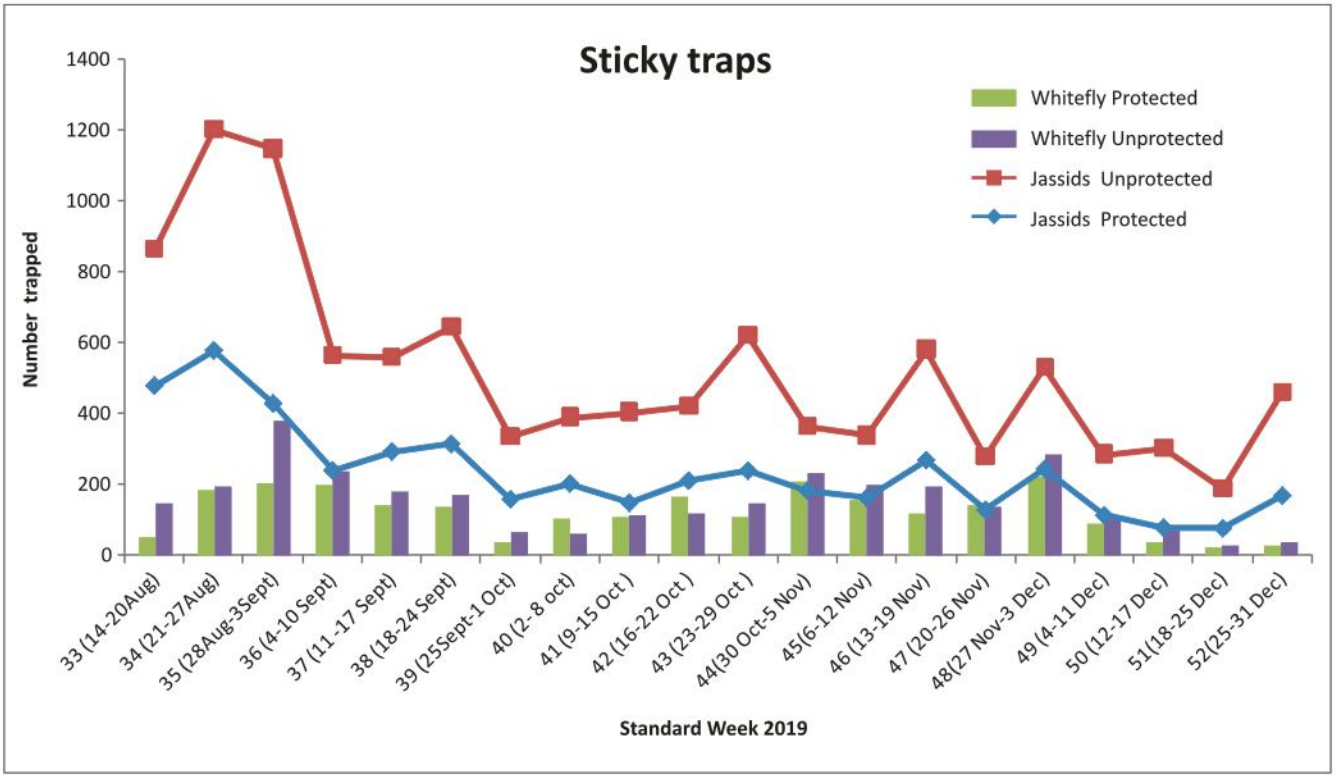


Fig.3.10.1.2: Jassid and whitefly population in yellow sticky traps during 2019-20

Sirsa

In RCH-650 BG-II hybrid leafhopper population ranged from 0.00-6.20/3 leaves peak with in 32nd SMW. Population of whitefly was initially observed in 22nd SMW (1.44 / 3 leaves) and peak activity occurred in 31th SMW (18.40 / 3 leaves). Thrips population ranged from 0.00-35.20 / 3 leaves which were first noted in 22th SMW and peak activity observed in 27th SMW (Fig..3.10.1.3 & Fig.3.10.1.4)

In HS-6, leafhopper population ranged from 0.00-5.80/ 3 leaves, peak activity was observed in 32th SMW. Population of whitefly was initially observed in 22nd SMW (0.60/ 3 leaves) & peak activity occurred in 30th SMW (29.50 / 3 leaves). Thrips population ranged from 0.00-31.20 / 3 leaves and peak activity in 28th SMW.

In Ganganagar Ageti (GA), the leafhopper population ranged between 0.40-6.60/3 leaves and peak activities of leafhopper was observed in 33rd SMW. Population of whitefly was initially observed in 22nd SMW (0.40/ 3 leaves) and peak activity in 30th SMW (23.40 / 3 leaves). Thrips population ranged from 0.00-31.70 / 3 leaves and peak activity observed in 27th SMW.

In RS-2013, leafhopper population ranged from 0.10-5.60 /3 leaves peak activity observed in 33rdSMW. Population of whitefly was initially observed in 22nd SMW (1.30/ 3 leaves) and peak activity occurred in 33rd SMW (18.50 / 3 leaves).Thrips population ranged from 0.00-30.80 / 3 leaves and peak activity of thrips was observed in 27th SMW.

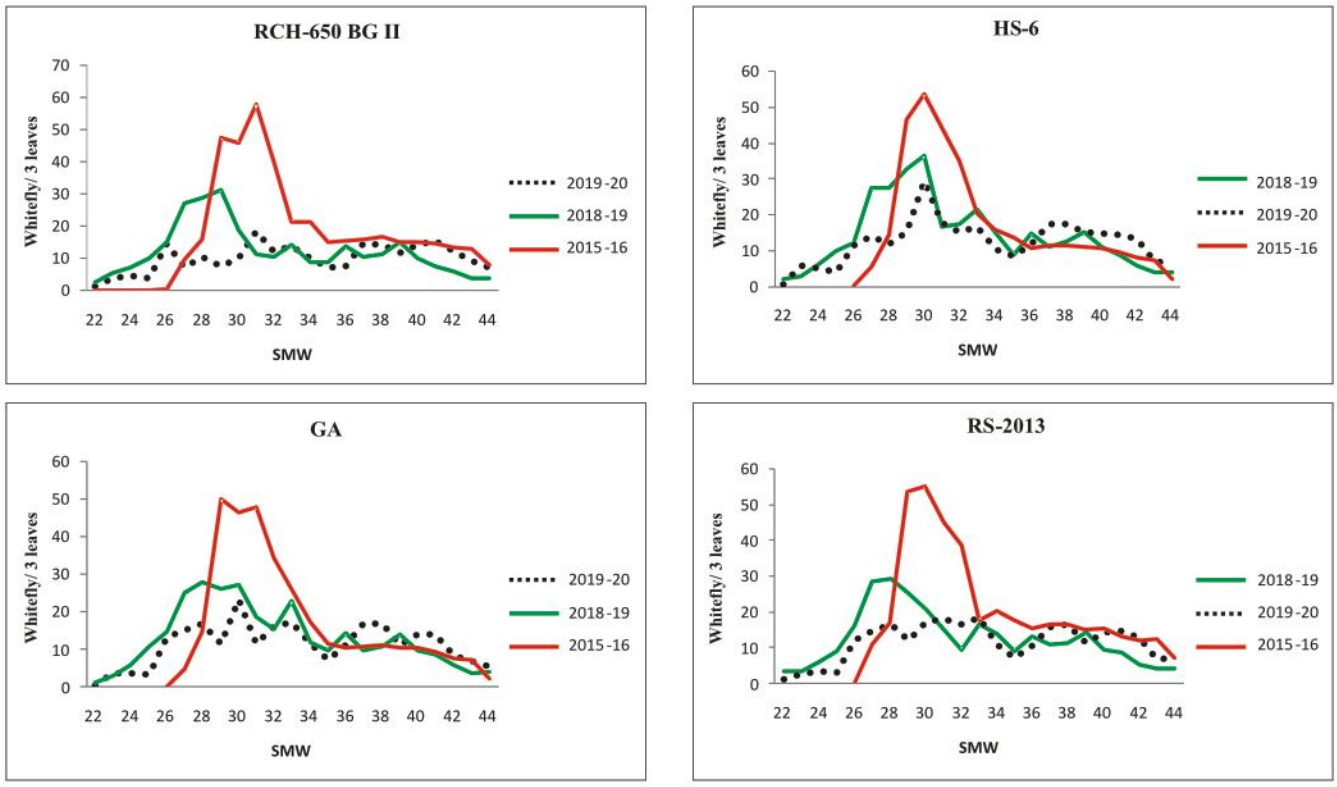


Fig.3.10.1.3: Population dynamics of Whitefly on cotton in north zone (2015-16-Epidemic year, 2018-19 & 2019-20)

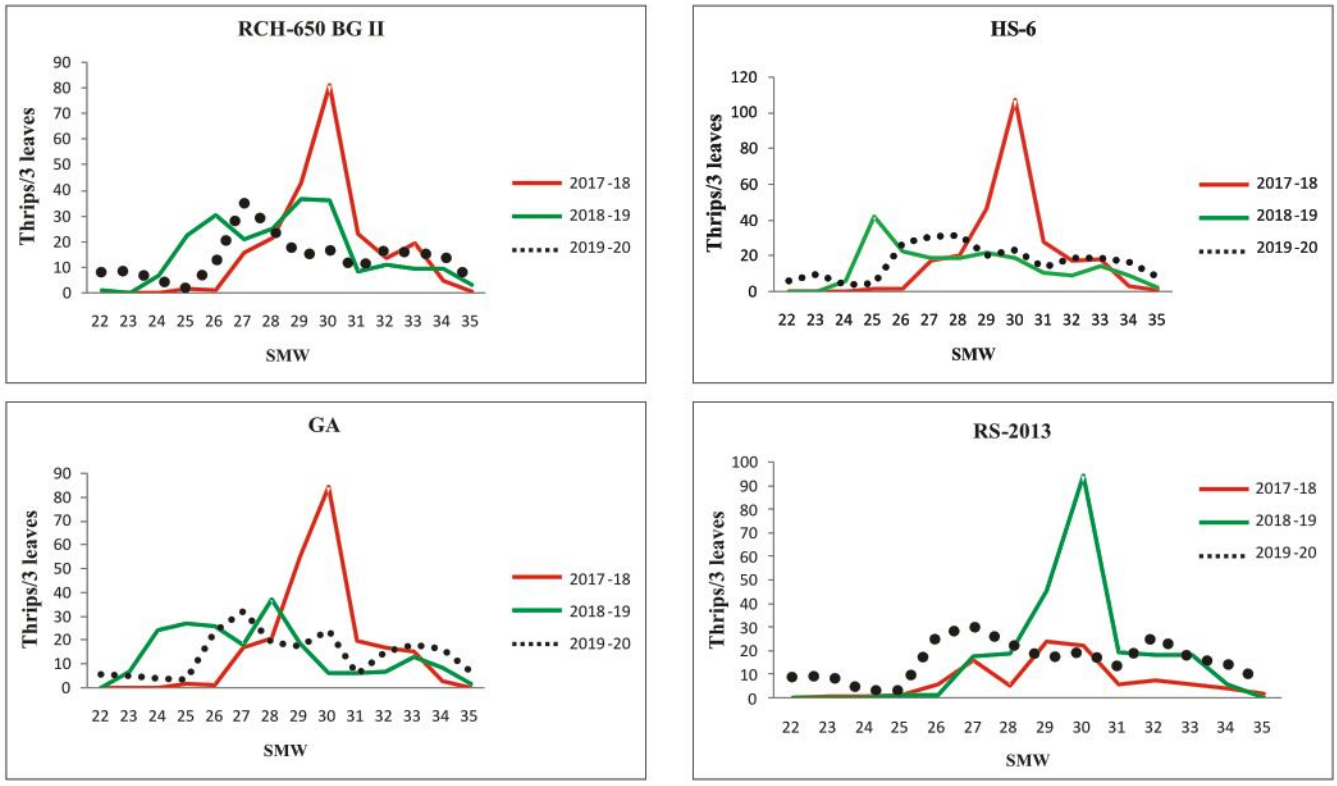


Fig. 3.10.1.4: Population dynamics (Thrips) on cotton in north zone (2017-20)

3.10.2: *Bollworms*

Nagpur

Pink bollworm (*Pectinophora gossypiella)* infestation ranged between 0-100% after 2-4 pickings in central and south India, while American bollworm (*Helicoverpa armigera)* and spotted bollworm (*Earias vitttela*) were in negligible number.

Evaluation of early (flower) and late (boll) populations of pink bollworm (PBW)

PBW in India appears in two stages, during the early flowering crop season at 60 to 80 DAS and in late season during boll development. Pink bollworm larvae collected from damaged rosette flowers and infested bolls were taken up for sequence analysis of COI region. The comparison of 36 early populations of Pink Bollworm collected from infested flowers was made with the same size of populations collected from infested bolls. The values of pairwise genetic distance between early and late populations was 0.08438 indicating moderate genetic differentiation. Significantly negative departures from zero for neutrality tests values also support population expansions. Genetic data shows that the two populations of pink bollworm, those occurring early in the season is genetically close to the late season populations with respect to their CO1 region (Fig. 3.10.2.1).

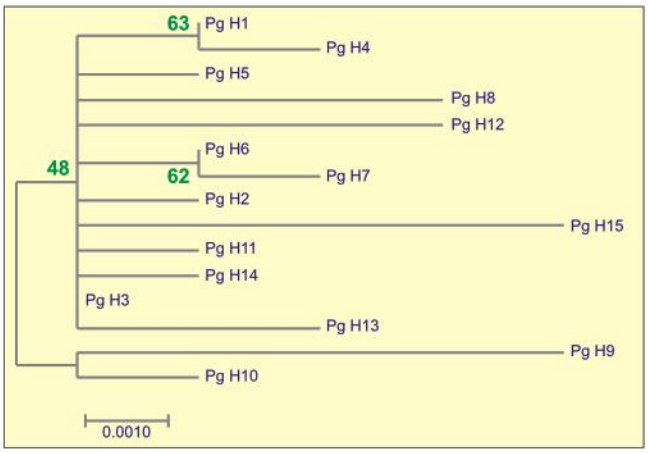


Fig. 3.10.2.1 : Phylogenetic tree of the 15mt COI DNA haplotypes in the early and late populations of *Pectinophora gossypiella*

Parasitoid infestation of Pink bollworm Larvae

Pink bollworm larvae were recovered from infested green bolls collected from different cotton growing districts of India. Dead larvae were kept for the emergence of parasitoids. Parasitization by *Apanteles angaleti* in Maharashtra was found to be in the range of 4.76% (Parbhani) to 13.04% (Yavatmal). In Gujarat, highest parasitization was recorded in Rajkot population (44.59 %) and lowest in Surendranagar (27%). In south India, the Kurnool population recorded highest parasitisation (12.50%) followed by Mehbubnagar (1.96%) population.

Endosymbionts from different geographical populations of Pink bollworm

Endosymbiotic microbiota in Pink Bollworm populations collected from 12 different districts of India was investigated. *Burkholderia* strains were isolated from most of the locations as endosymbionts. *Pluralibacter gergoviae*, *Enterobacter sp.* and *Citrobacter youngae* strain were also recorded.

Sirsa

American bollworm infestation was not observed on RCH-650 BG II. In Non Bt varieties HS-6, Ganganagar Ageti and RS-2013 first incidence of bollworm was observed in the 35th SMW which ranged from 0.34 to 7.80, 0.90-6.18, and 0.23 to 5.57 based on percent

fruiting body damage respectively in Non Bt genotypes.

PBW scenario in North india

Green boll infestations due to Pink Bollworm were studied through destructive boll sampling from Hisar, Sirsa, Bathinda, Faridkot and Sriganganagar at 90,120, 135 and 150 DAS. At these locations 4-31% pink bollworm larval recovery was observed in Non-Bt cotton at 150DAS. Though no larval recovery was recorded in BG-II cotton in three IRM adopted villages (ShamshabdPati, Panjuana, Kishanpura) and one Non-IRM Village (Kharian) in Sirsa district of Haryana. But in Jind (Haryana) under IRM project from two IRM villages (Palwan and Kirsindhu) 4.5-46.67% infestation of Pink Bollworm was recorded.

Similarly in villages namely Jodhpur Romana, Gurusar Sainewala and Sangat Mandi (Bathinda) Punjab during the months of October and November, the incidence of Pink Bollworm were observed in the fields of cotton growers in BG-II cotton fields. The damage was mainly confined to 20-25 acres of cotton crop near to Krishna Cotton Mill in Jodhpur Romana village. During the month of October, PBW incidence was below 5%, but during second fortnight of November about 30-38 % damage noticed in their fields where 2 pickings were already done from cotton crop.

Other pests

Migratory population of Fall armyworm *Spodoptera frugiperda* (Smith) (Lepidoptera:Noctuidae) was recorded to infest cotton crop cultivated adjacent to maize crop in Ahmednagar, Parbhani and Jalgaon districts of Maharashtra state. Flower chafer beetle (*Oxycetonia versicolor*) a minor pest of cotton was seen to infest cotton crop in central India.

Pheromone trap catches at Nagpur

During 2019-20, highest moth catches of American bollworm (4.6 moths/ trap/ week), Spotted bollworm (4.0 moths/trap/week) and Pink Bollworm (22.2 moths/ trap/ week) were recorded at 48SW (3 -9 Dec), 39 (1-7 Oct), 48SW (3-9 Dec) and 36SW (8-14 Sept), respectively (Fig. 3.10.2.2).

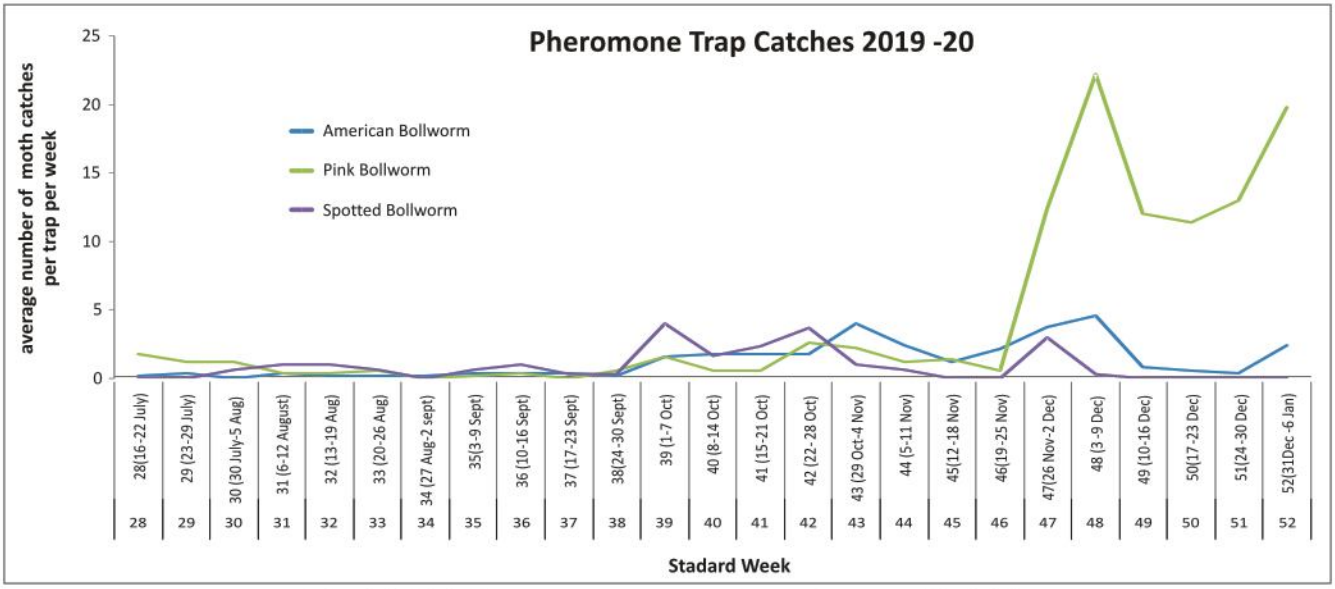


Fig. 3.10.2.2: Pheromone trap catches at Nagpur (2019-20)

Pink bollworm infestation at station trial in non-Bt and Bt cotton

Pink bollworm infestation was negligible till October end, however started increasing with the progress of season. Both Bt and non Bt cotton were found to be infested by pink bollworm however, higher infestation was recorded in non-Bt cotton. In non Bt cotton pink bollworm infestation was recorded starting from second week of November while in Bt cotton, it was started in fourth week of November (Fig. 3.10.2.3).

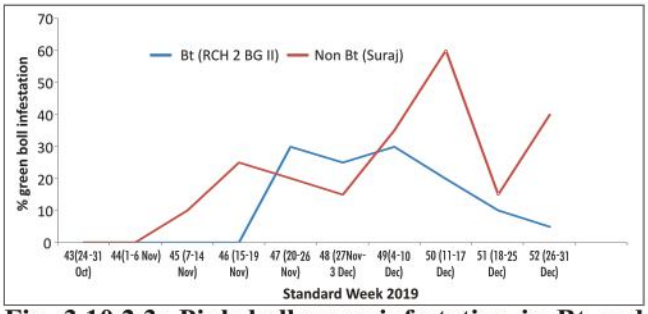


Fig. 3.10.2.3: Pink bollworm infestation in Bt and non-Bt cotton during 2019-20

Pink Bollworm infestation scenario

The per cent infestation of pink bollworm in flowers of BG-II at 60-70 days after sowing was observed in cotton growing districts of Maharashtra *viz.,* Yavatmal (10.57%), Nanded (8.00%), Parbhani (22.55 %), Akola (15.04%), Amarvati (5.77%) and Buldhana (1.38) while in Hingoli and Jalna no flower infestation was observed. Similarly the per cent infestation of pink bollworm in green bolls of BG-II at 160-165 days after sowing was observed in all cotton growing districts of Maharashtra *Viz.,* Parbhani (82 %), Yavatmal (72%), Hingoli (69%), Jalna (66.7%), Akola (62.67%), Nanded (60 %), Wardha (44 %), Aurangabad (42 %), Buldhana (37.33 %) while in Amravati nil incidence was recorded. Infestation on BG II cotton in Gujarat was in range of 0 to 8.00 per cent with highest in Vadodara district (8.00 %) at 80-90 DAS. In Telangana at 140-150 DAS the incidence of PBW was observed in Adilabad at 10.90% while in Kommaram bheem and Nirmal district infestation was below ETL. At 160-170 DAS in Ananthapur and Kurnool district of Andhra Pradesh, Raichur, Bellary and Yadgiri district of Karnataka and Mahaboobnagar district of Telangana infestation above ETL was observed. However, the pink bollworm infestation in North India (Punjab, Haryana and Rajasthan) at 140-150 DAS was recorded nil on BG-II hybrids except in Jind district of Haryana and Bhatinda district of Punjab with 6.90 % and 1.00% of incidence respectively. Similarly at 180 DAS PBW incidence of 69.60 % and 28.00 % was observed in Jind district of Haryana and Bhatinda district of Punjab respectively.

Seventeen teams consisting of Scientists and technical personnel conducted random surveys in 56 districts of 7 cotton growing states of India during October to December 2019. Till October infestation of pink bollworm (PBW) was negligible in central and south India. The survey teams visited 14 districts of Maharashtra (Yavatmal, Wardha, Nagpur, Amravati, Akola, Buldana, Jalgaon, Dhule, Nandurbar, Nanded, Hingoli, Parbhani, Beed and Ahemednagar), 13 districts of Gujarat (Bharuch, Ahmadabad, Vadodara, Surendranagar, Rajkot, Junagadh, Amreli, Bhavnagar, Mehsana, Banaskantha, Sabarkantha, Patan, Chhota Udaipur), 9 districts of Telangana (Adilabad, Mahabubabad, Warangal rural, Warangal urban, Karimnagar, Peddapalli, Narayanpet, Nirmal, Kumuram Bheem), 5 district of Madhya Pradesh (Khandwa, Khargone, Dhar, Barwani, Chhindwada), 5 districts of Karnataka (Dharward, Haveri, Raichur, Bellari, Yadgiri), 3 districts of Andhra Pradesh (Guntur, Prakasam, Kurnool) and 2 districts of Tamil Nadu (Coimbatore, Erode) covering 425 locations. State wise average percent infestation recorded as Madhya Pradesh- 33.4, Gujarat -30.42, Maharashtra -25.85, Andhra Padesh-17.46, Karnataka- 9.00, Telangana- 8.09 and Tamil Nadu- 7.23. During the survey 2-4 pickings were over at several locations (**Fig. 3.10.2.4**).

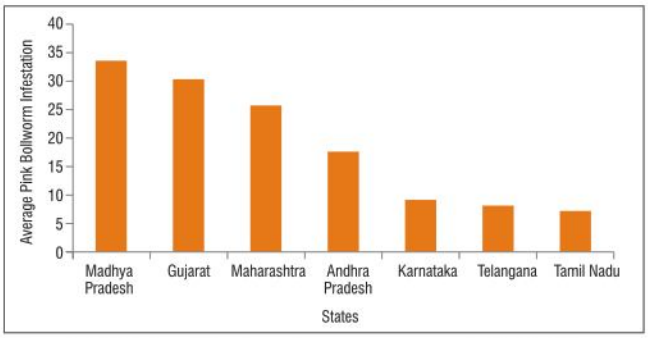


Fig. 3.10.2.4 : **State wise average pink bollworm infestation during 2019-20**

3.10.3: Disease Prevalance

Prevalance of *Xanthomonas citri* pv. *malvacearum* races of Cotton

Bacterial blight of cotton (BLB) caused by *Xanthomonas citri* pv. *malvaceulum* is an important disease of cotton. Bacterial blight infected cotton leaf samples (12) were collected from different cotton growing areas of Maharashtra (6 no.), Gujarat (3 no.) and North India(3 no.). Pathogenicity of all 12 isolates was confirmed on one month old seedling by syringe infiltration technique. The artificially inoculated leaf showing symptoms of BLB were again re-isolated to confirm the pathogenicity of original isolates. Biochemical and Molecular characterization of these isolates is progress.

1 Leaves showing the typical symptoms leaf blight

Oily spots observed on green bolls of cotton

Coimbatore

Symptom expression, host range, transmission studies with *Tobacco streak virus* (TSV) infecting cotton

Serological detection of *Tobacco Streak Virus* in the different plant parts of advance generations of *Gossypium barbadense* were carried out by DAS-ELISA. The different plant parts used for detection include root, stem, petiole, leaf, squares and pollen grains. It was observed that the absorbance value was more in leaf followed by petiole and squares **(Table 3.10.3.1).**

Table 3.10.3.1:Serological detection of TSV in the different plant parts of *Gossypium barbadense*

S. No	Advance generations	Root	Stem	Petiole	Leaf	Squares	Pollen grains
1.	CCB 129	1.236 (0.08)	1.789 (0.08)	2.287 (0.08)	3.237 (0.09)	2.220 (0.03)	1.119 (0.03)
2.	CCB 143	1.114 (0.05)	1.685 (0.05)	2.145 (0.05)	2.156 (0.05)	2.113 (0.09)	1.112 (0.02)
3.	CCB 64	1.115 (0.06)	1.520 (0.06)	2.210 (0.02)	3.193 (0.04)	2.118 (0.05)	0.998 (0.06)
4.	CCB 11	1.113 (0.04)	1.452 (0.08)	2.145 (0.06)	2.552 (0.03)	2.119 (0.08)	0.875 (0.05)
5.	CCB 11a	1.118 (0.06)	1.326 (0.09)	2.365 (0.08)	2.112 (0.07)	2.002 (0.02)	0.897 (0.06)
6.	CCB 26	1.119 (0.09)	1.258 (0.06)	2.114 (0.07)	2.345 (0.09)	2.006 (0.04)	0.568 (0.04)
7.	CCB 28	1.201 (0.08)	1.652 (0.06)	2.213 (0.07)	2.356 (0.09)	2.007 (0.05)	0.789 (0.05)
8.	CCB 29	1.203 (0.07)	1.456 (0.07)	2.140 (0.08)	2.564 (0.08)	2.008 (0.06)	0.226 (0.06)
9.	CCB 51	1.206 (0.05)	1.325 (0.08)	2.012 (0.05)	2.542 (0.06)	2.006 (0.07)	1.025 (0.05)
10.	CCB 51-2	1.205 (0.08)	1.234 (0.09)	2.031 (0.08)	2.411 (0.05)	2.003 (0.09)	1.042 (0.04)
11.	CCB 141	1.238 (0.06)	1.785 (0.05)	2.270 (0.05)	2.879 (0.07)	2.114 (0.08)	1.115 (0.05)
12.	CCB 142	1.115 (0.07)	1.256 (0.06)	2.014 (0.08)	2.213 (0.03)	2.115 (0.07)	1.032 (0.07)
13.	S X P	1.113 (0.04)	1.236 (0.04)	2.112 (0.08)	2.102 (0.04)	2.114 (0.06)	1.045 (0.05)
14.	Suvin (Control)	1.238 (0.05)	1.880 (0.05)	2.285 (0.08)	3.865 (0.09)	2.221 (0.04)	1.118 (0.08)

Molecular detection was achieved through RT-PCR which resulted in the amplification of coat protein gene of ~929 bp in all the TSV infected samples of *Gossypium barbadense.* Typical leaf symptoms from CCB 29, ICB 25 and Suvin were used for sap transmission studies on cowpea (CvCO7) seedlings. Symptoms like chlorotic lesions, necrotic lesions, necrotic spots, veinal necrosis, systemic symptoms, necrosis on petioles, stem necrosis and total necrosis were observed on cowpea seedlings at 3 to 7 days after inoculation. Viral inoculum was maintained artificially in different hosts under insect-proof net house conditions. Necrotic lesions were observed in greengram, black gram and soybean. Necrotic lesions and chlorotic lesions were observed on

mechanical inoculation on *Gossypium barbadense* (Suvin, ICB 25, CCB 11, CCB 29 and MRC 7918) and *Gossypium hirsutum* (Suraj and Mallika Bt) after 5 to 8 days of inoculation. Mosaic symptom and necrotic lesions were observed on Cucurbitaceae family hosts after 5 to 8 days of inoculation. Chlorotic lesions were observed on *Chenopodium amaranticolor* and *C.quinoa* 3 to 5 days after inoculation. Curling and necrotic lesions were observed on Nicotiana rustica and Nicotiana tabacum after 8- 17 days of inoculation.

3.11: Integrated Pest Management

Field evaluation of egg parasitoid *Trichogramma species* against pink bollworm

A field trial was conducted for evaluation of egg parasitoid *Trichogramma bactrae*, *Trichogramma brasiliensis* and *Trichogramma chilonis* through inundative release. Two weekly interval releases at flowering (40-55 DAS) and boll formation (60-75 DAS) stage along with a botanical, a microbial and two insecticides at 60-70 DAS, 70-80 DAS and 80-90 DAS were carried out. The observation were taken at ten days interval from 100DAS.

In all the treatments, in green bolls, number of exit holes, number of mines on the epicarp, number of larvae and per cent locule damage were recorded at ten days interval. From the seven treatments, Cypermethrin 4%EC+Profenophos 40% treatment was most promising with 13.49 per cent locule damage. The *T.bactrae* with 14.69 per cent locule damage was most effective among three parasitoids tested (Fig 3.11.1).

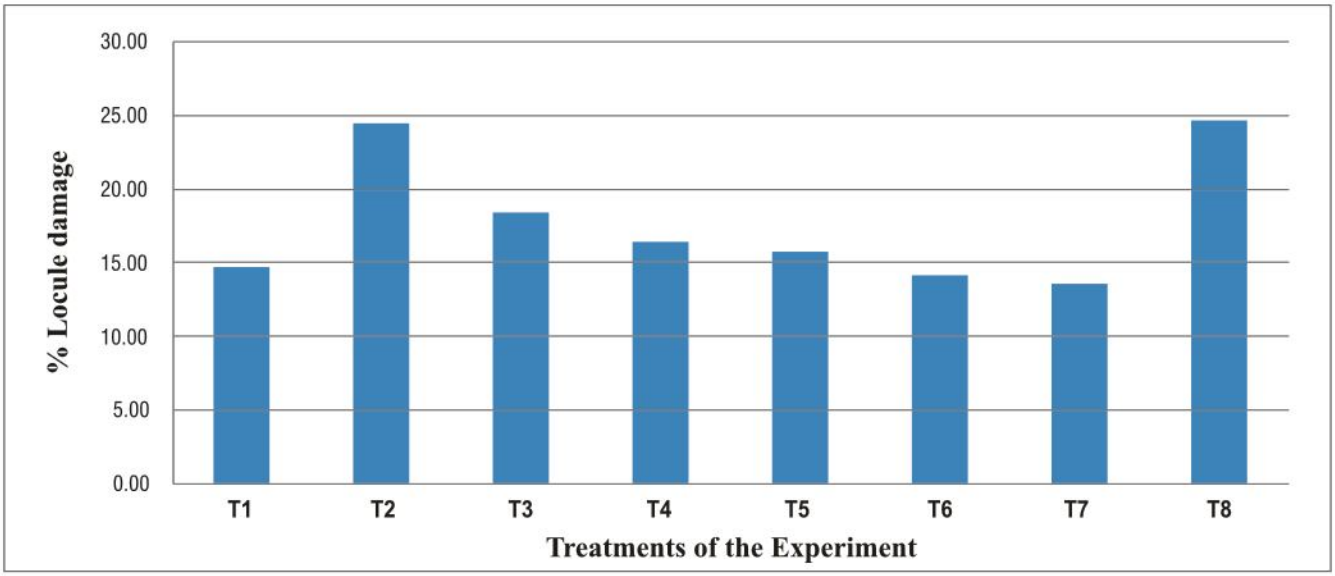


Fig 3.11.1:Evaluation of egg parasitoid *Trichogramma species* for management of pink bollworm *Pectinophora gossypiella* (Saunders) in field conditions. T1- T. bactrae, T2-T. brasiliensis, T3-T. chilonis, T4-Beauveria bassiana, T5-Neem oil, T6-Profenophos 50EC, T7-Cypermethrin 4% EC + profenophos 40% EC, T8- Control (water spray)

Resistance Monitoring

The resistance development in pink bollworm on BG-II and non Bt cotton fields was monitored across India. In North India, 9 districts from three states (Hisar, Fatehabad and Sirsa of Haryana, Mansa, Abohar, Bathinda and Faridkot of Punjab, Sriganganagar and Hanumangarh of Rajasthan), in Central India 23 districts namely Wardha, Yavatmal Washim, Hingoli, Nanded, Parbhani, Aurangabad, Buldana, Akola, Amravati, Rahuri, Jalgaon districts of Maharashtra; Surat, Bharuch, Vadodara, Anand, Ahmedabad, Bhavnagar, Amreli, Junagadh, Rajkot and Surendranagar districts of Gujarat, in South India 10 districts namely Ananthapur and Kurnool district of Andhra Pradesh; Adilabad, Komaram bheem, Nirmal and Mahaboobnagar district of Telangana, Raichur, Bellary, Yadgiri district of Karnataka were surveyed and monitored for pink bollworm infestation.

The populations were collected from the damaged green bolls of Bt and Non Bt cotton across India for conducting the resistance monitoring studies against Cry1Ac and Cry2Ab. The collected populations were reared on the semi-synthetic diet up to F_1 generation and later subjected to Cry toxin bioassay. Resistance monitoring was carried out with twenty nine populations collected, of these five population were from North India, nineteen from Central India and five populations were from South

India. The populations were subjected to Cry1Ac and Cry2Ab log doses assays. All populations of North India were susceptible to Bt toxins except population of Jind district of Haryana.




Leaf hoppers

In order to determine the resistance of leaf hopper to different insecticides, the leaf hopper populations were collected from Chandrapur, Wardha and Nagpur districts of Maharashtra and subjected to eight insecticide bioassay *viz*., Flonicamid, Monocrotophos, Acephate, Acetamiprid, Thiamethoxam, Imidacloprid, Acephate, Spiromesifen and Clothianidin at ICAR-CICR, Nagpur. The results indicated that, LC_{50} value to Flonicamid ranged from 0.004 mg/L (Chandrapur) to 0.284 mg/L (Wardha). Monocrotophos from 0.012 mg/L (Chandrapur) to 0.113 m g/L (Nagpur). Acephate from 0.013 mg/L (Chandrapur) to 0.052 mg/L (Nagpur). Imidacloprid from 0.012 mg/L (Chandrapur) to 0.048 mg/L (Wardha). Acetamiprid from 0.014 mg/L (Chandrapur) to 0.309 mg/L (Nagpur), Thiamethoxam from 0.005 mg/L (Chandrapur) to 0.24 mg/L (Wardha). Spiromecifen from 0.013 mg/L (Chandrapur) to 0.027 mg/L (Nagpur). Clothianidin from 0.012 mg/L (Chandrapur) to 0.028 mg/L (Wardha). Populations from Chandrapur were more susceptible to Flonicamid, Thiomethoxon, Acetamiprid, Imidaclopride, Acephate, Spiromesifen, Monocrotophos and Clothianidin.

Coimbatore

Identification of resistant genetic sources for Reniform nematode and mechanism of resistance

Screening of 29 *G.hirsutum* genotypes for identification of resistance to Reniform nematode was carried out. Elevated level of P peroxidase, G peroxidase, phenol and reducing sugar were recorded at 11 days post infection in all genotypes. Time taken to reach different developmental stage varies with the germplasm tested. There was significant difference in root and soil nematode population in different germplasm with BB-6-1-2 recording significantly low population. A positive correlation between nematode resistance and P peroxidase, G peroxidise and phenol was observed.

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

Out of nine insecticides tested (Chlorpyrifos, Thiodicarb, Flonicamid, Spiromesifen, Thiamethoxam, Imidacloprid, Thiacloprid, Diafenthiuron and Clothianidin), cotton leafhopper *A. biguttula biguttula*

was highly susceptible to thiamethoxam. The level of detoxification enzymes viz., esterase and mixed function oxidases were higher in insecticide exposed leafhoppers. The esterase activity was higher (21.614 uM napthol / min / mg protein) in thiamethoxam exposed insects. The activity of mixed function oxidase (MFOs) was higher in spiromesifen (118.17 nM cyto/min/mg protein) followed by thiamethoxam (117.30 nM cyto/min/mg protein) exposed leafhopper. As compared to control the activity of MFOs was reduced in clothionidin, flonicamid and diafenthiuron exposed leafhoppers.

Effect of thermal stress on fitness traits of two mealybug pests, *Phenacoccus solenopsis*, and *Paracoccus marginatus* and their parasitoids *Aenasius bambawalei* and *Acerophagus papayae*

The level of antioxidant enzymes present in the thermal stress exposed mealybugs and their enemies were studied. Irrespective of the population, the enzyme activities *in P. solenopsis* were significantly affected by increase in treatment temperatures. The activity of catalase (CAT), peroxidase (POD) and super oxide dismutase (SOD) in *P. solenopsis* were significantly increased as compared to control. The activity of SOD in *P. marginatus* was increased at higher temperature whereas there were no significant differences in POD level. The activity of CAT was higher in *P. solenopsis* parasitized by A. *arizonensis* at 34^{0}C. However, no significant difference was observed in the level of peroxidise.

Sirsa

Field study of IPM and biocontrol modules against whitefly

A field trial was conducted at ICAR- CICR Regional Station, Sirsa during 2018-19 and 2019-20 to evaluate the existing IPM module with three new IPM modules and three biocontrol modules along with commercial formulation of *Lecanicillium lecanii* and untreated control. The area under whitefly reduction curve (AUWRC) of pooled data revealed that the Bio module-1 (2 sprays each of neem+*Isaria javanica* CICR-RSS-0102) followed by existing IPM module (2 sprays each of neem+ flonicamid + spiromecifen), IPM module-3 (2 spray of neem+Flonicamid @ 1ml/L+ *Metarhiziumanisopliae* -1299) and Bio module-2 (2 sprays each of neem + *Beauveria bassiana*-4511 showed higher nymphal mortality than untreated control and other modules (Fig 3.11.2). The lowest CLCuD PDI was recorded in new IPM module-3, followed by IPM module-1, -2 and Bio module-3. However the highest seed cotton yield was recorded in IPM module-3 (25.4Q/ha) followed by Bio module-3 (25.3Q/ha). The new IPM module and Bio modules were at par with respect to the nymphal mortality, seed cotton yield, and CLCuD PDI. Based on economics of the four-spray applications, the Bio modules and new IPM modules can save up to Rs. 2250/- and Rs. 1500/- per ha over existing IPM module, respectively. Also, the entomopathogenic fungi used in bio and IPM modules are compatible with the recommended chemical insecticides for whitefly management.

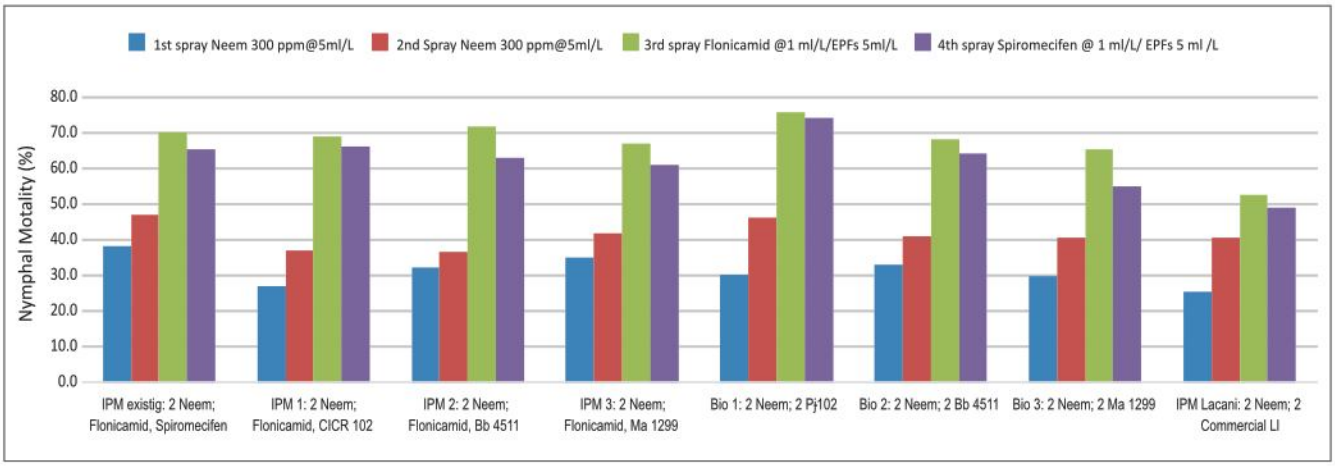


Fig 3.11.2: **Pooled Corrected mortality at 7 DAI 2018-19 & 2019-20**

IPM Strategies to combat whitefly infestation

A retrospective study on weather parameter triggering whitefly infestation studied using past data AICRP on Cotton for three North Zone locations at Faridkot, Hisar and Sriganganagar. Infestation level of whitefly shows significant change over different time periods (Table 3.11.1). There was also significant change in the peak occurrences of whitefly in all three locations (Fig 3.11.3)

Table 3.11.1: Average whitefly infestation per three leaves

	2005-06 to 2009-10 (Period 1)	2010-11 to 2018-19 (Period 2)	Increase (%) from period 1 to period 2	Peak Occurrence
Faridkot	2.99	8.2	174%	21.84 (2015-16)
Hisar	5.37	23.34	334%	66.40 (2017-18)
Sriganganagar	17.36	19.56	13%	50.92 (2014-15)

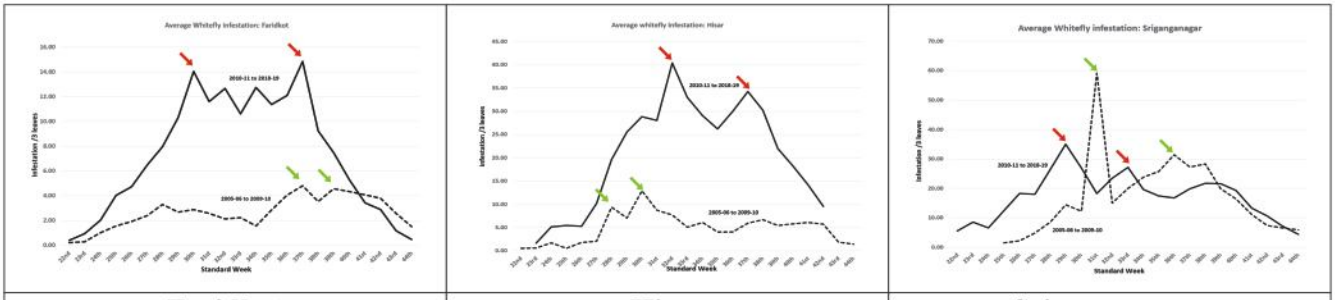


Fig 3.11.3: Average whitefly infestation per three leaves

Statistical Regression (log-linear) Model: Statistical Model (log-Linear) was developed for the whitefly population (dependent variable) against the weather parameters (independent Variables) *viz*., Maximum Temperature, Minimum Temperature, Rain Fall, Morning Relative Humidity, Evening Relative Humidity etc. The model attempted for three different scenarios - whitefly scenario based on the same week, previous week and week before previous week climatic factor.

The model estimates that Maximum temperature had high influence in decreasing whitefly infestations in all three locations especially after 2015-16. In contrary, Minimum temperature had high influence in increasing whitefly infestations in all three locations. Other weather parameter did not show any pattern or consistency over the years on whitefly infestation.

Bioefficacy of insecticides and biorationals against thrips and leafhoppers

Under the common trials conducted for GEAC approved genotypes and testing of agrochemicals during 2019-20, the efficacy of label claim insecticides studied under laboratory conditions against leafhopper recorded mortality (%) ranging from 26.67 to 72 percent. The maximum mortality (%) was observed in flonicamid (72), followed by dinotefuran (70), thiacloprid (57.33), acephate (55.33) and imidacloprid (56.67). Similarly for thrips also label claimed insecticides were screened under laboratory conditions and recorded mortality (%) ranging from 16.33 to 76.33 percent. The maximum mortality (%) was observed in Spinosad (76.33), followed by dinotefuran (70), thiacloprid (57.33), acephate (55.33) and imidacloprid (56.67).

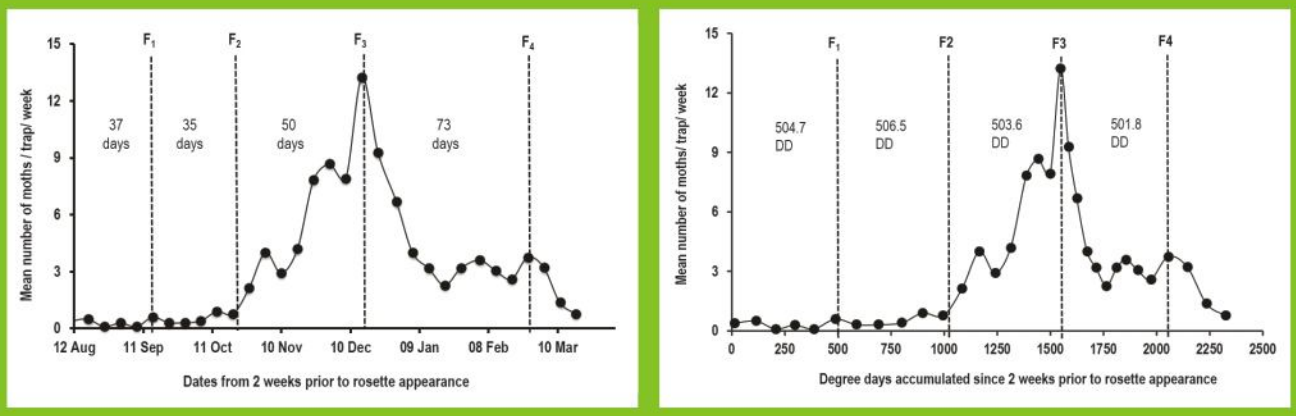
3.12: Development of new detection methods, tools and protocols

Degree-day based phenology model for cotton pink bollworm (*Pectinophora gossypiella*)

Development of degree-day based phenology model for predicting the developmental events of cotton pink bollworm (Saunders) in field was taken up. Lower and upper developmental temperature thresholds of 13.0 and 34.0 °C were determined for PBW, using a coefficient of variation (CV) technique of degree-day (DD) accumulations. Eight years (2009, 2012-2018) field data on pheromone trap catches of male moths recorded at Nagpur (Maharashtra) were used for DD accumulation between the consecutive moth peaks starting from beginning of the emergence, employing a sine wave method with horizontal upper cut-off. The combination of lower and upper developmental thresholds with the lowest CV of DD between events was accepted. The estimated thresholds and DD were validated at different locations across the North (Faridkot, Haryana), Central (Surat and Junagadh, Gujarat) and South (Dharwad, Karnataka) cotton growing zones of India. Two weeks prior to rosette appearance was used as starting point for DD accumulation assuming peak in-field infestation. Using 13.0/34.0 °C thresholds, the mean heat units (HU) accumulated between the consecutive moth peaks (one in field generation, adult to adult) were estimated at

504.05 ± 4.84 DD. Asynchronous moth peaks of eight years fairly coincided when plotted on HU scale. Seven generations were determined for PBW in a cropping season, the length of which varied between 35 - 73 days in response to temperature. Validation of model provided closer estimates across the tested locations. In the context of climate change, the present findings are crucial in predicting the dates of moth emergence, oviposition and egg hatch in PBW, which will aid in undertaking timely management strategies.

Prediction of in-field generation events



✓Field data on rosette flowers, green boll damage & moth trap catches for the cotton season 2018-19 at experimental field (C-19) of ICAR-CICR, Nagpur

Characterization of midgut alkaline phosphatase activity associated with Cry2Ab resistance in Pink Bollworm populations

Alkaline Phosphatase is one of the receptor which adheres to brush border membrane of midgut of PBW larvae. PBW larvae resistant to Cry2Ab toxins have shown higher alkaline phosphatase activity than the susceptible population (Fig.3.12.1). PBW larvae resistant to higher concentration to Cry2Ab have also shown protein bands in the range of 72kDa to 95kDa while susceptible population showed isozymes in the range of 55kDa to 65kDa with lower enzymatic expression. Midgut alkaline phosphatase is probably a key biomarker associated with Cry2Ab resistance in Pink Bollworm populations.

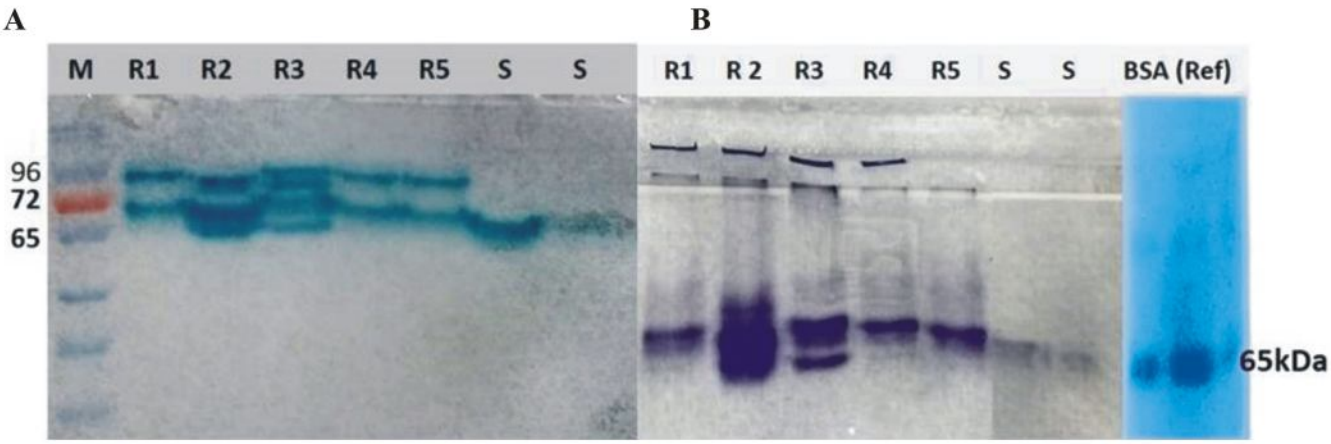


Fig.3.12.1:Gel electrophoresis for enzymatic activity of alkaline phosphatase in resistant and susceptible PBW protein samples [M- marker, R- Resistant population, S- Susceptible population. A] non-denaturing SDS PAGE B] Native PAGE]

4. TECHNOLOGIES ASSESSED AND TRANSFERRED

4.1 Demonstrations

4.1.1 Demonstrations in Experimental Farm

Nagpur

During 2019, field demonstrations of ICAR-CICR released Non Bt varieties *viz*., CNA 1003 (Roja), CNA 1028 (Ravi), Suraj and Bt varieties *viz*., Suraj Bt, Rajat Bt, PKV 081 Bt, GJHV 374 Bt and other public sector varieties NH 615 were conducted at ICAR-CICR farm to showcase the Institute technologies to the farmers

Coimbatore

During 2019, on farm demonstrations of cotton varieties Suraj, Suvin, Sunantha, Subhiksha, advanced line (CCB 51) and hybrid (MRC 7918 Bt BG II) were conducted with all recommended technologies.

Sirsa

Demonstrations were undertaken for 16 most prominent hybrids. The maximum yield was recorded in NSPL 2223 (35.58q/ha) whereas minimum yield was recorded in ACH 177-2 (20.72q ha).

4.1.2 Demonstrations in Farmers Field

Nagpur

The performance of four new Bt varieties *viz.* Suraj Bt, PKV 081Bt, Rajat Bt and GJHV 374 Bt released by ICAR–CICR were assessed and transferred to the farmers fields. Seeds of these varieties were distributed to the farmers/NGOs/Government organizations as detailed below:

Field demonstrations of Bt cotton varieties (2019-20)

Name of the organization	Quantity (No. of bags of 3kg each)
MGMG	114
FLDs/ TSP demos	231
MSSC, Akola (Mahabeej)	229
POCRA	81
Better Cotton Initiative, BCI	42
Directly to farmers	273
PDKV, Akola	10
Total demonstrations	**980**

Coimbatore

Thirty demonstrations on Integrated Crop Management in cotton and twenty demonstrations on ELS on cotton are being conducted in MGMG villages of Coimbatore district. The technologies *viz*., variety Surabhi, popular Bt cotton hybrids, Integrated Weed Management, Integrated Nutrient Management, Integrated Pest Management and application of growth regulators are being demonstrated.

Sirsa

FLDs on Integrated Crop Management (ICM) on CICR Bt-6 (67.5 x 30 cm normal spacing) in 40 ha, CSH-3075 (67.5 x 10 cm HDPS) in 8 ha and CSH-3129 (67.5 x 30 cm normal spacing) in 12 ha of farmers' field area were conducted under NFSM-Commercial Crops during the 2019-20 cropping season in the cotton growing districts of Haryana and Rajasthan. Highest seed cotton yield of CICR Bt-6 (Bt variety) recorded under FLDs at farmers' field was 31.25 q/ha. Non Bt varieties CSH 3075 and CSH 3129 recorded 35 q/ha and 22.5 q/ha, respectively.

Monitoring of FLDs conducted by ICAR-CICR, Regional Station, Sirsa during 2019-20 cropping season

Monitoring and survey for insect-pest and diseases in general and parawilt in particular were carried out in FLDs and non FLD fields of various cotton growing districts of Punjab, Haryana and Rajasthan.

4.2 Insecticide Resistance Management: Dissemination of Pink Bollworm Management Strategies

"Insecticide Resistance Management: Dissemination of Pink Bollworm management strategies" under Centrally sponsored scheme "NFSM: Commercial Crops" implemented during 2019-20. The project was implemented by ICAR-CICR as a Nodal institute in collaboration with 10 State Agricultural Universities (SAUs) and 3 KVKs. The collaborating SAUs were Dr PDKV, Akola, VNMKV Parbhani, MPKV Rahuri, NAU, Navsari, JAU, Junagadh, RVSKVV, Gwalior, UAS, Dharwad, UAS, Raichur, PITSAU, Hyderabad

and ANGRAU, Guntur. The project was implemented covering 1050 acre area in 21 districts from 105 villages of 8 states *viz*., Maharashtra, Gujarat, Madhya Pradesh, Andhra Pradesh, Telangana, Karnataka, Tamil Nadu and Haryana. IRM strategies were implemented through the project comprised of cultural, behavioural, biological, bio control agents, need based pesticides application, etc. With the implementation of pink bollworm management strategies IRM and non IRM fields received average 4.82 and 7.25 sprays, seed cotton yield 1921.38 and 1616.70 kg/ha, respectively. While, benefit: cost ratio accrued was 2:1, reduction in pesticide usage in terms of cost was 45% while reduction in volume was 41.69%. During crop season various outreach activities were carried out : Field visits, Farmers meetings, Field days, Farmers field trainings, Sensitization workshop for ginning mill owners/input dealers, Broadcasting voice messages, Exhibitions, TV talks, Radio talks, Farmers Mela, Lectures etc. Infestation of pink bollworm in IRM fields was in the range of 0-60% while it was 0-80% in non-IRM fields.

Sixteen teams comprising of Scientists and Technical Officers of ICAR-CICR visited IRM implementing districts as well other cotton growing districts of 8 states for monitoring. The teams conducted random surveys in 48 districts covering all the major cotton growing states during November to December 2019. After mid November the pink bollworm infestation in different states was: Maharashtra 0-64%, Gujarat 0-96%, Madhya Pradesh 12-84%, Telangana 0-56%, Andhra Pradesh <10%, Karnataka 0-50%, Tamil Nadu 8-84%, Punjab 0%, Haryana 35% (in the fields near to ginning mills of Jind, negligible in rest of the state), Rajasthan 0%. However by that time 2-3 pickings had been completed.

5. EDUCATION, TRAINING AND CAPACITY BUILDING

5.1: Training and Capacity Building

5.1.1: Training Received

International

Name	Name of the course/training	Place	Period
Dr. D.V. Patil	Summer school and training on "Grow Agro-biodiversity in a climate change"	Food and Agriculture Organization (FAO), Rome, Italy	18 - 26 September 2019
Dr. (Mrs.) Usha Rani	ICAC Research Associate Program 2019 "Risk Management in Cotton Industry (Production and Trade)"	ICAC, Washington DC, USA	23 September to 3 October 2019

National

Scientist

Name	Name of the course/training	Place	Period
Dr. Rishi Kumar	Training on Cotton technology under NFSM Project	HAMETI Jind, Haryana	04 July 2019
Dr. A. R. Reddy	MDP on "Priority Setting, Monitoring and Evaluation (PME) of Agricultural Research Project"	ICAR - NAARM, Hyderabad	18-23 July 2019
Dr. Chandrashekar N. Dr. Saravanan M. Dr. S. P. Gawande Dr. (Mrs.) K. Baghyalakshmi	ICAR short course on " Molecular Approaches for Cotton Improvement"	ICAR-CICR, Nagpur	19-28 September 2019
Dr V. S. Nagrare	Training Workshop for the Institutional Biosafety Officers and scientists	National Institute for Plant Biotechnology, New Delhi	20 September 2019
Dr. S. M. Palve	"CAFT Training Workshop for Vigilance Officers of ICAR"	ICAR – NAARM. Hyderabad	October 31 to November 1 2019
Dr. Amarpreet Singh	"Statistical and Machine Learning Techniques for Modeling and Forecasting Agricultural Data"	ICAR-IASRI, New Delhi	20 December, 2019 to 9 January 2020

Technical Staff:

Name	Programme details
Dr. Jimmy B. Vaidya, Mr. Rohit Katiyar, Mr. Ellendula Raghu, Mrs. Mithila Meshram, Mr. Arun Mate, Mr. Keshav Mogre, Mr. Bhumeshwar Fande, Mr. Jaibhim Kambe, Mr. Krushna Gajghate, Mr. Kunal Gaikwad, Mr. Ajit Meshram, Mr. Sujit Kumbhare, Mr. Dineshkumar Mahule, Mrs. Pooja Ghonge, Mr. Akshay Barahate, Mr. Akshay Kamble, Mr. Chandrashekhar Mundafale, Mr. Paresh Bhoyar, Mr. Pankaj Gadge, Mr. Eluka Sridhar	Skill Up gradation Training Programme for Technical Staff during 19-20 July, 2019 at ICAR-CICR, Nagpur
Mr. S. Manikandan, Sr. Technical Assistant (Driver), Mr. A. K. Sherkar Driver (T4), Sr. Technical Assistant (Driver)	Training programme on "Automobile Maintenance, Road Safety and Behavioral Skills for Regular Drivers in technical grades of ICAR" at ICAR - CIAE, Bhopal

Name	Programme details
Dr. U. A. Nandankar, CTO & Security I/c	"Capacity Building Programme towards Secure and Resilient workplace at ICAR-CPRI, Shimla, 25-27 November, 2019

Administrative Staff:

Name	Designation	Course / Training	Place	Duration
Mr. M. C. Tiwari	Personal Assistant	Training programme on "Improving skills of Administrative staff of ICAR dealing with court cases"	ICAR – CAZRI, Jodhpur	25-27 November 2019

5.1.2: Training Imparted

Name of Training	Organized by	No. of participants	Period
Skill Up gradation training program for Technical staff of ICAR-CICR, Nagpur	HRD Cell, ICAR - CICR, Nagpur	20	19-20 July 2019
ICAR short course on "Molecular Approaches for Cotton Improvement"	ICAR - CICR, Nagpur	21	19-28 September 2019

Student Research

1	Name of student	Mr. Hemant Peddu
	Name of Co-advisor	Dr. Babasaheb B Fand,
	Thesis title	Estimation of developmental thresholds and thermal requirements for cotton pink bollworm *Pectinophora gossypiella* Saunders
2	Name of student	S. Asha
	Name of Co-advisor	Dr. V,Chinna Babu Naik
	Thesis title	Efficacy of *Trichogramma bactrae against* Pink bollworm, *Pectinophora gossypiella* (Saunders) on Cotton

Student educational tour / field visit to ICAR-CICR Nagpur

Sr. No	College / Institute Name	No. of students	Class of Students	Date of Visit
1.	Shri Shivaji College of Agriculture Biotechnology, Amravati, Maharashtra	7	B. Sc. Agri. 8th semester	2 April 2019
2.	School of Agriculture of G. H. Raisoni University, Saikheda, Madhya Pradesh	27	B. Sc. Agri. 6th semester	4 April 2019
3.	Amity Institute of Biotechnology, Amity University, Raipur, Chhattisgarh	30	B. Sc. & B. Tech. 6th semester	12 April 2019
4.	Anand Niketan College of Agriculture, Warora, Chandrapur, Maharashtra	81	B. Sc. 2nd semester	29 April 2019
5.	IAS-Banaras Hindu University, Varanasi, Uttar Pradesh	7	M. Sc. Final year	28 May 2019
6.	College of Agriculture, Darwha, Maharashtra	53	B. Sc. 3rd semester	14 June 2019
7.	College of Agriculture, Sonapur, Gadchiroli, Maharashtra	77	B. Sc. Agri.	28 August 2019
8.	Vasantrao Naik Gramin College of Agriculture, Nehrunagar, Kandahar, Nanded, Maharashtra	88	B. Sc. 3rd semester	18 September 2019
9.	VNIT, Nagpur, Maharashtra	24	B. Arch. 3rd semester	21 September 2019
10.	School of Agriculture of G. H. Raisoni University, Saikheda, Madhya Pradesh	69	B. Sc. 3rd semester	15 October 2019

5.2: Trainings organised for farmers and extension functionaries

Sr. No	Name of Training	Organized by	Total no. of participants	Place & Date
1.	Training on latest cotton technology under NFSM: Commercial crops.	ICAR-CICR Regional Station, Sirsa	40	ICAR-CICR, Sirsa 03-04 June 2019
2.	Training on "Latest Cotton technology under state scheme	ICAR-CICR Regional Station, Sirsa	25 scouts & Agriculture Officers	ICAR-Sirsa 26-27 June 2019
3.	Farmer's awareness camp on management of Cotton pests	ICAR-CICR, Nagpur	50 farmers	Mangaon village of Tahshil Bhadravati, District Chandrapur 2 August 2019
4.	Interface meetings cum training on Identification and management of disease, insect pests' problems and crop cultivation practices	ICAR-CICR Regional Station, Sirsa	70 farmers	Village Khedi, Kagdana (Sirsa) 6 August 2019
5.	Farmers' field training	ICAR-CICR, Nagpur	35 farmers	Shendola village, Taluka Tivsa, Dist Amravati 21 August 2019

Sr. No	Name of Training	Organized by	Total no. of participants	Place & Date
6.	Farmers' field training	ICAR-CICR Regional Station, Coimbatore	60 farmers	Vadaputhur Kinathukadavu, Coimbatore district 13 September 2019
7.	Training on Latest Technologies in cotton production under 'NFSM: Commercial Crops'	ICAR-CICR Regional Station, Sirsa	40 scouts & Agriculture Officers	ICAR-CICR, Sirsa 13 September 2019
8.	Integrated Management Of Pink Bollworm in Cotton	ICAR-CICR, Nagpur	350 farmers	Mozari, Taluka Tivsa, Dist Amravati 24 September 2019
9.	Cotton Cultivation Technologies under TSP	ICAR-CICR, Nagpur	250 farmers	Chamorshi, Gadchiroli 26 September 2019
10.	Management of Pink Bollworm in cotton	ICAR-CICR, Nagpur & Ambuja Cement Foundation, Warora	100 farmers	Bawane Sabhagruh, Warora 7 October 2019
11.	Workshop on IRM: Dissemination of Pink boll worm management strategies in cotton	ICAR-CICR Regional Station, Sirsa	40 Ginners and Agro-input dealers	ICAR-CICR, Sirsa 1 November 2019
12.	TSP-Training cum workshop on "Cotton cultivation technologies"	ICAR-CICR, Nagpur	150 farmers	KVK, Sonapur, Gadchiroli 27 November 2019
13.	Training Organized under NFSM: Commercial Crops to disseminate the IRM strategies for pink bollworm management	ICAR-CICR Regional Station, Sirsa	40 farmers & extension officials	ICAR-CICR, Sirsa 03-04 December 2019
14.	Farmer's training programme on "Integrated Nutrient and Pink bollworm Management in Cotton" under SCSP	ICAR-CICR, Nagpur	300 farmers	Thaombra of Umred Tahsil Dist. Nagpur 17 December 2019
15.	Training on Cotton technology under NFSM: Commercial Crops	ICAR-CICR Regional Station, Sirsa	40: ATM/BTM/ ADOs/SMS/ APPOs	ICAR-CICR, Sirsa 18-19 December 2019
16.	Farmers Field training program on management of Pink Bollworm in cotton	ICAR-CICR, Nagpur	70 farmers	Ralegaon Tal Bhadrawati, Chandrapur 23 December 2019

6. AWARDS AND RECOGNITIONS

Awards

- Dr. Babasaheb B Fand - Young Scientist Award - 2019" by Dr. B. Vasanthraj David Foundation, Chennai, Tamil Nadu.
- Dr. S.K.Sain and Dr. Amarpreet Singh - Young Scientist Award 2019 by Society for Scientific Development in Agriculture and Technology.
- Dr. A. Manivannan - Best Poster Presentation for "Antixenosis mechanism of resistance of cotton genotypes to leafhopper (*Amrasca bigutulla bigutulla* (Ishida)" during National seminar on "Potential Crops for food and nutritional security" held at TNAU, Coimbatore on 14-15 December 2019.
- Dr (Mrs) S. Usha Rani - Best oral presentation award for "e-Kapas Cotton Advisory Service – A Mobile Phone based Cotton Extension Program for Knowledge Transfer" in the eSARD 2019 – International Conference on Extension for Strengthening Agricultural Research and Development: Focus on Farmers Income held at ICAR KVK, Suttur, Mysuru, Karnataka during 14-16th December 2019.
- Dr. C. Karpagam - Professor MS. Swaminathan Best Scientist & Distinguished Fellow Award (2018-2019) for Agricultural Extension by the Bose Science Society
- Dr. A. Manivannan- Excellence award for reviewing papers from Indian Journal of Agriculture Research, ARCC, Karnal

Recognitions

Dr. A. Manivannan - elected as 'Editorial Board' Member (2019-20) for Madras Agriculture Journal, MASU, TNAU, Coimbatore

Certificate of Appreciation

The following officials received Certificate of Appreciation from the Director during 43rd ICAR-CICR Foundation Day on 1 April 2019 :

Name	Category
Dr. S. Manickam	Scientific
Dr. K Velmourougane	
Sh. Bhausaheb Naikawadi	Technical
Suresh Kumar	
Smt Sundaravalli M. Kumar	Administrative
Smt Rama G. Iyer	
Sh. G L Navaye	Skilled Support Staff
Smt Saraswati Ganorkar	

7. LINKAGES AND COLLABORATIONS

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 SAU are Dr PDKV Akola, VNMKV Parbhani, MPKV Rahuri, NAU Surat, JAU Junagarh, RVSKVV Gwalior, UAS Dharwad, UAS Raichur, PITSAU Hyderabad and ANGRAU Guntur
Development of consensus genetic linkage map for *Gossypium* spp.	DBT, Ministry of Science and Technology, Govt of India
Development of thermal tolerant strain of biocontrol agent, *Acerophagus Papaya* for sustainable management of papaya mealybug,	DST-SEED, Ministry of Science and Technology, Govt of India
Pink bollworm: Resistance Monitoring, Fitness Costs, Inheritance of Resistance to Cry toxins	DST-SERB, Ministry of Science and Technology, Govt of India
Genetic diversity 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
Input management under Bt –hybrid cotton+ pigeon pea strip cropping system.	IFFCO, Pune
Development and validation of "Nutrient Expert System" for cotton	International Plant Nutrition Institute (IPNI), Gurgaon, Haryana
Monitoring changes in baseline susceptibility to Cry toxins in cotton bollworms	MAHYCO, Jalna
ICAR project on Seed Production in Agricultural Crops and Fisheries.	ICAR, New Delhi
An Inclusive Agri-Business Model for Sustainable Cotton Marketing in the State of Maharashtra.	NASF, New Delhi
Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem.	National Carbon Project, ISRO, Hyderabad
IPM strategies to combat whitefly and other emerging pests of cotton.	NICRA, Hyderabad
National Seed Project (Crops)	ICAR, New Delhi
Micronutrient, bio-stimulants and bio- nano-fertilizer formulations on cotton	Rashtriya Chemicals & Fertilizers Ltd, Mumbai
Novel sensor-less irrigation scheduling based on remote sensing for enhancing cotton production	RIVULIS Irrigation India Pvt. Ltd., Pune
Sorption of sulphur formulations and commercial nitro phosphate fertilizers	SMART CHEM Technology Ltd, Pune
Complex fertilizer with and without micronutrient combination in cotton	SMART CHEM Technology Ltd, Pune
Transgenic research	CSIR and NBRI, Lucknow

AREAS OF LINKAGES	INSTITUTION
Pheromone technology	CSIR and IICT, Hyderabad
Molecular mapping	TNAU, Coimbatore and UAS, Dharwad
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
Seed production and commercialization of Bt cotton varieties Suraj Bt, Rajat Bt, GJHV 374 Bt and PKV 081 Bt	Farmer Shri Raju Gotmare, Beed- Borgaon, Hingna
Seed production/ multiplication and commercialization of cotton varieties Suraj, Surabhi, CNA 1003 (Roja) & CNA 1028 developed by ICAR - CICR	Group of tribal farmer, Beed -Borgaon, Hingna
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 HRD of officials on BMPs for cotton	State Agricultural Departments of cotton growing states

8. ICAR-AICRP ON COTTON

During the year 2019-20, 12 non Bt Cotton varieties/ hybrids were identified for release during the Varietal Identification Committee meeting held on 30th May, 2019. Subsequently, 19 Bt Varieties/ Hybrids identified for release for commercial cultivation during the Varietal Identification Committee meeting held on 12th December, 2019.

Around 63.0 quintals of breeder seed were produced, as against the indent of 17.27Q.

Under DUS testing, seed multiplication, characterization and maintenance breeding of 185 extant cotton varieties were carried out. Reference varieties for conduct of DUS test in tetraploid and diploid cotton is maintained -141 in *G. hirsutum*, 34 in *G. arboreum*, 5 in *G. herbaceum* and 5 in *G. barbadense*.

Front Line Demonstrations (FLD) under NFSM - Commercial Crops was carried under which 522 on Integrated Crop Management on cotton, 243 on Desi / ELS cotton / ELS cotton seed production and 175 on intercropping with cotton were conducted at nineteen centers of ICAR – AICRP on Cotton.

8.1: Crop Improvement

Under Breeding programme, 10 national trials; four north zone trials; 12 central zone trials; and 15 south zone trials were conducted. Additionally, under evaluation of Bt cotton, four trials in north zone; 11 trials in central zone and eight trials in south zone were conducted.

North Zone: In Initial evaluation trials, RS 2928 (3440 kg/ha), PBD 92 (3033 kg/ha) and KR 155 (3314 kg/ha) were promising and have been promoted to coordinated trials. The *G.hirsutum* genotype F 2662 was promising in normal spacing, whereas, PBH 174 was better in closer spacing. Among desi cotton, PBD 36 was promising among varieties and KR 136 was promising hybrid.

Central Zone: In Initial evaluation trials, under irrigated conditions, the genotypes GJHV 566, DHCC 1901, RHC-HD 1405, CCB 141, and the hybrid DHB 1902 were promising and have been promoted to coordinated trials. TCH 1828 was promising with good overall yield among *G.hirsutum* genotypes in normal spacing, whereas, RHC HD 1406 was better in closer spacing for high density planting system.In Initial evaluation trials, under rainfed conditions, the genotypes viz., NH 702, GTHV 18/19, NDLA 3116-3, CINA 1069, and DDCC 1902 were promising and have been promoted to coordinated trials. The genotype NDLH 2051-1 was the best in normal spacing, while RHC HD 1433 was promising in closer spacing.GAM 259 (*G.arboreum* variety) and NACH 556 (desi hybrid) were better and has been recommended for agronomic evaluation.

South Zone: In Initial evaluation trials, under irrigated conditions, the genotypes TSH 383, CCHC 19-2, RHC-HD 1312, DB 1901, and hybrid DHB 1902 were promising and have been promoted to coordinated trials. The culture RHC 1217 was better in irrigated conditions under normal spacing, while RHC HD 1433 was promising with closer spacing. Naturally coloured cotton was tested for three years consecutively, the genotypes16301 DB (*G.hirsutum*) and DDCC 1 (*G.arboreum*) were recommended for agronomic evaluation. The extra-long staple *G.barbadense* genotypes, DB 1701 was promising and has been recommended for agronomic evaluation. ELS interspecific (H x B) hybrid, RHB 1002 was prominent under irrigated conditions and has been recommended for agronomic evaluation, initial evaluation trials, under rainfed conditions, the genotypes NDLH 2051-3, DSC 1951, NDLA 3116-3, PAIG 396, and DDCC 1902 were promising and have been promoted to coordinated trials. Under rainfed situations, the *G.hirsutum* genotype NDLH 2051-1 and *G.arboreum* genotype PA 837 have been recommended for agronomic evaluation.

8.2 Crop Production

Under Crop production programme, 11 agronomy trials; three physiology trials and five bio-chemistry trials were conducted.

Nutrient Management: Agronomic requirements of RHC 1217, GISV 310, CPD 1652,AKH 09/5, DB 1602, SB SG 1-5, CNA 1032, PA 810 and AJAH 101 in central zone, SCS 1061, CPD 1652, ARBHB 1601, LAHB 1 DB 1601, DB 1602, JLA 1110 and PA 810 in south zone were worked out. Nutrient and geometry requirements were worked out for RS 2818, RS 2827, ARBC 1601, BS 30 GISV 298, DSC 1651 and ARBC 1651 under High Density Planting System (HDPS). Research on reducing nitrogen dose and enhancing of nitrogen use efficiency in Bt cotton found that 25 % of Nitrogen saving by application of 75% of RDN + Placement (Spot

application in 4 splits) + Foliar application of 1 % urea (3 times) + raising of sunnhemp/fodder cowpea between rows incorporated before flowering at Rahuri. The result at Hisar, Khandwa and Chamrajnagar, Junagadh, Dharwad and Nandyal revealed that application of 75% of RDN + Placement (Spot application in 4 splits) + Foliar application of 1 % urea (3 times) was found optimum. Organic nutrient management packages including seed treatment, soil application of recommended bio fertilizers, foliar application of Pink Pigmented Facultative Methylotrops (PPFM) at flowering, soil application of Neem cake @ 250 kg/ha and raising and incorporation of Sunnhemp / fodder cowpea between rows registered significantly higher seed cotton yield at Khandwa (1203 kg/ha), Srivilliputhur(1493 Kg/ha and Coimbatore (1703 kg/ha). Seed treatment and soil application of recommended bio fertilizers and foliar application of PPFM with Neem cake 250 kg/ha and Intercropping with green gram/black gram/ ground nut/soybean registered significantly higher seed cotton yield at Junagadh (1415 kg/ha), LAM (959 kg/ha) and Raichur (1195 kg/ha).

Labour saving package: Practices like land shaping by machine, pre and post emergence application of herbicides, interculture by animal and boom spraying saved labour and the requirement per hectare was 126, 115, 70, 138, 113 and 98 man-days respectively at Bhawanipatna, Nanded, Akola, LAM, Surat and Raichur. This in turn was 35.1, 17.3, 19.5, 43.0, 41.5 and 14.0 percent lower than the requirement under normal practice.

Canopy management: Under HDPS, application of mepiquat chloride @ 20 g a.i. / ha. at 60 and 75 DAS reduced sympodial length/plant height by 15.6, 13.3, 14.7 and 10.9 per cent respectively at Surat, Junagadh, Dharwad and Khandwa. The same chemical and the dose increased the seed cotton yield respectively of 13.56, 10.5, 12.1 and 4.4 per cent at Surat, Junagadh, Dharwad and Khandwa.

Conservation agriculture: Conventional tillage+ No residue management had been observed to give higher seed cotton yield at Rahuri (2415 kg/ha), Chamrajnagar (2047 kg/ha) and Srivilliputhur (1803 kg/ha). Permanent bed system + Zero tillage+ 100 % residue management observed significantly higher seed cotton yield at Junagadh (2698 kg/ha). Highest net return of Rs1,14,262/-, 89,900/- and 54,430/- was recorded at Rahuri, Junagadh and Chamrajnagar respectively.

Physiological studies: Genotypes H 1567, H 1569 and H 1530 were identified as drought tolerant at Hisar. Higher oil content was observed in GISV-323 (18.95%), GJHV-566 (18.50%), GJHV-566 (19.96%) and LRA-5166 (19.73%) at Hisar. The lowest gossypol content was observed in G. Cot-16 and GISV-323 (0.38%) and the highest gossypol content was in GISV-319 (0.74%) at Surat. Genotypes viz., ARBC1651, ARBH813, DSC1651, CPD1652, LAHB-1 were identified as drought tolerant at Dharwad. Effect of Plant Growth Regulators (PGRs) on insect resistance in cotton found that mepiquat chloride @ 50 ppm foliar spray at 90 DAS registered significantly the least population of Jassid (9.46/plant), the highest of MDA content (0.475 mg/g), phenolic contents (1.062 mg/g), flavanoids content (0.873mg/g) and total gossypol content (0.925%). Levels of secondary metabolites and defensive enzymes were significantly higher with the spray of PGR. Biochemical basis of tolerance/susceptibility of Bt hybrids were investigated at Dharwad.

8.3 Crop Protection

8.3.1: Entomology

Under crop protection entomology trials, 13 trials were conducted and significant achievements are presented below:

Culture Screening: Sucking pests tolerant genotypes were identified. Advanced screening of promising entries for leaf hopper tolerance found seven entries at north zone, 10 entries at central zone, eight entries at south zone were tolerant to leafhopper.

Population Dynamics: Seasonal dynamics of key pests in relation to climatic conditions recorded across the zones on non Bt and Bt genotypes under unprotected conditions indicated that leaf hopper occurred at moderate level in all the centres. Bollworm infestation was moderate on non Bt in all zones throughout the season and on Bt, infestation of Spotted Boll Worm (SBW), Pink Boll Worm (PBW) was negligible in North India. Infestation of PBW was above ETL in Central Zone on non-Bt and Bt. In South zone, H. armigera was reported as above ETL in Dharwad on NBt. Infestation of PBW was reported as above ETL in south zone on nBt. On Bt, the infestation of PBW observed in Lam Guntur, Dharwad and Coimbatore as above ETL. Activity of predators namely spiders, Chrysoperla, Coccinellid & syrphid fly were recorded throughout the cropping season.

Pest Management: Management of pink bollworm studies revealed that the interventions T8 (Neem based insecticide spraying at 45 DAS followed by Thiodicarb spraying at 60 DAS, Chloropyriphos spraying at 90 DAS and Lambda-Cyhalothrin at 120 DAS) and T6

(Thiodicarb spraying at 60 DAS, Chloropyriphos spraying at 90 DAS and Lambda- Cyhalothrin at 120 DAS) recorded minimum percentage of pink bollworm damage and yield loss. Biorational options namely Pongamia oil 10ml/lit, Neem 1500ppm-5ml/lit and castor oil 10 ml/ lit were identified for the management of thrips.Bt formulation at the rate of 4.0 ml/lit was comparable with chlorantraniliprole 18.5 SC at the rate of 0.6 ml/ lit in reducing the population of Spotted Boll Worm (SBW). Microbial formulations against bollworm complex, Brigade – B WP formulation @ 7g/l, 5g/l and Bt 127 SC @4ml/l performed better than other treatments.

8.3.2: Plant Pathology

Under crop protection pathology trials, 13 trials were conducted and significant achievements are presented below:

Cotton leaf curl virus in the north zone, bacterial blight, grey mildew and Alternaria leaf blight in the central zone and Alternaria leaf blight, bacterial blight, grey mildew in the south zone were the major diseases reported during 2019-20 crop season. For the management of parawilt, foliar spray of 10 ppm Cobalt chloride immediately after the occurrence of disease followed by drenching of plants with a mixture of Copper oxychloride (COC) 50 WP@ 25g and 200g Urea in 10 liter of water found best. Highest reduction of sooty mold caused by whitefly/aphid was recorded by three sprays of Copper oxychloride (COC) 50 WP @ 2.25 g/liter of water followed by Propiconazole 25EC @ 1ml / liter of water.

9. KRISHI VIGYAN KENDRA

9.1 On Farm Trials (OFT)

Veterinary Science

The following OFTs were implemented in KVK adopted villages of Umred and Ramtek tahsils of Nagpur district

Assessment of performance of new breed of chicken - CARI-Nirbheek under Back yard system of rearing in farmer's field

Total 70 birds (10 weeks) of each improved varieties i.e. CARI-Nirbheek and Giriraja were distributed to 14 farmers of KVK adopted villages of Hingna tahsil of Nagpur district. 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 1.100 (TO1), 1.570 (TO2) & 1.690 (TO3) kg, respectively. Giriraja birds showed early sexual maturity at 155.15 to 157.27 days as compared to CARI-Nirbheek and local chicken. CARI-Nirbheek birds were found more active and pungacious than Giriraja. Though weight gain was lower than Giriraja, it fetched more prices due to its resemblance with fighter Aseel breed.

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

- In this trial, two multi-cut perennial varieties of hybrid Napier i.e. DHN-10 (developed by IGFRI, RRS, Dharwad) and BHN-6 (developed by BAIF, Karnataka) were compared with local prevalent variety CO4 (developed by TNAU, Coimbatore) on 2.69 ha area at 12 farmer's field. Both the varieties i.e. DHN-10 and BHN-6 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. However, green fodder intake was higher when BHN-6 was fed to the cows. That might be due to less serration, high succulence and good palatability of BHN-6.

Home Science

- **Assessment on suitability of mittens in harvesting soybean crop:** Use of Dharwad Mitten proved significantly superior over Parbhani mitten and local practice as it covered more area in less time with less drudgery.
- **Assessment of performance of vegetables sapling transplanter and sapling carrier for transplanting chilly and brinjal:** Transplanter with carrier was superior over manual transplanting method as it reduced drudgery of farm women by 25% and covered 5% more area.

9.2 Front Line Demonstrations (FLDs)

Livestock Production

Following technologies in livestock production were implemented on farmer's fields :

Supplementation of Probiotic (*Saccharomyces cervisiae*) to pre-ruminant CB calves

In this FLD, 25 g of Probiotic power was fed to 30 pre-ruminant jersey cross bred calves of 10 farmers, in addition to cow's daily diet. This trial of 30 days showed very promising results. The body weight and starter feed intake of calves in demonstration group was increased by 7.93% and 50%, than local check, respectively. Scour incidence was very less i.e. 6.66% in demo group as compared to 13.33% in local check.

Feeding of area specific mineral mixture (ASMM) to lactating cows.

Instead of commercial mineral mixture, ASMM @50 g/day/cow was added in the diet of 30 lactating cows of Kandri, Deolapar and Shivmadka villages of Ramtek tahsil. There was only a slight increase of 5.37% in milk yield, but the reproductive performances showed significant improvement local check.

Supplementation of mineral lick blocks to the local goats.

Forty local goats of 10 farmers in Dhanoli, Shivmadka and Kandri villages of Ramtek tahsil were supplemented with mineral lick blocks under this FLD. There was increase of 15.98% and 15.42% in body weight gain and milk yield of goats in demo group than local check, respectively.

Scientific cultivation of fodder hybrid napier RBN-13 (Phule Jaywant) variety.

In this FLD, perennial variety of Hybrid napier i.e RBN-13 (Phule Jaywant) developed by MPKV, Rahuri was demonstrated on 2.5 ha area of 10 farmers of Ramtek tahsil. This fodder crop showed slight increase in green fodder yield i.e. 1% than local check i.e CO4. The green fodder intake of RBN-13 & CO4 varieties was almost similar when fed to the cows.

Home Science enterprises

Nutrition Garden

FLD on Nutrition garden was conducted for nutrition management on 18 farm women's households' backyard. The improved technology of production of vegetables (T2: Refined Practice) at backyard is 35% more as compared to local practice of cultivation of vegetables (T1: Local Practice). Thus this helps T2 farm families in reduction in purchase of vegetables from local market & fulfilling essential nutrient too.

Cotton pellet as alternative cooking fuel

The FLD is conducted on 18 farm families in which cotton pellets used as cooking fuel was observed cost effective and eco friendly by 50% 53% respectively.

9.3 Cluster Front Line Demonstrations on Oilseed and Pulses

Four CFLDs on oilseeds (i.e. Soybean (MAUS-158), Summer Groundnut (cv TAG-24+INM) & pulses (i.e. Pigeonpea (PKV-TARA), Chickpea (Rajvijay-203) were conducted on the adopted villages of Nagpur district viz. Chargaon, Muradpur, Hiwra, Surabardi and Bendoli involving 200 farmers fields and covering 80 ha. 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.

FLD on Soybean Field Day

9.4 Trainings organized

KVK organized 85 ON and OFF campus trainings for practicing farmers, rural youth and extension functionaries as follows

Discipline	No. of courses	No. of total participants	SC/ST participants
Crop Production	14	532	171
Horticulture	8	328	105
Plant Protection	15	554	183
Veterinary Science	17	578	191
Home Science	15	539	162
Extension	16	592	189
Total	**85**	**3132**	**1001**

9.5 Attracting and retaining rural youth in Agriculture (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. During the year 2019-2020, the KVK trained 71 rural youths for production of disease free seedlings of Nagpur mandarin, 56 rural youth of different self help groups for custard apple processing, its value addition, preparation of pickle, citrus juice and solar drying of vegetables. Additionally, KVK provided technical support to rural youth of Katol block for multiplication of Nagpur mandarin seedlings. Twenty four rural youth beneficiaries later developed their nursery on Nagpur mandarin and are generating significant income. Seven rural youths from Ladgoan village, tahsil Katol also established their disease free nursery of citrus and Nagpur mandarin after acquiring training under ARYA.

Three days training programme on processing of citrus

based products was conducted during 07-09th August 2019. Thirty five rural farm female of 18-35 years of age group of Swayamsiddha mahila Swayamsahayata group, Nagpur tehasil and Shree Ganesh Mahila Bachat Group of Umred tehsil attended the skill oriented training programme at KVK, ICAR-CICR, Nagpur. They have learned the process of preparation of Orange, Sweet-lime and Lemon squash and pickles of seasonal fruits like Mango and Karvanda. They have started their own enterprises at their village level and are selling pickles, juice, squash, murrabba at village level and in various different exhibitions. Through adaption of this enterprise, the group is earning Rs.8000/- per month from September 2019 onwards.

Solar Drying of Vegetables

Value addition of Custard Apple

9.6 Sponsored Projects

9.6.1 Dissemination of IRM Strategies for Pink Bollworm in Cotton in Nagpur district

The project was implemented at Muradpur, Chargaon, Surabardi, Bendoli, Bothli. In IRM demonstration fields average mean pink bollworm infestation i.e. Rosette Flower, Green Boll, Open Boll observed was Rosette Flower 0.0, Green Boll 5.32, Open Boll 2.12 while it was Rosette Flower 0.0, Green Boll 10.05, Open Boll 4.20 in non-IRM fields.

In IRM demonstration fields, average mean sucking pest population i.e. Jassid (6.98 / 3 leaves), while it was (11.5 / 3 leaves) in non-IRM fields. Whitefly mean population obtained under IRM field was (5.91 / 3 leaves), while it was (9.39 / 3 leaves). Thrips mean population obtained under IRM field was (3.37 / 3 leaves), while it was (5.39 / 3 leaves) in non-IRM fields.

9.6.2 GKMS Scheme of IMD

The Gramin Krishi Mausam Sewa (GKMS) is a collaborative project between IMD and ICAR for issuing location specific weather based agro-advisories for cultivation. The weather data on minimum/ maximum temperature, relative humidity, rainfall, evaporation and wind direction is recorded and provided to the farmers through voice mails/messages. DAMU at ICAR-CICR-KVK Nagpur prepared Agromet advisory for 13 blocks of Nagpur District every Tuesday and Friday and was circulated to farmers using WhatsApp.

9.7 Meetings

9.7.1 Scientific Advisory Committee (SAC) Meeting

24th Scientific Advisory Committee (SAC) Meeting of Krishi Vigyan Kendra, ICAR-CICR, Nagpur was held on June 4, 2019 under the Chairmanship of Dr V N. Waghmare, Director, ICAR-CICR, Nagpur. Dr. Waghmare stressed the need for popularizing IRM technologies for control of pink bollworm in ensuing season and reducing the cost of production.

Dr. S.M. Wasnik, In-charge KVK and Member Secretary SAC presented achievements of KVK during the year 2018-19. Annual Action Plan for 2019-20 was presented by respective Subject Matter Specialists and was discussed thoroughly and suggestions emerged was incorporated. Dr. Panchbhai, Associate Dean, College of Agriculture, Nagpur, Dr. Nalini Bhoyar, Project Director ATMA, Dr. Blaise D., Head, Crop Production Divison, CICR, Dr. Nandini Gokte, Head, Crop Protection Division, CICR and other line department officials State Animal Husbandry Department, District Sericulture Officer, innovative farmers of Nagpur district and SAC member farmers took part in deliberations. Dr. S.S. Patil, SMS (Extension) welcomed the guests, Dr. U.V. Galkate, SMS (Veterinary Science) proposed vote of thanks.

9.7.2 25th Foundation Day

Krishi Vigyan Kendra, ICAR-CICR, Nagpur celebrated its 25th Foundation Day on 4 October 2019. Dr Ashish M. Paturkar Hon. Vice Chancellor, MAFSU, Nagpur was

Chief Guest and Dr V.N. Waghmare, Director ICAR-CICR chaired the inaugural function. Other dignitaries including Dr M.S. Kairon, Dr C.D. Mayee, Ex-Directors ICAR-CICR, and Dr S.M. Wasnik, In-charge KVK and Principal Scientist ICAR-CICR, Nagpur shared the dais.

Chief Guest Dr Ashish M. Paturkar, in his address congratulated KVK for successfully completion of 25 years in the service of farmers of Nagpur district. He emphasized the need of promoting the integrated farming system and increasing farmer income through incorporation of enterprises like dairy, goat rearing and poultry farming. In his address Dr M.S. Kairon, highlighted the role of KVK on technology transfer and stressed the need of carrying out adaptive research with proper impact. Dr C.D. Mayee, elaborated on evaluation and validation of location specific technology. He emphasized the need of validation of zero budget farming for generating scientific data.

Chairman of the function Dr. V.N. Waghmare, congratulated the present and ex-KVK officials for their achievements. He also highlighted the role played by KVK in outreach activities of ICAR-CICR.

9.7.3 QRT meeting

QRT team consisting of Chairman Dr. A.S. Khokhar, Ex. VC, CCSHAU, Hissar, members Dr Rayzada, Ex-ADG Fisheries, Dr Ratan, Ex-DEE, Ranchi & Dr Saxena Ex-DEE, RAU Banswada along with QRT Member Secretary Dr Lakhan Singh, Director ATARI, Pune, Dr D.M. Mankar, DEE Dr PDKV Akola visited KVK, ICAR-CICR Nagpur on 17th November, 2019. Director Dr V.N. Waghmare welcomed all members and briefed about ICAR-CICR and KVK activities. All SMS and other staff attended the meeting and shared their activities. Dr. S.M. Wasnik, Principal Scientist & In-charge, KVK ICAR-CICR presented KVK work for the period 2011-12 to 2018-19. The QRT members appreciated the work of KVK, ICAR-CICR Nagpur and took note of vacant posts of KVK.

Quinquennial Review Team

9.8 Extension Activities - field days / farmers meet/treatment camps organized

Sr. No.	Title of programme	Date	Venue	No. of participants	Dignitaries who attended the programme
1	Parthenium eradication week	16 – 22 August 2019	Takalghat	200	Sarpanch –Smt. Shardabai Shingare, Takalghat village
2	Kisan Mela	26 August 2019	Parshivani	1820	MLA - Sunil Kedar

Sr. No.	Title of programme	Date	Venue	No. of participants	Dignitaries who attended the programme
3	Livestock Treatment & Vaccination Camp	28 August 2019	Kandri village, Tah. Ramtek	120 goats	Dr. Avinash Jumde LDO, Veterinary Dispensary Grade-I, Kandri, Tah.Ramtek.
4	Livestock Treatment & Vaccination Camp	30 August 2019	Aamdi village, Tah. Ramtek	100 goats, 22 cows & calves, 4 bullocks	Dr. Avinash Jumde LDO, Veterinary Dispensary Grade-I, Kandri, Tah.Ramtek
5	Livestock Treatment & Vaccination Camp	30 August 2019	Bhilewada village, Tah. Ramtek	50 goats, 24 cows & calves	Dr. Avinash J umde LDO, Veterinary Dispensary Grade-I, Kandri, Tah.Ramtek
6	Live webcasting of inaugural ceremony of Hon'ble – PM address National disease control programme (Mathura)	11September 2019	ICAR-CICR, Nagpur	162	MLA- Samir Meghe, Dr. V.N. Waghmare Director ICAR-CICR, Nagpur.
7	Mega Tree Plantation Campaign	17 September 2019	ICAR-CICR, Nagpur	100	Dr. V.N. Waghmare Director ICAR-CICR, Nagpur, Sh. Nalin Patel, ZM-IFFCO
8	Foundation Day of KVK	4 October 2019	ICAR-CICR, Nagpur	250	Dr A. M. Paturkar, VC, MAFSU, Nagpur, Dr. V.N. Waghmare Director ICAR-CICR, Nagpur
9	Mahila Kisan Divas	15 October 2019	ICAR-CICR, Nagpur	110	Dr. V.N. Waghmare Director ICAR-CICR, Nagpur
10	Live webcasting of Fertilizer Awareness Programme	22 October 2019	ICAR-CICR, Nagpur	225	Dr. V.N. Waghmare Director ICAR-CICR, Nagpur
11	IRM Kisan Mela	07 November 2019	Village Bela, Dist. Nagpur	350	DSAO. Sh. Milind Shende, Nagpur
12	World Soil Day	05 December 2019	Village Chacher, Dist. Nagpur	300	JDA Bhosle, DSAO. Sh. Milind Shende, Nagpur
13	Kisan Divas	23 December 2019	Village Nildoh, Dist. Nagpur	105	Sarpanch- Sh. Jaydhar Shende, Nildoh
14	Jay Kisan Jay Vigyan Divas	25 December 2019	Village Bela, Dist. Nagpur	300	Dr. Nandini Gogkte, HOD Crop Protection Division, ICAR-CICR Nagpur

Kisan Mahila Diwas

World soil day

Distribution of Saplings

Live webcasting of Prime Minister's "National Animal Diseases Control Programme" on Foot and Mouth Disease & Brucellosis

Swachhata Pakhwada Programme

Live webcasting of Minister's "Fertilizer Awareness Programme"

Celebration of Krishi Vigyan Diwas

Dr Kimothi, ADG Coordination ICAR visited KVK Goat Unit on 6 April 2019

Fruits crops at KVK farm

Krishi Vigyan Kendra, CICR, Nagpur has established fruit crops such as Guava (L-49), Pomegranate (Bhagva), Orange (Nagpur mandarin) and Sweet Orange (Katol Gold), Mango and Sapota (Kali Patti) at its farm for the benefit of farmers and other visitors.

Soil Testing Activities of KVK

Five hundred fifty (550) soil samples were collected from 31 villages of the Ramtek and Umred blocks of Nagpur district and also from the field of adopted farmers of KVK. The soil samples were analyzed for 12 different parameters and 550 Soil Health Cards were generated.

Management of Osmanabadi Goat Unit at KVK:

KVK is managing a goat unit of comprising 70 goat of Osmanabadi breed on scientific line at KVK's campus. Several goat owners and rural youths are benefited by acquiring practical skills from the goat unit. About 12 males and 15 females of osmanabadi goat is ready for sale to the farmers of Nagpur districts.

Advisory Services Provided

KVK has provided advisory services to the farmers, rural youth and extension functionaries through personnel guidance, telephonic calls and mobile services on agricultural production, protection technology and allied fields. Also, several batches of input dealers DEASI were taken to the fields. Through the advisory services 31,898 clients in Nagpur district were benefited.

Participation in Exhibitions:

Name of event	Location	Date
State Level Exhibition	Deekshabhoomi, Nagpur	7 - 9 October 2019
Agro-Vision	Reshimbagh, Nagpur	22-25 November 2019
Kisan Mela Exhibition	ICAR-CICR, Nagpur	29 November 2019
Agro-Tech	Dr. PDKV, Akola	27-29 December 2019

Organization of Swachhta Hi Sewa from September 11 to October 02, 2019 – The main emphasis was on cleaning of the institute/residential premises and creating mass awareness in the adopted villages. The specific activities included-

- Uprooting of Parthenium in the research farm
- Cleaning of animal shed
- Cleaning of KVK premises
- Cleaning of ICAR-CICR premises
- Awareness rally and cleaning of premises of veterinary dispensary at Kandri village
- Cleaning of residential campus at Bajajnagar, Nagpur
- Cleaning at ICAR-CICR Agromet Observatory field
- Cleaning at Main Gate and entrance of of KVK, ICAR-CICR, Nagpur
- Cleaning of KVK, ICAR-CICR guest house premises
- Cleaning campaign at village Chargaon of Nagpur district
- Cleaning campaign at Canteen premises of KVK-CICR, Nagpur
- Cleaning of ATIC Building Premises of ICAR-CICR Nagpur

The programme concluded with Mega cleanliness drive at ICAR-CICR, Krushi Kunj residential complex, Bajaj Nagar, Nagpur on October 02,2019 to celebrate the 150th birth anniversary of Mahatma Gandhi

Swachhta Pakhawada was observed from December 16 to December 31, 2019 – The theme was 'Plastic Se Raksha–Swachhata Hi Suraksha'. A number of programmes and initiatives were made to reduce the use of Plastics (single use). These included -

- Removal of plastic Garbage of Canteen premises
- Oath taking ceremony by farmers for avoiding of single use plastics
- Rally by school children (from *Mahatma Phule uccha prathamik shala*, Parsodi and Ruhi School, Ruhi village, Nagpur) on theme *Swachhata hi suraksha* and ban on single use plastics
- Awareness campaign in the institute on ban on single use plastics
- Oath taking ceremony by school children (*Mahatma Phule uccha prathamik shala*, Parsodi and Z.P. School, Panjari, Nagpur) for avoiding of single use plastics
- Essay Writing Competition for 8th and 9th Class students on avoiding of single use plastic
- Creating mass awareness about disadvantages of single use plastic & collecting of plastic bags near Sonegon, Nagpur
- Spreading awareness through debate competition on avoiding of "single use plastic" by the students of *Mahatma Phule uccha prathamik shala*, Parsodi
- Demonstration and hands on training on preparing news paper carry bags to avoid single use plastic to Primary School students of *Mahatma Phule uccha prathamik shala*, Parsodi
- Oath taking & creating Awareness on avoiding "Single Use Plastic" to villagers focusing on farm women of Godhni village, Umred on avoiding "Single Use Plastic"
- More than 475 persons including staff, students, farmers, farm women actively participated in these campaigns.

9.9 Meetings / Workshop / Conference / Training attended

Name of the officials	Name of event	Location	Date
Meetings			
Dr. S.M. Wasnik, Dr. S.S. Patil	Workshop meeting of state agril dept for kharip planning	Vanamati, Nagpur	18 April 2019
Dr. S.M. Wasnik, Dr. S.S. Patil	ATMA Governing body me eting	Nagpur	10 May 2019
Sh. Eluka Sridhar	ATMA SREP Meeting	ATMA Nagpur	16 May 2019

Name of the officials	Name of event	Location	Date
Dr. S M Wasnik	Quarterly meeting of All India Radio	Akashwani Nagpur	28 May 2019
Dr. S.M. Wasnik, Dr. S.S. Patil, Dr. U.V. Galkate Smt. Sunita Chauhan, Dr. P. B. Deulkar, Dr. Amit Shahane, Sh. Eluka Sridhar Sh.Prashanth Gaikwad	Scientific Advisory Committee Meeting	ICAR-CICR, Nagpur	04 June 2019
Dr. S M Wasnik	Scientific Advisory Committee (SAC) meeting of KVK Selsura Wardha	KVK Wardha	20 June 2019
Dr. S. S. Patil	IRM – PBW Meeting	KVK- ICAR-CICR, Nagpur	05 July 2019
Dr. S M Wasnik, Dr. U. V. Galkate	NFSM & National sustainable agriculture mission organized by State Agril. Dept	Collector's office, Nagpur	19 July 2019
Dr. S M Wasnik,	District committee meeting on control of Pink Boll worm	Collector's office, Nagpur	31 July 2019
Dr. S M Wasnik	Meeting organized by ATARI & addressed by Dr Mohapatra, Hon DG, ICAR & Secretary DARE	College of Horticulture, Pune	3 August, 2019
Dr. S.M. Wasnik, Dr. S.S. Patil, Dr. U.V. Galkate Dr. Amit Shahane, Sh. Eluka Sridhar, Sh.Prashanth Gaikwad	Finalization of block level advisories for Nagpur district under GKMS, IMD	KVK, ICAR-CICR, Nagpur	07 September 2019
Dr. S M Wasnik	Interaction meeting organized by ATARI Pune on Jalshakti Abhiyan – A water conservation campaigns	ICAR-DOGR, Pune	09 August 2019
Dr. S M Wasnik	General body meeting of ATMA	Collector's Office, Nagpur	29 August 2019
Dr. S M Wasnik	Quarterly meeting of All India Radio	Akashwani Nagpur	03 September 2019
Dr. S M Wasnik	Farmers mela organized by CITI CDRA & State Agri dept. Wardha on *Kapus pik sarkshan , gulabi bond ali ani vyavashtahpan*	Dadaji Dhuniwale sabhagruh, Wardha	17 September 2019
Dr. S M Wasnik	Farmers mela on disseminating IRM strategy	Mozari, Tiwasa, Amravati	24 September 2019
Dr. S M Wasnik	IRM – PBW Mela	Girad, Samudrapur, Wardha	15 October 2019
Dr. P. B. Deulkar	Attended NTI Interview for DAESI Course & Presentation for selection of NTI	Vanamati, Nagpur	14 November 2019
Dr. S.M. Wasnik, Dr. S.S. Patil, Dr. U.V. Galkate, Smt. Sunita Chauhan, Dr. P. B. Deulkar, Dr. Amit Shahane, Sh. Eluka Sridhar	QRT Review team meeting	KVK, ICAR-CICR, Nagpur	17 November 2019
Dr. S.M. Wasnik, Dr. S.S. Patil, Dr. U.V. Galkate, Smt. Sunita Chauhan, Dr. P. B. Deulkar	QRT Review team meeting	Dr. PDKV, Akola	18 November 2019

Name of the officials	Name of event	Location	Date
Dr. P. B. Deulkar	Meeting of Rural Programme Advisory Committee	AIR, Nagpur	28 November 2019
Dr. S.M. Wasnik	Quarterly meeting of AIR	Akashwani Nagpur	04 December 2019
Dr. S.M. Wasnik, Eluka S.	World Soil Day	Chacher, Mouda, Nagpur	05 December 2019
Dr. S.M. Wasnik	Integrated Pest & Nutrient Management in Cotton meeting for farmers under SCSP project	Thombra, Tq. Umred, Dist.- Nagpur,.	17 December 2019
Workshop/Conference/Training			
Dr. S.M. Wasnik	Govt of Maharashtra Project POCRA - Climate Resilient Agril Workshop on Climate Resilient Technology	VNMAU, Parbhani	18 April 2019
Dr. S.M. Wasnik Dr. S.S. Patil	Annual Group Workshop of KVKs organized by ATARI, Pune	ICAR Complex, Goa	14-16 June 2019
Dr. P. B. Deulkar	Innovative Farmers meet	ICAR New Delhi	16-17 July 2019
Dr. S M Wasnik	Workshop for farm implements producers	VANAMATI Nagpur	27 August 2019
Dr. S. S. Patil	Review cum Training Workshop of CFLD Oilseed & Pulses	KVK, DY Patil Medical University, Kolhapur	10-12 December 2019
Dr. S.M. Wasnik Dr. S.S. Patil	ARYA Workshop	KVK, Kolhapur	12 December 2019
Guest Speaker			
Dr. S. M. Wasnik	Extension systems in cotton Production during training programme for newly recruited technical officials of CICR organized by HRD Cell	ICAR-CICR, Nagpur	17 September 2019
Dr. U. V. Galkate	Livestock based enterprises for sustainable livelihood in rural area (Sponsored training by Ambuja cement)	ICAR-CICR, Nagpur	24 & 27 July 2019
Dr. S. M. Wasnik	Field crop Demonstrations on cotton crop & Farmers visit organized by Mahabeej Ltd, Nagpur	Kuhi, Nagpur	13 November 2019
Dr. S.M. Wasnik, Dr. S.S. Patil, Dr. U.V. Galkate, Sh. Eluka Sridhar	Goat production technologies for rural area (Sponsored training by CARD)	Nildoh, Tah. Hingna	23 December 2019
Dr. S.M. Wasnik Dr. U.V. Galkate, Dr. B.B.Fand Sh. Eluka Sridhar	Feed management of dairy cattle (Sponsored training by CARD)	Mangrul, Tah. Hingna	28 December 2019

KVK progressive innovative farmer participated at Farm Innovators Meet held at NASC Complex, New Delhi

Progressive farmer Shri Aniket Subhashrao Lode from Hingna Tehsil, District-Nagpur was nominated by ICAR- ATARI, Zone –VIII, Pune to participate in Farm Innovators Meet held at NASC Complex, New Delhi during 16-17 July 2019 on occasion of ICAR Foundation Day. Hon'ble Shri Narendra Singh Tomar, Union Agriculture Minister, Govt. of India, New Delhi, Dr. A. K. Singh, DDG (Agri. Ext.), ICAR, New Delhi, Dr. V. N. Waghmare, Director-CICR, Nagpur, Dr. Lakhan Singh, Director-ATARI, Pune and Dr. Paturkar, Vice Chancellor, MAFSU, Nagpur visited the stall and

innovative farmer briefed about his activities of goat, poultry and quail farming for sustainable livelihood. Dignitaries appreciated the entrepreneurship.

IPM module of vegetables to enhance the income of farmers

Krishi Vigyan Kendra, ICAR-CICR, Nagpur has designed the IPM module of vegetables to enhance the income of farmers**.** Technological intervention as IPM component for controlling sucking pest (Aphid & Jassid) and nematodes have been undertaken in 5000 sq.ft area with an expectation of increased income in plot comprising of cabbage and cauliflower as main crop along with marigold, mustard and coriander. Sorghum was planted along the borders to act as crop and bird punchers. Yellow sticky trap, pheromone traps and trico-card were adopted.

In this model Bio-Dynamic formulation such as

Jivamrut, Decomposor and Neemark 5% was applied for pest and diseases management of cole crops. With the application of the organic inputs up to 60 days infestation of Diamond back moth was not observed. It lead to reduced expenditure on spraying of chemical for management of Diamond back moth.

9.10 List of publications

1. Wasnik S.M., Shahane Amit, Gayakwad Prashant and Waghmare V.N. (2019) : *Kapus Pik Utpadanawar Watawaran va Havamanacha Parinam*. Magazine monthly Baliraja Page no 77-80 (June 2019)
2. Wasnik S.M. (2019) : e-kapas/e-communication. Magazine monthly Baliraja Page no 13-16 (September - 2019)
3. Wasnik S.M., Patil S.S., Galkate U.V., Chauhan Sunita, Deulkar P.B., Shahane Amit and Khobragade Jayashree Yesankar (2019): Krishi Vigyan Kendra–ropya mahostavi varsh : 25 Varshachi Vatchal. Sovneir 'Kapus' ICAR-CICR Nagpur published on occasion of Kapas Mela 2019: page 92-98
4. Wasnik S.M., Khobragade Jayashree Yesankar (2019) : *Kapus Sahanshodhan Sanstha : Shetkaryankarita rabvat aslele prakalp* Sovneir 'Kapus' ICAR-CICR Nagpur published on occassion of Kapas Mela 2019: page 86-88
5. Wasnik S.M., and Sawai Hinali (2019) : e-kapas/e-communication va *CICR kapus app- kapus tantradhyan shetkaryanchya dari*. Sovneir 'Kapus' ICAR-CICR Nagpur published on occsassion of Kapas Mela 2019: page 82-85
6. Shahane Amit, Wasnik S.M. and Gayakwad Prashant (2019) : *Krishi Vigyan Kendrachi Zillastariy Krishi-Havamanshashtra Seva: Shetisathi Havamanawar adhatit krishi sallagar sammittee*. Sovneir 'Kapus' ICAR-CICR Nagpur published on occsassion of Kapas Mela 2019: page 78-81

Radio Talks (AIR, Nagpur) :

1. S.M. Wasnik, Pr. Scientist and Incharge KVK - Improved cotton cultivation techniques on 20.05.2019
2. Sunita Chauhan. SMS, KVK -Production of Organic Fertilizers on 21.06.2019
3. Sunita Chauhan SMS, KVK "Nutrition Garden" on 09.07.2019.

10. GENERAL

10.1 : List of Publications

10.1.1 Research papers (NAAS rating> 6)

1. Bandeppa S., Paul Sangeeta, Thakur Jyoti Kumar, Chandrashekar N., Deepika Kumar Umesh, Aggarwal Chetana, Asha A.D. (2019). Antioxidant, physiological and biochemical responses of drought susceptible and drought tolerant mustard (*Brassica juncea L*) genotypes to rhizobacterial inoculation under water deficit stress. *Plant Physiology and Biochemistry*, 143: 19-28. https://doi.org/10.1016/j.plaphy.2019. 08.018. (NAAS Rating: 8.72)
2. Bhargavi B., Behera U.K., Rana K.S., Singh Raj. (2018). Productivity, resource-use efficiency and profitability of high-value crops embedded diversified cropping systems. *Indian Journal of Agricultural Sciences*, 89 (5), 821-827. (NAAS Rating: 6.25)
3. Bharti A., Prasanna R., Velmourougane K., Kumar A., Shivay Y.S., Nain L. (2019). Development of nutrient Rich media through cyanobacterial amendment and their characterization. *Waste and Biomass Valorization*, doi.org/10.1007/s12649-019-00829-0. *(*NAAS Rating*: 8.36)*
4. Fand B.B., Nagrare V.S, Deshmukh V, Naikwadi B.V, Gokte-Narkhedkar N, Waghmare V.N. *(2019).* A simple and low-cost laboratory rearing technique for cotton pink bollworm, *Pectinophora gossypiella* (Suanders) (Lepidoptera: Gelechidae) using detached green bolls of cotton. *Phytoparasitica*. DOI:10.1007/s12600-019-00779-2. (NAAS Rating 7.02)
5. Fand B.B., Nagrare V.S., Gawande S.P., Nagrale D.T., Naikwadi B.V., Deshmukh V, Gokte-Narkhedkar N, Waghmare V.N. (2019). Widespread infestation of pink bollworm, *Pectinophora gossypiella* (Saunders)(Lepidoptera: Gelechidae) on Bt cotton in Central India: a new threat and concerns for cotton production. *Phytoparasitica*, DOI:10.1007/s12600-019-00738-x. (NAAS Rating 7.02)
6. Kumar Rakesh, Das Joy, Raghavendra K.P., Nandeshwar S.B. (2019). Identification and expression analysis of two novel zinc finger transcription factor genes during cotton fibre initiation. *National Academy Science Letters*. https://doi.org/10.1007 /s40009-019-00822-0. (NAAS Rating: 6.52)
7. Kumar Rishi., Kranthi S., Monga D., Kumar S., Sain S.K., Chaudhary A. (2019). Evaluation of moving yellow sticky traps for monitoring and management of whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) infesting cotton. *Indian Journal of Agricultural Sciences,* 89(8) 1245-1250. (NAAS Ratting 6.23)
8. Kumar Rishi, Kranthi Sandhya, Nagrare V.S., Monga D., Kranthi Keshav Raj, Rao Naveen, Singh Amarpreet (2019). Insecticidal activity of botanical oils and other neem-based derivatives against whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) on cotton. *International Journal of Tropical Insect Science,* DOI 10.1007/s42690-019-00027-4. (NAAS Rating : 6.66)
9. Kumar Rishi, Monga D., Naik Chinna Babu V., Singh Paramjit and Waghmare V.N (2019). Incipient infestations and threat of pink bollworm *Pectinophora gossypiella* (Saunders) on Bollgard-II cotton in North Cotton Growing Zone of India. *Current Science.* (NAAS Rating: 6.88)
10. Kumar Sunil, Dehury Budheswar, Tandon Gitanjali, Jaiswal Sarika, Iquebal Mir Asif, Ahmad Khurshid, Nagrale Dipak T, Singh Udai B., Jha Yachana, Singh Mahender Kumar, Singh Arjun, Rai Anil, Paital B., Kumar Dinesh (2019). An insight into molecular interaction of PGIP with PG for banana cultivar. (Accepted). *Frontiers in Bioscience*, Landmark, *Thomson Reuters.* (NAAS Rating: 8.21)
11. Kumari M., Verma Pooja. (2019). Genome-wide identification and characterization of the mildew resistance locus O (*MLO*) gene in *Solanum melongena* and *Capsicum annuum*. *Research Journal of Biotechnology* 14(7): 94-110. (NAAS Rating: 6.1)
12. Nagrare V.S., Fand B.B., Naik V.C.B., Naikwadi B.V., Deshmukh V., Sinh D., (2019). Resistance development in Cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) to insecticides from Organophosphate, Thiadiazines and Thiourea derivatives. *International Journal of Tropical Insect Science*, pp.1-8. (NAAS Rating :6.66)
13. Nagrare V.S., Fand B.B., Naikwadi B.V., Deshmukh V. (2019). Potential risk of establishment and survival of cotton aphid *Aphis gossypii* in India based on simulation of temperature-dependent

phenology model. *International Journal of Pest Management*, DOI: 10.1080/09670874. 2019.1649739. (NAAS Rating 6.9)

14. Pande R., Shah V., Verma, P. (2019). First report on identification of volatiles from egg and larval frass of Indian strain of the American bollworm *Helicoverpa armigera* (Hübner). *African Entomology* 27(2): 403–409. (NAAS Rating:6.54)
15. Qadir Razia, Khan Zainul A., Monga Dilip, Khan Jawaid A. (2019). Diversity and recombination analysis of Cotton leaf curl Multan virus: a highly emerging begomovirus in northern India. *BMC Genomics*. 20:274 https://doi.org/10.1186 /s12864-019-5640-2. (NAAS Rating: 9.73)
16. Raghavendra K.P, Rakesh Kumar, Das Joy, Santosh H.B., More Sachin A., Ramakrishna N., Chawla Shilpa G., Kranthi Sandhya, Kranthi Keshav Raj (2019). Quantitative real-time PCR based evaluation and validation of reference genes in *Gossypium arboreum* L. *Indian Journal of Agricultural Sciences* (In Press). (NAAS Rating: 6.23)
17. Sain S.K., Monga D., Kumar R., Nagrale D.T., Hiremani N.S., Kranthi S. (2019). Compatibility of entomopathogenic fungi with insecticides and their efficacy for IPM of *Bemisia tabaci* in cotton. *Journal of Pesticide Science*, 44 (2): 97-105. (NAAS Rating 7.02)
18. Sain S.K., Monga D., Kumar R., Nagrale D.T., Kranthi S., Kranthi K.R. (2019). Comparative effectiveness of bioassay methods in identifying the most virulent entomopathogenic fungal strains to control *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae). *Egyptian Journal of Biological Pest Control*, (29) 31: 1-11. (NAAS Rating 6.16)
19. Salunkhe V. N., Gawande S. P., Nagrale D. T., Hiremani N. S., Gokte-Narkhedkar N., Waghmare V. N. (2019). First report of Corynespora leaf spot of cotton caused by *Corynespora cassiicola* in Central India. *Plant Disease*, 103(7): Published online on 20 May 2019. (https://doi.org/1 0.1094/ PDIS-05-18-0823-PDN). (NAAS Rating: 8.94)
20. Santhy V., Meshram M., Santosh H.B., Kranthi K.R. (2019). Molecular diversity analysis and DNA fingerprinting of cotton varieties of India. *Indian Journal of Genetics and Plant Breeding,* 79(4): 719-725. (NAAS Rating – 6.47)
21. Santosh H.B., Bharadwaj C., Hegde V.S., Savitha S., Angadi C.., Kumar J. (2019). Relative potential of seed yield component traits as selection criteria in the segregating generations of a desi × kabuli cross of chickpea. *Legume Research,* 42(4): 473-478. (NAAS Rating – 6.34)
22. Thapa S., Prasanna R., Ramakrishnan B., Sheoran N., Kumar A., Velmourougane K., Kumar A. (2018). Interactive effects of *Magnaporthe* inoculation and nitrogen doses on the plant enzyme machinery and phyllosphere microbiome of resistant and susceptible rice cultivars. *Archives of Microbiology*, 200 (9): 1287-1305. (NAAS Score: 7.64)
23. Velmourougane K., Prasanna R., Chawla G., Nain L., Kumar A., Saxena A.K. (2019). *Trichoderma-Azotobacter* biofilm inoculation improves soil nutrient availability and plant growth in wheat and cotton. *Journal of Basic Microbiology*, 59(6): 632-644. (NAAS Rating: 7.76)
24. Velmourougane K., Prasanna R., Supriya P., Ramakrishnan B., Thapa S., Saxena A.K. (2019). Transcriptome profiling provides insights into regulatory factors involved in *Trichoderma viride-Azotobacter chroococcum* biofilm formation. *Microbiological Research*, 227, 126292. (NAAS Rating: 9.70)

10.1.2 Research papers published by the Institute's scientists NAAS rating< 6

1. Asha S., Naik Chinna Babu V., Neharkar P.S., Swati S.S. (2019). Parasitizing potential of four Trichogramma species on the eggs of pink bollworm, *Pectinophora gossypiella* (Saunders). *Journal of Pharmacognosy and phytochemistry*. 8(5): 857-859. (NAAS Rating: 5.21)
2. Asha, S., Naik Chinna Babu V., Neharkar P.S., Swati S.S. (2019). Effect of host age on the parasitising potential of four different *Trichogramma* species. *Journal of Pharmacognosy and phytochemistry*. 8(5): 889-890. (NAAS Rating: 5.21)
3. Bhargavi B., Behera U.K. (2019). System productivity and energetics of high-value crops embedded diversified cropping systems. *International Journal of Current Microbiology and Applied Sciences,* 8 (1), 1895-1905. (NAAS Rating: 5.38)
4. Bhargavi B., Behera U.K., Singh Raj, Rana K.S., Prasad Shiv., Pandey R.N., Singh Geeta. (2019). Crop diversification with high-value crops for higher productivity and profitability under irrigated ecosystem. *Indian Journal of Agronomy*, 64 (4): 440-444. (NAAS Rating: 5.46)
5. Blaise D., Manikandan A., Velmourougane K.

(2019). Farm practices and policies for mitigating N leaching and run-off. *Agropedology*, (Accepted). (NAAS Rating: 4.16)

6. Ladhalakshmi D., Avinash, P., Valarmathi, P., Laha, G.S., Srinivas Prasad, M. (2019). *In vitro* studies on *Ustilaginoidea virens*, a rice false smut pathogen. *Journal of Rice Research.* 12 (1): 56-59 (NAAS Rating: 3.22)
7. Manivannan A., Dharajothi B. (2019). Multivariate Analysis based Characterization of Cotton Germplasm. *International Journal of Current Microbiology and Applied Science,* 8(12): 480-487. (NAAS Rating : 5.38)
8. Naik Chinna Babu V., Nagrare V. S., Subbireddy K. B., Kumbhare Sujit, Wawdhane Pratik., Prabhulinga T. (2019). Management of Cotton Pink bollworm *Pectinophora gossypiella* (Saunders) with *Trichogramma bactrae* and *T. brasiliensis*. *Indian Journal of Entomology*, 81(4): 744-748. (NAAS Rating : 5.89)
9. Pandagale A.D., Baig K. S., Venugopalan M.V., Rathod S.S. (2019). Moisture conservation and nutrient requirement for rainfed cotton *(Gossypium hirsutum* L.*)* under High Density Planting System. *Journal of Agriculture Research and Technology,* 43 (2) : 292-297 (2018)- published in 2019. (NAAS Rating : 4.18)
10. Pande R., Patra S., Hazarika S., Ramkrushna G.I. (2019). Defensive behaviour relations of *Apis cerana himalaya* and predatory wasp at mid-hills of Meghalaya *Indian Journal of Entomology*, 81(4): online published. (NAAS Rating:5.89)
11. Prabhulinga T., Gawande S.P., Kranthi S., Monga D., Kumar R., Kranthi K.R., (2019). Status of cotton leaf curl virus disease and its vector whitefly in North India: A survey report. *Journal of Entomology and Zoology Studies,* 7(3):183-186. (NAAS Rating 5.53)
12. Prakash A.H., Sankaranarayanan K., Sabesh M. (2019). AICRP on Cotton- Fifty years of tireless Research on Nutritional Management for sustainable cotton production. *Indian Journal of Fertilisers,* 15(4): 450-464. (NAAS Rating: 2.89)
13. Rathinavel K., Kavitha H., Priyadharshini C. (2019). Genetic diversity among the extant reference varieties of tetraploid cotton (*Gossypium hirsutum* L.) *Journal of Cotton Research and Devlopement,* 33 (2) 197-207. (NAAS Rating: 4.69)
14. Sain S.K., Sathyanarayana N., Jeyakumar P. (2018) Evaluation of biodegradable agricultural substrates for mass production of entomopathogenic fungi. *Indian Journal of Plant Protection*, 46 (1): 78-83. (NAAS ratting 4.90)
15. Venugopalan M.V. (2019) Avenues to improve farm income from cotton under changing MV climatic scenario. *PKV Research Journal,* 43 (1): 1-9. (NAAS Rating :2.74)
16. Venugopalan M.V., Blaise D., Lakde S. (2019). Evaluation of diverse *G. arboreum* genotypes under High Density Planting System on rainfed Vertisols for earliness, productivity and fibre quality. *Cotton Research Journal (in press).* (NAAS Rating :3.45)

10.1.3 Other Publications

Book Chapters

1. Sampath Kumar A. and Valarmathi P. (2019). Identification and Management of Bacterial and fungal diseases in Cotton. *In* "Capacity Building Program on Cotton Production Technologies" Edited by Dr. A. H. Prakash., Dr. S. Usha Rani., Dr. M. Sabesh. and Sh. S. Sathyakumar. P 93-100.
2. Singh T.V.K. , Bentur J.S., Kalia Vinay, Mohan K.S., Komarlingam S, Kumar Rishi, Monga Dilip and Kumar Vijay . (2019). Mega Pests of Crops in India. Indian Journal of Entomology: Special Issue.
3. Valarmathi P. and Sampath Kumar A. (2019). Identification and Management of Viral and Fungal Diseases in Cotton. *In* "Capacity Building Program on Cotton Production Technologies" Edited by Dr. A. H. Prakash., Dr. S. Usha Rani., Dr. M. Sabesh. and Sh. S. Sathyakumar. P 101-106.
4. Venugopalan MV and Vandana Satish (2019). Climate change and cotton production in India-impact and adaptations.In Cotton India 2019-International Conference. Global Opportunities and Challenges in Cotton. Organized by CAI, Mumbai, 06-08 March, 2019, Mumbai, Maharashtra, Pp.72-76.
5. Venugopalan, MV. (2019). Organic cotton production in India- Current challenges and opportunities ahead. Oral Paper & Extended summaries, Global Organic Convention-2019. Natural resource Management for Sustainable Agriculture, Soil Health and Quality Food, Sept 15-17, 2019, Dr PDKV, Akola, *Pp.* 1-7

Technical Bulletins/leaflets:

1 Chinna Babu Naik V., V.S. Nagrare, P.A. Wawdhane, Babasaheb B. Fand, S Kranthi, Nandini Gokte-Narkhedkar and V.N. Waghmare (2019). Bio-control

Agents for Pink Bollworm Management. ICAR-CICR, Nagpur pp: 06. (English).

2 Chinna Babu Naik V., V.S. Nagrare, P.A. Wawdhane, Babasaheb B. Fand, S Kranthi, Nandini Gokte-Narkhedkar and V.N. Waghmare (2019). Bio-control Agents for Pink Bollworm Management. ICAR-CICR, Nagpur pp: 06. (Marathi).

3 Chinna Babu Naik V., V.S. Nagrare, P.A. Wawdhane, Rachna Pande, Babasaheb B. Fand, S Kranthi, Nandini Gokte-Narkhedkar and V. N. Waghmare (2019). Bio-control Agents for Pink Bollworm Management. ICAR-CICR, Nagpur pp: 06. (Hindi).

4 Kumar R, SK Sain and D Monga (2019). Success Story: Management of Whitefly- *Bemisia tabaci* (Gennadius) and Cotton Leaf Curl Disease (CLCuD) in North Cotton Growing Zone of India-(2016-18). ICAR-CICR Regional Station, Technical Bulleting No.1/2019. Pp 35.

5 Meena RA, Monga D, Waghmare VN, Mahajan SS, Hasan H, Sain SK, Tuteja OP, Verma SK, Kumar R, Singh AP. (2019). Cotton Germplasm Catalogue –II, ICAR-CICR Nagpur, 369 pp.

6 Rishi Kumar, Sain, SK, Monga, D. A.P. Singh (2019). Pocket note in Hindi on Integrated management of whitefly and CLCuD in cotton. ICAR-CICR Publication No.1, pp-6

7 V.S.Nagrare, V.Chinnababu Naik, Babasaheb B. Fand, Shailesh P.Gawande, Dipak T. Nagrale, Nandini Gokte-Narkhedkar, V.N.Waghmare (2019). Cotton: Integrated Pest, Disease and Nematode Management. ICAR-CICR Technical Bulletin No. 1/2019 (English).

8 V.S. Nagrare, V.Chinnababu Naik, Babasaheb B. Fand, Rachana Pande, Shailesh P.Gawande, Dipak T. Nagrale, Nandini Gokte-Narkhedkar, V.N.Waghmare (2019). *Kapas Nashjeev, Rog evam sutrakrumi ka samekit prabhandhan*. ICAR-CICR Technical Bulletin No. 2/2019 (Hindi).

9 V.S. Nagrare, V. Chinnababu Naik, Babasaheb B. Fand, Rachana Pande, Shailesh P.Gawande, Dipak T. Nagrale, Nandini Gokte-Narkhedkar, V.N. Waghmare (2019). *Kapus Kidi, Rog va sutrakrumni che ekatamik vyavasthapan*. ICAR-CICR Technical Bulletin No. 3/2019 (Marathi).

Popular Articles:

1. Babasaheb Fand, Chinna Babu Naik V, Vishlesh Nagrare, Nandini Gokte- Narkhedkar, Vijay Waghmare. (2019). *Kapashivaril American lashkari aliche niyantran.* Sakal Agrowon. 25th September 2019.
2. Babasaheb Fand, Chinna babu Naik V, Vishlesh Nagrare, Nandini Gokte-Narkhedkar, Vijay Waghmare. (2019). *Kapashivaril lashkari adiche ekatmik niyantran*. Dainik Agrowon, 25th September, 2019.
3. Babasaheb Fand, Chinna babu Naik V, Vishlesh Nagrare, Vijay Waghmare. (2019). *Gulabi bondadila rokhanyasathi ekatmik rananiti.* Dainik Agrowon, 8th August, 2019.
4. Babasaheb Fand, Vishlesh Nagrare, Chinna babu Naik V, Vijay Waghmare. (2019). *Gulabi bondali la rokhanyasati ekatmik ranniti.* Sakal Agrowon. August 16th 2019.
5. D. Blaise , Ramkrushna G.I., Rachana Deshmukh. (2019). *Kapus Utpadan Tantradyan. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. pp 26.
6. China Babu Naik V, V.S. Nagrare, Babasaheb Fand. Integrated management of pink bollworm in cotton (Marathi). Cotton: Production and management technologies. ICAR-Central Institute for Cotton Research, Nagpur published on 30 October 2019. Pp:49
7. China Babu Naik V, V.S. Nagrare, Babasaheb Fand,. *Trichogramma bactrae*: biological control agent for effective pink bollworm control (Marathi). Cotton: Production and management technologies. ICAR-Central Institute for Cotton Research, Nagpur published on 30 October 2019.Pp:64
8. Chinna babu Naik V, Babasaheb Fand, Vishlesh Nagrare, Nandini Gokte-Narkhedkar, Vijay Waghmare. (2019). *Gulabi bond adicniyantranasathi traicocardcha wapar.* Dainik Agrowon, 25th October, 2019.
9. Chinna Babu Naik V., V. S. Nagrare, Wawdhane P. A., Babasaheb Fand (2019). *Management of Sucking pests and bollworm on Cotton. Baliraja* (Marathi) May Issue, pp: 98-101.
10. Dipak Nagrare, Shailesh P. Gawande, Neelakanth Hiremani, Nandini Gokte-Narkhedkar, V.N.Waghmare. (2019). *Kapashitil bondsad vikrutiche vyavashtapan.* pp11. Sakal Agrowon. 30th September, 2019.
11. Dipak Nagrare, Shailesh P.Gawande, V.N.Waghmare (2019). *Kapashitil aaksmik mar roganche niyantran.* pp: 11, Sakal Agrowon. 4th October, 2019.
12. B. B Fand, V.S Nagrare , China Babu Naik V. (2019).

A new pest of cotton Fall armyworm: its lifecycle, nature of damage and control (Marathi). Cotton: Production and management technologies. ICAR-Central Institute for Cotton Research, Nagpur published on 30 October 2019.Pp:51

13. G. Balasubramani, J. Amudha and Sunil S. Mahajan (2019). *Biosafety of Genetically Modified Transgenic Cotton*. In: Smarnika, "*Kapus: Utpadanva Vyavasthapan Tantradnyan*", Published by ICAR-CICR, Nagpur, 15-18 pp.
14. A. Manikandan, Chandrashekhar Mundafale. (2019). Fertilizer application strategy for higher cotton productivity (in Marathi). *Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR. Pp.29.
15. A. Manikandan, Chandrashekhar Mundafale. (2019). Micronutrient deficiency symptoms. (in Marathi). *Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR Pp.42.
16. J.H. Meshram (2019). Akasmik Mar Rog (Para-wilt) ani vasthapan, *Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR. p.38.
17. J.H. Meshram (2019). Kapshivaril phul, patya, bond gal ani tayachey vavasthapan, *Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR,. p.35.
18. J.H. Meshram (2019). Lalya rogachey vavasthapan, *Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR,. p.36.
19. V.S.Nagrare, China Babu Naik V, Babasaheb Fund, Gokte-Narkhedkar N. and Waghmare V N. (2019). Cotton pink bollworm management in India-A success story (Marathi). Cotton: Production and management technologies. ICAR-Central Institute for Cotton Research, Nagpur published on 30 October 2019.Pp;47
20. V.S.Nagrare, China Babu Naik V, Babasaheb Fand. (2019). Integrated pest management in cotton (Marathi). Cotton: Production and management technologies. ICAR-Central Institute for Cotton Research, Nagpur published on 30 October 2019.Pp:44
21. Rachana Pande, Vivek Shah, P. Ghonge. (2019). *Madhumakshika paalan, sangopn evam vyavasthaapan. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. Pp. 73.
22. Rachana Pande, Vivek Shah, B. Naikwadi. (2019). *Vanaspatincha keetnashak mahnoon waapar. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. Pp. 69.
23. A. R.Raju, Ramkrushna G. I., Shahane A. A. (2019). *Kapus pikatil mahatwachi tane aani tyanche vyavashtapan. Kapus Utpadan Tantradyan. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. pp 31.
24. Ramakrushna G.I., S. M. Wasnik, Rachna Pande, Rachan Deshmukh, Pooja Ghonge (2019). *Gajargawat nirmulanasathi niyamit samudayik praytna aavashak.* Agrowon. 8 September 2019 (Sunday).
25. Ramakrushna G. I., D. Blaise, Rachana Deshmukh. (2019). *Gandulkhat: Mahatwa aani banavinyachi paddhat. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. pp 40.
26. M. Sabesh, A. H. Prakash. (2019) Fibres for Future - an Indian Perspective, Cotton Statistics & News, Cotton Association of India. No 25, 17th September, 2019.
27. M. Sabesh, A. H. Prakash. (2019). Does Indian Cotton Engine Need New Track? Cotton Statistics & News, Cotton Association of India. No 20, 13th August, 2019
28. Vivek Shah, R. Pande, B. Naikwadi (2019). *Nimboli ark (NSKE) tayaar karne baabat. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. Pp. 71.
29. Shailesh Gawande, Dipak Narale, Neelakanth Hiremani, N. Gokte-Narkhedkar, V. N.Waghmare. (2019). *Kapashitil rogansamndhi tatkalik samasya karane aani ekatmik rog vyavasthapan. Samrnika (Kapus Utpadan va Vyavasthapan Tantradyan). Kapus Medawa.* ICAR-CICR, Nagpur. Pp. 71.
30. Shailesh P. Gawande, Neelakanth Hiremani, Dipak Nagrare, Nandini Gokte-Narkhedkar, V.N.Waghmare. (2019). *Kapashivaril dahiya rogachi lakshne va ekatmik vyavashtapan.* pp: 11, Sakal Agrowon. 22th October, 2019.
31. Sunil S. Mahajan, Vijaykumari and V. Santhy (2019).*Kapus biyane prakriya va upayuktta*. In: Smarnika, "*Kapus: Utpadanva Vyavasthapan Tantradnyan*", Published by ICAR-CICR, Nagpur, 23-25 pp.
32. Sunil S. Mahajan, Vijaykumari, V. Santhy and Harish Kumbhalkar (2019). *Kapus biyane utpadan tantradnyan*. In: Smarnika, "*Kapus: Utpadanva*

Vyavasthapan Tantradnyan", Published by ICAR-CICR, Nagpur, 19-22 pp.

33. V. Chinna babu Naik, Vishlesh Nagrare, Babasaheb Fand, Nandini Gokte- Narkhedkar, Vijay Waghmare. (2019). *Gulabi bondali niyantranasati Tricocard.* Sakal Agrowon. 12th October, 2019.
34. V.N. Waghmare, S.M. Palve, Sunil S. Mahajan and T. R. Loknathan (2019). *Maharashtrat upalabdh lamb reshache deshi sudharit waan*. In: Smarnika, "*Kapus: Utpadanva Vyavasthapan Tantradnyan*", Published by ICAR-CICR, Nagpur, 01-04 pp.
35. Valarmathi P, Singh Kartar, Sharma Sapna, Bashyal Bishnu Maya and Aggarwal Rashmi. Studies on isolation of crude toxin, thin layer chromatography (TLC) and HPLC analysis of *Bipolaris oryzae*. ISMPP 40th Annual Conference and National Symposium on "Microbial based strategies for improvement of soil and plant health" at Karnatak University, Dharwad, 24-26th September 2019. P-179.
36. Gotmare Vinita (2019): *Naisargik rangit kapus* .In: Smarnika, "*Kapus: Utpadanva Vyavasthapan Tantradnyan*", Published by ICAR-CICR, Nagpur pp 8 -14
37. Venugopalan MV and Waghmare VN (2019). The Lost Glory of Desi Cotton and a Roadmap for its Revival. In Indian Cotton 2020, 18th & 19th Oct 2019, Akola. *Cotton Association of India 2019 (*Akola).Pp 44-48.

Training manuals:

1 P. Valarmathi and A. Sampath Kumar. (2019). Identification and Management of Viral and Fungal Diseases in Cotton. *In* "Capacity Building Program on Cotton Production Technologies" Edited by Dr. A.H. Prakash., Dr. S. Usha Rani., Dr. M. Sabesh. and Sh. S. Sathyakumar. P 101-106.

2 Sampath Kumar and P. Valarmathi. (2019). Identification and Management of Bacterial and fungal diseases in Cotton. *In* "Capacity Building Program on Cotton Production Technologies" Edited by Dr. A.H. Prakash., Dr. S. Usha Rani., Dr. M. Sabesh. and Sh. S. Sathyakumar. P 93-100.

3 V.N.Waghmare, K.P. Raghavendra, H.B. Santosh (2019). E-book on Molecular Approaches for Cotton Improvement available at https://cbp.icar.gov.in/EBook.aspx

10.2: List of on-going projects

S.No.	Project title and Investigators	Type	Duration
	CROP IMPROVEMENT DIVISION		
1	Development of Bt cotton varieties using deregulated and non deregulated transgenic events. **V.N.Waghmare (PI)**, Suman Bala Singh, Vinita Gotmare, D.V. Patil, G. Balasubramani, J. Amudha, K.P. Raghavendra, N. Chandrashekar, Rakesh Kumar, M. Saravanan, H.B. Santosh, M.V. Venugopalan, G.I. Ramakrushna, Vivek Shah, Rachna Pande, Babasaheb Fand, S. Manickam, K. Baghyalakshmi, K. Rameash, A. Sampath Kumar, O.P. Tuteja, S.K. Verma, Rishi Kumar, S.K. Sain	Institute	2018-23
2	Improvement of tetraploid and diploid cottons for fibre properties through population improvement approaches. **V.N. Waghmare (PI)**, Vinita Gotmare, O.P. Tuteja, S.K. Verma, D.V. Patil	Institute	2000-20
3	Development of consensus genetic linkage map for *Gossypium* spp. With SNP markers and QTL analysis for fibre traits. **V.N. Waghmare (PI)**, T.R. Loknathan	DBT	2017-20
4	Development of compact plant type with improved quality traits through selective mating system. **Suman Bala Singh (PI)**, T.R. Loknathan, J. H. Meshram, J. Amudha	Institute	2017-22

S.No.	Project title and Investigators	Type	Duration
5	Breeding of upland cotton for improved fibre yield, quality and resistance to biotic stress (Jassid). **S.M. Palve (PI)** , Rachna Pande, P. Mandhyan	Institute	2005-21
6	MAS/MAB for Water-logging in Cotton. **Vinita Gotmare (PI)**, M. Saravanan, J.H. Meshram J. Annie Sheeba	Institute	2012-20
7	Harnessing the potential of wild and unadapted germplasm in cotton improvement. **Vinita Gotmare (PI)** , S.K.Verma, H.B. Santosh, N. Chandrashekar, Rachna Pande, Neelkanth Hiremani	Institute	2018-23
8	Breeding for early maturity compact plant type and jassid tolerance in cotton. **H.B. Santosh (PI),** S. Manickam, K.P. Raghavendra	Institute	2014-19
9	Breeding to improve performance of G*ossypium herbaceum* for adaptation to climate change in central India. **D.V. Patil (PI)**	Institute	2015-20
10	ICAR project on Seed Production in Agricultural Crops and Fisheries. **P.R.Vijayakumari** (Nodal Officer), V. Santhy, K. Rathinavel, R.A. Meena	MSP	2007-18
11	Seed characterization based on protein quantification and profiling in cotton. **V. Santhy (PI)** , Pooja Verma	Institute	2019-22
12	Collection, conservation, evaluation, documentation and maintenance of germplasm of cultivated species of Gossypium. **Sunil S. Mahajan (PI)**, M. Saravanan, S. Manickam, K.P.M. Dhamayanthi, R.A. Meena, Anjali Kak	Institute	2018-23
13	Strategies to augment quality and storability of cotton seed under different environmental conditions. **Sunil. S. Mahajan (PI)**, V. Santhy, P.R. Vijayakumari	Institute	2017-20
14	Development of high strength cotton genotypes by reducing the short fiber content. **S. Manickam (PI)**, A.H. Prakash, B. Dharajothi, J. Gulsar Banu	Institute	2017-20
15	Breeding for high yielding, early maturing sucking pest tolerant extra-long staple G.barbadense genotypes with improved fibre properties. **K.P.M. Dhamayanthi (PI)**, A. Manivannan, K. Rameash	Institute	2017-20
16	Development of high yielding, early maturing Asiatic cotton (*Gossypium arboreum*) genotypes suitable to south Zone. **A. Manivannan (PI)**, V.N. Waghmare, M. Saravanan	Institute	2015-20
17	Development and Evaluation of ELS interspecific hybrids with better yield and fiber quality. **K. Baghyalakshmi (PI)**, M. Amutha, A. Sampath Kumar, Manivannan	Institute	2019-24
18	National Seed Project (Crops). **K. Rathinavel (PI)**	NSP	1999-20
19	Implementation of PVP legislation 2001 and DUS testing of cotton under ICAR-SAU system. **K. Rathinavel (PI)**	DUS	2003-20

S.No.	Project title and Investigators	Type	Duration
20	Identification of male sterile plants in ge netic male sterility (GMS) using molecular markers. **O.P. Tuteja (PI),** S.B. Singh, M. Sarvanan	Institute	2012-19
21	Development of varieties of upland cotton having better fibre traits and tolerance to CLCuD. **O.P. Tuteja (PI)** , V.N. Waghmare, S.K. Verma, D. Monga, Rishi Kumar	Institute	2017-20
22	Development of Cotton Leaf Curl Virus resistant genotypes using *G. arboreum* / *G. herbaceum* through introgression. **S.K. Verma (PI)**, V.N. Waghmare, S.M. Palve, Rakesh Kumar	Institute	2015-21
23	An efficient regeneration system for transformation studies with *CICRcry2Ab1Ac* and fiber strength genes in Cotton (*G. hirsutum*). **G. Balasubramani (PI)**, J. Amudha, K.P Raghavendra, Joy Das, Rakesh Kumar, N. Chandrashekar	Institute	2017-20
24	Targeted mutagenesis of ghPHYA1 through CRISPR/Cas9 in Cotton. **N. Chandrashekar (PI)**, K.P. Raghavendra	Institute	2017-20
25	Unveiling the potential of cotton WNT-like gene in somatic embryogenesis through genetic engineering. **N. Chandrashekar (PI)**	Institute	2018-21
	CROP PRODUCTION DIVISION		
26	Alleviating soil compaction – a production constraint in cotton. **Blaise Desouza (PI)**, Gautam Majumdar, A. Manikandan, Savita Santosh	Institute	2017-20
27	Exploring the productivity potential of long-linted *G. arboreum* cotton. **M.V. Venugopalan (PI)**, K. Sankarnarayanan, J. H. Meshram, G.I. Ramakrushna, Pooja Verma, S.S. Mahajan, T.N. Madhu, Neelakanth Hiremani, M. Sabesh	Institute	2017-20
28	Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem: Integrating ground observations, satellite data and modelling. **Director, ICAR-CICR, M.V. Venugopalan** , A. Manikandan	National carbon project	2017-20
29	Participatory evaluation of technology for improving profitability in calcareous soils. **A.R. Raju (PI)**, R.B. Singandhupe, Anuradha Narala, A. Manikandan	Institute	2016-20
30	Validation of impact of input on economics of Bt –hybrid cotton+ pigeon pea strip cropping. **A.R. Raju (PI)**	IFFCO Project	2017-20
31	Integrated farming system to double income of cotton farmer. **G.I. Ramkrushna (PI)**, A. Manikandan, Rachana Pande	Institute	2017-20
32	Estimating water footprint in cotton production system. **B. Bhargavi (PI)**, D. Blaise, P. Nalayini, K. Velmourougane	Institute	2019-22
33	Novel sensor-less irrigation scheduling based on remote sensing for enhancing cotton production **B. Bhargavi** (PI), A. Manikandan	RIVULIS Irrigation India Pvt. Ltd., Pune	2019-2020
34	Evaluation of Structured water for cotton production. **P. Nalayini (PI)**	Institute	2014-Sept.19

S.No.	Project title and Investigators	Type	Duration
35	Identifying edaphic & climatic factors influencing fibre quality parameters in cotton and low micronaire management in ELS Cotton. **K. Sankaranarayanan (PI)**, A.H. Prakash, M. Sabesh, A. Manivannan	Institute	2017-20
36	Development of remunerative cotton based cropping systems based on conservation agriculture principles. **R. Raja (PI),** D. Kanjana, K. Shankarganesh, A. Sampath Kumar	Institute	2015-Sept.19
37	Sustainable Intensification of Extra Long Staple Cotton Production in South Zone. **R. Raja (PI)**, Annie Sheeba, K. Rameash, K. Rathinavel	Institute	2019-23
38	Development of Cotton based cropping systems under Conservation Agriculture for North-Western Indian conditions. **Amarpreet Singh (PI)**, S.K. Sain, Rishi Kumar, K. Velmourougane	Institute	2018-23
39	Enhancement in productivity of cotton through improvement in agro-techniques under North-Western Indian conditions. **Amarpreet Singh (PI)**, Rishi Kumar, S.K. Sain	Institute	2019-22
40	Efficient nitrogen fixing legumes for cotton based cropping systems. **A. Manikandan (PI)**, D. Blaise, P. Nalayini, V.S. Nagrare	Institute	2015-20
41	Identification and characterization of water deficit period under various agro climatic regions with reference to cotton growing states of India. **A. Manikandan (PI)**, S. Chattraj (NBSS & LUP)	Institute	2017-20
42	Development and validation of "Nutrient Expert System" for cotton **A. Manikandan (PI)**, D. Blaise	IPNI	2018-20
43	Studies on sorption of sulphur formulations and commercial nitro phosphate fertilizers to different soils **A. Manikandan** (PI), D. Blaise	SMART CHEM Technology Ltd, Pune	2019-2020
44	Studies on response of complex fertilizer with and without micronutrient combination and comparison of commercial complex fertilizer to cotton **A. Manikandan** (PI), D. Blaise	SMART CHEM Technology Ltd, Pune	2019-2020
45	Evaluation of micronutrient, bio-stimulants and bio-nano-fertilizer formulations to cotton and soil health (Collaborative project) **A. Manikandan** (PI), D. Blaise, K. Velmourougane, Pooja Verma	Rashtriya Chemicals & Fertilizers Ltd, Mumbai	2019-2020
46	Effect of long-term application of organic and inorganic sources of nutrients on continuous cultivation of Bt and non Bt cotton with maize cropping system under irrigated conditions. **D. Kanjana (PI)**, K. Sankaranarayanan, Amarpreet Singh	Institute	2017-22
47	Evaluation of PGPR and microbial inoculants to alleviate drougt stress in cotton (*G. hirsutum* L). **J.H.Meshram (PI)**, K. Velmourougane, Pooja Verma, Shailesh Gawande, Dipak Nagrale	Institute	2019-22
48	Exploiting the epigenetic transgenerational inheritance of stress responsive traits for imparting abiotic stress tolerance to cotton. **J. Annie Sheeba (PI)**	Institute	2016-21
49	Metabolite exploration of drought stress in cotton. **Pooja Verma (PI),** G.I. Ramkrushna	Institute	2017-19

S.No.	Project title and Investigators	Type	Duration
50	Development of microbial biofilm formulations for cotton: effects on yield, pests, diseases and soil health. **K. Velmourougane (PI)**, Savitha Santosh, Rachana Pande, Dipak Nagrale	Institute	2017-20
51	Microbial dissolution of carbonate to ameliorate soil sodicity in Black Soil Regions of Maharashtra. **K. Velmourougane (PI)**, A. Manikandan, D. Vasu (NBSS & LUP)	Institute	2019-22
52	Microbial interventions for potassium nutrition in cotton. **Savitha Santosh (PI),** G.I. Ramkrushna, A. Manikandan	Institute	2017-19
53	An Inclusive Agri -Business Model for Sustainable Cotton Marketing in the State of Maharashtra. **A.R. Reddy (Co-PI)**, G.I. Ramkrushna	NASF	2018-21
54	e- Communication: Dissemination of Cotton Technology. **S.M. Wasnik (PI)**, S. Usha Rani, O.P. Tuteja	Institute	2017-20
55	Evaluation and Refinement of spindle type header prototype for development of a cotton picker (ICAR-CICR, Nagpur & CSIR-CMERI-CoEFM, Ludhiana) **G. Majumdar (PI)**	Collaborative	2019-22
56	Development of Extension Model for Promoting the Production of Extra Long Staple Cotton in India. **S. Usha Rani (PI)**, S.M. Wasnik, S. Manickam, K. Sankara Narayanan, M. Sabesh, M. Amutha, K. Valarmathi	Institute	2019-21
57	Development of transfer of technology innovations for bridging up the yield gap in cotton. **S. Usha Rani (PI)**, S. Manickam, R. Raja, M. Amutha, S.M. Wasnik	Institute	2017-20
58	Socio-technological analysis of drip irrigation in cotton cultivation. **C. Karpagam (PI)**, Shankarana Narayanan, K. Rameash	Institute	2017-20
59	Discontinuing Adoption Behaviour of Cotton Growers and Scope for Continuous Adoption – A Critical Enquiry. **C. Karpagam (PI)**, K. Sankara Narayanan, K. Shankarganesh	Institute	2019-22
	CROP PROTECTION DIVISION		
60	Standardization and integration of strategies for sustainable nematode management. **Nandini Narkhedkar (PI)**	Institute	2017-20
61	Monitoring changes in base line susceptibility to Cry toxins in the cotton bollworm, *H. armigera,* pink bollworm and *Spodoptera litura.* **Nandini Narkhedkar (Coordination),** V. Chinna Babu Naik, Vivek Shah	Mahyco	2012-18
62	Crop pest surveillance and advisory project (CROPSAP) in Maharashtra. **V.S. Nagrare (PI)**	CROPSAP	2010-18
63	Elucidating eco-toxicity and resistance development in sucking pests against newer insecticides used in cotton. **V.S. Nagrare (PI)**, V. Chinna Babu Naik, Babasaheb B. Fand	Institute	2017-20
64	Insecticide Resistance Management (IRM): Dissemination of Pink bollworm Management Strategies. **V.S. Nagrare (PI),** S.M. Wasnik,Vinita Gotmare, V. Chinna babu Naik, S.P. Gawande, B.B. Fand, D.V. Patil, S.S. Patil, K. Rameash	DAC	2018-19

S.No.	Project title and Investigators	Type	Duration
65	Pink bollworm, *Pectinophora gossypiella* (Saunders): Resistance Monitoring, Fitness Costs, Inheritance of Resistance to Cry toxins expressed in Bt cotton. **V. Chinna Babu Naik (PI)**, Sandhya Kranthi	DST-SERB	2017-20
66	Genetic diversity in geographical Population of Pink boll worm *Pectinophora gossypiella* (Saunders) in India. **V. Chinna Babu Naik (PI)**	DST-SERB	2017-21
67	Identification of oviposition deterrent for ethological management of cotton bollworm *Helicoverpa armigera* Hübner. **Rachna Pande (PI)**, Vivek Shah	Institute	2017-20
68	Evaluation of insecticide combinations against insect pest complex of cotton **Rachna Pande (PI)**, Neelakanth S. Hiremani	Gharda Chemicals Ltd	2018-20
69	Investigations into exacerbation of pest status of cotton pink bollworm *Pectinophora gossypiella* (Saunders) in the context of climate change through development of phenology model. **Babasaheb B Fand (PI)**, V.S. Nagrare, V. Chinna Babu Naik	Institute	2017-20
70	Push-pull strategy for management of pink bollworm in cotton. **Vivek Shah (PI),** Rachna Pande, Pooja Verma	Institute	2016-19
71	Studies on chemical cues mediating sucking pests and natural enemy interactions in cotton eco-system. **Vivek Shah (PI)**, T.N. Madhu, Rishi Kumar, K. Shankarganesh, K. Rameash	Institute	2016-20
72	Evaluation of cotton PGPR for broad-spectrum resistance against insect pests and diseases. **Dipak T. Nagrale (PI),** Vivek Shah, T. Prabhulinga	Institute	2016-19
73	Studies on prevalence of *Xanthomonas citri* pv. *malvacearum* races of cotton and breeding for BLB resistant varieties. **S.P. Gawande (PI),** V.N. Waghmare, Dipak Nagrale, Neelkanth Hiremani, S.K. Sain, A. Sampath Kumar	Institute	2018-21
74	Identification of endophytes from cotton with special reference to *desi* cotton and evaluation of biocontrol activity against major diseases. **Neelakanth Hiremani (PI)**, S.P. Gawande, S.K. Sain, Pooja Verma	Institute	2017-20
75	Role of plant defense activators for management of cotton leaf spot diseases. **Vanita N. Salunkhe (PI)**, S.P. Gawande, J.H. Meshram, Pooja Verma	Institute	2017-20
76	Identification of resistant genetic sources with mechanism of resistance against cotton leafhopper (*Amrasca biguttula biguttula*) (Ishida) (Hemiptera: Cicadellidae). **B. Dharajothi (PI)**, A. Manivannan, D. Kanjana	Institute	2017-20
77	Inventorying potential fungal metabolites for the management of sucking pests and nematodes of cotton. **J. GulsarBanu (PI)**, A.H. Prakash, M. Amutha, P. Valarmathi	Institute	2017-20
78	Development of wireless smart trap for automated monitoring of lepidopterous pests in cotton. **K. Rameash (PI)**, K. Shankarganesh	Institute	2019-22

S.No.	Project title and Investigators	Type	Duration
79	Diversity, Ecology and Improvement of eco-compatible management of Thrips in cotton ecosystem. **M. Amutha (PI)**, K. Sankaranarayanan, S.P. Gawande, B.B. Fand, Rishi Kumar	Institute	2017-20
80	Exploration and development of thermal tolerant strain of biocontrol agent, *Acerophagus Papaya* for sustainable management of papaya mealybug, *Paracoccus marginatus*in crops. **K. Shankarganesh (PI),** C. Karpagam	DST-SEED	2016-19
81	Development of effective IPM strategies for better management of Cotton stem weevil. **K. Shankarganesh (PI)**, J. Annie Sheeba	Institute	2019-22
82	Investigation on the susceptibility status and possible detoxification mechanism for neonicotinoids and newer molecules against cotton leaf hopper. **K. Shankarganesh (PI)**, M. Amutha, V.S. Nagrare	Institute	2019-22
83	Molecular characterization, virulence and genetic diversity analysis of *Alternaria* leaf spot disease of cotton. **A. Sampath Kumar (PI)**	Institute	2017-20
84	Studies on symptom expression, host range, transmission and spread of *Tobacco Streak Virus* infecting Cotton. **P Valarmathi (PI)** , M. Amutha, S.P. Gawande, S.K. Sain	Institute	2017-20
85	Development of IPM strategies to combat whitefly and other emerging pests of cotton. **Rishi Kumar (PI),** V.S. Nagrare, T. Prabhulinga, D. Monga, Rishi Kumar, M. Sabesh	NICRA	2016-20
86	Studies to identify the most virulent strains of entomopthogenic fungi for whitefly control. **S.K. Sain (PI),** D. Monga, S. Kranthi, Rishi Kumar, T. Prabhulinga, Dipak Nagrale	Institute	2016-19
	STUDENT'S PROJECTS		
S.No.	**Project title and Co-Guide**	**Student**	**Duration**
1	Isolation and characterisation of green tissue specific promoter(s) in elite cotton varieties of India. **Dr. G. Balasubramani**, ICAR-CICR, Nagpur	Dr. D. Anne Kitty Deborah (DST- WoSA)	2018-21
2	Exploring the potential of biofilm forming PGPR with cuticle degrading entomopathogenic fungus for the management of root rot (*Rhizoctonia* sp.) and American boll worm (*Helicoverpa armigera*) in cotton. **Dr. B. Dharajothi**, ICAR-CICR, RS, Coimbatore	Dr. SA. Ramyabharathi (DST-SERB-NPDF)	2018-20
3	Characterizations of *Lecanicillium* spp. and their efficacy against sucking pest of cotton. **Dr. Neelkanth Hiremani**, ICAR-CICR, Nagpur	Bodhit D Ramteke	2019-2020
4	Characterizations of *Metarhizium anisopliae* and their efficacy against lepidopteran pest of cotton. **Dr. Shailesh P. Gawande,** ICAR-CICR, Nagpur	Ravali Thota	2019-2020

S.No.	Project title and Investigators	Type	Duration
5	Characterizations of *Beauveria bassiana* and their efficacy against lepidopteran pest of cotton. **Dr. Dipak T. Nagrale** , ICAR-CICR, Nagpur	B Nimbekar	2019-2020
6	Isolation of entomopathogenic nematodes from cotton region against *Spodoptera frugiperda* **Dr. Nandini Narkhedkar,** ICAR-CICR, Nagpur	Chanchal Dadhe	2019-2020
7	Standardization and mass production protocol for entomopathogenic nematodes **Dr. Nandini Narkhedkar,** ICAR-CICR, Nagpur	Bharat Mahajan	2019-2020

10.3 : Consultancy, Patents, Commercialization of Technology

10.3.1 Contract Research / Revenue generation:

Particular	Amount (Rs.)
Sale of Farm Produce	21,26,957.00
Licence Fee	4,43,813.00
Interest earned on Term Deposit (TDR)	80,25,639.00
Miscellaneous Receipt	7,69,499.00

10.3.2 MoU Signed:

S. No.	ICAR-CICR signed MoU/ MTA with Institutions	Date	Area of work
1.	Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana	23 April 2019	Transfer of cry2Ab1Ac and cry2Ab1Ac::chitinase construct developed by ICAR -CICR for transformation with regenerable cotton genotypes by CCSHAU, Hisar (Research purpose only)
2.	Maharashtra State Seeds Corporation Ltd. (Mahabeej), Akola	28 May 2019	Production and commercialization of Bt cotton varieties developed by ICAR- CICR.
3.	Farmer Shri Raju Gotmare, Beed- Borgaon, Hingna	26 June 2019	Seed production/ multiplication and commercialization of Bt cotton varieties (Suraj Bt, Rajat Bt, GJHV 374 Bt and PKV 081) developed by ICAR- CICR
4.	Group of tribal farmer, Beed -Borgaon, Hingna	26 June 2019	Seed production/ multiplication and commercialization of cotton varieties (Suraj, Surabhi, CNA 1003 (Roja) & CNA 1028) developed by ICAR - CICR

S. No.	ICAR-CICR signed MoU/ MTA with Institutions	Date	Area of work
5.	Maharashtra Hybrid seeds Co. Pvt. Ltd, Jalna	06 August 2019	Contract Research Monitoring for shift in susceptibility in population of the cotton bollworms viz *Helicoverpa armigera* and *Pectinophora gossypiella* against *Cry 1 Ac* protein in various cotton growing country.
6.	Dr. Punjabrao Deshmukh Krishi Vidyapeet, Akola And ICAR-CIRCOT, Mumbai	23 August 2019	Seed cotton production of Naturally colored cotton varieties" developed at ICAR- CICR, Nagpur and value addition by ICAR-CIRCOT, Mumbai.
7.	Better Cotton Initiative-India	03 December 2019	Capacity building and layout of demonstrations of ICAR-CICR Bt cotton varieties and pest management

10.4 : Meetings of RAC, IMC and QRT

10.4.1 : 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 December 2019 under the Chairmanship of Dr. C.J. Dangaria, Hon'ble Vice Chancellor, Navsari Agricultural University, Navsari.

The Chairman and RAC Members visited selected laboratories/ experimental fields, interacted with the scientists and reviewed the progress of research work being carried out. This was followed by a review meeting in the Seminar Hall of the institute. Dr. M.V. Venugopalan, Member Secretary, welcomed the Chairman and members of the RAC. Dr. V.N. Waghmare, Director, ICAR-CICR also extended a formal welcome and underlined the importance of the RAC meeting for fine tuning the research activities.

In his opening remarks Dr. C.J. Dangaria, Chairman RAC appreciated the contribution of ICAR-CICR. He pointed out that cotton has traditionally been a problem oriented crop and climatic uncertainties are adding to the woes of farmers. Although ICAR-CICR is addressing both national and regional issues, there is need to increase the visibility of the institute and make the research work more relevant to the current situation.

A bulletin entitled "Success Story: Management of Whitefly-*Bemicia tabaci* (Gennadius) and Cotton Leaf Curl Virus Disease (CLCuD) in North Cotton Growing Zone of India (2016-18)" by Rishi Kumar, Satish Kumar Sain and Dilip Monga" was released by the RAC.

Dr. M.V. Venugopalan, Member Secretary RAC presented the Action Taken Report on the recommendations of the previous RAC meeting held on Feb 22, 2019. The RAC discussed and approved it with some suggestions. The Chairman RAC and the Members appreciated the work initiated on the suggested action points

The Heads of the divisions and regional stations presented the salient achievements of the research undertaken at their respective divisions/stations. They also presented the thrust areas for research to be undertaken during the next plan period (2020-25). After elaborate deliberations the RAC provided the following recommendations :

1. Separate national research programmes should be initiated for the development of compact plant types, CLCuV resistance, heterotic population and big boll with ICAR-CICR as lead centre and selected SAUs as co-operating centers
2. Granting non-exclusive licensing for certified seed production in Public-Private-Partnership mode should be encouraged
3. Work on gene pyramiding of transgenic events into elite varieties/genotypes of public sector institutions should be given top most priority

4. QTLs reported for improvement of fibre quality, yield and other important economic traits may be validated
5. With the availability of early maturing varieties, the possibility of adopting double cropping should be explored for those areas where supplemental irrigation is available in order to make the cropping system more profitable.
6. Studies on the effect of release of available susceptible pink boll worm population into a population of resistant ones has to be initiated under controlled conditions to understand its efficacy as a resistance management strategy for pink boll worm
7. Priority should be given for development, popularization and use of bio-agents (bio-fertilizers, bio-pesticides, predators and parasitoids) in management of biotic and abiotic stresses in cotton to reduce chemical impact on the environment
8. Studies on viruses and its association with pink boll worm have to be initiated. Further, studies on the role of available proven virus (NPV and GV) have to be tried against pink boll worm management
9. Estimate the fibre quality parameters including trash content of the cotton harvested through mechanical cotton picker following defoliation.

In his concluding remarks, Dr. Dangaria, Chairman RAC appreciated the conduct of the RAC meeting and urged the institute to look into the valuable suggestions provided by the members of RAC and incorporate them in the research programmes.

The meeting concluded with the vote of thanks proposed by Dr. D. Blaise, Head I/c, Division of Crop Production, ICAR-CICR, Nagpur.

10.4.2: Institute Management Committee Meeting

The 55th Institute Management Committee was held on 1st October, 2019 under the Chairmanship of Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur. At the outset, Sh. A.A. Goswami, SAO & Member Secretary (IMC) welcomed Dr. V.N. Waghmare, Director & Chairman (IMC), ICAR-CICR, Nagpur and other members of IMC including Joint Director of Agriculture, Govt. of Maharashtra, Division Nagpur and special invitees. Later Dr. Waghmare gave his introductory remarks and briefed IMC members regarding significance of this meeting and also highlighted the research activities and achievements of the Institute for the year 2018-19 and various other outreach activities undertaken during the period.

The hon'ble members of IMC made some suggestions with permission of Chairman, IMC. These are as under:

- Joint Director of Agricutlure (JDA), Maharashtra suggested to increase FLD's of Bt varieties and seed production on farmer's fields.
- Dr. A.R. Rao enquired the status of research on precision breeding mini core collection and host pathogen interaction. He has also emphasized training on Bioinformatics.
- Dr. Subhash Chandra, Member IMC stressed on need to increase adaption of IPM, bipesticides and bioagents. He also remarked that awareness should be created among farmers for safe use of pesticides.
- Dr. D. Sarkar, Member IMC expressed his desire to collaborate with ICAR-CICR for data analysis and fibre genomics.
- Dr. Vishwas Sawant, Farmers representative and Member IMC requested for organizing training programme in his area i.e. Jalgaon for benefit of farmers.

10.4.3: Recommendations of QRT (Quinquennial Review Team)

The QRT under the Chairmanship of Dr. S.A. Nimbalkar, Former Vice Chancellor, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola with the following members Dr. B.M. Khadi, Former Director, ICAR-CICR & Former Director Research, UAS, Dharwad ; Dr. K.V. Bhat, Ex-Pr. Scientist and Head Division of Genomic Resources, NBPGR, New Delhi; Dr. M.A. Shankar, Rtd. Director of Research, UAS Banglore;

Prof. T.V.K. Singh, Former Emeritus Scientist & Rtd. Dean of Agril. PJTSAU, Hyderabad. Dr. S.A. Nimbalkar, Chairman QRT submitted its report to the Council on 3rd April 2019. The recommendations are as follows:

- Greater attention should be given to maintain the purity of germplasm available at ICAR-CICR on the basis of original characters. Institute must have a structured, time bound multidisciplinary programme for thorough screening of germplasm to identify and validate the trait variations available in germplasm, thus to develop of trait-specific cores or diversity panels for further genetic analysis. Distribution of germplasm to the needy public and private institutes should be strengthened.
- Institute must initiate linkage disequilibrium and association analysis in a consortium mode using core collections already identified to associate the trait variations with molecular markers so that gene transfers can be brought about in targeted manner. Work should be initiated on development of SNP panels to assist pre-breeding work and also to utilize the transfer of useful genes to cultivated germplasm. Additional financial support through external funding can be sought for developing SNP panels for fast track pre-breeding.
- Pre-breeding work is required to be intensified by identifying region specific problems and taking indent of pre-breeding material from AICRP centres and private sectors. Location specific constraints (biotic stress, abiotic stress, plant type, nutrient use efficiency and fibre quality) need to be identified at different centres of AICRP and pre breeding work to cater to these issues must be done. This may be treated as a 'Flag-ship program' for ICAR-CICR with earmarked budget allocations.
- There is a need to re-orient the breeding programme as per the requirement of different agro-ecological regions. There should be a targeted, time bound programme with a team of scientists for wide hybridization. ICAR-CICR may focus attention on basic research related to tagging of fibre quality genes so that the diverse variations can be incorporated in a precise manner in breeding programs. Further, the institute should work on maintenance of varieties and parental lines of hybrids (Maintenance breeding), development of heterotic pools and hybrid development using GMS and CGM systems.
- Transgenic work on cotton may be properly restructured with emphasis on new technologies like gene editing.
- Inter-disciplinary studies on soil health should be intensified by the scientists of the Divisions of Crop Production and Crop Protection. The soil health studies should be a convergence approach in terms of economic value, positive externality, ITK's, location specific low-cost technology, use of microbial consortia and bio-agents etc.
- Climate change studies focusing on the spatio-temporal changes on the phenology of popular cultivars, the effect of prevailing weather pattern and stresses on duration of different phenophases. The impact of climate change on physiological processes, productivity and water use maybe quantified.
- Cost of cotton production is increasing and around 50% of the cost comprises labour charges. Selective mechanization to reduce dependency on labour is urgently needed. Appropriate machines (including picker) are not available, although some efforts have been made at ICAR-CICR, TNAU and PAU to mechanize other operations. A comprehensive cotton mechanization programme must be planned and initiated on a mission mode involving CIAE, Bhopal and other relevant partners.
- ICAR-CICR along with AICRP on Cotton has conducted extensive trials on HDPS on Cotton and developed Package of Practices for the same. However the varieties then recommended were non Bt. As the Bt varieties are available now, prospective Bt varieties may be evaluated under HDPS and if necessary, the technology may be fine-tuned to suit the Bt varieties.
- There is a need for impact assessment of the products, technologies and services rendered by ICAR-CICR and AICRP (cotton) system for internal feedback and evaluation, technology refinement and for documenting the success stories.
- To enhance the yield of *G. barbadense* and H x B hybrids, studies on "Strengthening of agronomic research on enhancing productivity of ELS cotton" can be initiated at ICAR-CICR Regional Station, Coimbatore.
- There is a need to further strengthen research on fertigation, water footprint, conservation tillage, residue management, micronutrient use, crop canopy management, use of drones, artificial intelligence, nano-technology.
- Socio-economics scientists at ICAR-CICR focus on emerging challenges at national / global level facing the cotton sector, implications of major Government and international policies affecting cotton dynamics

(area, production, trade) and translate them to policy papers. Focus should be on market intelligence, forecasting demand / supply, export/ import, forward contract / hedging, value chain analysis and scientific pricing of cotton.

- Resistance monitoring with new and old molecules should be continued. Baseline toxicity data needs to be generated for new emerging potential pests like *Spodoptera frugiperda*.
- Under climate change there is accentuation of some pests and diseases while some hitherto unknown pests of minor significance may become major pests. There is need to develop strategies for management of such pest and diseases which presently are minor and /or of sporadic occurrence but have the potential to acquire giant proportions.
- Much work has been done on identification of potential biocontrol agents including endophytes for management of pests and diseases. This should continue with emphasis on their commercialization.

Policy Recommendations

- Like the present MSP for Seed Cotton, a separate MSP may be fixed for lint also. This would encourage sale of lint, promote development of rural industries and provide additional remuneration to cotton growers.
- Cotton MSP should be fixed based on the Cost C2 of previous year. Currently, cotton MSP is fixed based on the Cost A2+ family labour. The data considered for fixing MSP has two years lag. During the two years prices of most of the inputs will increase. Hence previous year's data need to be considered while fixing cotton MSP.

Administrative Recommendations

- All vacant posts of technical and administrative staff may be filled up in a definite time frame. Council should finalize and communicate the policy of filling up of the post of Skilled Supporting Staff through direct recruitment. These posts are lying vacant for quite a long time.
- The administrative staff may be deputed for training in the fields of computerization, soft skills development and office automation procedures for enabling them to perform optimally in the digital era.
- Time bound promotion and financial benefits for administrative staff of the institute at par with their counterparts at ICAR headquarters is strongly recommended.

FinancialRecommendation

- The institute is 43 years old and there is a need to replace the old/obsolete/ unserviceable equipments and procure state of art equipment for cutting edge research in order to compete with their peers in the public and private sector. Commensurate funds to this effect may be provided.
- The institute is engaged in the development of indigenous Bt cotton (with new/non-deregulated events) and validation of new genes for other traits. It would require extra budgetary support to complete the mandatory tests required for submission to GEAC. The QRT recommends additional support for this purpose.

10.5: Other Important Workshop/ Symposia/Meetings/Events organised

Brainstorming on cotton breeding

A brainstorming meet on "Relevance of Cotton Breeding by Public sector in India" was held under the Chairmanship of Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR at NASC, New Delhi on 3rd April 2019. Dr. A.K. Singh, Deputy Director General (Crop Sciences), Dr. S.A. Patil, Former Director, IARI and Former Vice-Chancellor, UAS, Dharwad, Dr. C.D. Mayee, Former Chairman, ASRB, Dr. C.J. Dangaria, Chariman, RAC, ICAR-CICR and Former Vice-Chancellor, NAU, Navseri, Dr. S.A. Nimbalkar, Chairman QRT, ICAR-CICR and Former Vice-Chancellor, Dr. PDKV, Akola, Dr. N.C. Patel, Vice-Chancellor, Anand Agricultural University, Anand, Dr. R.K. Singh, ADG (CC) and Dr. P.K. Chakraborty, ADG (PP) prominently attended the meeting. The Chairman reiterated the relevance and important role being played by public sector in meeting demands of cotton growers.

However, in changing scenario, the role and strength of private sector can't be negated and urged to strengthen

the Bt hybrid cotton breeding and quality seed production in PPP mode. Other major action points emerged from the meet include, characterization of core collection and development of heterotic pools, sharing of germplasm for breeding of abiotic and biotic stress tolerance, exploration of speed breeding for generation advancement, and promotion of area under ELS and colour cotton. Cotton breeders and experts from ICAR-CICR and other Institutions viz. UAS, Dharwad, PAU, Ludhiana, VNKVV, Nanded as well as Scientists from Genomics lab, CSIR-NBRI, Lucknow participated and gave their inputs. During the meeting a technical bulletin on "Cotton Insects, Diseases and Nematode management" and a "CICR Cotton mobile App" were released at the hands of Director General, ICAR.

Review meeting-cum-Orientation workshop of Insecticide Resistance Management (IRM) scheme

A review meeting-cum-orientation workshop of "Insecticide Resistance Management: Dissemination of Pink bollworm management strategies" was held under the chairmanship of Dr. S.K. Malhotra, Agricultural Commissioner, Ministry of Agriculture and Farmers Welfare, Government of India, at ICAR-CICR, Nagpur on 17th May 2019. Dr R.P. Singh, Director, DCD was also present on the occassion. The dignitaries along with Dr. V.N. Waghmare, Director, ICAR-CICR visited the pink bollworm laboratory of the Institute wherein Dr. Chinna Babu, Scientist, Entomology explained the work being carried on Pink Boll worm resistance monitoring across all cotton growing states.

Discussion on Bt *Cry1Ac* protein calculation

A meeting, "discussion on Bt *Cry1Ac* protein calculation" was conducted by ICAR-CICR on 7th August 2019 under the chairmanship of Dr V.N. Waghmare, Director, ICAR-CICR Nagpur. At the outset, he welcomed the experts; Dr. Debashish Pattanayak, Principal Scientist, ICAR-NIPB, New Delhi and Dr. Nitin V Kurkure, Director of Research, MAFSU along with the representatives from different Private Seed industries. He briefly highlighted the purpose of meeting and initiated the proceedings.. From the Institute, Dr. A.H. Prakash, PC, ICAR-CICR, RS, Coimbatore, Dr. Blaise Desouza, Head, Division of Crop Production, ICAR-CICR, Nagpur, Dr. Nandini Gokte, Head, Divison of Crop Protection, ICAR-CICR, Dr. M.V. Venugopalan, Head, PME, ICAR-CICR, Dr.G. Balasubramani, Member Secretory, IBSC, ICAR-CICR, Dr. Amudha J, Principal Scientist, ICAR-CICR, Dr. Vishlesh Nagrare, Principal Scientist, ICAR-CICR, Dr Raghavendra K.P., Dr. Chandrashekar N, Dr. Pooja Verma, Dr. Vivek Shah, Scientists, ICAR-CICR, attended the meeting.

Dr. G. Balasubramani, ICAR-CICR, Nagpur made a presentation on "Quantification of Bt Cry1Ac proteins with reference to Calculation". He sought clarification for inclusion of multiplication factor in final calculation, which was not mentioned earlier in the Desigen kit manual. Dr. Bharat Char, Lead Biotechnologist Mahyco, also made a brief presentation on sampling and quantification protocol followed by seed industry and expressed Desigen point of view on inclusion of correction factor due to trypsinisation step in Bt *Cry1Ac* quantification in cotton. After presentations, the issue was discussed in detail between the scientists of ICAR-CICR and representatives of private seed industries under experts' guidance. Detailed deliberations were made on correction factor, trypsinization, standards used and other components of ELISA. Considering the experts' comments and the detailed deliberations, few action points were finalized for resolving the issue, to which everyone agreed. The meeting concluded with the vote of thanks proposed by Dr. G. Balasubramani, Principal Scientist, ICAR-CICR, Nagpur.

Institute – Industry Interface Meet

In compliance to action points of the Brain storming meet held on "Relevance of Cotton Breeding by Public sector in India" under the Chairmanship of Dr. T. Mohapatra, Hon'ble Secretary (DARE) & Director General (ICAR) during April 2019 at NASC, New Delhi, an Institute – Industry Interface meeting was organized by ICAR-Central Institute for Cotton Research, Nagpur on 8th November 2019. The meeting was held under the Chairmanship of Dr. A.K. Singh, DDG (Crop Science), ICAR, New Delhi. Dr. C.D. Mayee, Former Chairman, ASRB and Dr. R.K. Singh ADG (CC), New Delhi were also present in the meeting. Representatives from private

seed companies and Senior Cotton Breeders from SAUs and Scientists from ICAR-CICR attended the meeting. Dr V.N. Waghmare, Director, ICAR-CICR, Nagpur in his welcome address, highlighted the narrowing of genetic diversity as the main obstacle in cotton improvement programmes. Dr. A.K. Singh, DDG (Crop Sciences, ICAR, in his introductory remarks, stressed the need for gearing up to meet the challenges to break the yield barrier and overcome the emerging problems in cotton production. He assured, on behalf of Council, to provide assistance in the implementation of the action points emerging from this meeting.

Dr. C.D. Mayee, Former Chairman, ASRB, lauded the contribution of both public and private sector in improving production and productivity of cotton in India. Citing that there has been a stagnation in cotton yield for last 8-10 years, he called for a strong need for Public sector Institute and Industry to come together. Dr. R.K. Singh ADG (Commercial Crops), ICAR briefed about the importance the meeting in addressing the key issues of cotton production including quality seed production with public-private partnership for fostering new linkages and collaborations. Dr. Waghmare later made a detailed presentation on four major agenda points such as development of parental / inbred lines, widening genetic base and pre-breeding, Reciprocal sharing of germplasm and quality seed production of hybrids /varieties.

Detailed discussions and deliberations were held on the enlisted agenda items, popularization of stabilized materials of public sector through seed production programme including Bt varieties/ hybrids and diploid cotton. A major decision suggested by DDG (CS) was to organise a field day/demonstrations to private companies at the ICAR-AICRP centres and ICAR-CICR respectively, before 30th November, 2019.

Institute-Industry Interface Germplasm Field Day 2019

"Institute-Industry Interface Germplasm Field Day 2019" was organized on 20th December 2019 at ICAR-CICR, Nagpur for sharing of cotton varieties/ breeding materials / trait-based germplasm to develop parental lines and strengthen cotton breeding program in PPP mode. Seventeen cotton breeders from fifteen private R & D industries and eight scientists/breeders from the Division of Crop Improvement participated.

The participants were briefed by Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur. He explained the issues related to sharing of germplasm and its availability for display in the institute field. The core collection (755 accessions), representative of all the base collection and

registered lines (49 accessions) having unique traits were made available for observation in the field for all the breeders. The breeders observed each line meticulously and identified traits of their interest for cotton improvement. The requirements of germplasm with specific traits were received by germplasm curator, Dr. Sunil S. Mahajan for further course of action for sharing and collaborative research on PPP mode.

Events

CICR Foundation Day

Nagpur

The ICAR-CICR's 43rd Foundation Day programme was held at the Institute on 1st April, 2019. Dr. S.N. Puri, Ex Vice Chancellor, Central Agricultural University, Imphal was the Chief Guest. Dr. C.D. Mayee, Ex Chairman, ASRB, New Delhi and Dr. M.S. Kairon, Ex Director, ICAR-CICR, Nagpur were the Guests of Honor. Dr. M.S. Ladaniya, Director, ICAR-CCRI, Nagpur was also present as esteemed Guest. Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur presented an overview about the salient achievements and outreach activities of the Institute. Dr. Blaise D., Head I/c,

Division of Crop Production welcomed the guests and Dr. Nandini Gokte, Head I/c, Division of Crop Protection proposed vote of thanks. All retired employees of ICAR-CICR and laborers were also present. The best employees of the year from different work categories of staff were honored with certificates and mementos during the programme. Sh. Ghanshyam Deogirkar conducted the programme.

Coimbatore

Dr. A.H. Prakash, Project Coordinator and Head, ICAR-CICR, RS, Coimbatore inaugurated and addressed the staff. Dr. S. Usha Rani, Principal Scientist (Agrl. Extension), narrated the history of ICAR-CICR. Dr. K. Rathinavel, Principal Scientist, Seed Technology spoke about the contribution and impact of ICAR-CICR on cotton sector. As a token of remembrance of the day, tree saplings were planted. The Project Coordinator felicitated Dr. S. Manickam, Principal Scientist for bagging of 'The best Scientist award' and Mrs. Sundaravalli M. Kumar for bagging 'The best Administrative staff award' of the institute.

Dr. Babasaheb Ambedkar Jayanti

ICAR-Central Institute for Cotton Research, Nagpur celebrated 128th birth Anniversary of Dr Babasaheb Ambedkar on 15th April, 2019. Dr. Devidas Ghodeswar, a renowned constitutional expert was the Chief Guest. Dr. Ghodeswar highlighted the role of Dr Ambedkar in making several provision of articles and schedules in Indian constitution for upliftment of socially downtrodden and women citizens of India. He mentioned that Dr. Ambedkar incorporated the values of liberty, equality and fraternity in the Indian constitution for the overall development of the country having diverse cultures. Dr. V.N. Waghmare, Director, ICAR-CICR summarized work of Dr Ambedkar including fight against untouchability, caste discrimination, women empowerment, right to vote, welfare of small-marginal farmers and agricultural labourers. Dr Blaise Desouza, Head I/c Crop Production Division; Dr. S.M. Wasnik (Principal Scientist & Incharge KVK); Dr V.S. Nagrare (Principal Scientist) and Sh. Anil Goswami, Senior Administrative Officer also shared the dais. Dr. Dipak Nagrale conducted the programme.

International Yoga Day

ICAR-CICR, Nagpur celebrated International Yoga Day on 21st June, 2019. Shri. Srikant Muley and Smt. Ila Muley were the Yogacharyas (Trainers). The programme was attended by all the staff of the institute. The trainers explained various Asanas which could be performed and demonstrated them. They explain the importance of meditation and breathing exercise to maintain balance of life.

At ICAR-CICR RS Coimbatore, all the staff members participated in the International Yoga Day celebration. The Chief Guest, Acharya Vighnesh Chaitanya, Chinmaya Mission, elaborated on Yoga, its benefits and the ways to follow the same. Books on yoga *viz*., Yoga for Health, Easy Yoga for the Beginners and Yoga (in Tamil) were distributed to the participants.

Director General, ICAR visited ICAR-CICR

Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, New Delhi visited ICAR-CICR, Nagpur

on 8th August, 2019. He was accompanied by Dr. S.K. Chaudhary, Assistant Director General (NRM). At the outset, both the dignitaries were extended floral welcome by Dr. V.N. Waghmare, Director, ICAR-CICR. Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur presented salient achievements of the Institute before the dignitaries. Dr. S.K. Chaudhary, ADG (NRM) in his brief address informed about the visit of Director General and congratulated the institute staff for good work being carried out specially the outreach activities of the Institute. Dr. T. Mohapatra, Director General, ICAR personally enquired the problems if any, faced by the staff of the Institute. He elaborated on the issues concerning ICAR and institutes. He was very keen to know any impediments with respect to welfare of the institute staff. He addressed the staff including Scientists, Technical, Administrative and Supporting and exhorted them to effectively serve the farmers and to bring more visibility to the Institute.

Celebration of 73rd Independence Day

ICAR-CICR, Nagpur celebrated 73rd Independence Day on 15th August, 2019. Dr. V.N. Waghmare, Director of the Institute hoisted the National Flag which was followed by singing of National Anthem. All the martyrs who laid their life for this noble cause were fondly remembered.

Incentives in the form of cash awards were given by the Director to the meritorious wards of ICAR-CICR employees. A running race was held later for small children and the winners were given attractive prizes.

At ICAR-CICR, Regional Station, Coimbatore. National flag was hoisted by Dr. A.H. Prakash, Project Coordinator and Head. The bright and meritorious ward of the employees of ICAR-CICR, Regional Station, Coimbatore were presented with incentives. At ICAR-CICR Regional Station, Sirsa, Dr. D. Monga, Head of the Station hoisted the national flag.

Parthenium Awareness Week (16-22 August, 2019)

ICAR-CICR, Nagpur observed 14th *Parthenium* Awareness Week. Dr. S.M. Wasnik explained the history behind the introduction of *Parthenium* in our country. Dr. V.N. Waghmare, Director, highlighted the health hazards caused by *Parthenium* weed, besides its ill effects in agriculture. He emphasized the need for its management using conventional and eco-friendly

biocontrol methods such as use of Mexican beetles and competitive weed like tarota (*Cassia tora)*. Dr. A.R. Raju, elaborated the adverse effect of *Parthenium* on human, animals and soil health thereby increasing the cost of cultivation and reduction in crop yield. The programme was followed by uprooting of *Parthenium* plants in the experimental farm by the staff. Dr. Ramkrushna, G.I. coordinated the programme.

The Institute also organised a *Parthenium* awareness campaign on 23rd August 2019 at Bendoli village, Umred-Bela Taluka, Nagpur. More than 30 farmers and 20 students participated. Leaflets on *Parthenium* control published by ICAR-DWR, Jabalbur and ICAR-Krishi Vigyan Kendra, Nagpur were distributed. Dr. Vinita Gotmare emphasized the importance of management of *Parthenium* before its flowering. Dr. A. Manikandan explained about the problems of *Parthenium* weed and its management. Dr. Jayant Meshram explained about the preparation of compost at onfarm level. Dr. N Chandrasekar proposed the vote of thanks.

Swachh Bharat Programme

ICAR-CICR, Nagpur conducted "*Swachhata Hi Sewa*" program during 11th Sept. to 2nd Oct. 2019 at ICAR-CICR office premises and Krishi Kunj ICAR-CICR residential campus. Various cleaning activities were carried out at the premises of ICAR-CICR building, KVK building,

ATIC, farm Section, canteen area and training hall. The cleaning campaign was also undertaken at nearby Chargaon and Devli villages of Nagpur district. Dr. Waghmare, Director, ICAR-CICR, Nagpur in his address urged the staff to ban single use plastics. He stressed the need for one to be clean at both mind and body for higher work efficiency. The staff members undertook cleaning of premises in the ICAR-CICR residential complex at Krishi Kunj.

Gandhi Jayanti celeberation

One hundred fiftieth Gandhi Jayanti celeberation was organized at ICAR residential complex, Bajaj Nagar, Nagpur on 2nd October, 2019. Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur addressed the gathering and created awareness on restricting single use plastics. A drawing competition was also held for wards of CICR staff.

The staff members undertook cleaning of premises in the ICAR-CICR residential complex at Krishi Kunj. A drawing completion was also organized for youngsters and wards of CICR staff on the theme "Swacchta hi Sewa".

Rashtriya Ekta Diwas

ICAR-CICR, Nagpur observed Rashtirya Ekta Diwas / National Unity Day on 31st October 2019, the birth anniversary of Sardar Vallabhai Patel, the Iron Man of India. The staff of ICAR-CICR assembled and took a National pledge. Dr. Blaise D., the In-Charge, Head, Division of Crop Production administered the oath.

Vigilance Awareness Week

Vigilance awareness week was observed from 28th October to 2nd November 2019. The awareness week commenced with a pledge administered by the Director, ICAR-CICR to all the staff members of the Institute. An

essay competition was also held on the topic in which staff members from all work categories participated.

To create awareness on vigilance, various posters/ banners were displayed at the Institute premises. Lectures were arranged to sensitize students of Zilla Parishad Uchcha Prathmik school, Rui Village, Nagpur district about vigilance awareness.

Kapas Mela

ICAR-CICR organized Kapas Mela-2019 for cotton farmers of Maharashtra, on 29th November, 2019. Dr. S.A.Patil, Former Director, Indian Agricultural Research Institute, New Delhi was the Chief Guest. Dr. Sharad Nimbalkar, Former Vice-Chancellor, P.D.K.V., Akola, Dr. M.S. Kairon, Former Director, ICAR-CICR, Nagpur, Shri R.P. Singh, Director, Directorate of Cotton Development, Nagpur and Shri. Ravindra Bhosle, JDA Nagpur were the Guests of Honour. Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur welcomed the dignitaries and highlighted the technologies developed by the Institute and outreach schemes being undertaken. Shri. R.P. Singh made the farmers aware of various government schemes. Shri Ravindra Bhosle emphasized about community farming and the need to work in groups. Dr. M.S. Kairon stressed on the necessity of farm mechanization due to acute labour shortage. Dr. Sharad

Nimbalkar focussed on the need to follow good management practices for increased yield realization and pest control. Dr. S.A. Patil highlighted the need of a prior planning with respect to intercrops and other management practices in crop production. He explained the benefits of adopting integrated farming systems approach.

The Institute publications - pamphlets on Bt cotton - varieties developed by ICAR-CICR, Bio- control of Pink Bollworm and a booklet on Soil Testing were released. Eight champion cotton farmers, who successfully implemented and demonstrated ICAR-CICR technologies to other farmers shared their experiences and were felicitated.

A gallery exhibiting 24 stalls with agricultural and other innovative technologies were displayed The Cotton Fair was attended by more than 2500 farmers from different parts of Maharashtra who were provided with information about advanced technology of cotton farming. Farmers were also taken to fields to showcase improved public sector cotton varieties and improved cotton production technologies. Experts' talks were arranged to provide guidance on varieties, integrated management of major cotton insect pests specifically, Pink bollworm, climate resilient technologies, measures of increasing water use efficiency and the management of leaf reddening, major diseases occurring during the season such as Grey mildew, Boll rot, Leaf spot etc. Dr. S.M. Wasnik, Principal Scientist and Organizing Secretary, Kapas Mela-2019 proposed the vote of thanks.

Constitution Day

ICAR-CICR, Nagpur observed the Constitution Day on 26th November 2019 to commemorate 70th year of adoption of the Constitution of India.

Hon. Justice Sh. K.J. Rohee, former Justice Bombay High Court was the Chief Guest. Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur welcomed the Chief

Guest and gave a brief introduction about importance associated with Constitution Day and its celebration. The Chief Guest in his inaugural address spoke on Constitution and Fundamental Duties, History of Indian Constitution. Dr. Blaise Desouza, I/c. Head, Crop Production, Dr Nandini Gokte Head, Crop Protection, Dr. S.M. Wasnik, Principal Scientist (Extension) & I/c.Head KVK, ICAR-CICR, Nagpur were also present on the dais.

World Soil Day 2019

ICAR-Central Institute for Cotton Research, Nagpur celebrated World Soil Day on 5th December 2019. The theme for this year was "Stop soil erosion, save our future". Dr. A. Manikandan (Scientist-Soil Science) explained about the importance of the soil health in agriculture and ways to prevent soil erosion to Technical Assistants, Supporting staffs and farm labours of Division of crop production.

10.6 : Participation of Scientists in Seminars / Symposia / Workshops / Meetings

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Date and Place	Participants
1.	Brain Storming on `Relevance of Cotton Breeding by Public Sector in India'	3 April 2019 NASC Complex, New Delhi	Dr. V.N.Waghmare Dr. S. M. Palve Dr. D. Blaise Dr. Nandinit Gokte Dr. M. V. Venugopalan Dr. V. S. Nagarale Dr. S. B. Singh Dr. Vinita Gotmare Dr. G. Balasubramani Dr. J. Amudha Dr. Santosh, H. B. Dr. K. P. Raghavendra Dr. Sunil Mahajan Dr. N Chandrashekar Dr. M. Sarvanan Dr A H Prakash Dr. S. Manickam Dr. M. Damayanti Dr. Baghyalakshmi Dr. D. Monga Dr. O. P. Tuteja Dr. S. K. Verma Dr. D. V. Patil
2.	Conference on Developing a Comprehensive Roadmap to Incentivise the Production of Extra Long Staple Cotton and Suvin	23 April 2019 Hotel Trident, Mumbai,	Dr A H Prakash Dr. S. Manickam

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Date and Place	Participants
3.	Stakeholders' workshop and Panel discussion on "Developing a Comprehensive Roadmap for encouraging the production of Extra Long Staple Cotton and Suvin"	23 April, 2019 Cotton Corporation of India, Mumbai	Dr. A.H. Prakash Dr. M.V. Venugopalan
4.	Collaboration meeting for Technical Collaboration with SAUs and CRIDA	26 April 2019 VNMKV, Parbhani	Dr. S. M. Palve
5.	Panel discussion on approaches for doubling income of cotton farmers of Maharashtra	9 May 2019IDH at WTC, Mumbai	Dr. M.V. Venugopalan
6.	Meeting of core-committee on Preparation of policy document on Futuristic Crop Planning for 2030/2050	14-15 May, 2019 ICAR-IIFSR, Modipuram at NAAS Complex	Dr. V.N. Waghmare Dr. M.V. Venugopalan
7.	Review meeting cum orientation workshop on Insecticides Resistance Management (IRM) Dissemination of PBW management strategies.	17 May 2019 ICAR-CICR, Nagpur	Dr. V. N. Waghmare Dr. Blaise Desouza Dr. Nandini Gokte-Narkhedkar Dr. S. M. Wasnik Dr. Rishi Kumar Dr. Vinita Gotmare Dr. V. S. Nagrare Dr. K. Ramesh Dr. V. ChinnaBabu Naik Dr. Rachana Pande Dr. D. T. Nagrale Dr. B. B. Fand Dr. S. P. Gawande Dr. Neelkanth S. Hiremani Dr. Vivek Shah
8.	Group Meeting of All India Coordinated Cotton Improvement Project for Central and South Zone locations	30-31 May 2019 ANGRAU, Guntur	Dr. V.N.Waghmare Dr A. H. Prakash Dr. S. Manickam Dr. K.Rathinavel Dr. M. Sabesh Dr Sankaranarayanan Dr Dharajothi Dr. S. M. Palve Dr. Vinita Gotmare Dr. Santosh, H. B Dr. Sunil Mahajan Dr. G. Balasubramani Dr. Nandinit Gokte Dr. Vivek Shah Dr. B. B Fand Dr S.M. Wasnik Dr M.V. Venugopalan
9.	Joint ICAR-CSIR meeting on `Next Generation Insect Resistance in Cotton'	11 June 2019 Krishi Bhavan, New Delhi	Dr. V.N.Waghmare Dr. G. Balasubramani Dr. V. S. Nagrare Dr. Santosh, H. B. Dr. K. P. Raghavendra
10.	Workshop on "Important Plant protection Measures in Bt- Cotton after Sowing"	21 June 2019 Hanumangarh (Rajasthan)	Dr. V.N.Waghmare Dr. G. Balasubramani Dr. V. S. Nagrare Dr. D. Monga and Dr. Rishi Kumar

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Date and Place	Participants
11.	International seminar on Innovative Extension Management for uplifting livelihood of Farmers – Status, initiatives and way forward.	27-28 June 2019 TANUVAS, Chennai,	Dr. C. Karpagam
12.	Meeting of CROPSAP chaired by Dr Ashwin Mudgal, District Collector, Nagpur	31 July 2019 Nagpur,	Dr. V. S. Nagrare
13.	"International Conference on Plant Protection in Horticulture: Advances and Challenges"	24-27 July 2019 ICAR-IIHR, Bengaluru	Dr. K. Shankarganesh
14.	Kick-start campaign on pink bollworm management at the hands of Dr Anil Bonde, Agriculture Minister, Maharashtra	03 August 2019 Warud, Dist Amravati	Dr. V. S. Nagrare
15.	ICAR - Regional Committee No. VII - 25 th meeting	9-10 August, 2019 ICAR-NBSS&LUP, Nagpur	Dr. V.N. Waghmare Dr. M.V. Venugopalan Dr. D. Blaise Dr. Nandidini Narkhedkar
16.	Meeting on light trap developed by PDKV Akola and possible supply to farmers on subsidy under the Chairmanship of shri Eknath Dawale, Secretary, agriculture at Maharashtra	19 August 2019 Mumbai	Dr. V. S. Nagrare
17.	Half Yearly NARAKAS meeting 2019	22 August 2019 Punjab National Bank, Sirsa	Dr. S.K. Sain
18.	8th Meeting of the ICAC Asian Cotton Research and Development Network (ACRDN)	09-11 September 2019 Tashkent, Uzbekistan	Dr. D. Monga Dr. S. M. Palve
19.	National Conference on "Climate smart agriculture for livelihood Security: Challenges and opportunities"	13-14 September 2019 AC& RI Trichirapalli	Dr.K.Sankaranarayanan
20.	Global Organic Convention-2019 on "Natural Resource Management for Sustainable Agriculture, Soil health and Quality Food"	15-17 September 2019 Le Meridien Hotel, Nagpur.	Dr. M. V. Venugopa lan Dr. Vinita Gotmare Dr. V. Santhy Dr. J.H. Meshram Dr.. K.P. Raghavendra Dr. Chandrashekar N. Dr. H. B. Santosh Dr. Sunil S. Mahajan Dr. Rachna Pande Dr. M. Saravanan Dr. K. Velmourougane Dr. Savitha Santosh Dr. Pooja Verma
21.	Symposium cum Workshop on "Endophytes and their Applications in Agriculture"	24-28 September 2019 UAS, GKVK, Bangalore	Dr. Neelakanth S. Hiremani Dr. M. Amutha
22.	16th Review meeting of DUS test centers for Rabi crops	26-27 September 2019 NASC, New Delhi	Dr. K. Rathinavel
23.	National Symposium on "Microbial Based Strategies For Improvement of Soil And Plant Health"	26 September 2019. Karnatak University, Dharwad	Dr. P. Valarmathi
24.	Meeting of NETAFIM drip irrigation company dealers.	01 October 2019 Coimbatore	Dr. C. Karpagam

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Date and Place	Participants
25.	21st Scientist Advisory committee meeting of KVK-CCSHAU	4 October 2019 KVK CCSHAU, Sirsa	Dr. S.K. Sain
26.	National Conference of Plant Physiology (NCPP-2019)	19-21October 2019 Kerala Agricultural University, Thrissur	Dr. J.H. Meshram
27.	International Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2019)	20-22 October 2019 ICAR NAARM, Hyderabad	Dr. S.K. Sain Dr. Amarpreet Singh Dr. P. Valarmathi
28.	Scientific Advisory Committee meeting	22 October 2019 ICAR KVK-MYRADA, Erode	Dr. C. Karpagam
29.	2nd Steering committee meeting of CROPSAP chaired by Shri Suhas Diwase, Commissioner Agriculture, Maharashtra	23 October 2019 Pune	Dr. V. S. Nagrare
30.	Meeting of Parliamentary Standing Committee on Commerce on "Export of Organic Products"-cotton	24 October, 2019 Rajya Sabha Secretariat Parliament House Annexe, New Delhi,	Dr. VN Waghmare Dr. MV Venugopalan
31.	Workshop on Contract Farming- a Tool to Increase Production of ELS Cotton	25 October, 2019 The Residency Tower, Coimbatore	Dr. A H Prakash Dr. S. Manickam
32.	XIX International Plant Protection Congress IPPC2019. Crop Protection to Outsmart Climate Change for Food Security & Environmental Conservation	10-14 November 2019 Hyderabad, Telangana, India	Dr. Nandini Gokte-Narkhedkar Dr. V. S.Nagrare Dr. Chinnababu Naik Dr. Shailesh Gawande Dr. Babsaheb Fand Dr. P. Valarmathi Dr. M. Amutha Dr. J.Gulsar Banu Dr. M. Amutha Dr. A. Sampathkumar
33.	First National Agrochemicals Congress	13-16 November 2019 ICAR-IARI, New Delhi	Dr. K Rameash
34.	78 th Plenary meeting of International Cotton Advisory Committee (ICAC) at on Global Leadership: Pushing Cotton Boundaries	2-7 December 2019 Brisbane Australia	Dr A H Prakash Dr. P.Nalayini
35.	National Conference on Value Addition to Crop Residues of Natural Fibers	04 December 2019 ICAR-CIRCOT, Mumbai	Dr. K. Velmourougane Dr. A. Manikandan
36.	National Symposium on 'Nematodes: A threat to food security and farmer's livelihood'	11-13 December 2019 Imphal, Manipur	Dr. Nandini Gokte-Narkhedkar
37.	Central Variety Identi fication Committee Meeting	12 December 2019 Krishi Bhavan New Delhi	Dr. V. N. Waghmare Dr. A. H. Prakash Dr. D. Monga Dr.B. Dhara jothi Dr. S. Manickam Dr K. Sankaranarayanan

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Date and Place	Participants
38.	National seminar on "Potential crops for food and nutritional security"	14-15 December 2019 TNAU, Coimbatore	Dr. A. Manivannan Dr. K. Baghyalakshmi
39.	eSARD 2019 – International Conference on Extension for Strengthening Agricultural Research and Development: Focus on Farmers Income	14-16 December 2019 ICAR KVK, Suttur, Mysuru	Dr. S. Usha Rani

10.7: Distinguished Visitors

Name	Designation & Organization	Date
Nagpur		
Dr. S. N. Puri Dr. C. D. Mayee Dr. M. S. Kairon Dr. M. S. Ladaniya	Former Vice Chancellor, Central Agricultural University, Imphal Former Chairman, ASRB & President, SABC and Vice President, NAAS, New Delhi Ex Director, ICAR-CICR, Nagpur Director, ICAR-CCRI, Nagpur	01 April, 2019
Dr. S. P. Kimothi,	ADG (Coordination), ICAR, New Delhi	06 April 2019
Dr. Devidas Ghodeswar	Renowned constitutional expert	15 April, 2019
Dr. S. K. Malhotra	Agricultural Commissioner, Ministry of Agriculture and Farmers Welfare, Government of India	17 May 2019
Dr. Trilochan Mohapatra	Secretary, DARE and Director General, ICAR, New Delhi	08 August 2019
Shri Vishwas N. Sawant Dr. D. Sarkar Dr. A. R. Rao Dr. Subhas Chander	Joint Director of Agriculture, Govt. Of Maharashtra, Principal Scientist, CRIJAF, Barrackpore, Principal Scientist, IASRI, New Delhi Principal Scientist, IARI, New Delhi	1 October, 2019
Dr. Ashish M. Paturkar	Hon'ble Vice Chancellor, MAFSU, Nagpur	04 October 2019
Dr. A.K. Singh Dr. C. D. Mayee Dr. R.K. Singh	DDG (Crop Science), ICAR, New Delhi Former Chairman, ASRB & President, SABC and Vice President, NAAS, New Delhi ADG (CC), ICAR, New Delhi	08 November 2019
Dr. K.S. Khokhar Dr. Sudhir Raizada Dr. A.K. Mehta Dr. Indrajeet Matur Dr. RPS Ratan, Dr. Lakhan Singh Dr D.M. Mankar	Former Vice Chancellor, CCSHAU, Hisar Former ADG (Fisheries), ICAR, New Delhi Former ADG, (AE) ICAR, , New Delhi Former DEE, MPUA&T, Udaipur Former DEE, BAU, Ranchi Director ATARI, Pune DEE, Dr. PDKV Akola	17 November 2019
Hon'ble Justice Sh. K.J. Rohee	Former Justice Bombay High Court	26 November 2019
Dr. S.A. Patil	Former Director, Indian Agricultural Research Institute, New Delhi	28-30 November 2019
Dr. Sharad Nimbalkar Dr. M. S. Kairon Shri R. P. Singh Shri Ravindra Bhosle	Former Vice-Chancellor, Dr. PDKV, Akola, Former Director, ICAR-CICR, Nagpur Director, Directorate of Cotton Development, Nagpur JDA Nagpur	29 November 2019

Name	Designation & Organization	Date
Nagpur		
Dr. C. J. Dangaria	Hon'ble Vice Chancellor, Navsari Agricultural University, Navsari.	07 December 2019
Dr. R.K. Singh	ADG (Commercial Crops), ICAR, New Delhi	
Dr. S. V. Sarode	Ex-Director Research, Dr. PDKV, Akola	
Dr. A. J. Shaikh	Ex-Director, ICAR-CIRCOT	
Dr. S. S. Patil	Ex-Director Research, UAS, Dharwad	

10.8 : Personnel

Director
- Dr. VN Waghmare, Director (Acting)

Project Coordinator (Cotton)
- Dr. AH Prakash, PC (Cotton) & Head (Acting)

CROP IMPROVEMENT DIVISION

Genetics & Plant Breeding

Nagpur
- Dr. VN Waghmare, Head
- Dr. (Mrs.) Suman Bala Singh, Pr. Scientist
- Dr. TR Loknathan, Pr. Scientist
- Dr. SM Palve, Pr. Scientist
- Dr. (Mrs.) Vinita Gotmare, Pr. Scientist
- Dr. DV Patil, Sr. Scientist
- Dr. M Saravanan, Scientist
- Dr. HB Santosh, Scientist

Coimbatore
- Dr. (Mrs.) KPM Dhamayanthi, Pr. Scientist
- Dr. S Manickam, Pr. Scientist
- Dr. Manivannan A, Scientist
- Dr. (Mrs.) K Baghyalakshmi, Scientist

Sirsa
- Dr. OP Tuteja, Pr. Scientist
- Dr. SK Verma, Pr. Scientist

Agril. Biotechnology
- Dr. G Balasubramani, Pr. Scientist
- Dr. (Mrs.) J Amudha, Pr. Scientist
- Dr. KP Raghavendra, Sr. Scientist
- Mr. Joy Das, Scientist (Study Leave w.e.f.28.12.17)
- Mr. Rakesh Kumar, Scientist (Study Leave w.e.f.27.12.18)
- Dr. Chandrashekar N, Scientist

Seed Science &Technology

Nagpur
- Dr. (Mrs.) PR Vijayakumari, Pr. Scientist
- Dr. (Mrs.) V Santhy, Pr. Scientist
- Dr. SS Mahajan, Pr. Scientist

Coimbatore
- Dr. K Rathnivel, Pr. Scientist

Sirsa
- Dr. RA Meena, Pr. Scientist (Retired on 31.07.2019)

CROP PRODUCTION DIVISION

Agronomy

Nagpur
- Dr. Blaise Desouza, Pr. Scientist & Head, Crop Production (Acting)
- Dr. MV Venugopalan, Pr. Scientist
- Dr. AR Raju, Pr. Scientist
- Dr. Ramkrushna I Gandhiji, Scientist
- Dr. B Bhargavi, Scientist

Coimbatore
- Dr. (Mrs.) P Nalayani, Pr. Scientist
- Dr. K Shankaranarayanan, Pr. Scientist
- Dr. R Raja, Sr. Scientist

Sirsa
- Dr. Amarpreet Singh, Scientist

Soil Science

Nagpur
- Dr. A Manikandan, Scientist

Coimbatore
- Dr. (Mrs.) D Kanjana, Scientist

Farm Machinery & Power

Nagpur
- Er. G Majumdar, Scientist

Plant Physiology

Nagpur
- Dr. JH Meshram, Pr. Scientist

Coimbatore
- Dr. AH Prakash, Pr. Scientist & Head (Acting), RS Coimbatore
- Dr. (Mrs.) J Annie Sheeba, Scientist

Plant Biochemistry
- Dr. (Ms.) Pooja Verma, Scientist

Agricultural Microbiology

Nagpur
- Dr. K Velmourougane, Sr.Scientist
- Dr. (Mrs.) Savitha Santosh, Scientist

Agricultural Extension

Nagpur
- Dr. SM Wasnik, Pr. Scientist

Coimbatore
- Dr. (Mrs.) Usha Rani, Pr. Scientist
- Dr. C Karpagam, Sr. Scientist

Agricultural Economics

Nagpur
- Dr. AR Reddy, Pr. Scientist
- Dr. (Mrs.) A Narala, Scientist (Transferred to IIMR, Hyderabad on 23.11.2019)

Coimbatore
- Dr. (Mrs.) Isabela Agarwal, Pr. Scientist

Computer Application in Agriculture

Coimbatore
- Dr. M Sabesh, Sr. Scientist

CROP PROTECTION DIVISION

Agricultural Entomology

Nagpur
- Dr. (Mrs.) Sandhya Kranthi, Pr. Scientist & Head (Acting)
- Dr. VS Nagrare, Pr. Scientist
- Dr. Chinna Babu Naik V, Scientist
- Dr. (Mrs.) Rachna Pande, Scientist
- Dr. Babasaheb Fand, Scientist
- Mr. Prabhulinga Tenguri, Scientist (Study leave w.e.f. 27.08.18)
- Mr. Madhu TN, Scientist (Study leave w.e.f.11.09.18)
- Dr. Shah Vivek Hanskumar, Scientist

Coimbatore
- Dr. (Mrs.) Dhara Jothi, Pr. Scientist
- Dr. K Rameash, Sr. Scientist
- Dr. (Mrs.) M Amutha, Sr. Scientist
- Dr. K Shankarganesh, Scientist

Sirsa
- Dr. Rishi Kumar, Pr. Scientist

Plant Pathology

Nagpur
- Dr. SP Gawande, Scientist
- Dr. DT Nagrale, Scientist
- Dr. Neelakanth Hiremani, Scientist
- Dr. Vanita Salunkhe, Scientist (Transferred to NIASM, Baramati on 23.11.2019)

Coimbatore
- Dr.. A Sampath Kumar, Scientist
- Dr. P Valarmathi, Scientist

Sirsa
- Dr. Dilip Monga, Pr.Scientist & Head (Acting), RS, Sirsa
- Dr. Satish Kumar Sain, Sr. Scientist

Nemotology

Nagpur
- Dr. (Mrs.) N Narkedhkar, Pr. Scientist

Coimbatore
- Dr. (Mrs.) J Gulsar Banu, Pr. Scientist

KVK
- Dr. S. M. Wasnik, Principal Scientist & I/c Coordinator
- Dr. S. S. Patil, SMS (Extension)
- Dr. U. V. Galkate, SMS (Vet. Science)
- Smt. Sunita Chauhan, SMS (Home Science)

ADMINISTRATION
- Sh. A. A. Goswami, Sr. Administrative Officer
- Sh. Yashwant Sorte, Finance & Accounts Officer (Additional Charge from 23.07.2019)

10.9 : Other Information

10.9.1: Visits Abroad

8th Meeting of the ICAC ACRDN at Tashkent, Uzbekistan

Dr. S.M. Palve, Principal Scientist, Plant Breeding attended 8th Meeting of the ICAC Asian Cotton Research and Development Network (ACRDN) held at Tashkent, Uzbekistan, during 9-11 September, 2019. He presented research paper on "Genetic variation for agronomic and fibre properties in advanced breeding lines of cotton (*G. hirsutum* L.)". The theme of the meeting was 'Best Global Sustainable Practices on Production, Processing

& by-products Value Addition'. The 8th ACRDN was organized by the Uzbekistan Textile and Garment Industry Association, Uzbekistan and The International Cotton Advisory Committee (ICAC), Washington DC supported by the Ministry of Agriculture of The Republic of Uzbekistan and Ministry of Innovations of the Republic of Uzbekistan in collaboration with Congresses of Central Asia Company and The Indian Society for Cotton Improvement (ISCI), Mumbai, India.

Summer school and training at Rome, Italy

Dr. D.V. Patil, Senior Scientist (Plant Breeding) attended summer school and training on "Grow Agro-biodiversity in a climate change" at Food and Agriculture Organization of the United Nations (FAO), Headquarters, Rome, Italy during 18 - 26 September 2019. The Grow summer school was organized in collaboration with technical support of Mountain Partnership Secretariat, FAO, Platform for Agrobiodiversity Research (PAR), Bioversity International and Department of Environmental Biology, Sapienza University of Rome. This course focused on the importance of biodiversity in agriculture with particular attention to its role in enhancing resilience, adaptability of cropping and farming systems to climate change. The training included lectures on Management of agrobiodiversity, abiotic and biotic

components of agricultural ecosystem, agrobiodiversity on the ground, measuring the values on-farm diversity, agrobiodiversity values as market drivers, hands on experience on biodiversity and field visit to the slow food presidium of Vallepietra village, Simbrivio valley, Rome, Italy.

Deputation to International Cotton Advisory Committee – Research Associate Program 2019

Dr. (Mrs) S. Usha Rani, Principal Scientist (Agricultural Extension) was deputed to participate in the

International Cotton Advisory Committee – Research Associate Program 2019 at the Secretariat, ICAC, Washington DC.

The ICAC Research Associate Program 2019 was held at ICAC–Secretariat, Washington DC from 24.09.2019 to 03.10.2019. This year's theme of ICAC RA Program was "Risk Management in Cotton Industry (Production and Trade)". The purpose of the program is providing an opportunity for persons from ICAC members to receive additional knowledge in risk management at Cotton Industry (Production and Trade). A total of 10 participants from nine countries viz., South Africa, Switzerland, Turkey, Mozambique, Bangladesh, Zimbabwe, Argentina, Poland and India had participated in the program. The coordinator of the program was Mr. Andrei, Direct of Trade Analysis, ICAC. The first week of the program was conducted at the office of the ICAC Secretariat in Washington, DC. Presentations were made on topics of risk management in cotton production and trade. Participants were briefed by members of the Secretariat and by experts from the US cotton industry, various research institutions, international organizations, and the US Department of Agriculture. The program also included a visit to a cotton-producing area in North Carolina, United States for three days.

Visit to Azerbaijan

Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur visited Baku, Azerbaijan as an Indian Expert for establishment of possible cotton research in Azerbaijan during 27th October to 3rd November 2019. He had meeting with Mr. Rafayal Guliev, Head, Department for Organization and Monitoring of Plant Production, Mr. Imram Jimshudov, Director, Agrarian Science and Innovation Center and Mr. Farman Kherimov, Dy. Head, Agrarian Science and Innovation Center, Ministry of Agriculture, Republic of Azerbaijan, Baku. He also

visited Genetic Resources Institute (GRI) of the National Academy of Science, Azerbaijan; Salyan Regional Agrarian Science and Innovation Center and its experimental fields, Agrarian University, Ganja city and experimental field of Research Institute of Plant Protection and Industrial Crops (IPP&IC). He also made a presentation on Cotton Breeding before the faculty and students at GRI, Agrarian University and IPP&IC. Dr. Yagub Guliyev, Scientist Specialist, Agrarian Science and Innovation Center accompanied him during his complete visit to different research institutes and stations.

Dr. V.N. Waghmare, Director, ICAR-CICR with Mr. Rafayal Guliev, Head, Department for Organization and Monitoring of plant production, Mr. Imram Jimshudov, Director, Agrarian Science and Innovation Center and Dr. Yagub Guliyev, Scientist Specialist, Agrarian Science and Innovation Center.

Mr. Symur Movlayer, Director, Agency for Agrarian Services, Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur, India, Mr. Farman Kherimov, Dy. Head, Agrarian Science and Innovation Center and Dr. Yagub Guliyev, Scientist Specialist, Agrarian Science and Innovation Center.

78 th plenary meeting of ICAC at Brisbane, Australia

Dr. A.H. Prakash, Project Coordinator and Head and Dr. (Mrs.) P. Nalayini, Principal Scientist, CICR Regional Station, Coimbatore were invited by ICAC for the 78th plenary meeting of ICAC held during December 2-7 at Brisbane, Australia. The visit to Brisbane for the 78th plenary meeting was a great exposure as more than 350 scientists and policy makers across the globe

representing different cotton growing countries participated and exchanged their ideas and views on aspects related to cotton growing conditions and the challenges in cotton farming with global scientists and technocrats. Apart from participation in various technical sessions scheduled for the events, they also gave technical presentation to the global cotton scientists and policy makers, which was appreciated and well received by the global audience. Dr. Prakash spoke on "Will cotton win over climate change in Asian continent?" and Dr Nalayini presented on "Recent eco–agronomic technologies and potential for economic returns in small holder farms".

10.9.2: Mera Gaon Mera Gaurav

'Mera Gaon Mera Gaurav is being implemented by ICAR-CICR Nagpur and its Regional Stations Coimbatore and Sirsa. The Scientists remained in touch with the adopted villages and provided information to farmers on technical and other related aspects through personal visits to hasten the process of Lab to Land. During the year the programme was implemented in 63 adopted villages in 13 clusters (eight, four and one respectively from Nagpur, Coimbatore and Sirsa) in four district (Table 9.2.1). All three centres implemented the programme in the respective, villages adapted by team of scientists .

Table 10.9.2.1: Centers, Scientists involved and Farmers Benefitted

State	Name of centre	No. of Groups/ team formed	No. of Scientists Involved	No. of villages covered	No. of field activities conducted	No. of messages/ advisory sent	Farmers benefited (No.)
Maharashtra	ICAR-CICR, Nagpur	8	33	38	16	35	738
Tamil Nadu	ICAR-CICR, Coimbatore	4	19	20	8	10	225
Haryana	ICAR-CICR, Sirsa	1	5	5	2	7	50
Total		**13**	**57**	**63**	**26**	**52**	**1013**

Broad areas of activities undertaken

- Field crop demonstrations on tribal farmers fields
- Extending technical advices on integrated cotton production to the farmers of adopted villages
- Monitoring of insects/pests, updating with latest measures of controlling diseases and insect pests of major crops of locality
- Delivering need based weekly mobile advisory to the farmers registered with Institute e-Kapas/ Communication advisory system
- Organising meetings/ Gosthies at villages
- Providing literature support to farmers
- Creating linkages with other Departments/ Organizations /NGOs
- Updating farmers about soil health card importance
- Creating awareness about Pradhan Mantri Fasal Bima Yojana
- Providing technical inputs related to Goat farming for better farm profitability
- Creating awareness about cleanliness of village premises

Demonstrations to popularize ICAR-CICR Bt at farmer's fields

During *kharif* 2019-20, it was decided to popularize ICAR- CICR Bt varieties namely, Suraj Bt, PKV Rajat Bt, PKV 081 Bt, GJHV Bt among the farmers under MGMG villages and accordingly 114 farmers were selected. Seeds was provided to farmers of Nagpur & Wardha district of Maharashtra for conducting demonstration at farmers fields in Umred (Nagpur), Samudrapur (Wardha), Parshevani (Nagpur), Hingana (Nagpur), Ganeshpur (Wardha), Nandura (Wardha), Kalmeshwar (Nagpur), Navegaon (Nagpur), Dongargaon (Nagpur) clusters and Tivsa in Amravati district. Sowing was completed in June. During the crop season, pheromone traps were also distributed to all the farmers for monitoring of Pink Bollworm infestation in their respective fields. Awareness camps and interface meeting were organised for the management of Pink Bollworm and provided literature support.

Farmers were trained on appropriate technologies, necessary corrections were regularly provided. Technologies like profitable cropping systems, soil fertility maintenance, biofertilizers based INM, IPM, IWM, herbicide based weed management, bud and boll shedding management, sucking pests, PBW in cotton and pod borer in pigeon pea management were provided. Farmers were trained and regularly advised on nutrient losses, deficiencies and their correction.

Table 10.9.2.2: Training Organized under MGMG

S. No.	Month	Date	Name of Cluster & District	Name of Training Programme	Name of Village	No of Participants
1	Jun-19	19 June 2019	Parseoni, Nagpur	cotton cultivation & related issues	Narhar, Ambazari, Saleghat, Ghatpendri	100
2		19 June 2019	Parseoni, Nagpur	cotton cultivation & related issues	Narhar, Ambazari, Saleghat, Ghatpendri	100
3		25 June 2019	Umred-Surabardi, Nagpur	ICAR-CICR Bt cotton varieties cultivation practices	Bendoli	20

S. No.	Month	Date	Name of Cluster & District	Name of Training Programme	Name of Village	No of Participants
4	Aug-19	23August 2019	Umred-Surabardi, Nagpur	Training Programme on Parthenium Awareneas in Bendoli village of Umred Cluster	Bendoli, Umred	30
5		05 August 2019	Samudrapur, Wardha	Input Distribution & guidance on Pest & disease Management	Arvi, Jogingumpha Shivanphal	77
6		25 August 2019	Samudrapur, Wardha	IPM In Cotton	Shivnphal, Faridpur, Mohgaon	49
7	Oct-19	05 October 2019	Nandura, Wardha	Pin Bollworm Management in cotton	Karanji Kanji	70
8		15 October 2019	Samudrapur, Wardha	IPM In Cotton	Girad, Wardha	320
9	Nov-19	05 November 2019	Parseoni, Nagpur	Use of pheromone trap for PBW	Narhar, Ambazari, Saleghat,Ghatpendri, Dhawalpur	75
10	Dec-19	24 December 2019	Samudrapur, Wardha	Integrated Disease & Pest Management in Cotton	Arvi, Faridpur, Mohgaon, Shivanphal	95
Total						**836**

Training and other activities Organized at ICAR-CICR RS, Coimbatore

S. No	Name of the Village cluster	Name of the farmer training/ workshop conducted	Date of training/ meeting/ visit	No. of beneficiaries
1	Pollachi North block	Meeting with ADA, AO and AAO of the block to collect the details of cotton growing village	17 June 2019	30
2	Adhiyur, Zaminkalathur, Zaminkaliyapuram, Perumpathi and Puravipalayam Vadakipalayam	Discussion with the cotton farmers and rapport building	10 July 2019	30
3	Karamadai block	Importance of soil testing and balanced fertilization	11 July 19	25
4	Zaminkalathur	Baseline data collection and FLD Materials distribution	17 August 2019	30
5	Karamadai block	Awareness meeting on cotton varieties and hybrids	27 August 19	20
6	Adhiyur, Zaminkalathur, Zaminkaliyapuram, Perumpathi and Puravipalayam Vadakipalayam	Best Package of Practices of Cotton Cultivation	7 September 2019	30
7	Vadakkipalayam	Field Day on Cotton FLD for ELS cotton farmers	21 October 2019	50
8	Kinathukadavu –outskirts of Pollachi North	Field visit	20 December 19	10
Total				**225**

S. No	Name of the Village cluster	Name of the farmer training/ workshop conducted	Date of training/ meeting/ visit	No. of beneficiaries
ICAR-CICR RS, Sirsa				
1	Khedi, Kagdana (Sirsa)	One day training cum farmers Interface meeting	6 August 2019	70
2	Kirsindhu and Palwan villages Uchana	IRM: Dissemination of Pink Bollworm Management Strategies	22 July, 2019	17
Total				**87**

10.9.3: Schedule Castes Sub Plan

Indian Council of Agriculture Research - Central Institute for Cotton Research implemented a Centrally Sponsored Scheme of "Scheduled Castes Sub Plan (SCSP)" with the objective to increase the income of the target population by way of various income generating schemes and skill development trainings. The team consists of Dr. S.M. Wasnik, Principal Scientist (Extension) & I/C KVK ICAR-CICR- Nagpur as Nodal Officer and Dr. Sunil Mahajan, Principal Scientist (Seed technology), Dr S.P Gawande, Scientist (Plant Pathology), Dr Pooja Verma, Scientist (Crop Production), Mr. R.V. Salame, Technical Officer, SAO & FACO as members for programme execution. Earlier, secondary data of Nagpur district Scheduled Caste farmers were obtained from various sources and then surveyed villages and collected primary data from Gram Panchayat levels. Eleven villages having more than 50% SC farmers engaged in farming and allied activities were selected as a beneficiary for SCSP programme Table 10.9.3.1.

Table 10.9.3.1: Implementation of scsp project in Nagpur district villages indicating more than fifty percent SC population

SN	Block	Gram Panchayat	Village	Total Popu.	Total SC Popu.	Total % of SC Popu.
1	Ramtek	Kandri	Hiwara (bende)	540	281	52.04
2	Umred	Thombra	Thombra	989	579	58.54
3	Kalmeshwar	Sawangi(g)	Ghogali	558	470	84.23
4	Kuhi	Hardoli	Hardoli	757	409	54.03
5	Umred	Dhurkheda	Dhurkheda	1297	823	63.45
6	Umred	Aamboli	Amboli	857	477	55.66
7	Saoner	Sillori	Sillori	890	625	70.22
8	Saoner	Rampuri	Rampuri	1009	516	51.14
9	Saoner	Khairi(p)	Khairi (Panjabrao)	791	443	56.01
10	Umred	Welsakhara	Welsakra	984	515	52.34
11	Katol	Gonhi	Chikhali (Bk)	567	375	66.14

Farmers from these villages participated in the "Kapas Mela 2019" organized at ICAR-CICR, Nagpur on 29 November, 2019 and they were exposed to various activities of the Institute. Farmer's training workshop programme on "Integrated Nutrient and Pink bollworm Management in Cotton" was also held on 17 December, 2019 at Village-Thombra, Tahsil-Umred, Dist. Nagpur which was attended by Dr. V.N. Waghmare, Director, ICAR-CICR, Nagpur and Dr. S.M. Wasnik, Dr. Sunil Mahajan, Dr S.P Gawande, Dr. B.B. Fand, Dr. D.T. Nagrale, Dr. Bhargavi B and state agriculture officials. Dr. V.N. Waghmare urged the farmers to take the advantage of SCSP project aimed at upliftment of the scheduled caste farming community. During the

Workshop on Integrated Pest & Nutrient Management in Cotton at village Thombra, - Umred, Dist.- Nagpur

programme farmers were informed about e-Kapas, Mera Gaon Mera Gaurav and Cotton App developed by ICAR-CICR, termination of crop latest by first fortnight of January, crop rotation, adoption of early maturing varieties, sowing of next season's crop in June, installation of pheromone traps after 45 days of sowing, Safe use of pesticides , strict adherence to label claims, avoiding mixtures and overuse of pesticides and need based spray of only recommended chemicals, identification of diseases and integrated disease management in cotton, integrated nutrient and water management in cotton, procedure of collecting soil samples for soil test etc.

10.9.4: Tribal Sub Plan

One day farmers training cum workshop for tribal farmers of Gadchiroli on "Cotton cultivation technologies" was organised under TSP at Krishi Vigyan Kendra, Sonapur, Gadchiroli on 27th November, 2019 and distributed pheromone traps insecticides (Flonicamid & Pyraclostrobin) and leaflets of pink bollworm management and safe handling of pesticides were distributed to 150 tribal farmers. On this occasion, multidisciplinary team of scientists including Dr Vinita Gotmare, Principal Scientist (Plant Breeding & Genetics) and Nodal Officer (TSP), Dr Chinna Babu Naik, Scientist (Entomology), Dr Ramkrishna, G.I., Senior Scientist (Agronomy) and Dr Dipak Nagrale, Scientist (Plant Pathology) interacted and guided farmers about different aspects of improved cotton production technologies.

Another, one day farmers training program for tribal farmers of Gadchiroli on "Improved Cotton Cultivation Technologies" was organised under TSP at Kewalramji Harde College of Agriculture, Chamorshi, Gadchiroli on 26th September, 2019. During this event, subject experts including Dr Vinita Gotmare, Principal Scientist (Plant Breeding & Genetics) and Nodal Officer (TSP), Dr Babasaheb Fand, Scientist (Entomology) and Dr Dipak Nagrale, Scientist (Plant Pathology). During this program, Smt Preeti Hiralkar, Sub Divisional Agriculture Officer, Gadchiroli, Mr Vasant Valvi, Taluka Agriculture Officer, Chamorshi also grace the training program and their team participated actively in the workshop. Training kit containing literature on IPM of pink bollworm and safe handling of pesticides (leaflets) were distributed to more than 250 tribal farmers during the training program. In addition to this, on farm demonstration of 10 Bt cotton varieties were successfully demonstrated through MGMG programmee in tribal farmers dominated villages of Umred cluster, Dist.-Nagpur. More than 400 farmers were trained on "Cotton production technologies" with distribution of critical inputs. Also, awareness about "Improved cotton production technologies" was created among 150 tribal farmers through exposure visit to Kapas Mela, 2019 held on November 29, 2019 at ICAR-CICR, Nagpur.

10.9.5: Sports

ICAR-CICR Bagged Medals in ICAR-Western Zone Tournament - 2019 held at ICAR- Central Sheep & Wool Research Institute, Avikanagar during 14-18 November, 2019

S No.	Medal Type & Name of Event	Name of Participant/s
1	Table Tennis Winner Trophy 2019 (Gold Medal)	Shri Samir S. Chalkhure, Shri R. M. Lokhande, Shri Bhausaheb Naikwadi
2	Best Athlete Trophy (Women)	Miss. B. Bhargavi
3	Gold Medal -Athletics:(Long Jump)	Miss. B. Bhargavi
4	Gold Medal -Athletics:(Race 100 mtr.)	Miss. B. Bhargavi
5	Gold Medal- Athletics:(Race 200 mtr.)	Miss. B. Bhargavi
6	Gold Medal- Athletics:(High Jump)	Miss. B. Bhargavi
7	Silver Medal- Athletics:(Shotput)	Miss. B. Bhargavi
8	Bronze Medal- Athletics:(Javelin throw)	Miss. B. Bhargavi
9	Bronze Medal- Athletics:(Race 200 mtr.)	Shri Sujit Kumbhare
10	Bronze Medal- Athletics:(Race 800 mtr.)	Shri Sujit Kumbhare
11	Bronze Medal- Athletics:(Race 400 mtr.)	Shri Ajay Sirsam

10.9.6:Library

Additions

In the year 2019, the Library purchased 7 new books and 30 Hindi books. The Library procured the digital book series of Advances in Agronomy from 2012 to 2019 in digital form. Besides that the Library also procured 5 e-books. The Library also subscribed to 15 Indian Journals.

Documentation Services

- Library has developed computerized bibliographic database on Cotton to provide comprehensive and updated information on cotton. About 5144 bibliographic references along with abstracts have been stored in it. Based on this bibliographic database, the Library published a current awareness bulletin namely "COTTON RESEARCH ABSTRACTS". The Bulletin is circulated to all the scientists of the Institute and to all AICCIP Centers in India. Two issues of COTTON RESEARCH ABSTRACTS (V33, (No. 1-2), January – December 2019) were published and circulated.
- 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.
- 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.
- The WebOPAC version of the Library software SLIM21 was updated and by using this Library Application Software, the entire catalogue of holdings of the Library (books and bound volumes) is available on all terminals within the Institute. By its virtue, the entire holdings and the catalogue of the Library are visible on the LAN terminals within the Institute by clicking on the following link. Library Catalogue Web-OPAC Link http://cicrslim/w27/

Library meeting

A one day workshop was conducted by the Library on 13th November 2019 for Scientists and associated staff to enhance the usage and visibility of the CeRA platform. A lecture was arranged on the topic "J Gate@Cera-One platform to discover e-journal literature. The workshop was conducted by Mr Mayank Dedhia from Informatics India, Benguluru.

The Library procured E-books and E-Book series in the form of Advances in Agronomy (2012-2019). An interactive session was conducted for scientists on the effective use of E-book resources on 17th December 2019. Mr Siddhartha Ghosh and Ms Sangeeta Mehta from Elsevier were the resource persons.

10.9.7:Progressive Use of Hindi

भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में वर्ष 2019 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 त्रैमासिक बैठक का आयोजन

संस्थान में राजभाषा हिंदी के सक्रिय प्रचार–प्रसार के हेतु राजभाषा कार्यान्वयन समिति (वित्तीय वर्ष 2019–20) की त्रैमासिक बैठकों का आयोजन निम्नानुसार किया गया।

राजभाषा कार्यान्वयन समिति की बैठकों की तिथि :

क्र.	दिनांक	विषय
1	13 जून, 2019	वर्ष–2019, राजभाषा कार्यान्वयन समिति की द्वितीय बैठक
2	22 अगस्त, 2019	वर्ष–2019, राजभाषा कार्यान्वयन समिति की तृतीय बैठक
3	24 दिसम्बर, 2019	वर्ष–2019, की राजभाषा कार्यान्वयन समिति की चतुर्थ बैठक

हिंदी सप्ताह

'हिंदी सप्ताह समारोह' का विधिवत् उदघाटन दिनांक 07 सितम्बर, 2019 को भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर के निदेशक डॉ. विजय नामदेव वाघमारे, की अध्यक्षता में किया गया। अपने अध्यक्षीय संबोधन में संस्थान में राजभाषा (हिंदी) के बहुमुखी विकास हेतु उपस्थित अधिकारियों एवं कर्मचारियों से अपने प्रशासनिक कार्यों के अतिरिक्त वैज्ञानिक एवं तकनीकी क्षेत्रों में भी हिंदी का अधिक–से अधिक उपयोग करने का अनुरोध किया, ताकि सही अर्थों में संस्थान में राजभाषा(हिंदी) का बहुमुखी विकास हो सके। कार्यक्रम का संचालन करते हुए डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.) ने इस सुअवसर पर समारोह' के अंतर्गत विभिन्न हिंदी प्रतियोगिताओं का आयोजन किया।

हिंदी सप्ताह समापन समारोह' का आयोजन दिनांक 13 सितम्बर, 2019 को किया गया। इस अवसर पर श्रीमती सरोज व्यास, कवियित्री संस्थान की ओर से "मुख्य अतिथि महोदया" के रूप में सादर आमंत्रित थी। अपने मुख्य सम्बोधन में "मुख्य अतिथि महोदया" ने हिंदी को एक बहुत ही सशक्त एवं बहुआयामी भाषा बताते हुए उसके साहित्यिक पक्ष को सभा के सामने रखा और सभा को यह बताया कि आज हिंदी अपनी इन्हीं बहुआयामी विशेषताओं के कारण हर क्षेत्र में लोकप्रिय है और सही अर्थों में राष्ट्रभाषा पद की अधिकारिणी है।

इस समारोह के कार्यक्रमाध्यक्ष डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर के शुभहस्ते संस्थान में हिंदी सप्ताह समारोह –2019 के अंतर्गत आयोजित हिंदी संबंधित विभिन्न प्रतियोगिताओं के विजयी प्रतिस्पर्धी अधिकारियों एवं कर्मचारियों को नकद पुरस्कार वितरित किए गए।

'एक दिवसीय हिंदी कार्यशालायें

प्रशासनिक/तकनीकी संवर्ग के कार्मिकों हेतु

एक दिवसीय हिंदी कार्यशाला दिनांक 8 मार्च 2019 का सफलतापूर्वक आयोजन डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय

कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में एवं अतिथि वक्ता श्री मनोज कुमार, सहायक मुख्य तकनीकी अधिकारी(रा.भा), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली की गणमान्य उपस्थिति में संस्थान में प्रशासनिक एवं तकनीकी संवर्ग के कार्मिकों हेतु संस्थान में किया गया। मुख्य अतिथि वक्ता ने बड़े ही रोचक एवं मनोरंजक तरीके से संसदीय राजभाषा प्रश्नावली भरे जाने के संबंध में उपस्थित अधिकारियों/कर्मचारियों का मार्गदर्शन किया।

डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर उद्घाटन सत्र को संबोधित करते हुऐ।

वैज्ञानिक एवं तकनीकी अधिकारी

एक दिवसीय हिंदी कार्यशाला (दिनांक : 25 जून, 2019) का सफलता पूर्वक आयोजन डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में एवं मुख्य अतिथि डॉ. धर्मेश धावनकर, प्रोफेसर एवं विभागप्रमुख, जनसंवाद विभाग, राष्ट्रसंत तुकडोजी महाराज नागपुर विश्वविद्यालय, नागपुर की गणमान्य उपस्थिति में संस्थान के 'वैज्ञानिक एवं तकनीकी अधिकारी संवर्ग' हेतु किया गया। कार्यशाला के मुख्य अतिथि डॉ. धर्मेश धावनकर ने संस्थान में चल रही राजभाषा हिंदी संबन्धित विभिन्न गतिविधिओं की सराहना करते हुए कहा कि संस्थान में कार्यरत अधिकारी एवं कर्मचारीगण राजभाषा हिंदी के प्रति सजग है, जिसके परिणाम स्वरूप संस्थान को पिछले वर्ष परिषद के गरिमामयी 'राजर्षि टंडन राजभाषा पुरस्कार' से सम्मानित किया गया। इस हिंदी कार्यशाला में संस्थान के लगभाग 60 वैज्ञानिक एवं तकनीकी अधिकारियों ने सक्रिय रूप से भाग लेकर इस हिंदी कार्यशाला को सफल बनाया।

इसी वर्ग के लिए दूसरी कार्यशाला का आयोजन दिनांक 11 सितंबर, 2019 को डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता की गणमान्य उपस्थिति में संस्थान किया गया। कार्यशाला के मुख्य प्रशिक्षक डॉ. उल्हास नन्दनकर, मुख्य तकनीकी अधिकारी एवं प्रक्षेत्र अधीक्षक ने कार्यशाला में सहभागी समस्त प्रशासनिक एवं समस्त तकनीकी कार्मिकों को 'यूनिकोड' के महत्व को अवगत कराते हुए कहा की यह बहुत ही सरल–सुबोध सॉफ्टवेअर है जिसके माध्यम से अपना कार्यालयीन हिन्दी टंकन कार्य बडी आसानी से कर सकते है। संस्थान द्वारा 'वैज्ञानिक एवं तकनीकी अधिकारी संवर्ग' हेतु आयोजित इस हिंदी कार्यशाला में संस्थान के लगभग 60 अधिकारियों ने सक्रिय रूप से भाग लेकर इसको सफल बनाया।

वर्ष के अंतिम तिमाही में प्रशासनिक/तकनीकी संवर्ग के कार्मिकों के 'यूनिकोड' विषय पर आधारित शिक्षण–प्रशिक्षण कार्यशाला का आयोजन संस्थान में दिनांक 28 दिसंबर, 2019 को डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में एवं मुख्य अतिथि वक्ता डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा), भा.कृ.अनु.प.– राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो, नागपुर की गणमान्य उपस्थिति में किया गया। इस कार्यशाला में संस्थान के लगभाग 24 प्रशासनिक एवं तकनीकी संवर्ग के कार्मिकों ने सक्रिय रूप से भाग लेकर इस हिंदी कार्यशाला को सफल बनाया

राजर्षि टंडन राजभाषा पुरस्कार

नई दिल्ली स्थित राष्ट्रीय कृषि विज्ञान परिसर (NASC) के सी. सुब्रमणियम सभागार में दिनांक 16 जुलाई, 2019 को भारतीय कृषि अनुसंधान परिषद् के 91 वें स्थापना दिवस के सुअवसर पर भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर को 'ख' क्षेत्र के अंतर्गत वर्ष 2017–18 के दौरान सरकारी कामकाज में हिंदी के प्रयोग में उल्लेखनीय योगदान हेतु पुरस्कार समारोह में डॉ. त्रिलोचन महापात्र, सचिव (डेयर) एवं महानिदेशक, भा.कृ.अनु.प., नई दिल्ली के करकमलों द्वारा "राजर्षि टंडन राजभाषा पुरस्कार" (प्रथम पुरस्कार) से सम्मानित किया गया। संस्थान की ओर से यह पुरस्कार डॉ. विजय नामदेव वाघमारे, निदेशक एवं डॉ. महेन्द्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.), भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ने ग्रहण किया।

भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर "राजर्षि टंडन राजभाषा पुरस्कार (प्रथम) : 2017–18" से सम्मानित

10.10: Weather

Nagpur

Month	Temperature (^{0}C)		Relative Humidity (%)		Rain fall (mm)	No. of Rainy Days
	Max	Min	Max	Min		
April, 2019	37.07	24.99	48.88	21.87	18.30	3
May, 2019	40.40	30.12	32.82	19.52	0.0	0
June, 2019	37.92	29.03	51.86	35.82	132.40	8
July, 2019	29.99	25.08	77.60	65.52	398.4	20
August, 2019	28.2	24.9	87.4	79.5	343.40	20
September, 2019	28.2	24.4	91.6	79.1	275.0	19
October, 2019	28.3	22.4	82.9	59.0	77.0	4
November, 2019	26.5	17.3	76.8	46.4	0.0	0
December, 2019	22.9	13.1	73.0	48.1	14.6	3
Total					**1259.1**	**33**

Coimbatore

Month	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	No. of Rainy Days	Sun shine hours	Solar radiation (cal/cm2/ day)
	Max	Min	Morning	Evening				
April, 2019	36.7	24.5	85	43	23.6	2	8.8	391.1
May, 2019	35.8	24.9	85	51	77.8	6	8.6	372.2
June, 2019	33.5	24.8	79	55	21.0	3	7.1	364.9
July, 2019	31.8	23.7	82	58	8.5	-	4.9	492.0
August, 2019	29.9	23.0	84	66	221.3	7	4.2	264.5
September, 2019	30.9	23.4	84	65	57.3	9	5.4	315.8
October, 2019	30.7	22.7	87	62	246.9	13	5.9	299.8
November, 2019	29.6	22.2	87	60	167.1	9	6.3	337.4
December, 2019	27.8	21.2	86	62	36.0	5	4.3	280.7
Total					**859.5**	**54**		

Sirsa

Month	Temperature (°C)		Relative Humidity (%)		Rain fall (mm)	No. of Rainy Days
	Maximum	Minimum	Maximum	Minimum		
April, 2019	36.6	22.4	63.5	33.1	32.6	2
May, 2019	39.7	25.8	52.4	26.7	2.6	1
June, 2019	41.4	28.2	59.3	35.6	66.6	2
July, 2019	35.4	24.4	75.1	60.0	181.0	9
August, 2019	35.7	25.0	75.1	61.3	44.7	4
September, 2019	35.3	25.4	78.3	58.2	0	0
October, 2019	32.3	19.2	78.7	45.5	1.2	1
November, 2019	26.2	14.0	80.9	51.8	25.6	3
Total					**354.3**	**22**

10.11: Cotton Scenario

Area: in Lakh Hectares
Production: in Lakh bales of 170 kg.
Yield: Kg per hectare

State	Area		Production*		Yield	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Punjab	2.68	3.92	11.50	13.00	729.48	563.78
Haryana	7.08	7.01	23.00	22.00	552.26	533.52
Rajasthan	6.29	6.45	25.00	25.00	675.68	658.91
Total North Zone	**16.05**	**17.8**	**59.50**	**60.00**	**630.22**	**573.03**
Gujarat	26.59	26.29	87.00	95.00	556.22	614.30
Maharashtra	42.54	43.69	77.00	82.00	307.71	319.07
Madhya Pradesh	6.14	6.10	24.00	20.00	664.50	557.38
Total Central Zone	**75.27**	**76.08**	**188.00**	**197.00**	**424.60**	**440.19**
Telangana	18.27	17.61	47.00	53.00	437.33	511.64
Andhra Pradesh	6.21	5.86	15.00	20.00	410.63	580.20
Karnataka	6.88	5.50	15.00	18.00	370.64	556.36
Tamil Nadu	1.31	1.25	6.00	6.00	778.63	816.00
Total South Zone	**32.67**	**30.25**	**83.00**	**97.00**	**431.89**	**545.12**
Odisha	1.58	1.70	4.50	4.00	484.18	400.00
Others	0.50	0.43	2.00	2.00	680.00	790.70
All-India	**126.07**	**125.84**	**337.00**	**360.00**	**454.43**	**486.33**

Source: Cotton Advisory Board, Ministry of Textile, Govt. of India.
* Provisional as estimated by CAB in its meeting held on 28.11.2019

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