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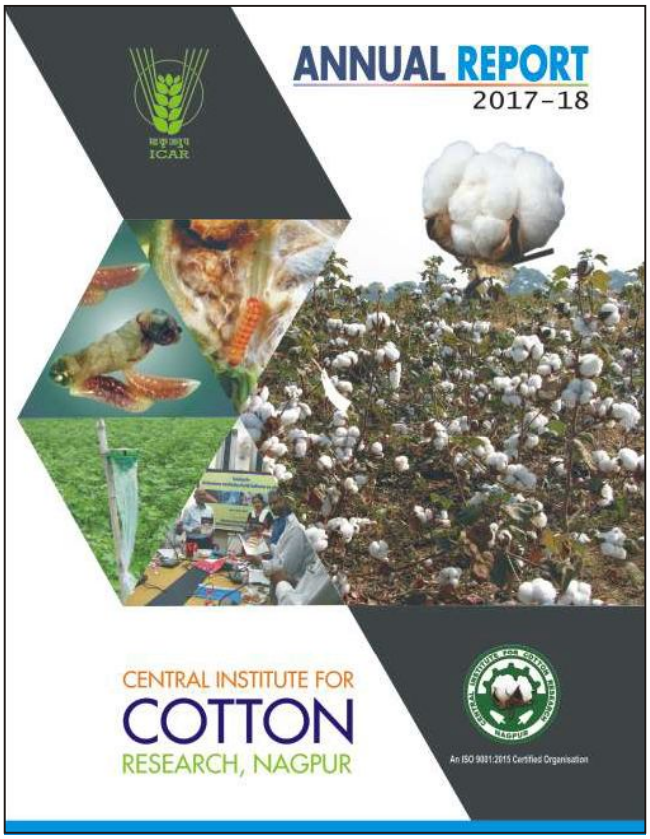
ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR



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PREFACE

Cotton, the `White Gold' is the most important natural fibre. Cotton crop not only provides fibre for the textile industry, but also plays a vital role in the feed and oil industries with its seed, rich in oil and protein. The area under cotton increased from 10.8 m ha in 2016-17 to12.429 m ha in 2017-18. However, there was decline in area of *desi* cotton, *G. arboreum* from 80,000 ha to 40,000 replaced by BGII hybrids. For the first time, 8 Bt varieties carrying *Cry1Ac* gene developed by public sector institutes were approved for commercial cultivation in the country. With the ongoing evaluation across different AICRP centers and ICAR-CICR, more promising Bt and non-Bt varieties will be made available for cultivation and farmers will have options to retain seeds from the produce, thereby reducing cost on seed and cotton production. Two *G. hirsutum* varieties, CCH 12-2 and CCH 12-3 were developed and identified for Central zone under irrigated condition. CCH 14-1 has also been identified for irrigated conditions of South zone. In addition, two varieties namely, CCH 15-1 (for irrigated conditions of central and south zones) and CSA 1028 (for rainfed conditions of central zone) have been promoted to Agronomic trials.

The ICAR-CICR is maintaining 11648 germplasm accessions and wild genetic resources of *Gossypium.* During 2017-18, institute enriched its Germplasm Bank by adding 58 exotic accessions and three variants of landraces. A protocol for somatic embryogenesis in Coker genotypes has been standardized which will pave way to development of indigenous transgenics in future. Sunhemp has been identified as the most effective legume cover crop for weed management in cotton. The resistance development of pink bollworm on BG-II and non Bt cotton fields was continuously monitored across all cotton growing states. The analysis of historical data on population dynamics of whitefly indicated that there has been an advancement shift in peak occurrences of whitefly infestation. Tobacco Streak Virus (TSV) on *G. hirsutum* was recorded in some fields of Punjab and Haryana and also on *G. barbadense* cotton in Tamil Nadu.

The Institute was in spotlight and under public scanner on account of widespread infestation of pink bollworm in all major cotton growing states, deaths of farmers and farm labourers due to indiscriminate and unscientific use of pesticides in Yavatmal district of Maharashtra and illegal cultivation of Herbicide Tolerant cotton in the states of Maharashtra, Gujarat, Telangana, Andhra Pradesh and Karnataka. The institute has ably provided leadership and coordinated the implementation of strategies to manage pink bollworm in Gujarat. Similar proactive strategies were devised for management of this pest in the states of Maharashtra, Telangana, Andhra Pradesh, Karnataka and Madhya Pradesh. Awareness campaign was launched involving all stakeholders including Researchers / Scientists of ICAR-CICR, SAUs and KVKs and officials of State Departments of Agriculture, representatives of Seed and Pesticide Industries and Ginneries. Our efforts to reach out to the farmers were vigorously pursued through the '*Mera Gaon Mera Gaurav*' (MGMG) programme and Tribal Sub Plan (TSP). Weekly articles on various improved production and protection technologies for the benefit of cotton farmers were further disseminated through the

popular articles in agricultural daily newspaper in Marathi / local languages through bulletins, radio talks and farmers meets. More than 6.11 lakh voice messages were delivered to 87,132 registered farmers on their mobiles in Nagpur district alone.

I am grateful to Dr. Trilochan Mohapatra, Secretary DARE & DG ICAR, Dr. A.K. Singh, DDG (CS), Dr J.S. Sandhu, [the then DDG (CS)] and Dr R. K. Singh, ADG (CC) for their constant encouragement, guidance and support. Contributions of Dr. M.S. Ladaniya in managing the activiites of the institute during his tenure as Director (Addl.Charge) is greatfully acknowledged. The Heads of Divisions I/c, Dr Blaise Desouza and Dr Nandini Gokte Narkhedkar, Dr. S. Kranthi and Dr D. Monga, Head, Regional Station, Sirsa, Dr A. H. Prakash, PC and Head I/c, Regional Station, Coimbatore and Dr M. V. Venugopalan, Principal Scientist & I/c PME Cell have contributed immensely to the execution of research programmes and their contribution in making of this report deserve special gratitude. Thanks are also due to the Editorial Committee members for their sincere efforts in bringing out this publication. Mrs. Rama Iyer, Sh. Sameer Chalkhure and Mrs Vandana Satish deserve special appreciation for their dedication, sincerity and commitment in bringing out this Annual Report to a beautiful shape in a short span of time.

(V. N. Waghmare)
Director (Acting)

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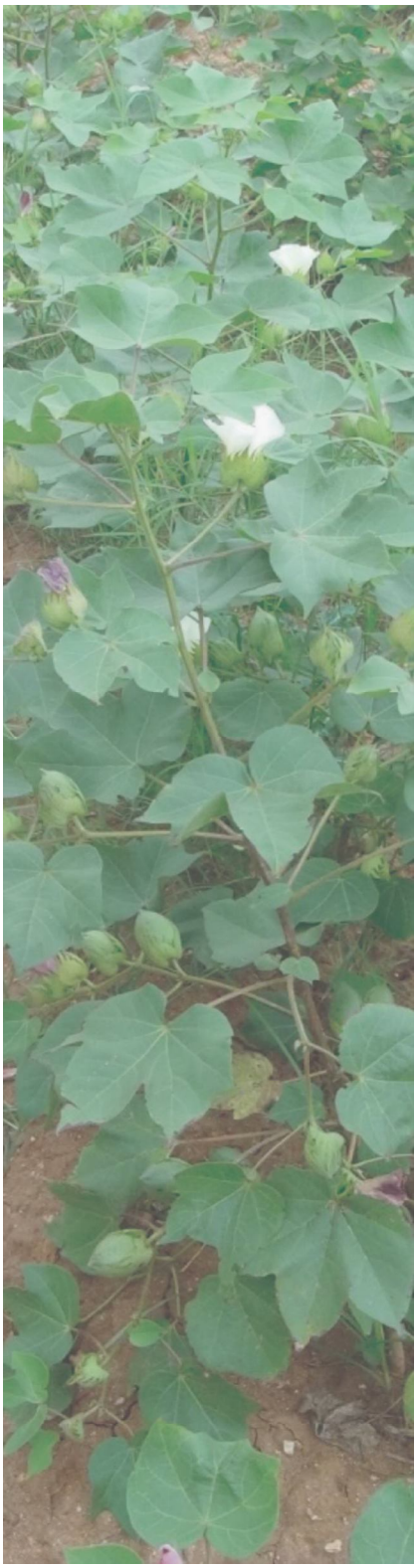


1. EXECUTIVE SUMMARY

CROP IMPROVEMENT

Genetic Resources

- A total base collection of 11648 accessions of cotton germplasm that includes *G. hirsutum* (8505), *G. barbadense* (312), *G. arboreum* (1936) and *G. herbaceum* (565) are maintained in the National Cotton Gene Bank at ICAR-CICR, Nagpur.
- Seeds of 1602 accessions of *G. hirsutum* and 3 registered genetic stocks of *desi* cotton (Brown linted) were deposited at ICAR–NBPGR, New Delhi for long term storage.
- National Cotton Gene Bank at ICAR-CICR, Nagpur was enriched with 56 accessions of *G. hirsutum* and 2 of *G. barbadense* procured from USA.
- Three GMS lines and 18 newly identified GMS lines were maintained through sibmating. A pigmented thermo-insensitive GMS line CISG 20 was identified for registration with ICAR-NBPGR, New Delhi.

Germplasm Evaluation

- A set of 34 Coker variants, 2 accessions resistant to CLCuD and 58 exotic accessions were characterized for economic and fibre quality traits.
- A set of 1000 *G. arboreum* accessions were evaluated for fibre quality traits and promising germplasm accessions were identified for future breeding programme.
- In *G. barbadense*, five accessions possessing hairiness *viz.*, ICB-85, ICB-124, ICB-264, ICB-284 and HAG-02 were identified as promising for sucking pest tolerance.

Wild Species

- Wild genetic resources including 24 wild species, 12 races, 40 interspecific derivatives, 254 perennials and land races of *Gossypium* species were maintained in wild species garden of the Institute. Herbarium of the available species, races of cultivated species and registered unique genetic stocks was made to showcase uniqueness and diversity of *Gossypium* species.
- F_4 population of four crosses *viz.*, *Jawahar Tapti* × *G. longicalyx*, *G. arboreum* × *G. thurberi*, *G. arboreum* race indicum × *G. davidsonii* and *G. arboreum* Cv. AK 8401 × *G. davidsonii* were evaluated for economic traits and promising single plants were selected.

Population Improvement

- Intermating between progenies of three-way and multiple crosses involving *G. hirsutum* and *G. barbadense* was attempted and promising single plant progenies based on specific trait performance and combination of introgressed characteristics such as sub-okra leaf shape, cleistogamous flowers, stay green plants, high fibre quality and yield potential were selected for generation advancement.
- To develop compact plant type with early maturity and good fibre quality, intermating was carried out between 15 inbred lines. Eight and ten parental crosses were advanced from F_2 to F_3 generation for development of MAGIC RILs.
- Based on the performance, uniformity and fibre quality, 16 progenies of *G. arboreum* and 32 of *G. hirsutum* were identified from random mating populations for evaluation in replicated trial.

Molecular markers

- A set of 227 RILs developed from interspecific cross of *G. arboreum* (KWAN-3) x *G. herbaceum* (Jayadhar) to be used for development of consensus map using SNP genotyping were evaluated for economic and fibre quality traits.
- A total of 86 distinctly polymorphic SSR markers were identified and utilized for molecular diversity analysis among cotton varieties. A selected set of 20 SSR markers with high PIC were identified and utilized in development of robust DNA fingerprint of cotton varieties.
- Microsatellite marker based molecular characterization of 114 accessions of perennials and landraces of *desi* cotton was completed.

Interspecific hybridization

- Three interspecific F_1 plants from the interspecific cross (*G. hirsutum* × *G. arboreum*) were established through embryo rescue/immature embryo culture. Sterility of these interspecific F_1 plants was confirmed through pollen studies.
- Study of heterosis among the intra- and inter-specific crosses revealed that *G. herbaceum* x *G. arboreum*

hybrids produced more heterosis than the intra-*herbaceum* hybrids.

Early maturity

- Two early maturing breeding lines namely, CNH 09-7 and CNH 09-9 with seed cotton yield of 1165 and 1192 kg/ha respectively and having Bartlett's earliness index of 0.9 were identified.
- Most promising plants were selected for earliness (120-130 days), jassid tolerance (grade 1), compact plant type, boll weight, yield and fibre quality characters from the segregating populations (F_2, F_3, F_5 and F_6). Potential of selected promising entries was assessed under HDPS. A total of 72 selected progenies possessing earliness, jassid tolerance and compact plant architecture were tested for Bt gene through ELISA and for homozygosity through gene-specific PCR. Of which 13, 48 and 11 progenies were identified as homozygous, hemizygous and azygous respectively for *cry1Ac* gene (Mon 531 event).

Varieties identified for release

- The high yielding variety Central Cotton CCH 12-2 (Suchitra) has been identified by CVIC for Central Zone under irrigated conditions. The variety recorded a mean seed cotton yield of 1767 kg/ha possessing an upper half mean length (28.0 mm), micronaire (4.2) and tenacity (29.0 g/tex).
- Central Cotton CCH 12-3, a *G. hirsutum* variety identified by CVIC for release in Central Zone under rainfed conditions recorded a mean seed cotton yield of 1060 kg/ha.
- Proposal for identification of high yielding good quality Central Cotton CCH 14-1 has been submitted to CVIC for release in irrigated condition in South Zone.

Bt varieties of ICAR-CICR

- Six Bt varieties *viz.,* ICAR-CICR Bt 14 (CPT2), ICAR-CICR Bt 9 (SRI1), ICAR-CICR GJHV 374 Bt, ICAR-CICR PKV 081 Bt, ICAR-CICR Rajat Bt and ICAR-CICR Suraj Bt carrying *cry1Ac* (Mon 531) gene were approved for commercial cultivation under rainfed conditions of Maharashtra.
- Bt variety CICR-Bt6 developed from ICAR-CICR, Regional Station, Sirsa was approved for commercial cultivation in Haryana state. It recorded the seed potential of 3046 kg/ha under HDPS and was found to be significantly superior than local check hybrid RCH 773 BGII in Haryana.
- Eleven new Bt genotypes (*cry1Ac*) were sponsored for testing in AICRP trial (2018-19) and the same number of entries tested in AICRP (2017-18) have been promoted for second year testing.

Stress tolerance

- One hundred and sixty six (166) cotton germplasm lines were evaluated in rainfed and irrigated regimes and seventeen (17) promising lines were identified as drought tolerant based on physiological parameters *viz.*, relative water content and mid-day leaf water potential. Lines DTS-405, DTS-413, Nagpur-9, N-2924, CNH-09-4 and 2853 were identified as promising for yield, drought tolerance and compact plant architecture.
- Crossing between five identified waterlogging tolerant (IC 359979, IC 359245, IC 357235, INGR 08092 & INGR 08093) and susceptible (IC 356708, IC 357607, IC 357558, IC 359242, IC 359915) accessions was attempted for development of water logging tolerant varieties.
- Sixteen crosses were attempted among CLCuV tolerant germplasm lines of *G. hirsutum* in a Line x Tester fashion. Thirteen F_6 progenies having high yield potential and tolerance against CLCuV were selected for advancement to station trial.

Transgene introgression

- Three BC_1F_1 populations of Tg2E13 event and three F_1 populations of CH12 event were evaluated for transgene expression. Event positive and high toxin expressing plants were utilized in backcrossing with their respective recipient cotton varieties in contained facility at ICAR-CICR, Nagpur. Embryo culture protocol was successfully explored for accelerated generation advancement.

Seed storability

- Different packaging materials were evaluated for better storability for varying period. Vacuum packing followed by orange paper envelop packing showed better storage results and maintained higher seed germination as compared to brown paper, polylined aluminium and polythene heat sealed packets.

Seed production

- A total of 1.73 q. nucleus seed of 3 Bt cotton varieties, 3.36 q. breeder seed of different cotton varieties and parents of the hybrid, 6.68 q. truthfully labeled seeds of different cotton varieties, 265 q. of certified seed of wheat Cv. WH 1142, 0.5 q. of certified seed of gram

Cv. Vijay, and 4.7 q. of certified seed and 5.14 q. truthfully labelled seeds of Red gram Cv. BSMR-736 was produced.

DUS characterization

- DUS characterization of 4 entries (first year trial), 4 entries (second year trial), 2 entries (Varieties of Common Knowledge trial), 2 entries (Essentially Derived Variety and Initial variety trial) and 12 entries (Reference trial) was conducted.

Somatic embryogenesis

- Protocol for transient gene expression through somatic embryogenesis in Coker genotypes (312 and 310) has been standardized. Indole-3-butyric acid (1mg/L) in woody planting medium was found to be effective for improving the rooting efficiency of germinated somatic embryos in Coker 310 genotypes.

Cotton genomics

- Genome wide *in-silico* analysis of *G. arboreum* led to identification of 16 *GaLIM* members similar to animal cysteine rich proteins and 4 belong to plant specific *LIM* family *viz., GaDA1-1, GaDA1-2, GaDA1-3* and *GaDAR1.* Gene expression patterns of plant specific LIM family in response to biotic and abiotic signals were found to be significant.
- Significant down regulation in the expression of zinc finger protein encoding genes *viz., Ghzfp5* and *Ghzfp8* at 0 and 1 days post anthesis in *G. hirsutum* Cv. MCU5 mutant compared to its wild type was recorded, suggesting possible involvement of GHZFP5 and GHZFP8 transcription factors in the gene regulatory pathway of cotton fiber initiation.

Gossypol detoxification

- Gossypol detoxification assay of deoiled cotton seed cake using CYP6AE14 protein from *H. armigera* and newly isolated microorganisms from cotton soil rhizosphere showed total gossypol reduction efficacy from 8.19 to 73% over control. Seven microbial isolates showed gossypol reduction of more than 40 per cent.

Herbicide Tolerant (HT) cotton

- ICAR-CICR, Nagpur conducted field surveys and collected 379 leaf samples from different cotton fields suspected to be growing HT cotton from Wardha, Chandrapur, Yavatmal and Nagpur districts of Vidarbha, Maharashtra. Out of 379 leaf samples tested, 171 samples were positive for Roundup Ready Flex (RRF) harbouring CP4-EPSPS gene confirming illegal cultivation of HT cotton.

Entries sponsored in AICRP (2017-18)

- Cultures CSH 3419 & CSH 1604 in Br 02(a), CNH 1126, CNH 25-09, CNH 11-11, CNH 12-4-2, CNH 2050, CNH 09-70 in Br 02 (b), CSH 3824 & CSH 1613 in Br 06(a), CNH 1127, CNH 1128, CNH 136, CNH 09-9, CNH 09-98, CNH 2048 in Br 06 (b), CCB 64, CCB 129, CCB 143, CCB 102 in Br 12 (a); CCHB 32, CCHB 14 in Br 15 (a); CNA 1033, CNA 1034, CNA 2016, CNA 2031, CISA 7, CISA 33-5 in Br 22 (a/b); CNA 1058, CNA 1067, CNA1037, CISA 33-7, CISA 33-8 in Br 22 (a/b) LL; CISAA 17-1, CISAA 17-2 in Br 25 (a/b) were sponsored in respective trials of AICRP on Cotton during 2017-18.

Entries promoted in AICRP (2018-19)

- **NORTH ZONE TRIAL :** CISAA 17-1 & CISAA 17-2 in Br 25 (a/b) and Culture CSH 3129-2 were promoted to Br 06(a) (North and south zone) & CSH 5640 to north zone only. CISA 33-3 was promoted to Br 24(a) zonal trial of AICRP on Cotton during 2017-18. The culture CISA 6-2 retained in Br 24(a) zonal trial (4th year) of AICRP on Cotton during 2017-18.
- **CENTRAL ZONE TRIAL** : CNH 11-11, CNH09-70 to Br 03 (b), CNH09-9 to Br 06 (b), CCB 64, CCB 129, CCB 143-(b) to Br 13 (a) PVT *G. barbadense,* CNA 2031, CNA 1054 to Br-24 (b) CVT – *G. arboreum,* CNA1037 to Br-24 (b) CVT -LL– *G. arboreum,* CISAA 17-2 to Br25 (b)
- **SOUTH ZONE TRIAL :** CSH 1613 to Br-06(a), CCB 143 (b), CCB 64, CCB 129 to Br 13 (a), CNH09-70 to Br-03(b), CNH 1128 to Br06 (b), CNA 1054 to Br-24 (b): CVT – *G. arboreum,* CNA1037 to Br-24 (b) LL: CVT – *G. arboreum,* 16315 LB, 16301 DB, 16337 LB to Coloured Cotton Trial *G. hirsutum,* CNA407 SLP, 16378 LB-1, CNA405, CNA407 and 16377 LB-A to Coloured Cotton Trial *G. arboreum.*

Entries proposed for agronomy trial

- **Central zone:** CCH 15-1, *G. hirsutum,* Variety (Irrigated), CSA 102, G. *arboreum* Variety, (Rainfed); **South zone:** CCH 15-1 *G. hirsutum,* Variety (Irrigated)

Crop Production

Weed management

- Sunnhemp, sorghum and sesame were the most effective in smothering weed growth. The major compounds identified in the cover crops were, phytol and pentadecanoic acid,1,4-methylene methyl ester in sorghum; squalene & linolenic acid in sunnhemp and 9,12-octadecadienoic acid, 9,12-octadecatrienoic

acid (Z,Z) & their methyl esters in sesame.

Long linted Desi cottons

- Among, seven *G. arboreum* genotypes (6 long linted - DLSA 17, PA 528, PA 402, PA 812, PA 760, CNA 1037 and short stapled Phule Dhanwantary evaluated under rainfed conditions at 2 spacings (60x10-HDPS and 60x 30 cm-normal) on a shallow Inceptisol (Typic Haplustept) and a deep Vertisol (Typic Haplustert) on two sowing dates - June 22 and July 7, 2017 at Nagpur, highest yield of 2522 kg/ha was realized with CNA 1037 planted at 60x10 cm on June 22, 2017 on an Inceptisol.
- Test of Homogeneity in yield for soil types and dates of sowing indicated that genotypes DLSA 17, PA 812 and Phule Dhawantary shows homogeneity for different soil types and dates of sowing for the spacing 60x10 cm. Similarly, under 60x30 cm spacing, the genotypes PA 402 and PA 760 shows homogeneity for different soil types and dates of sowing
- At Coimbatore, among seven long linted *G. arboreum* genotypes (DLSA 17, PA 760, PA 812, PA 402, PA 528, K12 and Phule Dhanwantery) planted in two dates of sowing dates (4th August and 4th September 2017). ,K-12 registered the highest seed cotton yield.
- De-topping + side shoot removal and application of Mepiquat chloride @ 50 g ai/ha in 2 sprays were effective in reducing plant height and improving the yield of *G arboreum* variety PA 255.
- Estimation of ethylene level in young cotton bolls was done in six long linted desi cotton genotypes (& check). There were significant differences among the genotypes. Expression analysis of two major enzymes of ethylene biosynthesis Aminocyclopropane (ACCS and ACCO) was performed using qRT-PCR, to correlate their expression with ethylene level. The expression of ACCS was more or less same as of ethylene level in respective varieties.

Nutrient management in calcareous soil

- Results of on farm field experiments in calcareous soil clearly indicated that moisture stress can be overcome by opening ridges and furrows with first hoeing operation. Further, multiple nutrient stress in calcareous soil can be managed by use of biofertilizer (*Azotobacter*+PSB+*Trichoderma*) treated seeds along with 125% RDF and application of micronutrients based on soil test.

Stress and cotton biochemistry

- Cotton leaves showed Oxalate oxidase (OxO) activity, but it was less as compared to sorghum a C-4 plant. Compared to other tissues (leaves, fiber), cotton seeds had maximum OxO activity. Drought stressed leaves had greater OxO activity than un-stressed leaf samples.

Brush type cotton harvester

- Under the development, refining and up-scaling of Brush type cotton harvester, quality of pre-cleaned cotton in a boll crusher did not significantly differ from that of brush type harvested cotton. Total picking cost for manual picking, Brush type Stripper cotton cleaned in pre-cleaner factory set up and Brush type Stripper cotton cleaned in a low cost boll crusher was found to be Rs. 6, Rs. 4.1 and Rs. 2.6/kg, respectively.

Nanofertilizers

- Commercially available nanofertilizers (Nualgi and Nanomol) were evaluated. Nualgi nanofertilizer without surfactant and Nanomol with surfactant showed significant effects on increasing Nitrogen concentration in the cotton plants. However, nanofertilizers did not influence fibre quality parameters.

Cotton epigenetics

- Epigenetic regulating chemicals (ERC) did not cause phytotoxicity or adverse effect to cotton plants. Among the different treatments, seed treatment with Nicotinamide @ 35 µM increased the plant height, number of leaves and number of bolls in case of Suraj and seed treatment with epigallocatechin @ 100 µM increased the number of bolls in LRA 5166.

Conservation agriculture

- Seed cotton yield was significantly influenced by the land shaping treatments, namely, ridge and furrow (1875 kg ha^{-1}), and bed and furrow (2157 kg ha^{-1}). In terms of cropping systems, highest seed cotton yield was recorded in cotton – black gram – maize (for grain purpose) system followed by cotton – maize (for green cobs) + pigeon pea (strip cropping 4:2 ratio) plots and conventional cotton – fallow system. Conservation agriculture found decreased soil penetration resistance.

Cotton economics

- Eighteen cotton growing districts of Maharashtra

were surveyed for changes in cotton area and cropping pattern for the period 2000-01 to 2014-15. Preliminary analysis indicated that in 13 districts, cotton area increased during the study period. Acreage increase ranged from <0.5 lakh to > 1.0 lakh ha. Highest increase in cotton area was observed in Aurangabad district followed by Beed and Jalna districts. Highest decrease in cotton area was observed in Amravati, followed by Akola, and Washim.

e-Kapas and Advisories

- Weekly/fortnightly cotton production advisories in Marathi language were prepared and published regularly in news papers Agrowan-Sakal, Deshonnati-Krushokonnati for wider dissemination among the growers. More than 6.11 lakh recorded voice messages were uploaded in the form of automatic phone calls to 87,132 registered farmers' mobile numbers of Nagpur district alone.

Decision support systems

- Grow Good Cotton- a mobile app for cotton pest management was developed. The Mobile application included interactive Decision Support system where user can interact and choose the option for pest management based on Economic Threshold Levels (ETLs). The application also incorporated voice module and pictorial representation to select the correct symptoms of damages on cotton plant and also to break the language and literacy barriers

Yield gap analysis

- Yield gap between potential and realized yield on farmers field is more than 30%. Analysis on yield enhancement due to Front Line Demonstrations (FLD) revealed that an average of 18.70 per cent increase over the normal farmers' practices was obtained in various locations. Possibilities exist to bridge the gap in cotton yield by proper diagnosis of the gap, devising appropriate management options to close the gap and fitting TOT innovations to disseminate the gap reducing technologies.

Crop Protection

Population dynamics of pests

- Seasonal pest population dynamics data on DCH 32 at Nagpur under pesticide free conditions recorded that Jassid were above ETL starting from third week of August till second week of September with a peak population at 36 SW (Standard Week). The highest number of aphids (146/3 leaves) were recorded during 33 SW. Whitefly and thrips were below ETL throughout the season. Negligible population of American bollworm, spotted bollworm, mirid bug and spider populations were recorded.
- Pest population dynamics in five genotypes (DCH32, RCH2, Phule Dhanwantary, Suraj and Suvin) were compared at Nagpur over the season. Population of Jassid and aphid was significantly higher at 6.51 jassid and 11.46 aphids/ 3 leaves on DCH 32. Thrips, mirids, American bollworm, spotted bollworm, mirid and spider populations were negligible in all the genotypes
- Pink bollworm infestation at Nagpur was recorded on cv Suraj from September end till first week of January. During first fortnight of October 68% boll infestation was recorded. Infestation reduced in first week of November and again steadily increased to reach up to 84% boll infestation.
- During 2017-18, highest pheromone trap moth catches of American bollworm (5.80 moths/ trap/ week), spotted bollworm (5.33 moths/trap/week), pink bollworm (99 moths/ trap/ week) and tobacco caterpillar (26.6moths/ trap/ week) were recorded at 50SW (23-29 Dec), 50SW (23-29 Dec), 47 SW(26 Nov. - 1 Dec) and 45SW (12-18 Nov), respectively .
- In yellow sticky trap catches, the highest whitefly population at 322 whitefly/ trap/week and jassid population at 435 jassid/ trap/week was recorded during 37SW (15-21 Sept) at Nagpur.
- The analysis of historical data from Hisar was carried out for population dynamics of whitefly for the period from 2004-05 to 2016-17. The analysis indicated that peak occurrences of white fly infestation has advanced. Between 2004-05 and 2009-10 peak occurrence of white fly was recorded in 40th and 41st standard weeks, whereas it was 31st and 32nd standard week during 2010-11 to 2016-17.
- Seasonal dynamics of pests at CICR RS Sirsa was studied on RCH-650 BGII hybrid, HS-6, Ganganagar Ageti and RS-2013. Peak activity of leafhopper was observed in 30th-31st SMW (Standard Meteorological Week). Peak in population of whitefly and thrips recorded in 30th SMW (40-45 whitefly/3 leaves). Bollworm infestation was not observed on RCH-650 BG II. In Non Bt varieties HS-6, GA & RS-2013 first incidence of bollworm was observed in the 37th SMW which ranged from 0.1 to 0.5, 0.30 to 0.90 & 0.23 to 1.20% fruiting bodies damage respectively.

- Average infestation of white fly per three leaves at CICR RS Sirsa was 3.98 between 2004-05 and 2009-10, whereas it was 13.70 during 2010-11 to 2016-17.
- Whitefly prefers to feed on lower canopy of the plant as compared to middle and upper canopy. Mean whitefly adults population/leaf recorded during the entire season of 2017-18 on upper, middle and lower strata was 4.77 (2.99-6.63), 12.07 (7.63-21.79) and 15.15 (7.50-33.06), respectively during different time of the day in RCH 650BG-II.

Pink bollworm infestation

- Infestation in BG II cotton fields of Gujarat was in the range of 20 to 90 per cent. The highest infestation was observed in Amreli (90%) while in Bharuch infestation at 25% was recorded lowest.
- The per cent infestation of pink bollworm in green bolls of BG-II at 140-180 days after sowing was observed in all cotton growing districts of Maharashtra *Viz.*, Yavatmal (56.63%), Akola (80%), Amaravathi (70.67%), Nandurbar (86.7%), Dhule (99%), Jalgaon (92%), Aurangabad (91%), Jalna (79%), Nanded (81%), Parbhani (82%), Hingoli (80%) and Buldhana (99%). Infestation of BG II cotton in Madhya Pradesh was recorded 68 per cent.
- Infestation of pink bollworm in South India was similar to that of central India. In Andhra Pradesh the infestation ranged from 72 to 84 per cent and in Telangana 69 to 91.2 per cent with highest population observed in Adilabad (91.2%).
- In North India Pink bollworm infestation on Bollgard-II was negligible. Pink bollworm damage in the range of 7-42% was recorded on non-Bt cotton in Punjab, Haryana and Rajasthan after the third picking.

Resistance monitoring

- The resistance development of pink bollworm on BG-II and non Bt cotton fields was monitored in 46 districts across India. Thirty one populations of Pink bollworm were subjected to Cry1Ac and twenty seven population were subjected to Cry2Ab log dose probit assays. Pink bollworm populations from Prakasam, Bharuch, Rajkot, Kurnool and Surendrangar recorded 172, 278, 372, 391 and 674 fold increase in resistance to Cry1Ac over susceptible check. Surendranagar, Guntur, Warngal, Yavatmal, Jalna, Buldhana, Jalgaon, Anand, Vadodara, Bharuch, Aurangabad, Dhule, Rajkot and Khammam populations recorded 141, 182, 182, 220, 287, 315, 436, 436, 444, 518, 671, 671, 4214 and 5947 fold increase in resistance over the susceptible check to Cry2Ab.
- Resistance monitoring was carried out with four population of Leafhopper from Nagpur, Wardha, Amravati and Yavatmal against nine insecticides. Nagpur populations were more susceptible to Flonicamid while susceptibility of populations from Amravati were more to Clothianidin and Dinotefuran as compared to other populations.
- Resistance monitoring for cotton whitefly (*Bemisai tabaci*) was initiated from 2015-16 for Nagpur population. Twenty one insecticides from 10 groups (Biorationals, Neonicotinoid, Phenylpyrazole, Carbamates, Pyridinecarboxamide, Insect Growth Regulators, Organophosphate, Pyridine, Tetronic acids, Synthetic pyrethroid) were taken for resistance monitoring during 2015-16, 2016-17 and 2017-18. In the current year, resistance was negligible in all the insecticides indicating intact susceptibility of whitefly.
- Whitefly resistance to insecticides in India with special reference to North zone was studied at CICR, RS Sirsa with organophosphate, neonicotinoid, synthetic pyrethoids and insect growth regulator. Resistance ratios for various organophospahtes ranged between 1.84 to 54.6 fold in 2017-18 and could be correlated with the insecticide use patten not only of cotton but also other crops. High resistance was recorded for Thiamethoxam but not with other neonicotinoids (acetamiprid, imidacloprid, dinotefuran, thiacloprid, and clothianidin). Among the synthetic pyrethoids very low or minimal resistance in Fenpropathrin was recorded. Among the newer insecticides, insect growth regulator Difenthiauron recorded 70.67-163.30 & 33.33-128 fold increase in resistance ratio during 2016-17 & 2017-18.
- Abundance and diversity of natural enemies was studied in cotton cvs. Phule Dhanwantary, Suraj, Suvin, RCH-2 and DCH-32. It was observed that species richness and abundance was highest in Phule Dhanwantari (H=1.94, S=20) followed by Suvin (H=2.09, S=15) and Suraj (S=15) as compared to the RCH-2 and DCH-32. Unprotected cotton varieties carry more species richness than protected ones.

Bollworm management

- The lowest per cent of locule damage by PBW at Nagpur was observed in Deck (Cypermethrin+ Profenophos) (8.62%) followed by cypermethrin 25

EC (13.60 %).

- *Trichogramma bactrae* treatment recorded significantly lower per cent locule damage due to pink bollworm and it was at par with chemical treatment (profenophos 50 EC, thiodicarb 7 WP, Cypermethrin 25 EC).
- Fatty acids like Palmitic acid, Linoleic acid, Oleic acid, Steric acid and their methyl esters were identified from eggs and faecal pellets of pink bollworm in studies done on Push Pull strategy for PBW management at Nagpur.
- Eight new dispensers and ten pheromone trap designs were evaluated against the cotton pink boll worm. The dispenser made of polypropylene (11.28 adult/trap/week) and silicone (10.93 adult/trap/week) were significantly superior to the standard rubber dispenser (7.36 adult/trap/week) in attracting the pink bollworm moth
- A combo trap for pink bollworm targeting both chemo and visual stimuli was developed at CICR RS Coimbatore by combining pheromone compound gossyplure (chemical stimulus) and LED light source (visual stimulus). The trap with blue colour light provided significantly more traps catches.
- Compounds *viz.*, hexadecanoic acid octadecanoic acid dotriacontane, dodecanoic acid and tetradecanoic acid were identified as potential oviposition deterrant for *H.armigera* at Nagpur.

Sucking pest management

- Among the insecticides tested at Nagpur, Dinotefuran 20% SG and Flonicamid 50% WG registered lowest population of jassid. Whitefly population was lowest in Spiromesifen 22.9% SC and Flonicamid 50% WG.
- The field trial conducted at CICR RS Sirsa during 2017-18 recorded highest nymphal mortality with *Beauveria bassiana.* 4511 (83.65%) followed by *Paecilomyces javanicus* CICR RS S 0102 (81.78%) and were significantly superior to Diafenthiuron 50% WP (1. g/L), Neem oil (300 ppm) and commercial formulation of *Lecanicillium lecanii* (0.1% WP).
- Efficacy of twelve label claim insecticides and five biorational interventions (castor oil, pongamia oil, sesame oil, 2 neem based formulation) were tested under laboratory conditions against thrips at CICR RS Sirsa at three dosages during 2017-18. Among the insecticides spinosad, fipronil, spinoteram, diafenthiuron and profenphos gave highest mortality (66-78%). Among the biorational approaches, sesame oil, castor oil, pongamia oil recorded moderately good mortality (40-66%) against thrips.
- Castor oil, pongamia oil and sesame oil reduced whitefly population by 42.81, 39.20 and 36.86 percent respectively. The maximum reduction was obtained in chemical treatment with difenthiauron (55.24%) .
- Out of eight insecticides tested, clothinidin was found to be more toxic to *P. solenopsis*. The descending order of toxicity clothionidin > cypermethrin > pyriproxyfen + fenpropathrin > lambdacyhalothrin > spiromesifen > flonicamid > diafenthiuron.
- Out of thirteen different insecticides evaluated against larvae of *Chrysoperla zastrowii sillamii,* thiamethoxam (LC_{50}=7.010mg ai/ L) was found to be more harmful to the larvae of chrysoperla, whereas thiodicarb (LC_{50}= 307.75 mg ai/l) was found to be safer
- In safety evaluation study of fourteen different insecticides against the grubs of *Cryptolaemus montrouzieri*, imidacloprid (LC50= 3.70 mg ai/l) was found to be more harmful to the grubs of *Cryptolaemus*, whereas thiodicarb (LC50= 286.51 mg ai/l) was found to be safer to the grubs.
- Use of Basil oil in yellow sticky traps found to enhance efficacy against sucking pests (whitefly, jassids and aphids) of cotton.
- Intercropping of cotton with marigold was effective in reducing population of thrips at CICR, RS, Coimbatore.
- In studies on isolation and identification of Kairomone from sucking pests, three probable compounds (1-Dodecanol, Eicosane and Octadecane) have been identified in samples analysed in GC-MS.
- Bacterial endophytes *B. subtilis* and *B. cereus* strain used as seed coating, soil drenching and foliar spray reduced the population of sucking pests *viz.*, Aphid, Jassid, and Whitefly by 10-15% as compared to the control.
- A new wax degrading entomopathogenic fungus, *Aspergillus fumigatus* Fresenius 1863 (Accession No. MF421525) isolated from striped mealybug, *Ferritia virgata* Cockerell found to degrade waxy coating of mealybug under laboratory condition at CICR RS Coimbatore.
- EPF strain namely, *Paecilomyces javanicus* - 89 *Paecilomyces javanicus* 102, *Metarhizium anisopliae* - 1299, *Beauveria bassiana* - 4511 were found to be the

most compatible with full and half dose of the chemical and botanicals tested.

- CICR Whitefly adult suction trap designed under TMC 1.5 project was evaluated consecutively for two years under AICRP on cotton at multi locations. The trap was recorded to reduce whitefly population by 12.7 to 46.6% at different locations and was reported to be more efficient in situations with high adult whitefly pressure.
- Modified poly house bioassay method was standardised for screening of entompathogenic fungi against white fly nymphs at CICR RS Sirsa and was found to be most suitable.

Disease incidence

- During survey, the cotton leaf curl virus disease grading was recorded highest in Fatehabad District (Haryana) followed by Sirsa (Haryana) and Hanumangarh District (Rajasthan).
- Target leaf spot caused by *Corynospora cassicola* was recorded as emerging potential pathogen of *G. hirsutum* in central india.
- For the first time symptoms resembling Tobacco Streak Virus (TSV) on *G. hirsutum* were recorded in some fields of Fatehabad and Sirsa Districts of Haryana during survey.
- TSV infected cotton plants in the germplasm of *Gossypium barbadense* at CICR RS Coimbatore were observed at 90 DAS (Days after sowing). The per cent disease incidence ranged between 1.61% (CCB 140) to 26.60% (ICB 71). In varieties and hybrids of *Gossypium hirsutum* TSV infection was observed at 60 to 70 DAS (Days after sowing). The per cent disease incidence varied from 5.0% (Suraj) to 16.6 % (Surabhi and RCH659 BG-II).
- In soil samples collected from 9 districts of Vidarbha, the reniform nematode *Rotyelcnchulus reniformis* was most frequent and dominant species followed by *Meloidogyne incognita*

Disease Dignosis

- Standardized and validated the protocol for diagnosis of CLCV by using LAMP technique.

Disease Management

- Among PGPR strains evaluated against soil borne fungal pathogens, *Bacillus aryabhattai* CICR-D5, *Bacillus cereus* CICR-D3 and *Bacillus tequilensis* CICR-H3 were found to be most effective under *in vitro* and glass house studies at Nagpur.
- In 2017-18 on Cv PKV081 formulation with curcumin, cow urine and neem oil reduced nematode population and increased yield by 29% at Nagpur. The spray treatments were better than the corresponding treatments applied to soil in reducing nematode population and increasing seed cotton yield.

2. INTRODUCTION

2.1 : Brief History

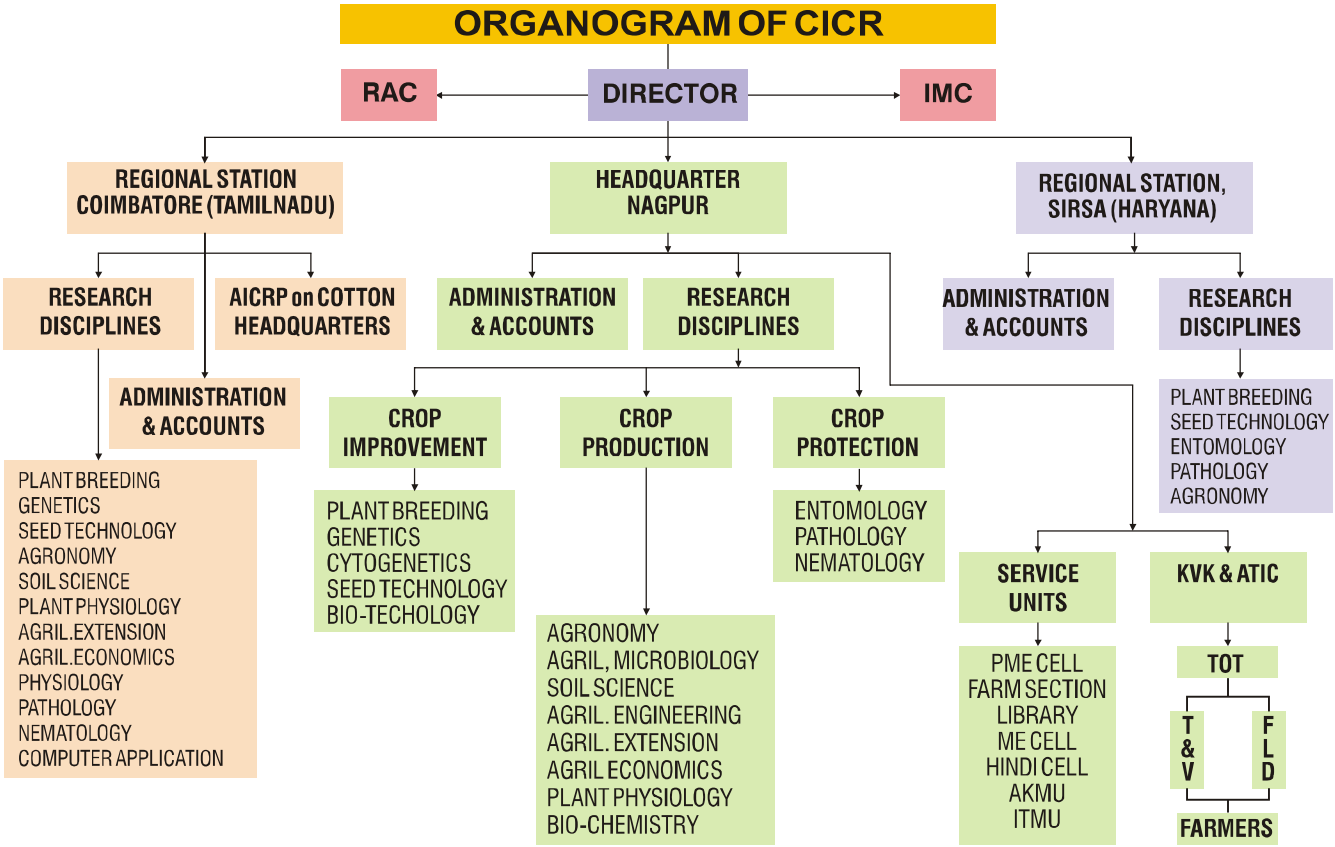
The ICAR-Central Institute for Cotton Research (CICR) was established at Nagpur in 1976. The two regional stations of IARI located at Sirsa (Haryana) and Coimbatore (Tamil Nadu) were transferred to CICR to cater to the needs of north and south India, respectively.

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, Regional 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 March, 2018)

Name of the Post	Sanctioned Cadre Strength				Post Filled Up			
	NGP	CBE	Sirsa	Total	NGP	CBE	Sirsa	Total
Director (RMP)	1	--	--	**1**	--	--	--	**--**
Scientific	51	21	8	**80**	44	21	8	**73**
Technical	46	16	10	**72**	24	13	9	**46**
Administrative	34	9	5	**48**	22	6	5	**33**
Supporting	43	17	10	**70**	30	11	8	**46**
Krishi Vigyan Kendra								
Training Organizer	1	--	--	1	--	--	--	--
Technical	11	--	--	11	8	--	--	8
Administrative	2	--	--	2	1	--	--	1
Supporting	2	--	--	2	--	--	--	--

NGP – Nagpur; CBE - Coimbatore

2.4 : Financial Statement

The budget grant and actual expenditure for the year 2017-18 are furnished below:

(Rs. in Lakhs)

Name of Scheme	2017-18	
	Sanction	Expenditure
Plan Scheme	1932.80	1918.88
Deposit Scheme	757.66	648.13
Revolving Fund	15.16	16.79
Govt. Grants (Non-Plan & Plan merged from 2017-18)	3966.33	3947.72
Total (in lakhs)	**6671.95**	**6531.52**
Revenue Generation (Revenue Receipts)	64.48	0.00

3. RESEARCH ACHIEVEMENTS

3.1:Consolidation and characterization of genetic diversity

Status of cotton germplasm

ICAR-CICR, Nagpur maintains one of the largest cotton germplasm collections of the world with 11,648 accessions covering all the cultivated and wild species of *Gossypium* including perennials, landraces and interspecific derivatives (Table 3.1.1).

Table 3.1.1: Status of cotton germplasm at ICAR-CICR, Nagpur

Species	Number of accessions
G. hirsutum	8505
G. barbadense	312
G. arboreum	1936
G. herbaceum	565
Wild Species	24
Interspecific derivatives	40
Perennials and land races	254
Races and derivatives of species	12
Total Collection	**11648**

Exploration and collection of cotton germplasm

Exploratory survey was carried out to collect unique germplasm from Rayagada, Nuapada and Kalahandi districts of Odisha. Three morphological variants of *Gossypium barbadense* were collected of which one belonged to *G. barbadense* var. *brasiliensis* possessing a unique character of fused seeds (Kidney cotton). One sample of *G. barbadense* was collected from Mandya district of Karnataka (Table 3.1.2).

Table 3.1.2 : List of perennials of cotton collected from exploratory surveys

Sl. No	Districts	State	No. of Accessions	Species	Perennials/Annuals/ Landraces
1.	Nuapada	Odisha	2	*G. barbadense*	Perennials
			1	*G. barbadense var brasiliensis*	Perennial
2.	Mandya	Karnataka	1	*G. barbadense*	Perennial
Total			**4**		

Perennial cotton *G. barbadense* from Nuapada, Odisha

Conservation of germplasm in long term storage : Seeds of one thousand six hundred two (1602) accessions of *G. hirsutum* and three registered genetic stocks of *desi* cotton (Brown coloured linted) were submitted for long term storage at ICAR – NBPGR, New Delhi.

Maintenance of germplasm under Medium Term Cold Storage : Two units of medium term cold storage modules were maintained at ICAR-CICR, Nagpur for conservation of cotton seeds at 4^0 to 5^0 C temperature and 32% to 35% relative humidity.

Maintenance of *Gossypium barbadense* germplasm : Three hundred and twenty *Gossypium barbadense* germplasm lines were maintained at ICAR-CICR, Regional Station Coimbatore during 2017-18 crop season.

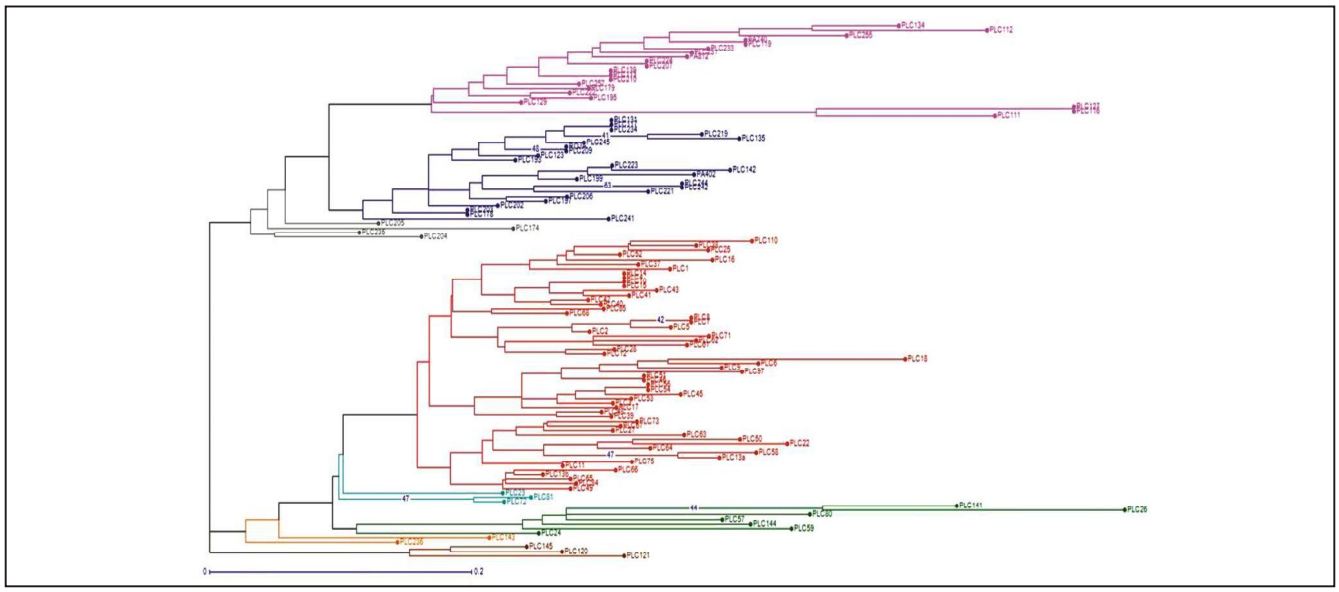
Enrichment of Cotton Gene Bank : Fifty eight (58) exotic accessions consisting 56 *G. hirsutum* accessions and 2 *G. barbadense* accessions were procured from USA through ICAR-NBPGR, New Delhi to enrich Cotton Gene Bank maintained at ICAR-CICR, Nagpur. A set of 36 exotic accessions including 34 Coker variants and 2 accessions of CLCuD resistant accessions (EC881780 and EC881781) were grown in field, characterized and evaluated for economic and fibre quality traits. Superior accessions were identified for ginning outturn, staple length and fibre bundle strength for further utilization in breeding program (Table 3.1.3)

Table 3.1.3: Fibre quality characters of exotic Coker and CLCuD resistant accessions

S. No.	Accession Number	UHML (mm)	MIC (µg / inch)	Tenacity 3.2 mm (g/tex)
1	EC882398, EC882405, EC882408, EC882424, EC882425	32.0-37.0	3.0-4.4	29.3-35.0
2	EC882399, EC882403, EC882404, EC882407, EC882409, EC882413, EC882414, EC882415, EC882417, EC882418, EC882419, EC882420, EC882421, EC882422, EC882426, EC882427, EC882428, EC882429, EC882430, EC882431, EC796545, EC807817, EC881780	28.4-30.9	3.2-4.0	26.0-34.5
3	EC882400, EC882401, EC882402, EC882406, EC882410, EC882411, EC882412, EC882416, EC882423, EC881781	23.3-27.8	2.8-4.4	25.4-33.2

Morphological and molecular characterization of perennials of *desi* cotton

Morphological including DUS characterization was completed for 58 accessions of *desi* cotton and perennials. Molecular characterization was done for 114 accessions of perennials and landraces of *desi* cotton along with 5 popular desi cotton varieities using identified SSR markers. Out of 60 SSR primers screened, thirteen markers showed polymorphism (21.6%). Based on the study, 119 accessions were grouped into different groups using DARwin statistical package.



Dendrogram depicting genetic relationships among accessions of the perennials and landraces of desi cotton (Bootstrap values >50% are shown).

Germplasm evaluation of *G. herbaceum*

Identified 25 early maturing G. *herbaceum* germplasm accessions were evaluated for yield performance. Data on plant height, days to fifty percent flowering, days to harvest, days to 70 per cent harvest, number of bolls and seed cotton yield were recorded. Seed cotton yield ranged from 1210 kg/ha (IC 3712208) to 1560 kg/ha (IC – 371166). Baluchistan – 1 and IC – 371437 were found to be early in maturity as compared to standard checks

Evaluation of *G. arboreum* germplasm for fibre quality

A set of 1000 *G. arboreum* accessions were evaluated for fibre quality traits at ICAR-CICR, Regional Station, Coimbatore during 2017-18. Based on superiority for specific traits, germplasm accessions were identified as detailed hereunder:

Staple length : Eleven accessions namely 360-SP1 (29.3mm), Shamali (28.2mm), Desi-103 (28.1mm), 5974 (28mm), 6582 (28mm), 30859 (27.9mm), AK 606-SP1 (27.9mm), AC 3695 (27.9mm), Sarguja-NL-WF (27.8mm), 30843 (27.8mm) and 30839 (27.4mm) were identified for staple length.

Uniformity ratio : Seven accessions namely Gao 16 CB-9 (60), Obtusifolium-B-Indica (58), 360 (57), GDH 149 (Sel.) (57), Arboreum (Kanpur A) (56), Chinese broad lobe (56)and PBN 48 (56) were identified for uniformity ratio.

Elongation: Twenty five accessions showing higher elongation of more than 6.2% were identified.

Strength: Fifty three genotypes possessing high fibre strength above 27.6 g/tex have been identified.

Strength to Length (SL) ratio: Set of twenty accessions showing SL ratio more than unity namely AC 3522 B, AC 3451, Arboreum (Kanpur A), AC 3284, AKA 14, AH 71, H 575, AC 3234, AC 3289, Desi-1, PS-135, SC 97, 79/BH-97, H 52-473, CC-1-1-3, AC 3368, 7763, 8410-2, PBN 6977 X AKH4, 30819-SP1 were identified. These accessions with long and strong fibre will be useful to textile industries.

Evaluation of *G. barbadense* germplasm

Eleven hairy germplasm accessions were evaluated for superior plant types in terms of yield, quality and earliness. The top performing five accessions *viz.*, ICB-85, ICB-124, ICB-264, ICB-284 and HAG-02 have been identified as moderately resistant to sucking pests over the check Suvin which is highly susceptible. These identified lines may be useful for development of sucking pest tolerant/resistant lines in future.

Table 3.1.4: Performance of hairy germplasm lines over the years

S. No.	Germplasm lines	Seed Cotton Yield (kg/ha)			Mean	GOT (%)	Fibre qualities			Sucking pest incidence
		2015-16	2016-17	2017-18			2.5% SL (mm)	Strength (g/tex)	Mic (µ/inch)	
1	ICB-124	736	712	601	683	31	35.2	31	3.1	MR*
2	ICB-284	801	786	546	711	30	34.7	33	3.1	MR*
3	ICB-85	688	634	504	609	30	33.6	31	3.0	MR*
4	ICB-264	702	621	542	622	29	34.2	30	2.9	MR*
5	HAG-02	623	569	497	563	31	33.5	32	3.3	MR*
	Suvin	619	587	364	523	30	36.7	30	3.0	S**

**MR-Moderately resistant, **S-Susceptible*

Development of Mini-Core group

Geographically and genetically diverse 788 accessions of core germplasm assembly were grown for seed multiplication & DUS characterization. Data on morphological traits were recorded and lint samples are being analyzed for fibre quality traits. After, evaluation of fibre quality traits, the dissimilarity index and matrix will be prepared for the development of Mini Core group.

Distribution of cotton germplasm

A 'Germplasm Field Day' was organized at boll bursting stage so as to facilitate selection of suitable germplasm lines by the cotton breeders across all three cotton growing zones (North, Central and South zone). Nine hundred forty three (943) elite germplasm lines of *G. hirsutum* including exotic accessions were distributed to breeders/scientists of different State Agricultural Universities to be used by them in their breeding programme.

Wild species of *Gossypium.*

Conservation

Twenty four wild species, 15 races of cultivated species and more than 45 synthetic polyploids were conserved

in the ICAR-CICR Wild Species Garden & green house. Herbarium of the available species, races of cultivated species and six registered unique genetic stocks of introgressed derivatives namely, MSH-91 SP, MSH 53 (Vaidehi-95), MSH 345 (Cleistogamous genotype), NISC 40, NISC 43, NISC 44 and CNA-5 were prepared.

Herbarium of *G. trilobum*

Utilization of wild species

Wild species were used in crossing programme and fresh crosses were attempted using *G. anomalum, G. trilobum* and *G. barbosanum* with cultivated species for introgression of economically important traits from wild species. Sterile F_1 crosses between *G. capitis virides, G. bickii* and *G. stocksii* were established in pots.

Interspecific crosses involving wild species of cotton: a) AK 8401 x *G. bickii; b)* Suraj x *G. stocksii and c)* Phule dhanwantary x *G. capitis virides*

Plants of F_4 population of *Jawahar Tapti* × *G. longicalyx, G. arboreum* × *G. thurberi, G. arboreum* race indicum × *G. davidsonii* and *G. arboreum Cv.* AK 8401 × *G. davidsonii* were evaluated in the field. Single plant based selections were made and were advanced to next generation. The plants of *G. herbaceum* × *G. anomalum* cross were advanced from F_4 to F_5 generation.

Evaluation of introgressed derivatives:

A total of 461 introgressed derivatives were evaluated at Nagpur for fibre & economic traits. Among the 313 *G. hirsutum* based introgressed derivatives; fifteen (15) high yielding derivatives were identified. Among 60 *G. arboreum* based introgressed derivatives, ten high yielding derivatives were identified. In *G. hirsutum* based introgressed derivatives, CNH 17297 ranked first with seed cotton yield of 2832 kg/ha followed by CNH 17293 with 2348 kg/ha and CNH 17295 with 2036 kg/ha. In *G. arboreum* based introgressed derivatives; CNA 17350 ranked first with seed cotton yield of 1472 kg /ha followed by CNA 17369 and CNA 17342 with seed cotton yield of 1334 kg/ha and 1288 kg/ha respectively.

CNH 16300 (*G. hirsutum* based introgressed derivative) evaluated in the Institute trial ranked third with seed cotton yield of 1986 Kg/ha as compared to the checks Suraj (1317 kg/ha), NH 615 (1350 kg/ha) and AKH 8828 (1662 kg/ha).

CNA 16383 (*G. arboreum* based introgressed derivative) ranked first with seed cotton yield of 2062 kg / ha as compared to the checks AKA 8401 (686 kg/ha) and PA 255 (706 kg/ha). The other parameters of CNA 16383 are also promising with fibre length of 27.9 mm and bundle strength of 27.6 g/tex.

Naturally coloured cotton:

A total of 128 coloured cotton genotypes of natural dark brown, light brown linted and other derivatives were evaluated for yield and tolerance to sucking pests during 2017-18. Single plant selections were made for high yield per plant.

Development of consensus genetic linkage map of *Gossypium*

A set of 227 RILs mapping population obtained from a cross of *G. arboreum* (KWAN-3) × *G. herbaceum* (Jayadhar) was grown as single row progenies. Two plants from each progeny (RIL) were selfed for maintenance and seed cotton of remaining plants was bulk harvested. Seeds of RILs shall be shared with the participating centers for phenotyping at three locations. Genomic DNA from each RIL progeny was extracted using cTAB method that will be shared with NBRI, Lucknow for SNP genotyping.

Molecular diversity analysis and DNA fingerprinting in cotton

Morphological characters based on DUS traits were documented for 50 public sector released varieties of tetraploid cotton (*G. hirsutum* and *G. barbadense*) as well as 27 *G. arboreum* released varieties and a fingerprint chart based on morphological traits was developed. Fifty additional SSR markers were screened among tetraploid varieties out of which 18 were found to be

polymorphic. Thus, over the years, screening of 400 SSR markers have been completed for tetraploid cotton and 86 polymorphic markers were obtained which can be used to complement DUS traits. A selected set of 20 SSR markers with high PIC could identify each variety under study including all CICR released varieties and a DNA fingerprint was developed. Screening of 27 diploid cotton (*G. arboreum*) released varieties using additional 100 markers revealed 16 to be informative. A total of 48 useful markers have been identified for G. *arboreum* varieties for further utilization. A selected set of 8 markers with high PIC could identify each *G. arboreum* variety under study at probability of identical match 2.68×10^{-6}.

3.2 Breeding for premium fibre quality and high yield as per global needs

Improvement of *G. arboreum* cotton

Evaluation of GMS based *G. arboreum* hybrids

Eight GMS based *G.arboreum* hybrids were evaluated for seed cotton yield with two check hybrids AAH 1 and CICR 2 at Sirsa. Three GMS based hybrids CISAA 212 (3274.6kg/ha) and CISAA 512 (2920.6 kg/ha) could record significantly higher seed cotton yield than the highest yielder check hybrid CICR 2 (2544.0 kg/ha) (Table 3.2.1).

Table 3.2.1: Performance of GMS based *G. arboreum* hybrids in replicated trial at Sirsa

Entry Name	SCY (kg/ha)	Lint Yield (kg/ha)	GOT %	Boll No. per plant	Boll Wt (gm)	UHML (mm)	UI	Strength (g/tex)	Mic (μ/inch)
CISAA 1312	2622.2	935.6	35.7	45.5	2.0	25.6	81	26.1	5.9
CISAA 1302	2264.3	815.8	36.0	46.6	2.1	25.6	81	26.2	5.8
CISAA 2012	2144.6	743.7	34.7	46.9	2.0	24.6	81	24.5	5.7
CISAA 2002	2323.9	834.2	35.9	39.3	2.1	25.0	81	24.7	5.6
CISAA 212	3274.6	1194.4	36.5	62.0	2.2	24.8	81	25.1	6.2
CISAA 202	2472.1	872.13	35.3	48.1	2.0	25.8	81	26.7	5.8
CISAA 512	2920.6	1127.9	38.6	47.5	2.1	23.4	80	24	6.2
CISAA 502	2541.5	948.9	37.3	42.0	2.0	23.6	80	24.2	6.2
AAH 1	2333.4	850.9	36.5	47.1	2.1	18.8	76	21.5	6.8
CICR 2	2544.0	1025.7	40.3	51.5	2.1	20.1	77	21.9	6.6
CD	**248.56**								
CV (%)	**5.87**								

Maintenance of GMS lines

Three GMS lines (DS5, CISA 2, GAK 413A) 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 sibmating at Sirsa. Pigmented GMS line CISG 20 is having red flower colour with petal spot. The plant is robust and the line is thermo-insensitive and no pollen shedders were reported.

Evaluation of Spinnable *G. arboreum* cultures

Fourteen spinnable *G. arboreum* cultures were evaluated under RBD along with two checks CISA 310 (3219.7 kg/ha) and PA255 (889.6 kg/ha) at Sirsa. None of the genotypes could give significantly higher yield than the checks. However genotype CISA 33-9 showed numerically superior yield of 3380.2 kg/ha as compared to 3219.7kg/ha in check but had fiber length of 19.8mm. However genotypes CISA-6-295, CISA-6-350, CISA33-8, CISA-41-1 and CISA-6-209 having yield more than 30 q/ha and have promise for spinning. Four genotypes CISA-6-295, CISA-33-6, CISA 33-8 and CISA 6-256 were having UHML (mm) >25.0mm and strength ~25.0 g/tex.

Evaluation of High Yielding *G. arboreum* genotypes

Fourteen high yielding *G. arboreum* genotypes were evaluated in RBD design with two check varieties CISA 614 and Phule Dhanvantri at Sirsa. Two genotypes CISA-6-2 (3483.5kg/ha) and CISA 405 (3240.3kg/ha) gave significantly higher seed cotton yield (table 3.2.2) than high yielding local checks CISA 614 (2725.4 kg/ha).

Table 3.2.2: Performance of *G. arboreum* genotypes at Sirsa

Entry Name	SCY (kg/ha)	Lint Yield (kg/ha)	GOT %	Boll wt (gm)	UHML (mm)	UI	Strength	Mic
CISA-6-165	2679.30	936.48	35.0	2.2	19.0	76.0	21.4	6.7
CISA 6-2	3483.50	1342.36	38.5	2.3	19.4	76.0	21.6	6.8
CISA-6-123	1765.70	610.12	34.6	2.0	18.7	76.0	21.4	6.8
CISA-6-187	1854.80	647.40	34.9	2.0	19.0	76.0	21.4	6.8
CISA-6-214	1712.00	660.50	38.6	2.2	24.8	81.0	23.8	5.8
CISA 10	2247.50	794.95	35.4	2.1	27.8	82.0	26.7	5.9
CISA 6	2810.80	1100.64	39.2	2.1	20.0	77.0	21.8	6.8
CISA 405	3240.30	1235.78	38.1	2.2	19.9	77.0	21.8	6.7
CISA 8	2618.50	994.01	38.0	2.1	20.3	77.0	22.1	6.8
CISA 7	2636.60	1031.53	39.1	2.2	20.2	77.0	22.3	6.7
CISA 9	1743.30	629.25	36.1	2.0	22.9	80.0	24.0	6.3
CISA 294	1868.20	747.43	40.0	2.0	22.7	79.0	23.6	6.6
CISA 33-4	2589.40	982.37	37.9	2.1	25.1	81.0	26.0	6.1
CISA 33-5	2909.70	1115.94	38.4	2.0	20.0	77.0	22.0	6.6
Phule Dhanvantri	2623.00	940.21	35.8	2.0	21.5	78.0	22.6	6.4
CISA 614	2725.40	1013.26	37.2	2.1	19.4	76.0	21.6	6.8
CD	**309.35**							
CV (%)	**7.52**							

Thirteen *G. arboreum* selections were evaluated in two replications, of them SPS 16-3 (787 kg/ha) and SPS 1-1-1 (740 kg/ha) which found superior to check AKA 8401 (648 kg/ha).

Improvement of *G. herbaceum* cotton

Inter specific hybridization (*G. herbaceum* × *G. arboreum*): In a line × tester mating design involving seven *herbaceum* lines (GVHV-655, IC-371437, Jayadhar, IC-371158, Baluchistan – 1, IC-371136 and IC-371360) and three *arboreum* testers (PA – 740, PA – 785 and PA-812), twenty one F_1 crosses were made at Nagpur. Twenty one F_1 crosses, 3 standard checks (DDhC -11, Jayadhar and GN.Cot – 25) and 10 parents were analysed for general and specific combining ability. Parental lines, IC–371437 and PA-785 found to be the good general combiner for number of bolls and seed cotton yield. The inter specific crosses between *G. herbaceum* x *G. arboreum* exhibited higher level of heterosis than intra-*herbaceum* crosses.

Evaluation of F_1 intra specific *G. herbaceum* crosses: Twenty eight F_1 crosses were derived using line x tester mating design consisting seven lines (IC - 371437, IC-371360, GVHV-655, IC – 371136, IC-371177, IC-371362 and IC - 371527) and four testers (Baluchistan – 1, Jayadhar, IC-371158 and IC-371336). Relative heterosis and heterobeltiosis was studied in 21 F_1's and standard heterosis was estimated using three standard checks (DDhC - 11, Jayadhar and GN.Cot – 25). Intra – specific *herbaceum* crosses IC – 371437 × Baluchistan – 1 and IC – 371437 × Jayadhar showed better performance for boll number and seed cotton yield over the mid parent.

Improvement of *G. hirsutum* cotton

Population Improvement

GMS based simple recurrent selection at Nagpur:

In the year 2016-17, all sterile plants were tagged and harvested separately from each of the trait specific GMS based recurrent populations. In the *G. arboreum* GMS based recurrent population, 1768 sterile plants were evaluated as plant to row progenies while, in *G. hirsutum* 2129 GMS sterile plants were evaluated. Observations were recorded on 3 fertile plants in each progeny for plant height, monopodia, sympodia, boll number, boll weight and GOT. Composite lint samples of each progeny were analyzed for fibre quality traits. Based on

the trait values and superiority for specific economic trait, about 5-7% superior plant progenies will be identified for boll weight, seed cotton yield, GOT, fibre strength and fibre length for making trait specific groups. Seed obtained from sterile plants of the identified trait specific superior progenies shall be bulked and grown as composite population during 2018-19.

Evaluation of single plant selection: About 1850 superior single plant selections from random mating populations and reselected plants from the segregating progenies were evaluated in plant to row progeny plots at Nagpur. The progenies were monitored for segregation, if any and also evaluated for uniformity, economic and fibre quality traits. Based on the performance, uniformity and fibre quality of plant progenies 16 progenies of *G. arboreum* and 32 of *G. hirsutum* were identified for evaluation in replicated trial. From the remaining progenies about 2055 superior single plants were reselected based on economic yield and manual evaluation for fibre quality traits.

Evaluation of advance cultures:

130 cultures of *G. arboreum* and 85 cultures of *G. hirsutum* were evaluated in 8 replicated trials (4 rows plots in 2 replications) during the crop season 2017-18 at Nagpur. In all, 5 trials of *G. arboreum* and 3 of *G. hirsutum* were conducted following spacing of 60x45 cm and 60x 60cm, respectively. The seed cotton yield among the *G. arboreum* cultures ranged from 722 to 1886 kg/ha while, in *G. hirsutum* it ranged from 907 to 2562 kg/ha. The range of trait values for boll weight, GOT and fibre quality traits is given in the table 3.2.3.

Table 3.2.3: Range of variability for economic and fibre quality traits

Particulars	Range in *G. arboreum* selections	Range in *G. hirsutum* selections
Ginning percent	29.6 – 44.1	29.8 – 37.5
Boll weight (g)	1.52 – 2.60	2.8 -4.5
Fibre length (mm)	24.7 -29.3	24.0 – 32.4
Uniformity Index (%)	79 - 85	80.3 – 84.1
Micronaire value	4.4 – 5.9	3.7 – 5.0
Fibre strength (g/tex)	24.0 – 31.8	26.6 – 33.8

Based on performance for seed cotton yield and fibre quality traits, 79 cultures of *G. arboreum* and 55 of *G. hirsutum* were retained for second year replicated trial. From the evaluated selections, four *G. hirsutum* and six *G. arboreum* cultures entered in AICRP National trials.

The cultures entered in AICRP trials were grown on large plots for seed multiplication which includes CNA 1028 of *G. arboreum,* CNH 11-11, CNH 1123, CNH 1125, and CNH 1126 of *G. hirsutum*.

Plants with high boll number and big boll size; compact plant type selection from random mating population of *G. hirsutum*

GMS based random mating population

At flowering, the individual plant in the population was monitored for sterility/fertility at anthesis repeatedly at an interval of a week and tagged all the 400 sterile plants at Sirsa. All the 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 the 6th cycle of random mating 80 fertile plants having high yield potential and tolerance against CLCuV were selected for evaluation in progeny row trial.

Genetic enhancement

Cultures *viz.,* CNH-2073 (1320 kg/ha, boll wt 4.6) followed by CNH 2053 (1250 kg/ha, boll wt 4.1 g) and CNH 2046 (1050 kg/ha) were found superior to check Suraj (1050 kg/ha, boll wt (4.4 g). CNH 2073 (fibre length 28 .8 mm and fibre strength 31.8 g/tex) was identified as a superior fibre quality line having semi compact plant architecture. CNH 2039, a synchronized bearing and bursting, uniformity in boll size within the plants was identified which had a boll weight of 4.4 g and 926 kg yield/ha. Amongst jassid tolerant cultures with grade 1, culture CNH 2053 was superior to check Suraj. In advanced generation selections SPS 13-2-1, SPS 14-1 and SPS16-3, zero monopodial closed sympodial plants (extreme compact types) with single plant yield ranging from 43 g to 116 g and a boll weight ranging from 2.5 g to 3.8 g were recorded.

Breeding for earliness and fibre quality

Forty-five (45) advanced selections based on early maturity of 145-150 days and better fibre properties were evaluated for seed cotton yield. Promising individual plants (200) having earliness and compact plant architecture were selected from the F_2 segregating populations of three-way and double crosses. 220 F_3 single plant selections were advanced to F_4 for evaluation in progeny rows and 35 F_4 progenies were selected for fibre quality, earliness, plant type and seed cotton yield.

In order to obtain recombinant and fertile progenies of interspecific crosses between *G. hirsutum* and *G. barbadense*, intermating between progenies of three-way and multiple crosses was attempted. Promising interspecific F_3 single plant progenies were evaluated. Based on specific trait performance and presence of combination of introgressed characteristics of *G. hirsutum* and *G. barbadense* such as sub-okra leaf shape, cleistogamous flowers, stay green plants, high fibre quality and yield potential, promissing single plants were identified. The selected BC_1F_3 progenies of a cross, (Suraj × Suvin) × Suraj had better fibre properties than Suraj. About 75 single plants were identified in F_3 with fibre length of 29.0 mm to 34.7 mm and fibre strength of 30.0 g/tex to 34.4 g/tex.

Four entries each for seed cotton yield (CNH 09-70, CNH 09-76, CNH 09-73 and CNH 14-5) and fibre length (CNH 09-52, CNH 09-54, CNH 6 and CNH 10-6-1) were identified based on replicated station trials. Two entries CNH 09-73 and CNH 09-11 were identified based on seed cotton yield in institute common trial for sponsoring to AICCIP Br 02 (b) trial 2018-19. In addition, two entries CNH 09-45 and CNH 09-11 were sponsored for compact genotypes trial Br 06 (b). Entries CNH 09-70 and CNH 09-9 were promoted to preliminary varietal trial, Br 03(b) and coordinated varietal trial, Br 06(b), respectively in AICCIP trial 2018-19. Entries, CNH 09-4 and CNH 09-62 were retained for second year in coordinated varietal trial of compact genotypes Br 06(b).

Early maturing breeding lines identified

Two early maturing breeding lines namely, CNH 09-7 and CNH 09-9 with seed cotton yield of 1165 and 1192 kg/ha respectively were identified. The percentage of seed cotton in the first picking of the total seed cotton yield was 86% in CNH 09-7and 82% in CNH 09-9. Both the entries recorded Bartlett's earliness index of 0.9 indicating early maturity of the identified genotypes.

Development of high yielding varieties with improved fibre quality

The high yielding good quality variety Central Cotton CCH 12-2 (Suchitra) has been recommended by Central Variety Identification Committee for release in Central Zone States of Gujarat, Maharashtra and Madhya Pradesh under irrigated conditions. The variety recorded a mean seed cotton yield of 1767 kg/ha as against 1644 kg/ha of the Zonal check. The variety has an yield potential of 2598 kg/ha. It has an upper half mean length of 28.0 mm, micronaire of 4.2 and tenacity of 29.0 g/tex (in HVI mode). The variety is tolerant to grey mildew and moderately tolerant to jassids. The proposal for notification has been submitted to Central Sub Committee for Release and Notification.

Central Cotton CCH 12-2 (Suchitra)

Central Cotton CCH 12-3 has been recommended by Central Variety Identification Committee for release in Central Zone States of Gujarat, Maharashtra, Orissa and Madhya Pradesh under rainfed conditions. It recorded a mean seed cotton yield of 1060 kg/ha as against 1053 kg/ha of the Zonal check variety. The variety recorded an upper half mean length of 27.0 mm, micronaire of 4.3 and tenacity of 28.7 g/tex (HVI mode).

Proposal for identification of high yielding good quality Central Cotton CCH 14-1 has been submitted to Central Variety Identification Committee for release in irrigated condition in South Zone States. The variety possesses an yield potential of 3675 kg/ha. The variety combined excellent fibre quality *viz*., upper half mean length of 32.0 mm, micronaire of 3.7 and tenacity of 32.7 g/tex (in HVI mode) and 2.5% span length of 32.8 mm, micronaire of 3.6 and tenacity of 24.1 g/tex (in ICC Mode) matching the ICAR-CIRCOT norm for 50s count yarn. It is resistant to bacterial leaf blight, Grey Mildew and Tobacco Streak Virus and Immune to Root Rot. The variety is tolerant to jassids, white fly, thrips, aphids and stem weevil.

Central Cotton CCH 14-1

Development of cotton genotypes with least short fiber content

In a station trial, 13 long staple cultures were evaluated along with Surabhi and Suraj as check varieties. Quality wise, YLS 21-4 was the best combining UHML of 34.1 mm and tenacity of 33.8 g/tex as compared to the best check variety Suraj (Table 3.2.4).

Table 3.2.4: Performance of select long staple cultures

Entries	Fibre length (mm)	Micronaire	Tenacity (g/tex)
YLS 19-2	33.0	2.9	30.3
YLS 21-2	34.0	3.4	31.0
YLS 21-3	34.1	3.4	33.4
YLS 21-4	34.1	3.9	33.8
YLS 25-1	32.7	3.7	32.9
Suraj	32.7	4.2	31.3
Surabhi	32.8	3.5	30.9

Evaluation of advance cultures of *G. hirsutum* : In this trial 20 *G. hirsutum* cultures were evaluated at Sirsa against the check varieties RS 2013, LH 2076 and F 1861 in RBD with three replications. The highest seed cotton yield was recorded in the advance culture CSH 1601 (2360.3 kg/ha) followed by CSH 2902 (2088 kg/ha) as against the check variety LH 2076 (1694.5 kg/ha). Maximum ginning out turn of 38.2 per cent was recorded in the variety CSH 2924 as compare to local check varieties RS 2013 (37.1%) and LH 2076 (36.7%). The culture CSH 2924 also recorded the highest lint index of 3.9 and GOT of 38.2% (Table 3.2.5).

Table 3.2.5: Performance of promising advance cultures of *G. hirsutum*

Variety	Plant height (cm)	Number of monopods	Number of sympods	Number of bolls / plant	Boll weight(g)	Ginning outturn(%)	Seed Cotton Yield (kg/ha)	CLCuV (PDI)
CSH 2837	102.8	3.4	6.0	15.9	2.2	33.5	1967	27.1
CSH 2902	95.0	2.7	10.1	19.9	2.2	32.4	2088	24.1
CSH 2924	95.2	2.1	7.6	16.1	2.5	38.2	1725	22.4
CSH 1601	104.8	1.2	9.0	18.8	2.2	30.9	2360	26.4
RS 2013	111.2	3.4	7.6	16.8	2.5	37.1	1150	25.2
LH 2076	98.2	2.5	7.1	16.4	2.5	36.7	1695	21.9
F 1861	86.7	2.7	5.4	11.4	2.3	33.3	999	22.7
CD @ 5%	16.10	0.62	1.73	3.63	20.33	0.52	292.30	
CV %	10.23	14.25	14.53	13.81	13.57	0.93	13.54	

In another trial, 24 *G. hirsutum* cultures were evaluated against the check varieties RS 2013, LH 2076 and F1861 in RBD with three replications. The highest seed cotton yield was recorded in the advance culture CSH 1626 (1513 kg/ha) followed by CSH 1622 (1392 kg/ha) as against the check variety LH 2076 (1242 kg/ha). Maximum ginning out turn of 36.4 per cent was recorded in the variety CSH 1620 as compare to local check varieties RS 2013 (32.8%) and LH 2076(33.5%).

Selection of single plant progenies from segregating populations: Sixteen crosses were attempted among CLCuV tolerant germplasm lines of *G. hirsutum* in a Line × Tester fashion at Sirsa. Out of 91 single plants progenies 13 progenies having high yield potential and tolerance against CLCuV were selected in F_6 generation. The progeny CSH 1714 recorded the highest yield of 3145 kg/ha followed by CSH 1717 (3052 kg/ha) and CSH 1715 (2820 kg/ha) as compared to check variety F 1861 (1424 kg/ha). The culture CSH 1715 recorded the highest ginning out turn of 37.4 % followed by CSH 1718 (36.8 %).The mean fiber length and bundle strength ranged from 25.0 to 28.2mm and 24.5 to 29.3g/tex respectively.

Breeding for high GOT and high yield

In large plot size (97.2 sq. meter area), 15 promising high GOT selections in F_5 generation were evaluated at Sirsa. Three F_5 selections P-10 (RS-875 × SA-524), P-4 (RS-875 × SA-524) and P-68 (SA-977 × SA-112) gave lint yield of 1127.2, 1016.1 and 1062.8 kg/ha and GOT of 38.8, 38.1 and 41.8% respectively against the 3 checks CSH-3129 (882.4 kg/ha, 33.4%), F-1861 (708 kg/ha, 34.6%) and Bt 773 (751.8 kg/ha, 34.2%).

Evaluation of compact lines

Fifteen compact accessions from *G hirsutum* germplasm were evaluated at 67.5 × 10 cm. against Bt and Non-Bt promising checks in 3 replications at Sirsa. Accessions for seed cotton yield were EC140818 (36.7 q/ha), EC745226 (34.7 q/ha), EC 700495 (33.7 q/ha) against check F1861 (29.7 q/ha) and F 2383 (28.6 q/ha). The yield potential of these accessions was lower than Bt check hybrid Raghav (37.3 q/ha) but the differences were non-significant. Similarly, among 15 accession of *G arboreum*, accessions AC-3562 (30.2 q/ha), 412090 (30.4 q/ha) were superior in yield over check HD432 (24.2 q/ha), CICR 1 (24.7 q/ha) and CICR 3 (25.2 q/ha).

Improvement of ELS cotton

Out of 15 single plant progenies isolated from BC_2F_4 generation, 5 promising selections have been identified for further evaluation. These promising selections possessed high yield potential and high ginning percentage and also exhibited high quality parameters which can rightly fit in to the ELS category. From the backcrossed F_2 segregating population, 167 single plants superior in terms of seed cotton yield, number of bolls and sucking pest tolerance, have been identified for further evaluation.

Mass multiplication of seeds of advance cultures for the Station as well as AICRP trials was done and a total of eight advance cultures (CCB-26, CCB-28, CCB-29, CCB-51, CCB-51-2, CCB-64, CCB-129, CCB-143B) were entered in three breeding trials (Br.12a, Br13a and Br.14a) during AICRP-2018-19.

3.3. Breeding for climate resilience and biotic stress tolerance

Bt varieties carrying *cry1Ac* (Mon 531) gene were approved for commercial cultivation under rainfed conditions of Maharashtra (Table 3.3.1). These varieties have recorded more than 15 percent increase in seed cotton yield over the BG II check hybrid. The fibre quality and seed cotton yield of these Bt varieties are presented in as Table 3.3.1.

Table 3.3.1 Yield and fibre quality parameters of ICAR-CICR Bt varieties approved for commercial cultivation

S. No.	Varieties	SCY (kg/ha)	FL (mm)	FS (g/tex)	Mic (g/in)
1.	ICAR-CICR Bt 14 (CPT2)	3066	28.1	25.4	4.8
2.	ICAR-CICR Bt 9 (SRI1)	3109	25..7	25.5	4.4
3.	ICAR-CICR GJHV 374 Bt	2577	28.2	26.8	4.4
4.	ICAR-CICR PKV 081 Bt	2743	28.5	27.9	3.9
5.	ICAR-CICR Rajat Bt	2660	26.8	26.1	4.5
6.	ICAR-CICR Suraj Bt	2407	29.1	26.0	4.3

Bt varieties developed by ICAR-CICR, Nagpur: a) ICAR-CICR Suraj Bt; b) ICAR-CICR PKV081 Bt

Sixty-one genotypes from different agro-ecological regions have been converted into Bt background at ICAR-CICR, Nagpur and were also tested for presence of Bt gene and maintained through selfing. About 144 random Bt positive plants were tested for homozygosity and 114 plants were identified as homozygous for *cry1Ac*.

Bt variety CICR-Bt6 was developed from Sirsa and was approved for commercial cultivation in Haryana state. It recorded the seed potential of 3046 kg/ha under HDPS and was found to be significantly better than local check hybrid RCH 773 BGII in Haryana. This Bt variety also recorded UHML of 26.1 mm, Micronaire of 4.7 µg/in, bundle strength of 26.6g/tex and uniformity index 81.5% which is at par with the local check BG II hybrid. The variety is moderately resistant to CLCuV.

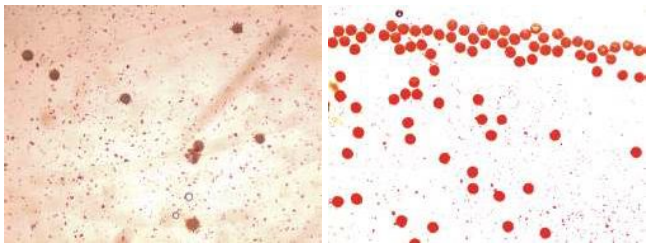
Field view of ICAR-CICR Bt6 variety (RS 2013 Bt)

Introgression of genes for whitefly and CLCuD resistance in upland cotton

Following the standardized protocol for embryo rescue/immature embryo culture, three interspecic F_1 plants (*G. hirsutum* × *G. arboreum*) were established in the crossing block at Nagpur. An interspecific F_1 plants were examined for pollen fertility and found completely sterile. Few of the sterile flowers of the F_1 plants were crossed using fertile pollens from elite *G. hirsutum* parental lines. However, we could not succeed in getting fertilized backcrossed embryo/boll setting. Alternately, growing axial buds of the F_1 plants were subjected to 0.5% colchicine treatment using cotton swabs. Treatment of axial buds repeated 3-4 times on every alternate days.

At Sirsa, interspecific crossed bolls were harvested from a cross of *G. hirsutum* CSH 3129 × *G. arboreum* and also from crosses between *G. hirsutum* (GMS lines- 14, 17, 20, 22 & 32) × *G. arboreum. Crosses have also been* attempted using pollen from colchicines treated plants. The F_1 seeds obtained from the above crosses will be raised during 2018-19.

Interspecific cross between *G. hirsutum* and *G. arboreum*



Pollen sterility in interspecific F_1 (*G. hirsutum* × *G. arboreum*) hybrid and normal stained fertile pollen in control variety.

Breeding cotton for drought tolerance

One hundred and sixty six (166) cotton germplasm lines were evaluated in rainfed and irrigated regime in the field at Nagpur. Seventeen promising drought tolerant lines were identified based on physiological parameters *viz.*, relative water content and mid-day leaf water potential. Lines DTS-405, DTS-413, Nagpur-9, N-2924, CNH-09-4 and 2853 were identified as promising for yield, drought tolerance and compact plant architecture.

Among the F_5 populations of twelve crosses, the cross 28I × Suraj recorded highest seed cotton yield of 1201 kg/ha with 52 percent increase over the check LRA 5166 which recorded seed cotton yield of 789 kg/ha. The cross combinations 28I × P3, 28I × HSD, NH 615 × Rex and LRA 5166 × N 170 recorded more than 15 percent increase over the check LRA 5166. The crosses, 28I × HSD, PKV 081 × CCH 510-4 and PKV081 × P3 showed good fibre quality.

F_3 generations of 33 single, three-way, double, six and eight parental crosses were evaluated. The genotypes showed significant difference between the treatments for seed cotton yield which ranged from 739.94-1651.16 kg/ha. Three-way cross [(28I × Moco) × 28I] showed best performance and recorded good fibre quality. Twenty nine crosses were at par to the check NH 615 which recorded seed cotton yield of 942.24 kg/ha. Multi-parental crosses, NH 615 × Suraj, PH 93 × Suraj, (28I × HSD) × (28I × HSD 11), (PKV 081 × Suraj) × (NH 615 × Rex) x (PH 93 × Rajat) and (CCH510-4 × Moco) × (NH 615 × Rex) × (PH 93 × Rajat) and (CCH 510-4 × Moco) × (NH 615 × Rex) × (PH 93 × Rajat) where some of the crosses which recorded fibre strength of 28.5-32.1 g/tex and fibre length of 28.4-32.1mm. Thirteen advance cultures along with check LRA 5166 were evaluated and the seed cotton yield ranged from 876-1539 kg/ha. with non-significant difference between the treatments. Ten cultures were at par to the check LRA 5166 which

recorded seed cotton yield of 956.73 kg/ha. Eight cultures showed more than 15 percent increase over the check variety. High GOT of 42.3 percent was recorded in case of NHP2 followed by DTS 108, DTS 155 and DTS 39. Culture DTS 44 performed well recording highest seed cotton yield and fibre quality.

Attempt was made to improve the fibre quality of identified drought tolerant cultures. Culture 28I has been selected for improving the fibre quality using Suraj, Suvin, P3 and HSD as donors. (28I × HSD) × 28I recorded high SCY of 1647 ka/ha and GOT of 39.6 percent. Promising single plants were selected from the cross (28I × Suvin) × 28I.

To develop compact plant type with early maturity, that can escape drought and good fibre quality, intermating was carried out between 15 inbred lines within cross which were stable for zero monopodia. Generation was advanced for development of MAGIC RILs for eight and ten parental cross. In eight parental crosses variation in selected F_2 plants (104), seed cotton yield ranged 17.4 to 116.2 g, boll wt from 1.7 g to 4.4 g and GOT from 27.3 to 44.9%.

Breeding for early maturity, compact plant type and jassid tolerance in cotton

Segregating populations *viz.*, F_2, F_3, F_5 and F_6 including 151 selected single plant derived progenies were evaluated for jassid tolerance, earliness, compact plant type, boll weight, yield and quality characters under normal spacing (60×60 cm) at Nagpur. Most promising plants were selected and advanced. Among the promising entries selected for earliness, jassid tolerance and compact plant type, 31 Bt (cry1Ac gene; Mon531 event) entries and 15 non-Bt entries were evaluated in replicated trial under high density (spacing 60×10 cm) along with standard checks to assess their potential. More than 1000 plants belonging to 72 promising plant to progenies were tested for cry toxin expression through ELISA and zygosity test through PCR. Of the 72 progenies, 13, 48 and 11 progenies were identified as homozygous, hemizygous and azygous for *cry1Ac* gene (Mon 531 event), respectively. The promising homozygous progenies having desirable characters like early maturity, jassid tolerance, compact plant architecture with good yield and fibre quality characters were identified for seed multiplication.

Promising single plant selections

Evaluation of promising entries under normal (60x60cm) spacing and high density (60x10cm)

Introgression of indigenous transgenic events for effective bollworm management

In order to introgress the indigenous transgenic events *viz.*, Tg2E13 (cry1Ac gene) and CH12 event (cry2Ax1 gene) into elite cotton genotypes, the BC_1F_1 population of three crosses *viz.*, Suraj × Tg2E13, NH615 × Tg2E13 and CISH3178 × Tg2E13 were raised in seedling trays along with the recipient or recurrent parents under contained facility at Nagpur. ELISA was carried out at 30 days after sowing (DAS) to identify the event positive plants and event negative plants were discarded. Event positive plants were transplanted to larger pots and

high toxin expressing plants were identified among the BC_1F_1 population of each of the three crosses through ELISA at 60DAS. Backcrossing of event positive, high toxin expressing BC_1F_1 plants of Tg2E13 event and backcrossing of F_1 plants of CH12 event to their respective recipient cotton varieties was successfully attempted in contained facility at Nagpur. Embryo culture protocol was standardized and successfully explored for accelerated generation advancement. Accordingly, excised embryos excised from old crossed boll were cultured and established for further backcrossing in contained facility.

Introgression of Tg2E13 (*cry1Ac* gene) and CH12 event (*cry2Ax1* gene) into elite cotton genotypes in contained facility. Backcross population of three crosses in seedling trays (a); Segregating F_1 (b) and backcross populations (c).

Backcrossing of event confirmed high toxin expressing plants recipient genotypes

Embryo culture in cotton: Culturing of embryo on culture media (a); Hardening of seedlings on soil rite (b); transplanted hardened seedlings in bigger pots (c).

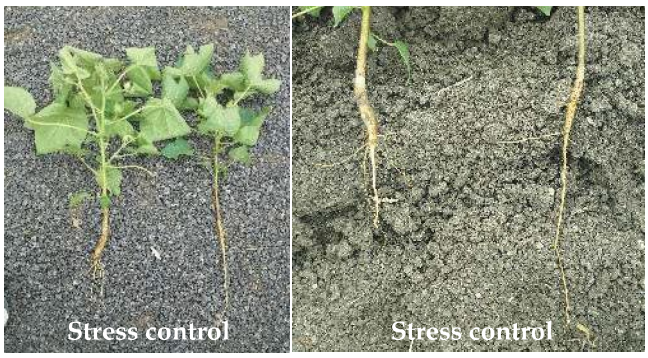
Water logging tolerance in cotton

Five accessions each of the identified water logging tolerant (IC 359979, IC 359245, IC 357235, and INGR 08092 & INGR 08093) and susceptible (IC 356708, IC 357607, IC 357558, IC 359242, IC 359915) genotypes were used in the crossing program to develop segregating populations for water logging tolerance at Nagpur and the crossed seed were harvested.

a) IC 359915 (Water logging susceptible);

b) INGR 08092 (Water logging tolerant)

Physiological studies were carried out on 80 cotton germplasm accessions which were exposed to continuous 20 days water logging in the field starting from 45 days after sowing. The phenotypic score was used based on leaf coloration in response to water logging like yellow and red leaves. Amongst the tested accessions, waterlogged tolerant lines *viz.*, IC 357235, IC 359979 and INGR 08092 had better root length and seed cotton yield (g/plant) compared to susceptible one (IC 357608 and IC 357607). The maximum root length of 40 cm was recorded in tolerant genotype IC 357235 under waterlogged condition. Difference in root growth was clearly observed under control and waterlogged plants



Root growth pattern in water logging stress imposed and control plants

Fifteen lines shortlisted from 210 lines based on replicated field trial conducted during the season 2016-17 were evaluated under pot culture experiment at Regional Station, Coimbatore. The lines were screened for water logging tolerance at 5 days after water logging under pot conditions. IC563997, IC357101, IC359925 and LRA 5166 (check) were identified as tolerant to water logging in terms of lenticel formation and absence of Fe deficiency.

3.4 Gene discovery, genomics and trait improvement

Gene expression analysis of *G. arboreum* LIM (*GaLIM*) gene family members

Protein containing LIM domains are documented for their role in regulation of gene expression at transcription level and cytoskeleton organization. Genome wide *in-silico* analysis identified 16 *GaLIM* members similar with animal cysteine rich proteins and 4 belong to plant specific *LIM* family. Gene expression analysis of plant specific *GaLIM* family members in response to pathogen *Fusarium oxysporum*, NaCl (200 mM), abscisic acid (100 µM) and jasmonic acid (100 µM) treatments were quantified at different time intervals through q-Reverse transcription PCR (qRT-PCR). The plant specific *GaLIM* family members *GaDA1-1*, *GaDA1-2*, *GaDA1-3* and *GaDAR1* showed significant differential response to the above treatments. Significant up regulation of *GaDA1-3* and down regulation of rest of the three genes in response to abscisic acid treatment was observed.

Zinc finger proteins for cotton fibre initiation

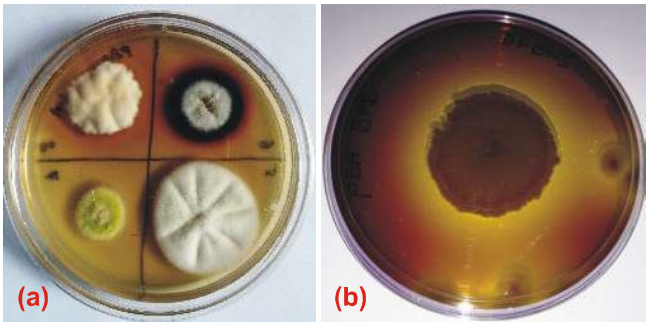
Quantification of gene expression of two putatively uncharacterized Zinc finger protein (ZFP) encoding genes *viz.*, *Ghzfp5* and *Ghzfp8* was carried out using MCU5 and its isogenic fibreless mutant, to aid the future research for the elucidation of their possible role(s) during cotton fiber initiation. Significant down regulation in the expression of *Ghzfp5* and *Ghzfp8* genes during 0 and 1 DPA (Days Post Anthesis) of MCU5 mutant compared to its wild type suggested the possible involvement of GHZFP5 and GHZFP8 transcription factors in the gene regulatory pathway of cotton fiber initiation.

Gossypol detoxification efficacy of bacterial clones expressing *CYP6AE14* Protein

Gossypol detoxification gene coding for CYP6AE14 protein was cloned in to expression vector *pET28c* and mobilised in to Rosetta-gami 2 (DE3) host strains. The overnight grown bacterium was inoculated (5%) on known amount of deoiled cotton seed cake and the gossypol content was estimated after 48 hrs of incubation by American Oil Chemists' Society (AOCS) method. Host cells with CYP6AE14 showed 73 and 56 *per cent* reduction in free and total gossypol content respectively over the control.

Isolation and characterization of microbes for gossypol detoxification

The gossypol detoxifying microorganisms were isolated from cotton rhizosphere soil and quantified for gossypol detoxification. Ten fungal and seven bacterial isolates were shortlisted and tested for gossypol detoxification. Total gossypol reduction efficacy of the microbes varied from 8.19 to 64.46 per cent over control, among them seven microbial isolates showed gossypol reduction more than 40 per cent. Earlier studies have reported increased expression of *laccase* protein in microbes growing on gossypol containing media; these isolates were further screened for *laccase* activity by guaicol assay and bromophenol blue assay. Screening resulted in identification of fifteen microbial isolates positive for *laccase* activity.

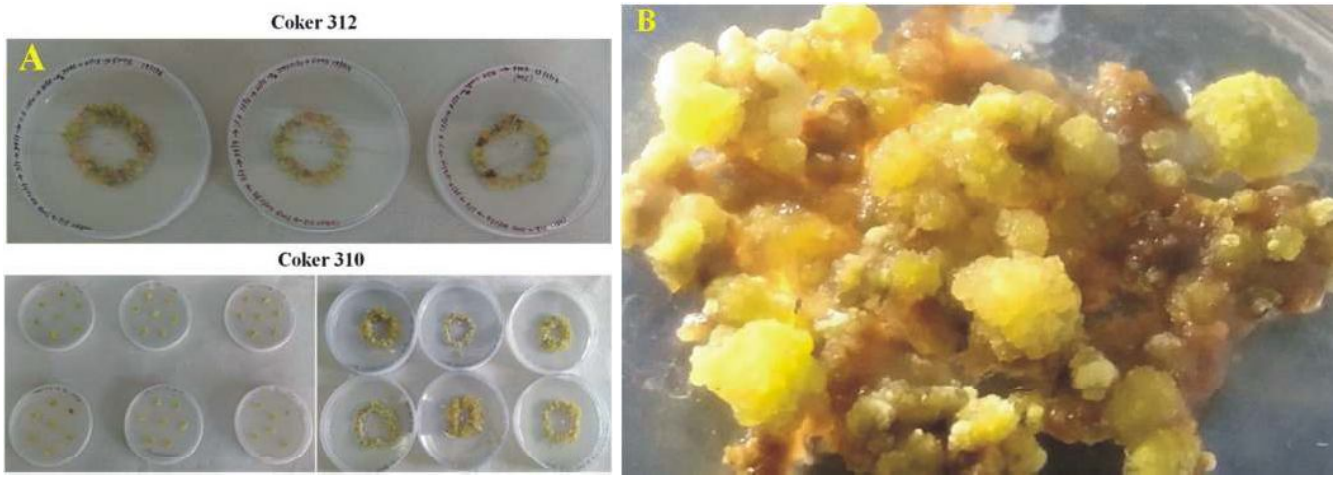


Screening of fungal isolates for *laccase* activity :

A. Brown discoloration in Guaicol assay B. Yellow discoloration in bromophenol blue assay observed due to *laccase* activity

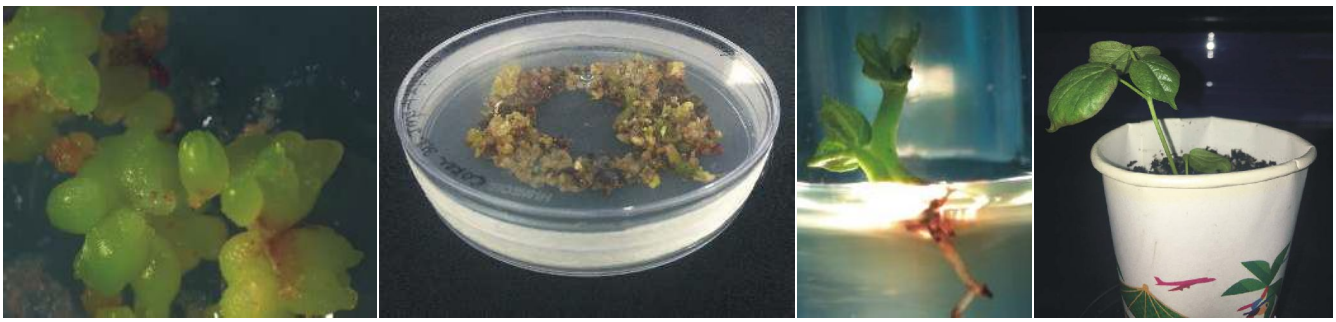
An efficient regeneration system for transformation

Induction of callus cultures for somatic embryogenesis : Callus cultures were induced on Murashige and Skoog (MS) medium supplemented with various combinations of auxins. Among them, media supplemented with 2, 4-D (0.1mg/L) and kinetin (0.5 mg/L) induced friable callus from *Gossypium hirsutum* Cv. Coker 310 and Coker 312. These callus cultures are being maintained through sub culturing for the generation of somatic embryos. The fresh calli were sub-cultured on MS medium with double the concentration of KNO_3, without NH_4NO_3 and growth hormone to obtain embryogenic callus.



A. Callus cultures induced from coker genotypes of *Gossypium hirsutum;* B. Friable callus

Somatic embryogenesis of cotton : A medium recipe for healthy root and shoot growth in germinated somatic embryos has been standardized. Among different concentrations of indole-3-butyric acid IBA treatments, woody planting medium with 1mg/L IBA has showed significant improvement in root growth of germinated somatic embryos in Coker 310 genotypes followed by 0.5mg/L of IBA.

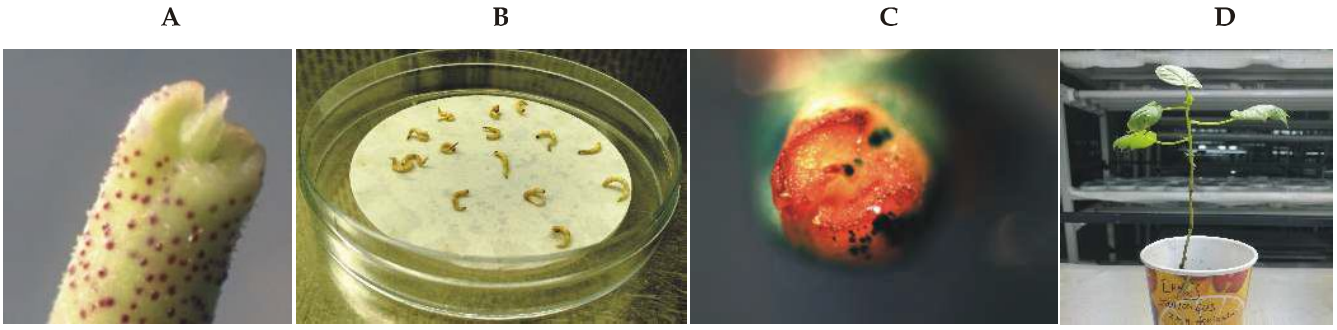


A. Somatic embryos initiation B. Germination and maturation C. Shooting and rooting D. Hardening

Standardization of In planta transformation method for transient gene expression in cotton

A protocol for genotype independent sonication and vacuum infiltration assisted Agrobacterium tumefaciens mediated in planta method for gene delivery into cotton was standardized. Mature excised embryos with intact apex, when subjected to a combined treatment of sonication (for 3 min) followed by vacuum

infiltration (10 min at 500 mmHg) of *Agrobacterium* suspension (OD at 600nm; 0.6-0.8), resulted in successful, deeper and uniform penetration of bacterial cells into explant. The infected explants when further co-cultivated on 1.5 to 2ml co-cultivation medium at lower temperature (23°C) in dark resulted in desired gene delivery and transient gene expression in to the plant cells. The present standardized method can be used as a tool to study transient gene expression in cotton tissues for functional gene characterization.



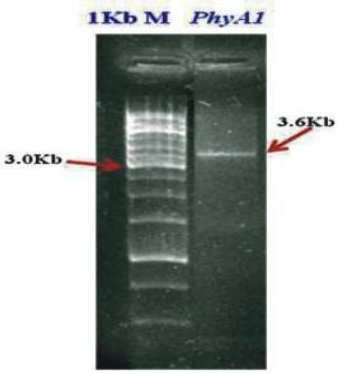
Steps in in-planta gene delivery in cotton A) excised mature embryo with apex B) co-cultivation on filter paper with minimum co-cultivation medium C) Transient GUS gene expression assay D) Plantlet regeneration

Isolation of *PhyA1* gene from cotton fiber for *CRISPR/Cas9* mediated mutagenesis

PCR variation was employed for the amplification of 3.6 Kb full length *PhyA1* gene from cotton genome. It will be utilized for sequence confirmation through cloning and sequencing before proceeding with *CRISPR/Cas9* mediated mutagenesis.

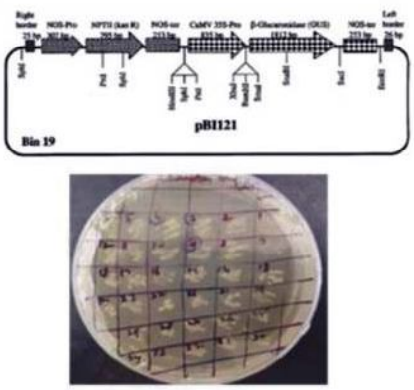
Isolation and molecular cloning of *Wnt*-like putative candidate gene expressed during cotton somatic embryogenesis

Full length *Wnt*-like gene was amplified from cDNA of *Gossypium hirsutum* fiber. The purified PCR gene product was cloned into plant binary vector *pBI121* as per the principle of directional cloning and was confirmed through colony PCR, plasmid PCR and restriction release. This construct will be utilized for the functional validation through plant genetic transformation studies.

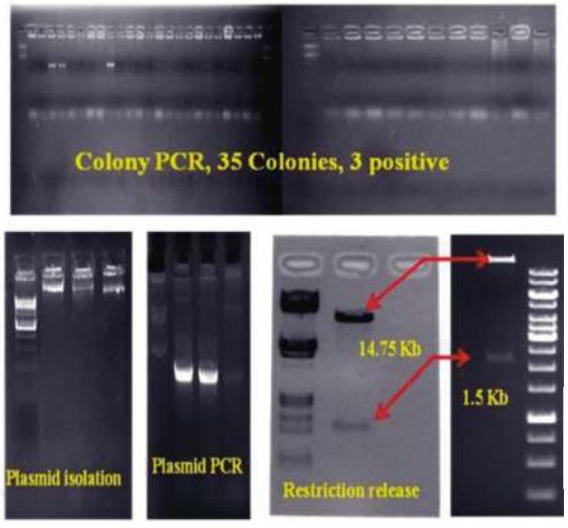


PCR amplification of 3.6 Kb *PhyA1* gene

PCR Amplification of Wnt-like gene



Colonies after transformation and plating



Amplification, directional cloning and confirmation of cotton *Wnt*-like gene

Unapproved Herbicide tolerant GM cotton testing at ICAR-CICR, Nagpur

Commercial cultivation of herbicide tolerant (HT) Bt-cotton seeds shocked everyone, since these transgenic cotton seeds were not permitted for sale or commercial cultivation in India by Genetic Engineering and Appraisal Committee (GEAC). Earlier ICAR-CICR, Nagpur tested 9 Bt hybrid samples (Kharif-2017; Feb 2017) submitted by Shri. Amol Pusadkar, Nagpur and 6 Bt hybrid were reported to be positive for HT event (RRF MON88913). During Kharif 2017-18, scientists of ICAR-CICR, Nagpur conducted field surveys and collected 379 leaf samples from different cotton fields suspected to be growing HT cotton from Wardha, Chandrapur, Yavatmal and Nagpur Districts of Vidarbha, Maharashtra. Out of 379 leaf samples tested 171 samples were positive for roundup ready Flex (RRF) harbouring CP4-EPSPS gene confirming illegal cultivation of HT cotton. Different print and electronic media have also reported about illegal cultivation of HT cotton in Maharashtra, Gujarat, Karnataka, Telangana and Andhra Pradesh. The state government seed inspectors have also sent 531 seed samples for testing presence of HT gene (*cp4-epsps*) in the seed samples. ICAR-CICR, Nagpur tested all the samples by qualitative detection method and it was found that 8 samples were positive for the presence of CP4-EPSPS protein. The gene and event was confirmed by PCR amplification using RRF-event (MON88913) specific primers.

3.5 Seed production and quality improvement

Storability of cotton seed

Different packaging materials were evaluated for better storability at quarterly intervals. Genotypic differences were observed for Suraj (*G. hirsutum*) and Phule Dhanwantari (*G. arboreum*) when stored for 12 months. Irrespective of storage containers, packaging materials and storage conditions, Suraj exhibited relatively higher seed germination (69%) as compared to Phule Dhanwantry (58%) at the end of 12 months from the initial seed germination of 85% and 81%, respectively. Vacuum packing followed by orange paper envelop packing showed better storage results and maintained higher seed germination as compared to brown paper packet, polylined aluminium packet and polythene heat sealed packets. Storage conditions had significant influence on seed germination. Seed stored under cold storage conditions maintained higher seed germination till 12 months as compared to ambient storage conditions. Seed stored under vacuum packing conditions exhibited higher seed germination as compared to non-vacuum packing containers. Seeds stored in airtight acrylic box with inbuilt hygrometer along with zeolite beads maintained higher viability and germination after six months of storage both in ambient as well as refrigerated conditions. Among the different seed treatments with organic materials after six months of storage, seed treated with Tulsi leaf powder had recorded highest seed germination (87%) followed by Moringa leaf powder (80%).

Effect of pollination systems on boll and seed setting

With augmented pollinators, in GMS crop of DS 5, the boll setting of 14.25% and seed setting of 56.0% was obtained as against 10.64% and 47.3% without augmented pollinator. Similar results were observed in GMS 16 line emphasizing the contribution of pollinators in boll and seed setting in sterile population. In its fertile plants of GMS lines, the boll and seed setting were 63.6% and 93.6% in DS 5 and 64.8% and 78.8% in GMS 16, respectively. Delayed picking of bolls after opening was observed to affect the boll and lint characters in cotton. If picking of opened bolls is delayed by 25 days after its opening, the reduction of boll weight up to 0.2 gm, seed index up to 0.4 gm, lint index up to 1.2gm and micronaire up to 0.4 was observed in *G. hirsutum* cultivars. While, in *G. arboreum* genotypes, reduction of boll weight up to 0.5 gm, seed index up to 0.2gm, fibre length up to 0.5 mm and increase in micronaire up to 0.1 was observed. The other traits remain unaffected.

Enhancement of quality of primed seeds through pulsed magnetic seed treatments

A laboratory experiment was conducted to assess the effectiveness of seed priming with chemicals and botanicals followed by treatment with pulsed electromagnetic field using acid delinted seeds of cotton variety Suraj. The priming of seeds with KH_2PO_4 @ 450 ppm followed by pulsed electromagnetic treatment has recorded 93% germination which was higher by 18% over untreated seeds (75%), however, priming with KH_2PO_4 @ 450 ppm alone (87%) enhanced germination by 12%. Seed priming with $CaCl_2$ @ 2%, KCl @ 1.0%, $MnSO_4$ @ 0.1%, Prosopis leaf extract @1.5% with pulsed electromagnetic treatment has also significantly increased the germination over control. The seedling length, vigour and dry matter of seedling have shown significant increment corresponding to the above treatments. For assessing the effectiveness of these seed treatments towards seed and seed cotton yield, treated

seeds of Suraj variety were sown in field in two replications with RBD. The plant height was recorded at 90 DAS, 120 DAS and 150 DAS. At 90 DAS, among the treatments, seeds primed with $CaCl_2$ @ 2% (92cm), Prosopis leaf extract @ 1.5% (89cm), KH_2PO_4 @ 450 ppm (89cm) recorded significantly higher growth when compared to control. The boll number, dry matter of plant, boll weight, seed index and ginning % were also positively influenced by seed priming with chemicals and botanicals followed by pulsed electromagnetic field treatment showed to enhance of seed germination, seedling vigour and plant establishment.

Seed Production

Seed belonging to different stage of certification was produced as under at ICAR-CICR, Nagpur, Coimbatore and Sirsa during 2017-18 (Table 3.5.1).

Table: 3.5.1: Seed Production during 2017-18

Crop	Variety	Stage	Quantity produced (q)
Cotton	Suvin, Surabhi, LRA-5166, MCU 5VT, CICR-2 Female, CICR-2 male, CISA 614, CISA-310, CSH 3075, CSH 3129	BS	3.36
	Suraj, LRA-5166, LRK-516, PKV 081, NH-615, , NH 452, CNA 1003 (Roja), AKA 7	TFL	0.98
	Bt Varieties (3)	NS	1.73
	Stock Seed (48 varieties)	TFL	1.32
	Suraj*	TFL	4.38
Wheat	WH 1142	CS	265
Red gram	BSMR-736	CS	4.70
Gram	Vijay	CS	0.50
Red gram	BSMR-736	TFL	5.14
Grand Total (Cotton & other crops)			**286.13**

** Produced through Farmers Participatory Approach in mediation with Suyash NGO, Wardha; BS – Breeders Seed; TFL – Truthful Labeled Seeds; NS – Nucleus Seed; CS – Certified Seed*

PVP legislation and DUS testing

Five separate trials were conducted to undertake DUS testing of 4 entries (first year trial), 4 entries (Second Year trial), 2 entries (Varieties under Common Knowledge trial), 2 entries (Essentially Derived Variety and Initial variety trial) and 12 entries (Reference trial). Twenty four *desi* cotton varieties were sown for maintenance and seed multiplication. The monitoring of DUS trial conducted at ICAR-CICR, Nagpur was held on 26.10.2017 under the Chairmanship of Dr. Phundan Singh, Former-Director, ICAR-CICR, Nagpur.

During the year 2017-18, the data base on extant cotton varieties has been updated. Seed multiplication, characterization and maintenance of 142 extant cotton varieties (118 of *G. hirsutum*, 15 of *G. arboreum*, 3 of *G.herbaceum* and 6 of *G.barbadense)* was undertaken.

At ICAR-CICR, Regional station, Coimbatore, field trials for DUS testing of new cotton genotypes, varieties of common knowledge, and essentially derived variety was conducted. There were 5 new candidate varieties in the second year testing trial. In the first year trial, 2 new candidate varieties were grown along with 15 reference varieties. The trial was conducted as per test guidelines for tetraploid cotton. Morphological characters were recorded form seedling stage to harvested fiber.

Promising entries of ICAR-CICR under evaluation in different trials

State Multi Varietal Trial (SMVT) at CICR, Nagpur

A State Multi-location Varietal Trial (SMVT) of *G. arboreum* (21 entries + 3 control varieties) and *G. hirsutum* (16 entries + 5 control varieties) with three replications following recommended package of practices was conducted at CICR, Nagpur during 2017-18. At the terminal stage of the crop, 7-12% infestation of pink

bollworm was observed on *G. hirsutum* as well as *desi* cotton. In *G. arboreum*, seed cotton yield ranged from 1364 to 2176 kg/ha. The maximum seed cotton yield of 2176 kg/ha was obtained from JLA 1321 followed by CNA2016 (2147 Kg/ha). In *G. hirsutum,* the seed cotton yield ranged from 847 to 1917 kg/ha. Rajat, a control variety recorded highest seed cotton yield of 1917 kg/ha while the genotypes under evaluation had seed cotton yield less than the control. The range of variation for fibre quality traits are presented in Table 3.5.2.

Table 3.5.2 : Fibre quality parameters of the entries tested in SMVT at Nagpur

Particulars	Range in *G. arboreum*	Range in *G. hirsutum*
Ginning percent	31.4 – 38.1	27.4 – 38.0
Boll weight (g)	2.3 – 3.0	2.7 -4.9
Fibre length (mm)	24.8 -30.8	26.4 – 30.2
Uniformity Index (%)	81.7 - 83.5	81.7 – 83.4
Micronaire value	4.7 – 5.6	3.9 – 4.8
Fibre strength (g/tex)	25.3 – 30.2	27.2 – 30.8

Testing of ICAR-CICR entries under AICRP on Cotton

Seven AICRP trials *viz.,* Br 02 (b), Br 22 (b), Br 22 (b) LL, Br 24 (b), Br 24 (b) LL, Br 03 (b) and Br 06 (b) and two Institute common trials of *G. hirsutum* and *G. arboreum* were conducted at ICAR-CICR, Nagpur.

Trial name	Entries sponsored for testing under AICRP on Cotton in 2017-18
Br 02(a)	CSH 3419, CSH 1604
Br 02 (b)	CNH 1126, CNH 25-09, CNH 11-11, CNH 12-4-2, CNH 2050, CNH 09-70
Br 06(a)	CSH 3824, CSH 1613
Br 06 (b)	CNH 1127, CNH 1128, CNH 136, CNH 09-9, CNH 09-98, CNH 2048
Br 12 (a)	CCB 64, CCB 129, CCB 143, CCB 102
Br 15 (a)	CCHB 32, CCHB 14
Br 22 (a/b)	CNA 1033, CNA 1034, CNA 2016, CNA 2031, CISA 7, CISA 33-5
Br 22 (a/b) LL	CNA 1058, CNA 1067, CNA1037, CISA 33-7, CISA 33-8
Br 25 (a/b)	CISAA 17-1, CISAA 17-2

Zone	Trial name	Entries Promoted / Retained*
NORTH	Br 25 (a/b)	CISAA 17-1, CISAA 17 -2
	Br 06(a)	CSH 3129-2, CSH 5640
	Br 24(a)	CISA 33-3
	Br 24(a)	CISA 6-2*
CENTRAL	Br 03 (b)	CNH 11-11, CNH09-70
	Br 06 (b)	CNH09-9, CNH09-4*
	Br 13 (a) PVT *G. barbadense*	CCB 64, CCB 129, CCB 143-b
	Br-24 b CVT – *G. arboreum*	CNA 2031, CNA 1054, CNA1031*, CNA1032*
	Br-24 b CVT -LL– *G. arboreum*	CNA1037
	Br25 (b)	CISAA 17-2
	Br 03 (a)	CCH16-1
	Br 06 (a)	CSH 1613, CSH 3129-2*

Zone	Trial name	Entries Promoted / Retained*
SOUTH	Br 13 (a)	CCB 143 b, CCB 64, CCB 129, CCB29*, CCB51*
	Br-03 (b)	CNH09-70
	Br06 (b)	CNH 1128, CNH09-62
	Br-24 (b): CVT -*G. arboreum*	CNA 1054, CNA1031*
	Br-24 CVT -LL– *G. arboreum*	CNA1037
	Coloured Cotton Trial: *G. hirsutum*	16315 LB, 16301 DB, 16337 LB
	Coloured Cotton Trial: *G. arboreum*	CNA407 SLP, 16378 LB-1, CNA405, CNA407 and 16377 LB-A

Note: entries marked with asterisk (*) denotes retained entries

Entries Proposed for Agronomy Trial

Central zone: CCH 15-1, *G. hirsutum,* Variety (Irrigated), CSA 1028, G. *arboreum* Variety, (Rainfed); **South zone:** CCH 15-1 *G. hirsutum,* Variety (Irrigated)

In multilocation evaluation of pre-release Bt varieties with deregulated event Mon 531, six, three and two entries were promoted in North, Central and South zones, respectively (Table 3.2.7).

Table 3.5.3 : Bt entries from ICAR-CICR under testing in AICCIP trials

Year (2017-18)	ZONE	Name of the entries
11 entries	North	CICR 242 BT, CICR 562 BT, CICR76 BT, CICR 98 BT, CICR 38BT, CICR 861 BT,
	Central (Rainfed & Irrigated)	CICR 81 BT, CICR16 BT, CICR 2017 BT
	South (Rainfed & Irrigated)	CICR 902 BT, CICR23 BT

3.6 : Enhancing resource use efficiency through climate smart agro-techniques

Nagpur

Allelopathy an alternative weed management strategy in cotton

Timely weeding is a major issue in the sticky black cotton soils on which cotton is grown. Furthermore, cost of weeding is substantially higher that leads to a reduction in profitability of cotton production. Therefore, devising alternate weed control strategies using allelochemical producing cover crops were considered as a possible solution. The cover crops were evaluated under rainfed conditions at Nagpur and winter irrigated conditions at Coimbatore.

Field studies were conducted to screen cover crops in the rainy season as well as the winter season to study their efficacy in controlling weeds and on cotton productivity. Among the 12 cover crops evaluated, sunnhemp, sorghum, sesame were found to not only smother the weeds effectively but also had high seed cotton yields (Fig. 3.6.1).

Using the GC-MS, cover crops were analyzed for the allelochemicals. The allelochemicals belonged to the category primarily of fatty acids and their derivatives, terpenes, sterol, aliphatic hydrocarbon and aldehydes. The major compounds identified in cover crops under study were, phytol and pentadecanoic acid,1,4-methylene methyl ester in sorghum; 9,12-octadecadienoic acid (Z,Z) - methyl ester and neophytadiene in pearl millet; squalene & linolenic acid in sunnhemp; 9,12-octadecadienoic acid, 9,12-octadecatrienoic acid (Z,Z) & their methyl esters in sesame; quinic acid & decanal in marigold; γ-sitosterol & octatriconyl pentafluropropionate in bitter cumin; 9,12,15-octadecatrienoic acid and strearic acid methyl ester in desmodium.

With regard to soil biochemical properties, the plots with the sunnhemp as a cover crop had better enzymatic activity (Acid phosphatase, Alkaline phosphatase and β-glucosidase) as compared to the other cover crops as well as mulch of the polythene and newspaper. Sorghum as a cover crop had the highest dehydrogenases activity.

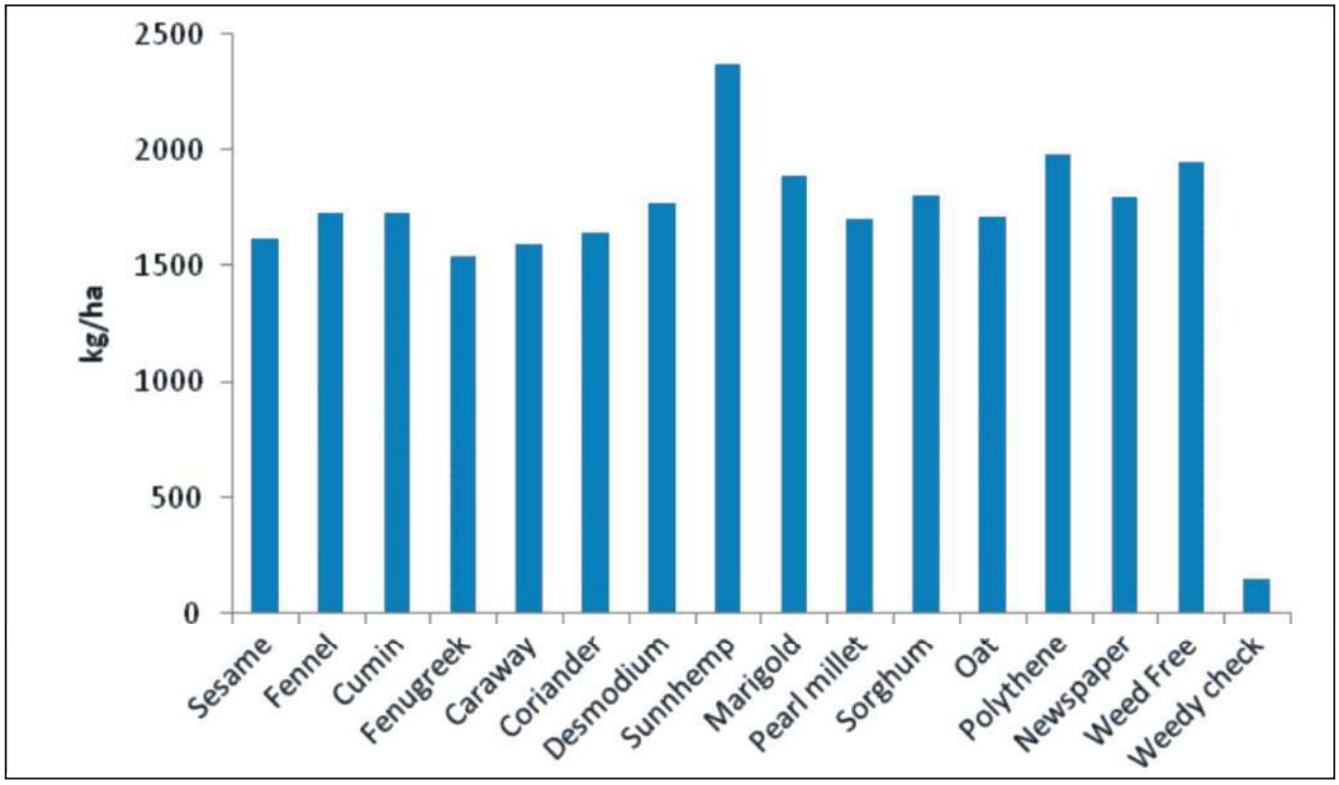


Fig. 3.6.1: Effect of cover crops on seed cotton yield

Inter-row cover of sorghum at Nagpur

Weed free cotton with Desmanthus cover at Coimbatore

Coimbatore

Five legume cover crops were evaluated for two consecutive years (2015-16 and 2016-17). All the legume cover crops were equally effective in reducing weed density, but the cover crop of sesbania had reduced the boll number significantly and consequently resulted in a reduction in seed cotton yield (Table 3.6.1). Forage cowpea and sunnhemp had significantly higher seed cotton yield than the traditional weed control method. The seed cotton yield was similar with all the five legume cover crops.

Table 3.6.1: Yield attributes and seed cotton yield as influenced by cover crops at Coimbatore*

Treatments	Bolls/plant	Boll Wt (g)	SCY (Kgs/ha)
SSBT** followed by Thornless mimosa +one HW	28.0	6.15	2203
SSBT followed by Sunhemp + one HW	33.4	6.08	2463
SSBT followed by Daincha (Sesbania +one HW)	24.8	6.28	2143
SSBT followed by Forage cowpea +one HW	34.0	6.03	2494
SSBT followed by Desmanthus + one HW	28.2	5.92	2276
No SSBT (pendimethalin 1.0 kg) as pre emergence + HW (Twice)	24.9	5.82	1959
SEd	1.63	0.17	105.36
CD (P=0.05)	3.49	NS	224.58

* Pooled data for 2015-16 and 16-17, ** Stale Seed Bed Technique

Across locations and years, it is evident that sunnhemp as a cover crop is an option for effective weed control. Furthermore, it also provides the benefit of nitrogen (N) fixation.

Alleviating soil compaction – a production constraint in cotton

Excessive use of machinery has created problems of soil compaction. Tractors are employed to cultivate soils when the soils are wet leading to sub-soil compaction. Most often, the common problem faced by cultivators is poor root growth of cotton. This may be due to a hard compact zone at a lower depth. As a result, the crop growth is adversely affected. Therefore, large-plot field experiments were conducted to evaluate the effects of sub-soiling on crop growth and yield. In the first year of the study, it was observed that seed cotton yield was not significantly different with or without sub-soiling (Fig 3.6.2). However, shallow sub-soiling resulted in 5.7 to 8.6% greater seed cotton yield than the control treatment. The sub-soiled treatments also had a deeper root system (79.3±14.9 cm) than the control treatment (72.0±8.5 cm).

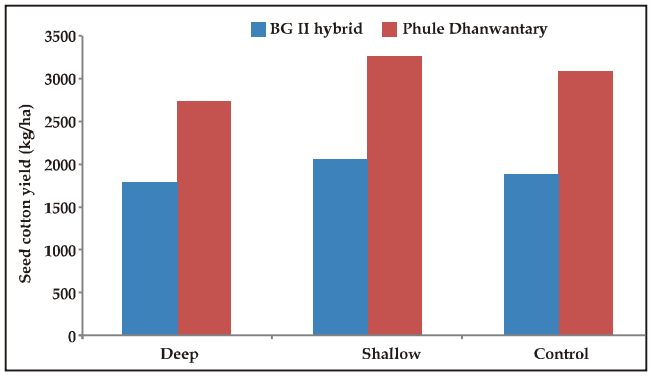


Fig 3.6.2: Effect of sub-soiling (deep and shallow) on seed cotton yield of Ajeet-104 BG II hybrid and Phule Dhanwantary as compared to the control

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

Desi cotton (*G. arboreum*) is a potential alternative to obtain sustainable yields under sub-optimal agro-climatic conditions. However, non-availability of long staple *G arboreum*'s, with comparable fibre properties of their hirsutum counterparts is the main hurdle in deploying them. The project was conceived to provide location specific long linted arboreums tailored with an agronomic package to maximize the productivity of cotton and climate proof the cotton growers.

Nagpur

- Seven *G. arboreum* genotypes (6 long linted - DLSA 17, PA 528, PA 402, PA 812, PA 760, CNA 1037 and short stapled Phule Dhanwantary were evaluated under rainfed conditions at 2 spacings (60x10-HDPS and 60x 30 cm-normal) on a shallow inceptisol (Typic Haplustept) and a deep vertisol (Typic Haplustert) on two sowing dates - June 22 and July 7, 2017. The highest yield of 2522 kg/ha was realized with CNA 1037 planted at 60x10 cm on June 22, 2017 on an inceptisol.
- The gain yield with 60x10 cm spacing over 60x30 cm spacing was 19.1% in D1 on an inceptisol, 23.5% in D2 on an inceptisol, 14.8% in D1 on a Vertisol and 22.9 % in D2 on a vertisol.
- Averaged across the soils and sowing dates the seed cotton yield of the different genotypes under normal spacing and HDPS is depicted in Fig 3.6.3. The yield gain under HDPS ranged from 10.3% with PA 760 to 27.6% with CNA 1037.

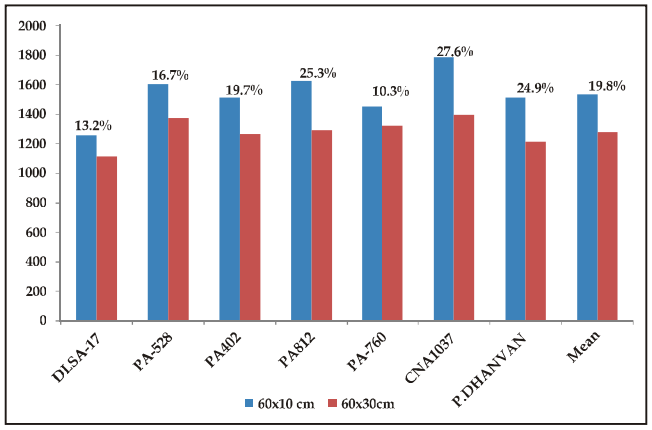


Fig 3.6.3: Seed cotton yield (kg/ha) of different desi cotton genotypes under normal spacing (60x30 cm) and HDPS (60x10 cm)

- Test of homogeneity in yield for soil types and dates of sowing indicated that genotypes DLSA 17, PA 812 and Phule Dhawantary shows homogeneity for different soil types and dates of sowing for the spacing 60x10 cm. Similarly, under 60x30 cm spacing, the genotypes PA 402 and PA 760 shows homogeneity for different soil types and dates of sowing
- Among 8 treatments used for modifying crop architecture, de-topping + side shoot removal and application of Mepiquat chloride @ 50 g ai/ha were effective in reducing plant height and significantly improving the yield of *G. arboreum* var Cv. PA 255.
- East-west direction of row planting produced significantly higher seed cotton yield than other row directions in variety PA 255. North-South direction of row planting gave more seed cotton yield over North West-South East row direction in varieties Phule Dhanwantary. There was no significant effect of row direction planting at boll position of upper and lower half of cotton plant in both the varieties
- Estimation of ethylene level in young cotton bolls was done in six long linted desi cotton genotypes. There were significant differences among the genotypes. Expression analysis of two major enzymes of ethylene biosynthesis (ACCS and ACCO) was performed using qRT-PCR, to correlate their expression with ethylene level. The expression of ACCS was more or less same as of ethylene level in respective varieties.
- Eight long linted cotton genotypes were evaluated in pots for root traits. Amongst the genotypes, DLSA-17 had the maximum root length of 64 cm at 60 DAS with Ralligold @ 5g Mycorrhizal biofertilizer

Coimbatore

- Seven long linted *G. arboreum* genotypes (DLSA 17, PA 760, PA 812, PA 402, PA 528, K12 and Phule Dhanwantery) were planted in two dates of sowing (4th August and 4th September, 2017). Amongst them, genotype, K-12 registered the significantly higher seed cotton yield (1360 kg/ha) followed by Phule Dhanwanthry (1050 kg/ha) and DLSA-17(929 kg/ha). Between the dates of sowing, significantly higher yield was recorded with 4th August sowing (1060 kg/ha) than 4th September sowing (810 kg/ha).
- The productivity of *G. arboreum* was assessed with respect to row orientation (North- South, East – west and diagonal) using two contrasting (tall and short) genotypes (K 11 and DLSA 17) under HDPS. Significant difference was observed with respect to growth characters (monopodia and dry matter production) which were higher with north-south row orientation. However, the same was not reflected in seed cotton yield.

Participatory evaluation of technology for improving profitability in calcareous soils.

Cotton grown on the rainfed black calcareous soils are prone to moisture and multi-nutrient stresses. On-station field experiment was conducted with a *G. hirsutum* cultivar (PKV081) and a BG II hybrid (Ankur 3028) with fourteen different nutrient treatments. Seed cotton yield (SCY) of the cotton variety PKV081 was improved by the nutrient interventions over no fertilizer nutrient control. There was no significant difference among the different interventions. However, the hybrid Ankur 3028, SCY was significantly enhanced by the treatments T_2 (seed treatment with biofertilizers + 125% RDF (NPK)+ Mg, S (10, 10 kg ha^{-1})+Micronutrients (Fe, Mn, Zn, B) as per soil test + Opening of ridges & furrows after 1st interculture) and T_8 –(T_2+Humic acid treated fertilizers (0.02%) + Micronutrients soil application (15 kg ha^{-1}) by 11.3 and 10.3%, respectively, over the control (Fig. 3.6.4). From the experiment, it was inferred that on calcareous soils, moisture stress could be overcome by opening ridges and furrows with first hoeing operation and multiple nutrient stresses can be managed by use of biofertilizer (*Azotobacter* spp, PSB, *Trichoderma* spp) treated seeds along with 125% RDF and micronutrient applied as per soil test.

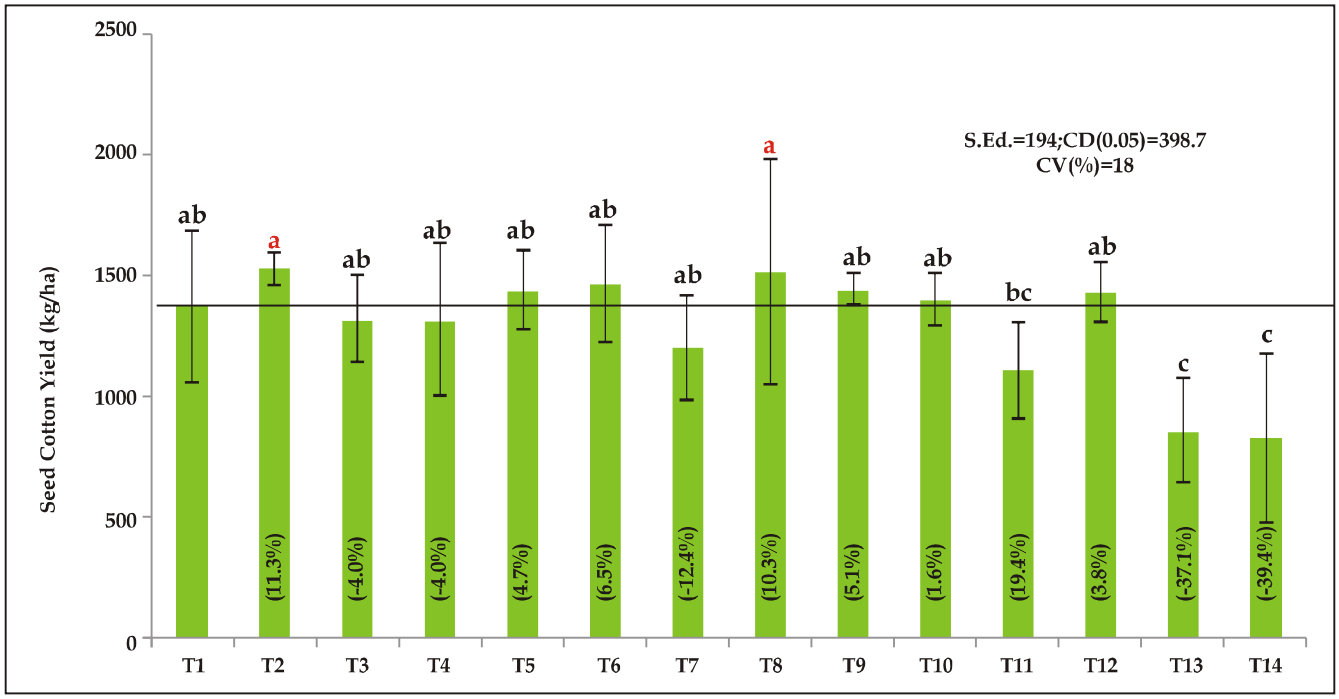


Fig. 3.6.4 : Effect of input management on seed cotton yield (kg ha^{-1}) of BG II hybrid Ankur 3028 under rainfed black calcareous soil

T_1- Control (100% RDF)(N, P, K, Zn (12.5 kg ha^{-1})+ B (5 kg ha^{-1}) + RF; T_2-125% RDF (NPK) + Mg, S (10 kg: 10kg ha^{-1})+Micronutrients (Fe, Mn, Zn, B) as per soil test + ST(B)+ RF; T_3-100% basal+ 25% P, K, Mg split soil application @ 45 DAS ST(B)+RF; T_4-125% RDF (NPK)+ Micronutrients (0.05% B+ 0.5% Fe +0.3% Mn + 0.5% Zn Sulphate) @ 45 DAS+P (2% DAP @ 75 DAS) Foliar Spray+ ST(B)+ RF; T_5-125% RDF (NPK)+ Chelated Micronutrients 2 kg ha^{-1} (Soil application)@ 45 DAS+ ST(B) +RF ; T_6-125% RDF (NPK)+ Chelated Micronutrients 0.5% (Foliar Spray) @ 45 DAS + ST(B)+ RF; T_7-125% RDF (NPK) + Animal Manure in Root Zone (2 t ha-1) + Micronutrients soil application (15 kg ha^{-1}(Hybrid)/ 12 kg ha^{-1} for Variety +ST(B)+ RF ; T_8-125% RDF (NPK) + Humic acid treated fertilizers (0.02%) + M Micronutrients soil application (15 kg ha^{-1}(Hybrid)/ 12 kg ha^{-1}for Variety +ST(B)+ RF; T_9-125% RDF (NPK) + Chelated Micronutrients soil application 2 kg ha^{-1} + ST(H)+ RF; T_{10}-125% RDF (NPK)+ Chelated Micronutrients 0.5% (Foliar Spray) @ 45 DAS +ST(H)+ RF; T_{11}-100% RDF+ Micronutrients (Zn, B, Mn, Fe) (12.5:5:5:5 kg ha^{-1}); T_{12}-125% RDF alone (NPK only); T_{13}-RF(Nil fertilizers); T_{14}-Absolute Control (Nil fertilizers). [RF-Opening of ridges & furrows after 1st interculture; ST (B)- Seed treatment with biofertilizers (Azotobacter, PSB, Trichoderma); ST(H)- Seed treatment with humic acid (0.02%)]. Data represent means and error bars refers standard deviation of three independent replicates. Statistically significant differences with LSD test at CD (0.05) are indicated by different characters. The horizontal line represents the SCY in control and percent variation depicted in parenthesis. Based on ranking, a has the best and c has the poorest performing groups.

Identification and characterization of water deficit period

The objective of the study was (i) to identify water deficit and water surplus period with climatic water balance study, (ii) to assess the impact of drought stress indicators on cotton yield under rainfed condition, (iii) to categorize severity of drought index based on the water balance data, and (iv) to identify the length of the growing season based on reference ET and rainfall at micro level.

Climatic water balance was computed as per Thornthwaite and Mather procedure (1955) to assess the daily soil moisture status and other soil water components. The reference evapotranspiration was calculated by temperature based method of Hargreaves and Samani (1985).

The storage capacity of 0-142 cm soil depth was 262.7 mm. When the climatic water balance computation was

initiated from 1.1.2017 and continued up to 31.12.2017, the available soil water on 1.6.2017 was only 10.2 mm, which was further, increased through rainwater recharge by rainwater to its full capacity of 262.7 mm on 19.8.2017. Thereafter, it was fluctuating within a range of 226.1 to 262.7 mm up to 21.9.2017 depending upon the amount of rainfall received during this period. Within this period, about 135.1 mm excess rainwater was recorded. After termination of monsoon rainfall on 21.9.2017, the depletion of available soil moistures continued to meet the ET demand of the crop and 50 % depletion of soil moisture was observed on 3.11.2017 (Fig. 3.6.5).

If the climatic water balance components are considered in 0-60 cm soil depth with available water storage capacity of 111.6 mm, the soil profile of 0-60 cm was fully recharged to its maximum potential of 111.6 mm on 2.7.2017 (3.6.6). During the rainy season particularly after complete saturation of the soil profile, 236.1 mm surplus rainwater was available up to 21.9.2017 and depletion of available soil moisture was started from 21.9.2017 and 50% depletion was recorded quite early on 13.10.2017 as compared to the whole soil profile soil moisture, which was considered for study. As the root density beyond 60 cm soil depth is limited, the availability of soil moisture in below layer is also quite high for longer period. It has been observed that the soil profile of 61-142 cm depth was fully recharged by the receipt of rainfall on 18.7.2018 and this trend was continued up to 21.9.2017 with slight depletion depending upon the interval of non-rainy days (3.6.7). During this period, about 211.6 mm rain water was found to be non–effective.

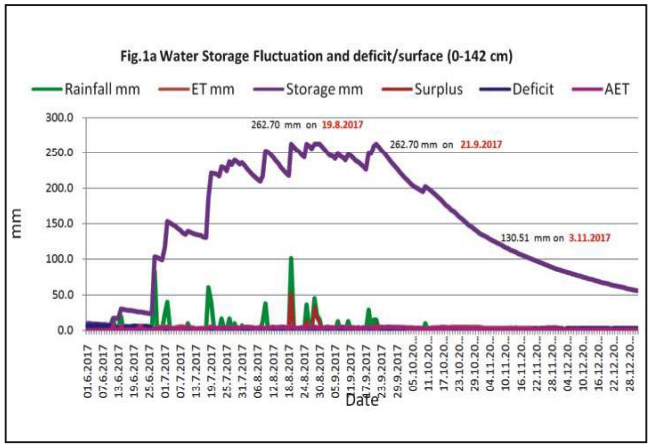


Fig.3.6.5 : Water Storage Fluctuation and Deficit/surface (0-142 cm)

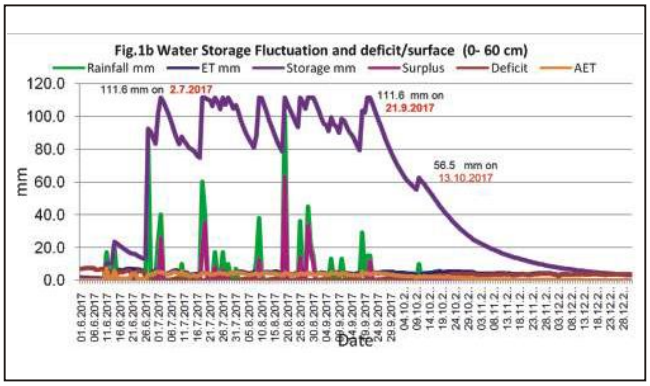


Fig.3.6.6 : Water Storage Fluctuation and deficit / surface (0-60 cm)

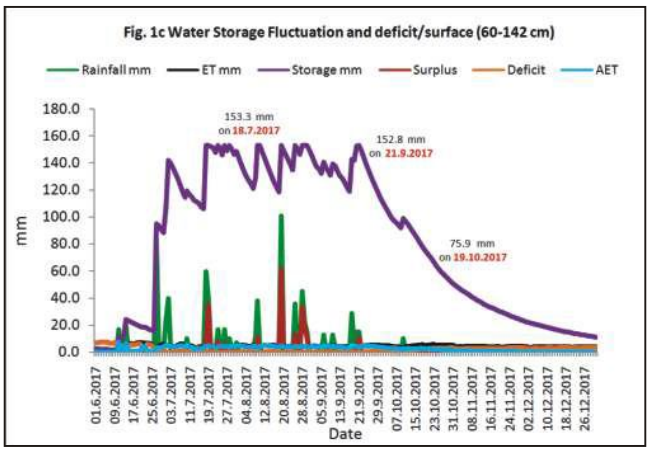


Fig.3.6.7 : Water Storage Fluctuation and Deficit / surface (60-142 cm)

Aridity Index

The aridity index = {(ETo-AET/ETo)*100}, was calculated by considering two parameters of water balance ETo and AET showed severe drought (>50% aridity index) in 0-142 cm soil depth during early growth period due to in-adequate amount rainfall and dryness of soil profile (Table 2). There after due to receipt of good amount of rainfall, the soil profile was fully recharged and the soil moisture stress in terms of aridity index nil (1-25%) was negligible as significant amount of moisture from below layer contributed towards evaporative demand of the atmosphere even up to mid of October. From 16 October on wards, the soil moisture depletion was in increasing trend and severe stress was recorded beyond this period. The depletion of soil moisture in case of first soil layer (0-60 cm) was quite fast and the severe stress was recorded from first fortnight of October where the number of immature cotton bolls were high in all Bt hybrids and Bt varieties.

Hence, it is highly essential to correlate development pattern of bolls, opening of the bolls of each variety to select an appropriate Bt variety or Bt hybrids for harvesting potential seed cotton yield from medium to heavy soil.

Table 3.6. 2 : Aridity index of the experimental field in different soil depth (cm)

Period	Aridity Index (%)		
	0-142 cm	0-60 cm	61-142 cm
1-15 June	82.7	83.2	85.9
16-30 June	67.8	58.5	63.2
1-15 July	30.0	11.0	12.3
16-31 July	9.10	3.80	3.4
1-15 Aug	9.60	10.4	8.0
16-31 Aug	4.10	7.70	5.8
1-15 Sept	4.70	10.4	7.7
16-30 Sept	6.40	13.7	10.4
1-15 Oct	19.7	38.7	30.7
16-31 Oct	38.4	66.3	55.6
1-15 Nov	53.6	82.8	72.7
16-30 Nov	63.0	89.9	81.5
1-15 Dec	70.3	94.0	87.3
16-31 Dec	77.4	96.4	91.7

Phenotyping of root system architecture in cotton (*Gossypium hirsutum* L.) for its adaption to drought

Forty five cotton genotypes were evaluated for their root architecture in acrylic glass tubes. Cotton genotypes were grown in the tubes and water was withhold for a week period after 20, 30, 40 DAS along with control. Soil media mixture used for growing cotton seedling in acrylic tubes was consisted of soil, sand, FYM and Vermi-compost in 2:1:1:1 (w/w) ratio. After 60 DAS, best genotypes were identified based on root architecture (Table 3.6.3).

Root characters of *G. hirsutum* accessions

Genotype	Root /shoot characteristics
IC 357429, 5133, CHO09-5, IC 357103, 5095, LRA ZFP, IC 359024 and IC 358108	High tap root length: >79.3 cm (19.5 cm – 79.3 cm)
Suraj, N-108, Rajat and IC-357103	High shoot dry weight: >2.38 g (1.15 g- 2.38 g)
IC-357103 and Suraj	High root dry weight: >0.82 g (0.40 g – 0.82 g)
5144, 30I and DCI-453	High fresh shoot weight: > 49.1 g (5.2 g – 49.1 g)
DCI-453, CNH 09—5, LRK-DREB/A and DTS 108-09	High fresh root weight: > 39.2 g (1.9 g – 39.2 g)
IC-358108, Suraj, DCI-453 and IC-359035	High root/shoot dry weight ratio: > 0.43 (0.24 – 0.43)
DCI-453, DTS 155-09 and DTS 108-09	High root/shoot fresh weight ratio: > 0.94 (0.41 – 0.94)

Table. 3.6.3: Root /shoot characteristics of cotton genotypes after 60th DAS

Metabolite exploration of drought stress in cotton :

Extreme environmental conditions, such as drought affect growth, productivity and quality of crop adversely. The impacts of drought on cotton are widespread and varied. A new metabolic path "alarm photosynthesis" pathway was discovered in some of the model plants, aiding them in sustaining under drought stress conditions well enough. The project was initiated to explore the existence of this pathway in cotton along with characterizing the effect of drought stress on metabolites at different stages of growth. All the four *Gossypium* spp. (*G hirsutum*: DTS-44 - drought tolerant & 3763 - drought susceptible, *G. arboreum*: Phule Dhanwantary, *G. barbadense*: Suvin and *G. herbaceum*: G-cot 25) were subjected to drought stress by withdrawing irrigation for 10 days. Expression analysis (qRT-PCR) of GLP/oxalate oxidase (major gene of alarm photosynthesis pathway) was performed in cotton leaves, cotyledon, root as well as 10 DPA (days post anthesis) and 25 DPA ovule, all of them showed Oxalate oxidase (OxO) expression in the respective tissue, except

the root (Fig. 3.6.8 & 3.6.9). OxO enzyme assay was done in cotton leaves, seeds and fiber tissues and compared with sorghum. Cotton leaves showed activity, but it was less as compared to sorghum a C- 4 plant. Compared to other tissues (leaves, fiber), seeds were found to have maximum OxO activity. Among the treatments, drought stressed leaves were observed to have more OxO activity than control samples.

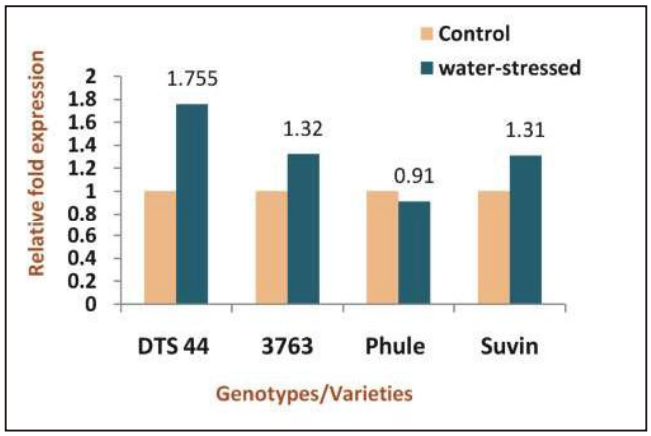


Fig. 3.6.8 : Expression analysis of oxalate oxidase

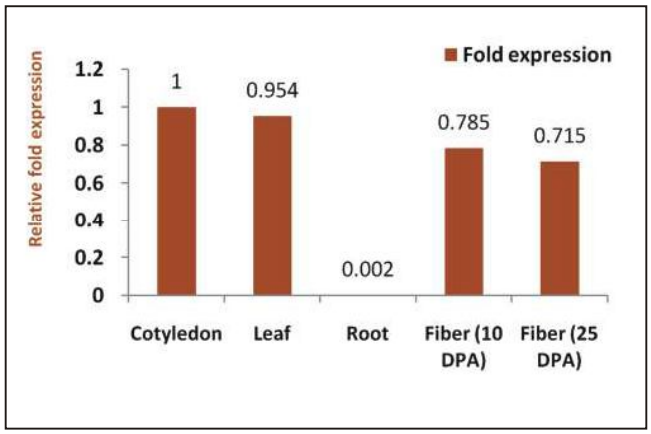
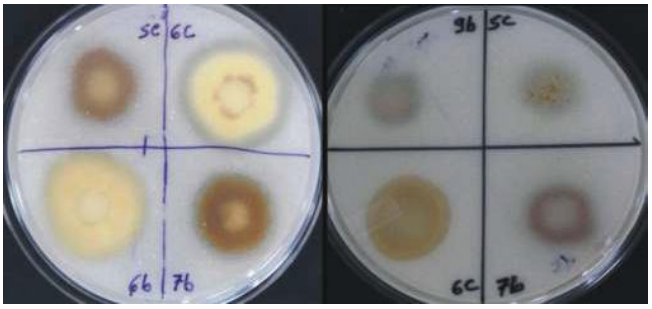


Fig.3.6.9 : Expression analysis of oxalate oxidase (OxO) of different cotton species (OxO) in different cotton tissues

Microbial interventions for potassium (K) nutrition in cotton.

To isolate K-solubilising microorganisms, cotton rhizosphere samples were collected from different cotton growing districts of Vidarbha region. The isolates obtained on specific media were further screened for K solubilisation. Among 20 isolates that showed significant zone of solubilisation on specific media, five isolates had 1 mm zone of solubilisation, 10 isolates had 2 mm zone of solubilisation, three isolates showing 2.5 mm zone of solubilisation and two isolates ≥ 3 mm zone of solubilisation indicating their potential for use as K solubilizing bioinoculant for cotton.



Screening for zone of potassium solubilisation

Development of microbial biofilm formulations for cotton

Native bacterial and actinobacterial isolates were isolated from cotton ecosystem comprising soil, plant parts using diverse growth media including nutrient agar, soil extract agar, Pseudomans agar, Kings B agar, Dexria agar, Startch agar, Ashby mannitol agar, Jenson's agar, LB agar, Pikovaskya agar, Yeast extract mannitol agar, Kenknight agar, Sabourd agar, Czapeks agar, Actinomycetes agar Potato dextrose agar. The isolates which have shown higher polysaccharide production has been selected for further biofilm development using fungal matrix such as Trichoderma, Metarhizium, Beauveria, Verticillum.

Refining, up-scaling and large-scale evaluation of tractor mounted ICAR-Mahindra Brush type cotton harvester vs. available cotton harvesting techniques

A tractor mounted brush type stripper was developed earlier in order to bring down the trash content in machine stripped cotton. The brush type header consists of two numbers of rotary brushes for stripping of cotton from plants and two auger conveyors for collection of the stripped cotton, which was fed to a belt conveying system. From the header the stripped cotton was conveyed through a perforated conveyor to the field cleaner mounted at the back of the tractor and finally after cleaning the cotton was conveyed into a wire mesh storage tank. The trash content of brush type harvester was found 10.8 % seed cotton basis. Trash content analysis of the machine harvested cotton and cleaning in a commercially available boll crusher machine was done (Table 3.6.3). The brush stripped cotton contained 16.5% trash initially (seed cotton basis), which was then pre-cleaned to 7% in a commercially available low cost boll

crusher machine. The fibre quality of pre cleaned cotton in a boll crusher did not significantly differ from that of brush type harvested cotton (Table 3.6.4). Cost of harvesting cotton with a brush type stripper harvester and subsequently cleaning machine-harvested cotton in a traditional pre cleaner factory set up and in a low cost boll crusher machine is given in Table 3.6.5. Hand picking cost is assumed to be Rs. 5/kg on an average and cleaning would require another Rs. 1/kg bringing the total cost of hand picking and cleaning cotton to Rs. 6/kg. Cost of harvesting cotton in a brush type harvester works out to be Rs. 1.10/kg. In a pre-cleaning factory the cost of cleaning a stripper harvested cotton is Rs. 3/kg bringing the overall cost of stripper harvesting and cleaning in a factory set up to Rs. 4.10/kg. Whereas, if the stripper harvested cotton is cleaned in a commercially available low cost boll crusher machine the cost of cleaning comes to a mere Re 0.9/kg. Hand harvesting the left over cotton from a brush type stripper would cost another Rs. 0.6/kg bringing the overall cost of stripper harvesting and cleaning cotton in boll crusher to Rs. 2.6/kg.

Table 3.6.3: Trash constituents of machine harvested and pre cleaned cotton in a Boll crusher machine

Sample code	Bracts / Burrs (%)	Sticks (%)	Dry Leaves Fine Trash (%)	Total trash (%)
Brush stripper harvested cotton	2.54	1.71	12.21	16.46
Pre cleaned in Boll crusher (Setting 1)	0.14	0.92	6.12	7.17
Pre cleaned in Boll crusher (Setting 2)	0.22	0.87	5.93	7.02

Table 3.6.4: Fibre quality analysis of brush type stripper harvested cotton and boll crusher pre cleaned cotton

Sample Code	UHML (mm)	UI %	MIC µg/ inch	Tenacity 3.2 mm (g/tex)	EL %	SFI
Brush stripper harvested cotton	28.1	84	3.8	30.0	5.4	8.1
Pre cleaned in Boll crusher (Setting 1)	27.4	83	4.0	28.2	5.2	8.3
Pre cleaned in Boll crusher (Setting 2)	28.0	83	3.8	28.3	5.5	8.5

Table 3.6.5: Cost (Rs/kg) comparisons of harvesting and cleaning machine harvested cotton

Harvesting method	Harvesting cost	Cleaning cost			Hand harvesting left over	Total cost
		Manual cleaning	Pre cleaner Factory	Boll Crusher		
Manual picking	5	1	-	-	-	6
Brush type stripper cotton cleaned in pre cleaner factory set up	1.1	-	3	-	-	4.1
Brush type stripper cotton cleaned in a low cost boll crusher	1.1	-	-	0.9	0.6	2.6

Seed cotton yield and quality of ELS cotton

The field experiment was conducted with three dates of sowings (4th July, 4th August & 4th Sept.), three foliar spraying of nutrients (N1. Recomended nutrients, N2. N1+Foliar application of K_2SO_4 @ 1% at 75,100,125 DAS and N3.N1+Foliar application of KNO_3 @ 1% at 75,100,125 DAS) with two genotypes (Suvin, MRC 7918 BG II) to assess the effect of environment and foliar spraying of nutrient on seed cotton yield and micronaire of ELS cotton. Seed cotton yield was significantly influenced by dates of sowing, genotypes and foliar spraying of nutrients. Sowing on 4th August registered significantly higher seed cotton yield (22.4 q/ha) which was 1.4 and 1.8 fold higher than 4th July (9.3) and 4th Sep. (7.9 q/ha) sowing respectively. The genotype, MRC 7918 BG II registered significantly higher yield (17.5

q/ha) than Suvin (8.9 q/ha). Amongst foliar spraying of nutrients, application of recommended nutrients with KNO_3 @ 1% at 75,100,125 DAS registered significantly higher yield (17.3 q/ha). The interaction results revealed that planting of MRC 7918 BG II on 4th August and foliar application of KNO_3 @ 1% at 75,100,125 DAS registered significantly highest yield of 38.3 q/ha. However, significant improvement was not observed in micronaire with different times of sowing and foliar spraying of nutrients and their interactions.

Evaluation of nano-formulated micronutrients foliar spray for yield maximization in different cotton genotypes

Field experiment was conducted to evaluate the effectiveness of different dosages of best performed commercially available nano-fertilizers like Nualgi and Nanomol with or without surfactant on cotton. As like seed cotton yield during 2016-17 winter irrigated season, fibre quality parameters were also not influenced by foliar application of nano-fertilizers with or without surfactant. However, nualgi nano-fertilizer without surfactant and nanomol with surfactant showed the significant effects on increasing the nitrogen concentration in the cotton plants as compared to phosphorus and potassium content.

Another field experiment was carried out to study the interaction effect of best performed four different types of metal oxide nano-particles like zinc, iron, copper and magnesium with organic fertilizer i.e. seaweed liquid fertilizers. The individual and combined form of metal oxide nano-particles along with seaweed liquid fertilizers had a significant influence on fibre quality parameters like fibre length and strength. Regarding the effect of metal oxide nano-particles on macro nutrient concentration of cotton plants, single form of metal oxide nano-particles viz., Zn, Mg, Cu and Fe with and without seaweed liquid fertilizers significantly increased the total nitrogen concentration as compared to combined metal oxide nano-particles. Inversely, the combined form of Zn + Fe, Zn + Mg + Cu and Zn + Mg +Cu + Fe metal oxide nano-particles without seaweed liquid fertilizers significantly increased the total P content. Foliar application of single metal oxide nano-particle i.e. ZnO with and without organic fertilizer had antagonistic effect on phosphorus and synergistic effect on nitrogen and potassium concentration of cotton. All the metal oxide nano-particles like zinc, magnesium and copper except iron significantly increased the total potassium concentration in cotton.

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

Phenotyping of 145 advanced lines of previously stressed Suraj and LRA 5166 was carried out during summer 2017. Tolerant lines were identified based on Relative Water Content, SPAD values, and other morphological parameters. Generation will be further advanced to screen for drought tolerance.

Experimental view of summer sown *G. hirsutum* lines predisposed to drought stress

Experimental view of plants treated with epigenetic regulating chemicals

Epigenetic regulating chemicals (ERC) did not cause any phytotoxicity or adverse effect to cotton plants. Among the different treatments, seed treatment with Nicotinamide @ 35 µM increased the plant height, number of leaves and number of bolls in case of Suraj and seed treatment with epigallocatechin @ 100 µM increased the number of bolls in LRA 5166. Since ERCs did not affect the normal physiology of the plant, generation advancement of ERC treated lines are being carried out for screening the progenies for drought tolerance.

Waterlogged plants showing Fe deficiency symptoms

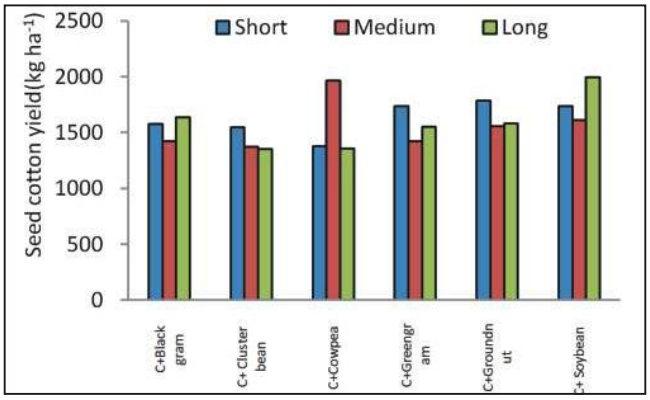


Fig. 3.7.1 : Effect of N fixing legumes on SCY (kg ha^{-1}) (a) Suraj (90 x 10 cm); (b) Phule Dhanwantary (90 x 10 cm)

Screening for water logging tolerance

Pot culture experiment was conducted with fifteen lines shortlisted from 210 lines based on replicated field trial. The lines were screened for waterlogging tolerance at 5 Days after waterlogging under pot culture conditions. Out of the lines, 8 lines (169, 192, 193, 209, 167, 15, 89 and check (LRA 5166) were found to be tolerant in terms of lenticel formation and absence of Fe deficiency. Line No. 180, 30, 162 are highly susceptible lines. Both susceptible and tolerant lines will be used for Marker Assisted Breeding for waterlogging tolerance.

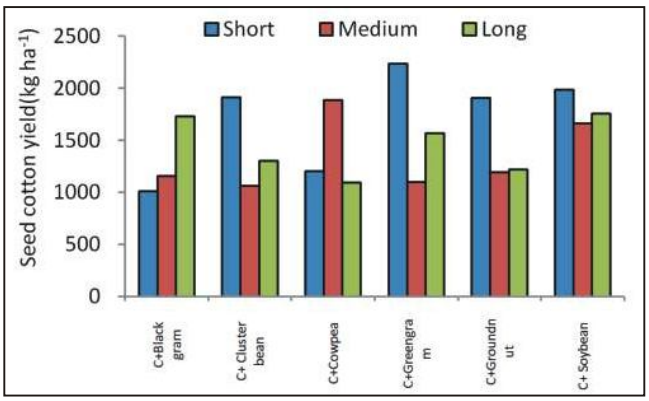
3.7: Sustainable farming systems through conservation agriculture and precision techniques

Nagpur

Efficient nitrogen (N) fixing legumes for cotton based cropping systems.

In order to identify compatible N fixing legume variety for cotton based inter-cropping systems, six different legumes with three varieties (short, medium and long duration) were tested under rainfed conditions at 1:1 ratio with spacing of 90 x 10 cm in *G. hirsutum* var Suraj as well as in *G. arboreum* var Phule dhanwantary. Legumes were sown 15 days later. Overall legume intercropping improved seed cotton yield. Averaged over varieties, higher seed cotton yield of Suraj was recorded with greengram (2235 kg ha^{-1}), cowpea (1885 kg ha^{-1}) and soybean (1754 kg ha^{-1}), respectively (Fig. 3.7.1a). In case of *desi* cotton higher seed cotton yield was recorded with groundnut (1786 kg ha^{-1}), cowpea (1967 kg ha^{-1}) and soybean (1998 kg ha^{-1}) (Fig. 3.7.1b). Similar trend was observed for the cotton equivalent yield.

Based on the seed cotton yield and cotton equivalent yield, greengram, cowpea, soybean of short, medium and long duration variety was found suitable for rainfed areas for *G. hirsutum* var Suraj, respectively. Short, medium and long duration variety of groundnut, cowpea and soybean was identified for *G. arboreum* var Phule dhanwantary, respectively.



Cotton (Suraj) + legume intercropping in 1:1 ratio

Cotton (Phule Dhanwantary) + legume inter-cropping (1:1 ratio)

Coimbatore

Efficient nitrogen fixing legumes for cotton cropping systems : Alley cropping of perennial legumes with cotton

The feasibility of growing perennial legumes as alley cropping with cotton for sustainability was initiated during 2016-17 cropping season. Three perennial legumes *viz.*, Desmanthus virgatus (hedge lucerne), Medicago sativa (lucern) and Mimosa invisa (Thornless mimosa) were grown as alley crop with cotton and compared with sole cotton (without perennial legumes). The recommended spacing of 90x60cm was followed for sole cotton. In perennial legume plot, the spacing followed was 90x45cm. Every fifth row was sown with two rows of perennial legume without sacrificing the cotton plant population as compared to sole cotton. After the harvest of cotton, the maize crop was grown as a succeeding crop. Based on this study, Desmanthus virgatus has been identified as suitable perennial legume to be grown as alley crop with cotton. This legume crop is fast growing, hardy, withstands drought, has no pest and disease problem and is amenable for pruning. So far since 2016-17, six prunings were made with the fresh biomass addition of 44,252 kgs/ha (13.25 t/ha on dry weight basis) with the nitrogen content of 3.15%. while, other two perennial legumes were not amenable for pruning and contributed lesser biomass (4211 kgs and 475 kgs/ha with Mimosa and Medicago respectively). Alley cropping of Desmanthus virgatus resulted in reduction in soil pH (8.74) and electrical conductivity (0.480 dSm^{-1}) as against sole cotton without alley cropping with the pH of 8.77 and EC of 0.516 dSm^{-1}). The nitrogen content of cotton plants with alley cropping of Desmanthus enhanced to 1.75% as compared to cotton crop under sole cotton with the nitrogen content of 1.57%. Growing of Desmanthus virgatus as alley crop and addition of pruned lopping from perennial legume to cotton and maize crop enriched the soil and resulted in additional seed cotton yield of 2 q/ha and maize grain yield of 3 q/ha over sole cotton without alley cropping.

Alley cropping of cotton + Hedge lucern

Table 3.7.1 : Seed cotton yield, maize grain yield, number of pruning and total biomass added due to perennial legumes

Treatments	Seed cotton yield (kg/ha)	Maize grain yield(kg/ha)	Number of pruning	Total Biomass added since 2016 (t/ha)
Cotton +*Desmanthus virgatus*	1314	2303	6	44252
Cotton +*Mimosa invisa*	1122	2214	2	4211
Cotton + *Medicago sativa*	1272	2259	2	475
Sole cotton	1106	1984		
SEd	210.9	276.8		
CD (p=0.05)	NS	NS		

Integrated farming system to double the income of cotton farmer

Field surveys were conducted in Nagpur and Wardha districts of Maharashtra under agro ecological subregion (AESR) 10.2 with five blocks in each districts and one village in each block to study the existing farming systems. Six farmers were selected from each village. During survey, it was found that 35% farmers had only agriculture and no other allied activities. The remaining farmers had different enterprises such as dairy, goatery, poultry, and horticulture, but very few were doing these allied enterprises on commercial level. Majority of small and marginal farmers had to supplement the income earned from sole agriculture through daily wage work. Average return from daily wage work for small and marginal farmers was Rs. 56,500 per family/annum. Average cost of cultivation recorded was Rs. 15,100/acre (no family labour considered) with average gross returns from crops and cropping systems was Rs 27,310/acre/annum. Average return from allied enterprises (Dairy, poultry, goatery, horticulture) was Rs. 21,700 per household. Many traditional crops like jowar, sesame, linseed, moong, urd were abandoned by farmers due to poor productivity, lack of quality seeds, damage by wild animal, poor price support, etc. Honey bee diversity was studied and bee flora calendar was developed for Wardha and Nagpur districts.

Development of remunerative cotton based cropping systems using conservation agriculture principles under irrigated condition

Field experimentation is in progress from 2015 onwards by combining land shaping with residue retention coupled with location specific remunerative cropping systems for improving system productivity and soil quality under conservation agriculture (CA) vis-a-vis conventional practices under irrigated condition. The main plots involved conventional system (Farmer's practice, M_1), CA system with minimal land reshaping and partial (50% of residue from above ground biomass and 100% roots) residue recycling (M_2) and CA system with 100% residue recycling (M_3). The subplots involved four different cropping systems. viz., S_1: Cotton - Black gram - Maize (for grain purpose); S_2: Cotton - Maize (for green cobs) + Pigeon pea (Strip cropping@ 4:2 ratio); S_3: Cotton - Groundnut (for table purpose) + Pigeon pea (Strip cropping @ 8:2 ratio) and S_4: Cotton - Fallow (Control).

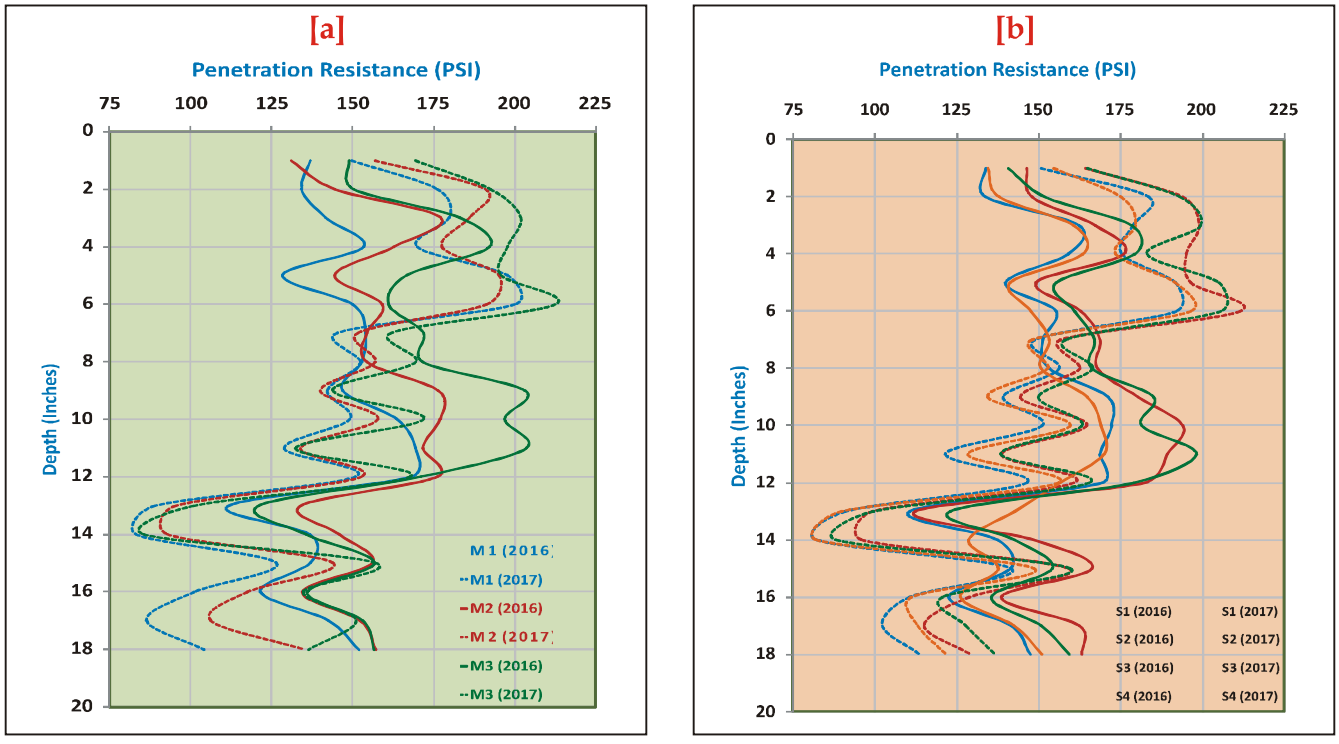


Fig. 3.7.2: Soil Penetration Resistance recorded at different soil depths (inches) in different land shaping treatments (a) and cropping systems (b) during I and II Cropping Sequences

Analysis of seed cotton yield and Cotton Equivalent Yield (CEY) indicated no significant yield difference in land shaping treatments during the second cropping sequence (2016-17 sequence). Among the cropping systems evaluated during second cropping sequence, Cotton-Black gram-Maize (for grain purpose) registered significantly higher CEY of 4174 kg ha^{-1} followed by Cotton-Groundnut (for table purpose) + Pigeon pea (Strip cropping @ 8:2 ratio) registering CEY of 3148 kg ha^{-1}; Cotton – Maize (for green cobs) + Pigeon pea (Strip cropping @ 4:2 ratio) recorded CEY of 2884 kg ha^{-1} which was significantly higher than the conventional Cotton – Fallow system (CEY of 1223 kg ha^{-1}). Analysis of seed cotton yield of third year cotton crop indicated significant difference in yield among land shaping treatments viz. Ridges and furrows (M_1: 1875 kg ha^{-1}), and Beds and furrows (2051kg ha^{-1} in M_2 & 2157 kg ha^{-1} in M_3). In terms of cropping systems, highest seed cotton yield of 2159 kg ha^{-1} was recorded in Cotton–Black gram–Maize (for grain purpose) plots followed by 2070 kg ha^{-1} in Cotton–Maize (for green cobs) + Pigeon pea (Strip cropping @ 4:2 ratio) plots and 1996 kg ha^{-1} in conventional Cotton – Fallow system.

To study the effect of CA practices on soil compaction, soil penetration resistance (Cone index) was recorded using Cone Penetrometer during 2016 (I Cropping Sequence) and 2017 (II Cropping Sequence). Pooled analysis of soil penetration resistance (Fig. 3.7.2) using MSTATC over two cropping sequences revealed significant difference among land shaping treatments viz., Ridges and furrows (M_1: 143 PSI), and Beds and furrows (153 PSI in M_2 & 163 PSI in M_3) as well as cropping systems (S_1: 146, S_2: 159, S_3: 147 and S_4: 159). However, interaction effects of land shaping treatments and cropping systems at different depths over first and second cropping sequences were not significant.

3.8: Economics and extension research and e- communication tools

Dynamics of cropping pattern in cotton growing districts of Maharashtra

The fluctuations in cropping patterns will have important implications for the supply-demand balances of not only cotton but also the competing crops. Shifts in crop areas will lead to deficit of particular crop in the domestic market and pressures for increased imports. If the processes underlying the crop use shifts are quantified, then future adjustments in land use can be projected and actions can be taken to achieve desirable land use. This study was under taken to analyze the transactions of area among different crops in relation to cotton in major cotton growing districts of Maharashtra and to find out the factors influencing the changes in crop area. The secondary data on area under all major crops in selected 18 cotton growing districts of Maharashtra was collected for the period 2000-01 to 2014-15 and preliminary analysis was done.

Changes in cotton area : Preliminary analysis indicated that in 13 districts cotton area increased during the study period (Fig 3.8.1). In four districts i.e. Aurangabad, Beed, Jalna and Dhule, increase in cotton area was more than one lakh ha. In another seven districts i.e. Jalgaon, Nanded, Ahmednagar, Nandurbar, Chandrapur, Parbhani and Wardha, increase in cotton area was between 0.50 lakh to 1.0 lakh ha. In Nagpur and Nashik, the increase in cotton area was less than 0.50 lakh ha. Highest increase in cotton area was observed in Aurangabad district followed by Beed and Jalna districts. In Aurangabad cotton area increased from 136400 ha to 434400 ha. In Beed and Jalna increase in cotton area was 258767 ha and 146267 ha respectively. Five districts *viz.*, Amravati, Akola, Washim, Buldhana and Yavatmal recorded a decrease in cotton area during the study period. Highest decrease in cotton area was observed in Amravati, followed by Akola, and Washim. In Amravati, cotton area decreased from 304233 ha to 194400 ha. in Akola and Washim districts decrease in cotton area was 82392 ha and 72167 ha, respectively.

Changes in crop pattern : Aurangabad, Beed, Jalna, Dhule, Jalgaon, Nanded, Ahmednagar, Nandurbar, Chandrapur, Parbhani, Wardha, Nashik and Nagpur are the 13 districts in which area of cotton increased during the study period. Along with cotton, area of soybean, maize and pigeon pea also increased. Major crops that lost area include pearl millet, jowar and moong. In Yavatmal, Buldhana, Washim, Akola and Amravati cotton area decreased. Along with cotton, area of jowar and moong decreased during the study period. In these districts area of soybean, arhar and maize increased.

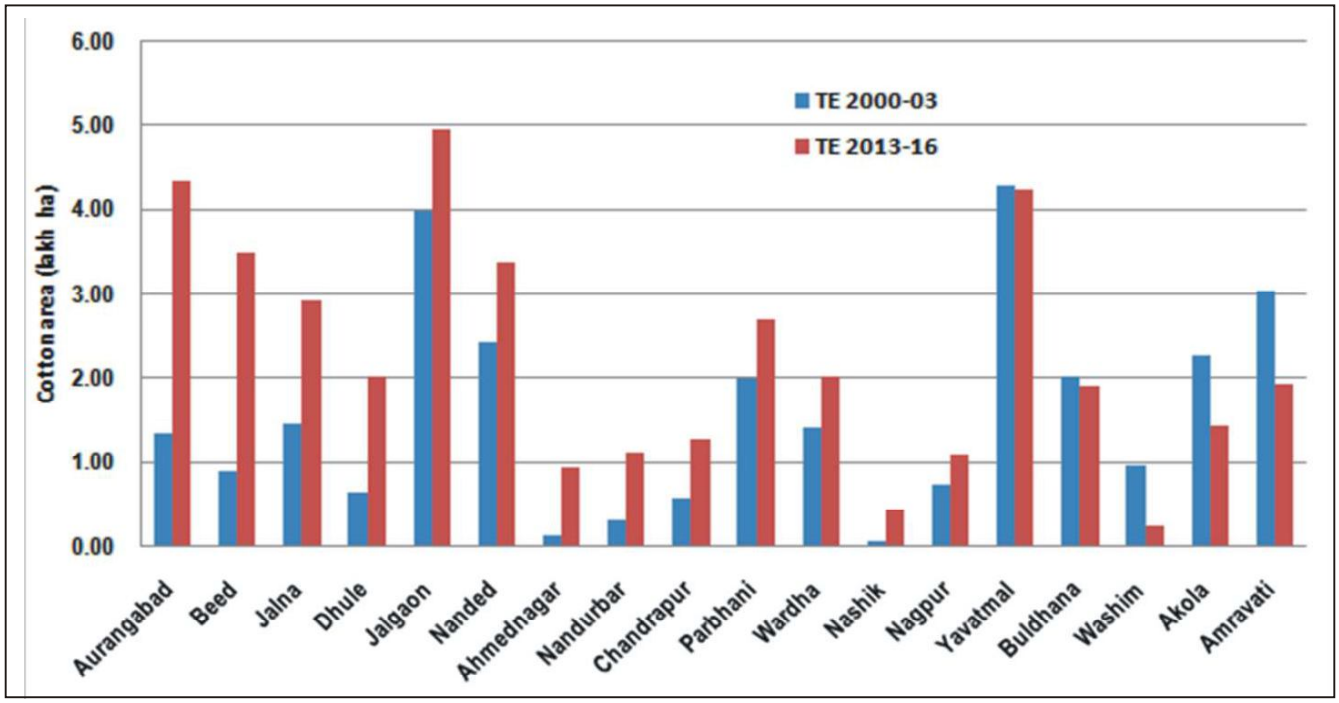


Fig.3.8.1: Change in cotton area during 2000-01 to 2015-16

Impact analysis of shift in global cotton trade on Indian cotton scenario

India, USA, China, Pakistan, Uzbekistan, Brazil, Burkino Faso are the major countries where in the cotton area share is maximum. Major cotton growing countries showing positive trend in cotton area from 2006 to 2017 are Peru (+144.49%), Mexico (+103.88%), South Africa (+94.74%), Argentina (+66.67%), Egypt (+65.45%), Greece(+25.01%), B. Faso (+21.43%), USA (+19.36%), Brazil (+19.15%) and India (+13.36%) whereas negative trend was seen in Afghanistan(-11.63%), Iraq (-23.08%), Australia (-25.01%), Indonesia (-33.33%) and Chad (-61.90%).

In case of world cotton producing countries, India, China, USA, Pakistan, Brazil, Australia, Turkey, Uzbekistan, Mexico, Turkmenistan, Burkino Faso, Greece occupy the major share. Positive trend over the same years seen in countries like South Africa (+143.06%), Peru(+138.10%), Mexico(+101.74%), Egypt (+76.47%), Zimbabwe (+64.23%), Turkey(+25.01%), Argentina(+24.13%), USA(+23.84%), China(+20.88%), India(+5.56%) while negative trend seen in Colombia (-6.98%), Israel(-13.85%), Afghanistan(-14.63%), Iraq (-34.78%) and Indonesia(-40.70%). The major cotton producing countries with high productivity are Australia, Turkey, China, Israel, Mexico, Brazil, Venezuela, Greece, South Africa and USA. Positive trend in yield growth rate in major cotton producing countries registered in Columbia (+97.64%), Zimbabwe (+67.81%), Australia (+44.87%), South Africa (+24.85%), Senegal (+34.85%), Ethiopia (+15.43%), Turkey (+6.37%) and USA (+3.74%). India showed negative trend with -7.01 per cent along with Uzbekistan (-2.33%), Greece (-4.00%), Pakistan (-8.73%), Indonesia (-9.92%), Iraq (-15.06%), Burkino Faso (-18.18%) and Argentina (-25.59%).

Cotlook index was low from 2000 to 2009 hovering around 45 to 62 cents. Sharp increase was seen during 2010 and 2011, later it dropped to 95 to 82 to 74 during 2012 to 2016. Finally, it got stabilized with a slight increase to 86 cents during 2017. The transition period changes in cotton trade flows resulting in new importers and exporters on the world market. The leading exporters throughout the outlook period are the United States, Brazil and Australia. Surge in productivity and production, India has become a major player on the world cotton market, accounting for as much as 17 per cent of the world's cotton exports. Sub-Saharan African countries continue to be a major source of cotton exports to the world market. As per the data received from various trade sources, the CAI estimates cotton arrivals up to 28th February 2018 at 247.10 lakh bales. The recent trade war between the United States of America and China has sparked a ray of hope for Indian exports such as cotton, soyabean and maize to Asian markets, especially to China. As China imposes tariff barriers to

US products, Indian exports are expected to increase. China is the largest market for India's cotton yarn, yet exports halved from $2.2 billion in 2013 to $1.1 billion in 2016. The decline is attributed to China's increasing import of cotton yarn from Vietnam, which registered an 88 per cent increase over the same period. China has shifted from India to Vietnam/Indonesia as they have duty free access while Indian yarn carries 3.5 per cent import duty.

The growth in cost of cotton production was worked out for the periods 2005-10 and 2011-16. The growth rate of cost of cultivation (Rs./ha) during both the periods was between 15 to 19% per annum in the States of Karnataka, Maharashtra and Rajasthan where as it was 8 to 10% per annum in other cotton growing states including Orissa. The growth rate of cost of Production (COP) (Rs./qtl.) was to the tune of 8 to 11% per annum in the states of Haryana, Gujarat, Maharashtra, Karnataka Andhra Pradesh and Tamilnadu during these two periods. In Punjab and Rajasthan it was 11 to 12% per annum and in Orissa it was 16 to 18% during the same period. The lowest growth rate in the cost of production was observed in Madhya Pradesh which was in the range of 4 to 6%.

Among the inputs, human labour registered maximum growth rate (20 to 22%) in Rajasthan, Maharashtra and Karnataka during these two periods. The growth of wage rate in India is higher than Bangladesh, but lower than China and Vietnam. China has the highest labour wages amongst the competing nations, but it has developed sufficient training infrastructure to meet industry requirements. On the other hand, there is limited availability of skilled labour in Bangladesh, India and Vietnam. The cost of power in India is high when compared with Bangladesh and Vietnam.

e-Communication : Dissemination of Cotton Technology

e-Kapas network project proved beneficial for effective transfer of knowledge among registered cotton growers in ensuring the availability of right information at right time at the doorstep of clients. The efforts were continued in e-Communication dissemination of cotton production technology project with the objectives : (i) to deliver voice messages to registered farmers of CICR (Nagpur, Coimbatore & Sirsa), (ii) to prepare cotton-production advisories and publish weekly/ fortnightly in news-papers (iii) to develop and exchange images and video based information for illiterate & tribal farmers, (iv) to develop monthly calendar of operations for Vidarbha cotton farmers.

Weekly/Fortnightly cotton production advisories in Marathi language were prepared and published regularly in news papers agro-one, Sakal, Deshonnati, Krushokonnati for wide dissemination among the growers. More than 6.11 lakh noise free and clear-recorded voice messages were uploaded in the form of automatic phone calls to 87,132 registered farmers' mobile numbers of Nagpur. During the season, there was a heavy incidence of pink bollworm in Maharashtra and providing timely voice messages on taking the proactive corrective measures proved to be highly beneficial to the farmers.

Grow Good Cotton- a mobile app for cotton pest management

Methodology for the development of Android based mobile application for the cotton pest management has been developed. The Mobile application included interactive Decision Support system where user can interact and chose the option for the pest management based on Economic Threshold Levels. The application is also incorporated with voice module and pictorial representation to select the correct symptoms of damages on cotton plant and also to break the language and literacy barriers.

Cotton Portal – Information for global reach

The cotton Portal – CICR website has four sub-domain websites – www.cicr.org.in; www.aiccip.cicr.org.in; www.tmc.cicr.org.in; www.kvknagpur.org.in. The website has around 8000 individual pages including HTML, pdf and more than 2500 images. The CICR website has wide range of information including research reports, annual reports, institute publications,

and databases. AICRP website has information including AICRP reports for the past 18 years, FLD reports, Bt Cotton evaluation reports etc. The Krishi Vigyan Kendra under CICR website has detailed activities of KVK including training programmes and extension activities.

www.cicr.org.in

www.aiccip.cicr.org.in

www.tmc.cicr.org.in

www.kvknagpur.org.in

Development of Transfer of Technology Innovations for Bridging up the Yield and Knowledge Gap in Cotton

Cotton yields are stagnated for the past few years due to various factors. Cotton research system has develoed and released many technologies to improve the yield under various agro-ecological conditions. However, there is always a gap between the potential yield of the technologies claimed by the technology inventors and the actual yield realized by the farmers in the fields. Studies say that the yield gap between potential and realized yield on farmers field is more than 30%. Analysis on yield enhancement due to Front Line Demonstrations (FLD) revealed that an average of 18.70 % increase over the normal farmers' practices was obtained in various locations. Therefore, there are possibilities of bridging the gap in cotton yield by properly identifying the causes of gap, devising appropriate management options to close the gap, fitting TOT innovations to disseminate the gap reducing technologies and implementing the package in the poor small and marginal farmers' fields. Similarly a gap exists

among the cotton growers about the knowledge of novel yield enhancing cotton cultivation technologies. Hence, a study to assess yield gap in cotton between the potential, actual and attainable yields, the knowledge gap among cotton growers and to find out the reasons for the yield and knowledge gap and propose appropriate TOT innovations to reduce the gaps is planned.

During the year 2017-18, the various types of yields *viz.*, potential yield, actual yield and attainable yield and yield gaps were operationalized for the study. The average yield details of the states and the FLDs in the respective states were collected from the available secondary data from the AICRP- FLD reports and CAB from 1997-98 to 2017-18 and yield gap was analyzed. Analysis revealed that the national average seed cotton yield of FLD was 1686 kg/ha as compared to the local farmers' practices 1433 kg/ha (1997-98 to 2017-18). The average yield gap between the seed cotton yield of FLD and farmer's practice over 20 years was 254 kg/ha. To know the potential yield of cotton at station with all recommended technologies of CICR, one acre potential yield trial with cotton variety Suraj (0.5 acre) and Jadoo Bt BG II (0.5 acre) was conducted at ICAR-CICR, Regional Station, Coimbatore. The cotton variety (Suraj) with all recommended technologies of CICR yielded 2721 kg/ha and the Bt cotton hybrid Jadoo Bt BG II gave 2580 kg/ha seed cotton yield.

Socio-technological analysis of drip irrigation in cotton cultivation

Surveys were undertaken in Erode and Namakkal districts of Tamil Nadu to explore the impact and constraints for drip irrigation in cotton cultivation. Adoption of farmers for cotton technologies were significantly at higher rate in the study area. The major varieties cultivated in this area were, ATM Bt (KCH 311 Kavery seeds), Jadoo Bt (KCH 14K59, Kavery Seeds), Jackpot Bt (15K39, Kavery seeds), MRC 6918, RCH 2, and RCH 625 (Bumbag). Major observations on impact made by the drip irrigation are : a) There was a yield increase due to adoption of drip irrigation, b) Drip irrigation made soil into more friable condition and increased root growth, c) Soil compaction was reduced, d) Thrips and other sucking pest population was reduced, e) Water saving was about 30-40%, f) Cotton boll size was higher, g) Seed germination was good and, h) Weed population was reduced in drip irrigated fields. The survey revealed that the major cropping pattern available in this area are, Cotton-Maize-Green gram or Onion-Groundnut-Maize and Green gram or Cotton-Onion–Green gram. Constraint analysis revealed that the major issues for drip irrigation in cotton cultivation are 1. Not exactly 100 percent subsidy by state government, 2. Non-availability of water even for drip irrigation, 3. Damage to drip laterals due to rodents, 4. Crop specific subsidy for drip irrigation for specific year, 5. Getting subsidy documents from Village Administrative Office is cumbersome, 6. Clogging in drippers due to poor quality of water, 7. Accelerated price due to increased tax slab rate of 12-18% in the present GST for drip system, and 8. Standard technical specifications for drip installation does not match with local farm condition.

3.9 : New eco-compatible pest management strategies

Cotton bollworm Management

Nagpur

Push-Pull strategy for management of pink bollworm

The 'push-pull' strategy is an novel ecological pest management strategy to be utilized in integrated pest management programs. This relies on the manipulation of pest behaviour through the use of behaviour modifying stimuli to alter the distribution and abundance of insect pest. For isolation and identification of oviposition deterrent volatiles, field population of pink bollworm from Nagpur (ICAR-CICR farm) was established in the laboratory. The eggs and faecal pellets of pink bollworm were collected in five solvents namely hexane, acetone, methanol, dichloromethane and pentane with difference in polarity. The samples were analysed in GC-MS for identification of volatiles. Results were obtained in methanol as solvent for egg extract and with solvent as acetone, dichloromethane and methanol for faecal pellet extracts. Fatty acids like Palmitic acid, Linoleic acid, Oleic acid, Stearic acid and their methyl esters were identified from eggs (E) and faecal pellet (FP). (Table 3.9.1) These need to be further subjected to lab bioassays evaluation for oviposition deterrent effect.

Table: 3.9.1: Potential oviposition deterrant for Pink bollworm identified

Sr. No.	Volatiles	Area (%)	Recurrence
1.	Hexadecanoic acid and its ester	22-51	Methanol (E), Acetone (FP), DCM (FP), Methanol (FP)
2.	Octadecanoic acid and its ester	27- 78	Methanol (E), Acetone (FP), DCM (FP), Methanol (FP)
3.	Hexacosanol	6-22	Acetone (FP), DCM (FP), Methanol (FP)

Egg parasitoid *Trichogramma bactrae* and *T. brasiliensis* against Pink boll worm

In order to promote the bio control agents for managing pink bollworm, an experiment was conducted at ICAR-CICR, Nagpur to evaluate the efficiency of *Trichogramma bactrae* (T1) and *Trichogramma brasiliensis* (T2) in comparison with chemical sprays (profenophos 50 EC; thidocarb 75 WP; cypermethrin 25 EC). The results indicated that, least number of exit holes were observed in the plots sprayed with chemical insecticides (0.39 exit holes/10 G.B.) and it was at par with *Trichogramma bactrae* (0.50 exit holes). Lowest number of mines on epicarp were noticed in the plots release with *Trichogramma bactrae* (3.25 mines/10 G.B) followed by chemical insecticides (3.39). Mean locule damage (%) was highest in the control plots and lowest in chemical treated plots. (Fig.3.10.1) Amongst the egg parasitoids, plots treated with *T.bactrae* had lower locular damage.

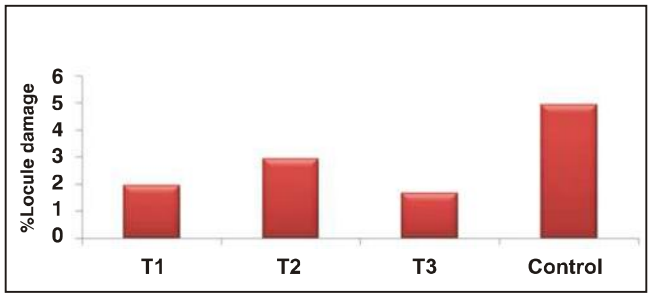


Fig: 3.9.1: Effect of egg parasitoid *Trichogramma bactrae* and *T. brasiliensis* against Pink bollworm (2017-2018)

Coimbatore

Exploring novel dispensers to enhance the trapping efficacy of pheromone traps for Pink bollworm management

Eight new dispensers and ten trap designs were prepared for the pheromone compound gossyplure and evaluated against the cotton pink boll worm under field experiment in RBD with three replications. The dispenser made of polypropylene (11.28 adult/ trap/ week) and silicone (10.93 adult/trap/week) were significantly superior to the standard rubber dispenser (7.36 adult/trap/week) in attracting the pink bollworm moth. The neoprene dispenser recorded highest catch (14.67 adult/trap/week) in first three weeks, but had short persistence (7 weeks) compared to that of standard dispenser (13 weeks). Among the different traps tested, wing trap and LED combo trap provided significantly higher mean trap catch per week compared to the standard funnel trap. The mean moth catch in pheromone trap had significant negative correlation with the boll damage (r = -0.76) and mean larval count (r = -0.81) in field.

A combo trap for pink bollworm targeting both chemo and visual stimuli was developed by combining pheromone compound gossyplure (chemical stimulus) and LED light source (visual stimulus). Solar sensor based automatic on/off switch with rechargeable Le-ion batteries were used to fabricate portable combo traps. Three different colour LED lights *viz.*, red, blue and white with gossyplure pheromone were tried for their efficacy in attracting the male pink boll worm moths and among the combo traps tested, the trap with blue colour light provided significantly higher traps catches.

Nagpur

Identification of oviposition deterrent for ethological management of Cotton Bollworm *Helicoverpa armigera*

Though commercial cultivation of transgenic cotton in India has reduce of bollworm damage, *Helicoverpa armigera*, strategy to manage this pest needs to be in place due to possible development of resistance against Bt toxins. Ethological management of *Helicoverpa* can be developed as a eco-friendly management tactic. Oviposition deterrent is the most promising tool of ethological management as it minimizes the attack of insect at very initial level. In this context collection and identification of volatiles emitted from eggs (E) and faecal pellets (FP) was done from laboratory reared population of *H. armigera* on natural food (cotton square). The volatiles compounds identified from eggs and faecal pellets in different solvents are presented in Fig : 3.10.2 & 3.10.3 respectively. On the basis of area (%) and recurrence of the volatiles in different solvents 5 compounds were identified (Table: 3.9.2), which will be tested as oviposition deterrent against *H. armigera* under

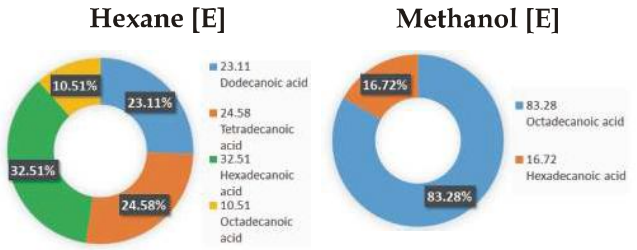


Fig.3.9.2 : Major compounds identified in egg sample

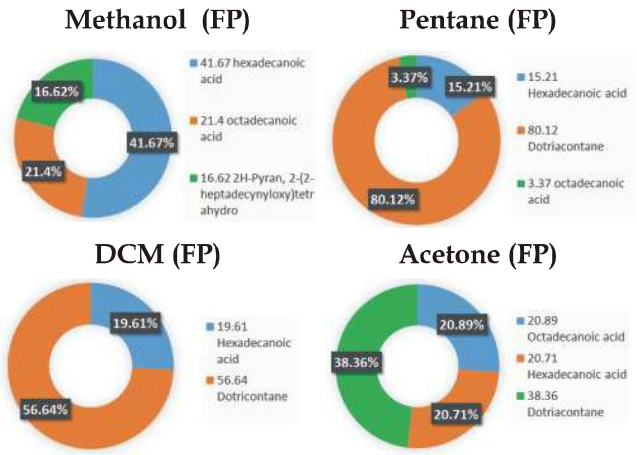


Fig.3.9.3 : Major compounds identified in egg sample

laboratory condition. Hexadecanoic acid fraction was recorded in all the solvents with 15-41% area under GCMS. Other compounds as Octadecanoic acid, Dotriacontane, Dodecanoic acid and Tetradecanoic acid shared 3-83%, 38-80%, 23% and 24% area, respectively No peak was detected in egg sample with acetone, dichloromethane, pentane solvent and in faecal pellets sample with hexane solvent.

Table 3.9.2 : Compounds identified in samples extracted with different solvents

S. No.	Volatiles	Area (%)	Recurrence
1.	Hexadecanoic acid	15-41	All the solvents
2.	Octadecanoic acid	3-83	Hexane (E), Methanol (E), Acetone (FP), Methanol (FP), Pentane (FP)
3.	Dotriacontane	38-80	Acetone, DCM, Pentane (FP)
4.	Dodecanoic acid	23	Hexane (E)
5.	Tetradecanoic acid	24	Hexane (E)

E-eggs, FP-Faecal Pallet

Management of sucking pests

Nagpur

Semio-chemical-based pest management technology

Semio-chemical-based pest management technology is known to serve a major role as rapid advancements are being made to curb the insecticide usage. Within semio-chemicals, pheromones and kairomones are most effective tools in behavioural manipulation; they are species specific and non-toxic to the environment. Isolation and identification of kairomone from the sucking pests was initiated by Solvent method. The sample was subjected to GC-EAD against *Chrysoperla* and *Coccinellids* . Samples were analysed in GC-MS and three probable compounds (1-Dodecanol, Eicosane and Octadecane) have been identified. Behavioural studies will be done in the lab and field after identification and characterization of kairomone.

Enhancing the efficacy of yellow sticky traps

Essentials oils considered to be 'green pesticides', were evaluated for exploring their potential in enhancing efficacy of yellow sticky traps. Different natural essential oils in combination with yellow sticky traps were evaluated against sucking pests of cotton (whitefly, jassids and aphids) at 3 locations *viz.*, ICAR-CICR Nagpur, Coimbatore and Sirsa.

The 6 different natural essential oils *viz.*, Sandal wood, Basil, Clove, Grape fruit, Rose and Mint oils were evaluated. Sandalwood oil and Basil oil in yellow sticky traps attracted maximum number of whiteflies and leaf hoppers among other treatments. For practical utility, being cost effective, Basil oil is potentially the best option to enhance the effectiveness of yellow sticky traps.

Coimbatore

Evaluation of different trap crops for thrips management

To evaluate a suitable trap crop for thrips, Bt cotton was grown with different intercrops such as Marigold, Vegetable cowpea, Onion, French bean and Groundnut. Population dynamics of thrips were recorded at fortnightly interval. Among these, cotton intercropped with Marigold recorded least population of thrips. (Table 3.9.3)

Table 3.9.3: Evaluation of different trap crops for thrips population

Treatments	Thrips population (Nos. /3 leaf/plant)					
	September	October	November	December	January	Mean
T1 – (Bt Cotton) Sole Crop	4.03	4.07	4.17	9.13	8.77	6.03
T2 – (Bt cotton+ Marigold)	1.97	2.36	2.86	7.70	8.20	4.62
T3 – (Bt cotton+ Vegetable cowpea)	2.83	3.00	2.93	8.13	8.03	4.99
T4 – (Bt cotton+ French Bean)	2.33	3.07	2.97	7.90	8.30	4.91
T5 – (Bt cotton+ small Onion)	2.57	3.27	3.16	7.60	8.50	5.02
T6 – (Bt cotton+ Ground Nut)	2.73	2.93	2.53	8.40	7.70	4.86
S. Ed	0.12	0.10	0.08	0.06	0.03	

Evaluation of bacterial endophytes against sucking insect pests

Five bacterial endophytic isolates were evaluated in a field experiment during 2017-18. Three methods *viz.*, seed coating, soil drenching and foliar spray were followed to inoculate the endophytes into cotton plants. Under protected condition, all the treatments recorded reduced population (10-15%) of sucking pests *viz.*, Aphid, Jassid and Whitefly compared to control. Among the isolates, *B. subtilis* and *B. cereus* strain inoculated plants recorded least insect pest population (Table 3.9.4).

Table 3.9.4 : Efficacy of bacterial endophytes against sucking pests under field condition

Treatments	Sucking pests population/3 leaf/plant*		
	Aphids	Jassids	Whitefly
Bacillus sp. E13	24.94	6.28	3.41
B. subtilis	22.54	6.65	3.40
B. cereus B1	25.49	8.60	3.95
B. cereus strain Z2	26.89	7.50	4.87
B. cereus strain S - 11	28.18	8.09	3.82
Control	37.99	10.70	5.29

Sirsa

Morphological and molecular characterization of newly isolated Entomopathogenic fungi (EPF)

A total of 105 EPFs collected from 19 locations from 11 districts of Punjab, Haryana and Rajasthan were morphologically characterized. Out of these, twelve EPFs were selected for molecular characterization. The sequences generated in this study were submitted to NCBI GenBank (Table 3.9.5).

Table 3.9.5 : List of gene sequences of the EPFs isolated from *Bemisia tabaci* cadavers and submitted to NCBI

Sr.No.	Organism	Location	Strain ID	NCBI Gen Bank accession number
1	*Fusarium sudanense*	Punjab	CICR - RSS - 0033	MG976228
2	*Aspergillus versicolor*	Rajasthan	CICR - RSS - 0074	MG976229
3	*Penicillium oxalicum*	Pun jab	CICR - RSS - 0082	MG976230
4	*Fusarium* sp.	Punjab	CICR - RSS - 0083	MG976231
5	*Paecilomyces* sp.	Rajasthan	CICR - RSS - 0089	MG976232
6	*Penicillium oxalicum*	Haryana	CICR - RSS - 0085	MG976233
7	*Isaria javanica*	Punjab	CICR - RSS - 0102	MG976234
8	*Aspergillus oryzae*	Haryana	CICR - RSS - 0015	MG976235
9	*Aspergillus quadrilineatus*	Haryana	CICR - RSS - 0044	MG976236

Sr.No.	Organism	Location	Strain ID	NCBI Gen Bank accession number
10	*Emericella* sp.	Haryana	CICR -RSS -0064	MG976237
11	*Fusarium* sp.	Punjab	CICR -RSS -0035	MG976238
12	*Beauveria bassiana*	Haryana	CICR -RSS -0093	MG976239

Multi-location evaluation of Suction trap against whitefly adults

A trap named as CICR Whitefly Adult Suction Trap, was designed under TMC1.5 project. The trap is power operated, shoulder mounted, portable, adjustable and helps in suction of whitefly adults on the underside of the cotton leaves without any harm to the natural enemies fauna and cotton crop itself. The suction trap was evaluated consecutively for two years under AICRP on Cotton at different locations of the Northern Cotton Growing Zone of India. Based on the data obtained from these locations, the trap reduced whitefly population from 46.6% to 12.7% at different locations and was found to be more efficient in situations with high adult whitefly pressure

Coimbatore

Wax degrading bacteria for management of mealy bug

E*ight wax degrading bacteria viz., Pseudoxanthomonas suwonensis* PSAD1 (KY780940), *Acinetobacter lwoffii* PSAD2 (KY780941), *Klebsiella aerogenes* PSAD3 (KY780942), *Providencia rettgeri* PSAD5 (KY780943), *Enterobacter cloacae* PSAD6 (KY780944), *Acinetobacter beijerinckii* PSAD7 (KY780945), *Klebsiella aerogenes* PSAD8 (MF373207) and *Serratia marcescens* PSAD9 (MF373208) from cotton mealybugs were isolated, screened , characterized and submitted to Gene Bank. Among the isolates *A.lwoffii* PSAD2 and *A.beijerinckii* PSAD7 showed maximum lipase, biosurfactant production and insecticidal activity. Apart from this, *A.lwoffii* PSAD2 and *A.beijerinckii* PSAD7 showed positive plant growth promoting activities. Laboratory bioassay methods to assess the insecticide activity of the isolates against various sucking pests of cotton confirmed the effectiveness of *A.lwoffii* PSAD2 and *A.beijerinckii* PSAD7 as promising biocontrol agents. Based on the results from the above experiments three different formulations of wax degrading bacteria were developed and tested for their effectiveness under field conditions. Different biochemical and growth parameters of cotton analyzed indicated that plant metabolism is favoured due to application of wax degrading bacterial formulation with reduction in sucking pest population including mealybugs.

A new wax degrading entomopathogenic fungus, *Aspergillus fumigatus* Fresenius 1863 was isolated from striped mealybug, *Ferritia virgata* Cockerell. Molecular characterization was carried out and submitted to Gene Bank (Accession No. MF421525). This new fungus is able to produce lipase and degrade waxy coating of mealybug under laboratory condition.

Development of thermal tolerant strain of biocontrol agent, *Acerophagus papayae* for papaya mealybug, *Paracoccus marginatus*

Preliminary screening work has been initiated to identify the thermo tolerant strain of *A. papayae*. The developmental biology of field collected *A. papayae* as well as laboratory populations were compared to bring out the potential strain. The results revealed that the percent parasitization by field collected parasitoid to the second instar mealy bug was high (46.34%) when compared to the lab culture (34.27). In addition, the per cent adult emergence was high (73.43%) in field collected strain.

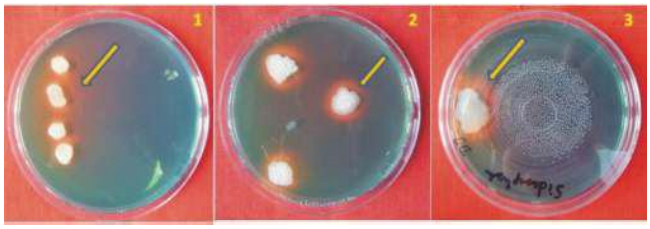
Management of cotton Diseases

Nagpur

Potential of Plant Growth Promoting Rhizobacteria (PGPR) in disease management

Efficient strains of PGPR were polyphasic characterized *in vitro* and nucleotide sequences were submitted to NCBI GenBank accession numbers MG645235-MG645246. Among them, *Bacillus aryabhattai* (CICR-D5), *B. cereus* (CICR-D3) and *B. tequilensis* (CICR-H3) were promising in reducing diseases. Incompatibility study of PGPR with agrochemicals revealed incompatibility of strains *B. altitudinis* CICR-S8, *B. altitudinis* CICR-D2, *B. cereus* CICR-D1, *B. safensis* CICR-4B and *B. safensis* CICR-4A2 with Thiram 75% WS while strains B. *tequilensis* CICR-H3, *B. altitudinis* CICR-D4, *B. safensis* CICR-4B and *B. safensis* CICR-4A2 were incompatible with Mancozeb at recommended dose. Strain *B. tequilensis* CICR-H3 was effective as biocontrol agent followed by *B. cereus* CICR-D3 under dual culture inoculation technique against *Macrophomina phaseolina*. Strains *B. cereus* CICR-D3, *B. tequilensis* CICR-H3 and *B. aryabhattai* CICR-S6 had significant siderophore production. In addition to this, *B. cereus* CICR-D3 and *B. aryabhattai* CICR-D5 were found to produce HCN.

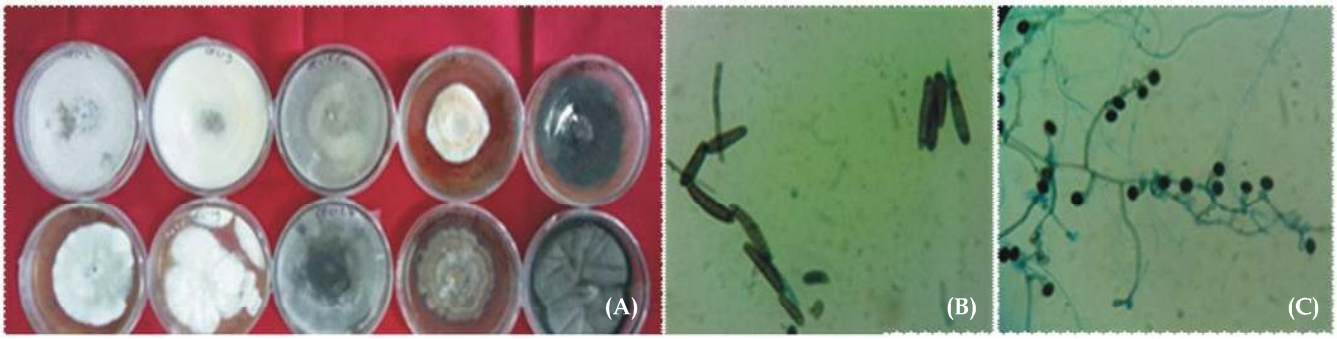
1 & 2 : *Macrophomina phaseolina*+ *B.Cereus* CICR-D3 and 3: *Macrophomina phaseolina* (Control)



Siderophore activity of PGPR strains on Chrome azurol S (CAS) agar medium, 1: *B. aryabhattai* CICR-S6; 2: *B. tequilensis* CICR-H3 and 3: *B. cereus* CICR-D3

Endophytes from cotton with biocontrol activity against major diseases

Studies were initiated to identify endophytes from cotton for biocontrol activity against major diseases. Samples of *Gossypium arboreum* from North India and *G. hirsutum* samples from Gujarat and Maharashtra were collected. About 30 Endophytic fungi from leaf, petiole, stem and root tissues of *G. arboreum* and 45 from *G. hirsutum* from Haryana, Rajasthan, Punjab, Gujarat and Maharashtra states were isolated. Based on the morphological characters some of the endophytic genera identified are *Alternaria*, *Bipolaris*, *Curvularia*, *Fusarium* and *Nigrospora*.



Pure culture of the different fungal endophytes (A), conidia of *Bipolaris* sp. (B) and *Nigrospora* sp. (C) at 40x magnification

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

Nagpur

Seasonal Dynamics of Insect Pests and Diseases: ***Seasonal dynamics of sucking pests and bollworms***

Seasonal pest population dynamics data was generated under pesticide free conditions by taking weekly sucking insect number counts on DCH 32. Jassid and aphid population crossed ETL while whitefly and thrips were below ETL throughout the season. Jassid were above ETL starting from third week of August till second week of September with a peak population at 36 SMW (07 Sept 2017) (Fig 3.10.1). The highest number of aphids (146 / 3 leaves) were recorded during 33 SMW (17 Aug 2017) (Fig 3.10.2). Negligible population of American bollworm, spotted bollworm, mirid bug and spider populations were recorded over the crop season.

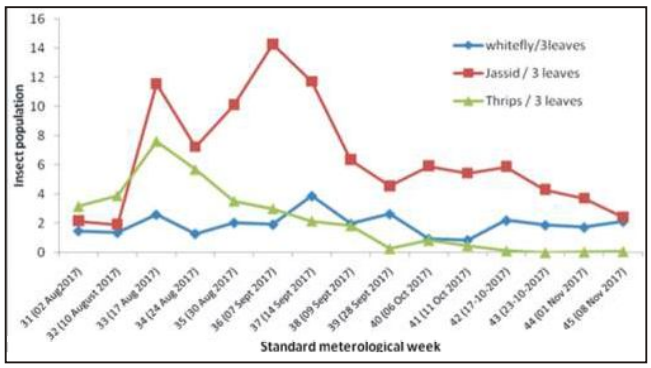


Fig 3.10.1. Population dynamics of sucking pests over the season 2017-18

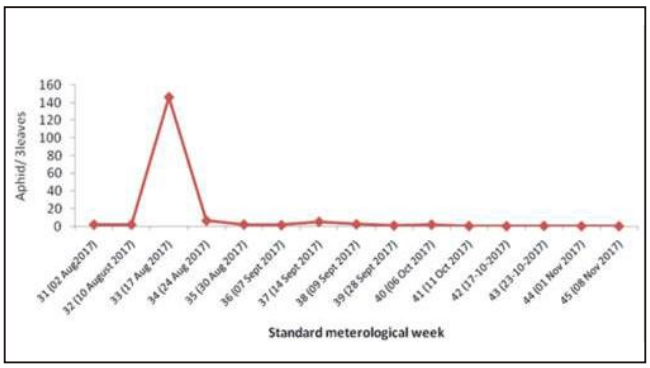


Fig 3.10.2 : Population dynamics of aphid over the season 2017-18

Population dynamics of sucking pests across five genotypes

Pest population dynamics in five genotyes *viz.*, Suraj, Suvin, DCH32, RCH2 & Phule Dhanwantari were compared over the season. Significant variation was observed in population of jassid and whitefly among the genotypes. Population of Jassid and Aphid was significantly high 6.51 jassid/ 3 leaves and aphid 11.46 aphids/ 3 leaves on DCH 32. Thrips, mirids, American bollworm, spotted bollworm and mirid populations were negligible over the crop season in all these genotypes (Fig. 3.10.3).

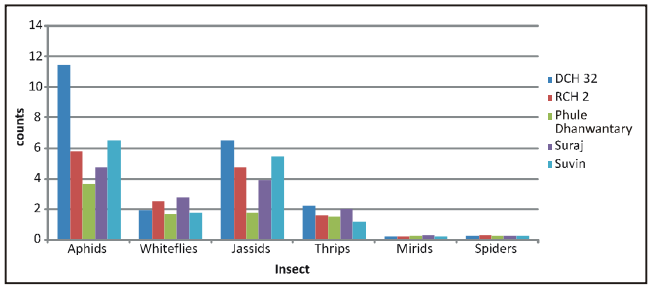


Fig. 3.10.3: Pest population dynamics on five genotypes over the season

Pink bollworm infestation

Pink bollworm infestation was recorded on *G.hirsutum* cv Suraj starting from September end till first week of January. Initially infestation was low but it increased with the progress of the season. During first fortnight of October, 68% boll infestation was recorded. Infestation reduced in first week of November and again it steadily increased to reach up to 84% boll infestation. Infestation in the flowers was high during first week of October thereafter it gradually decreased with the availability of bolls on the cotton plant (Fig 3.10.4).

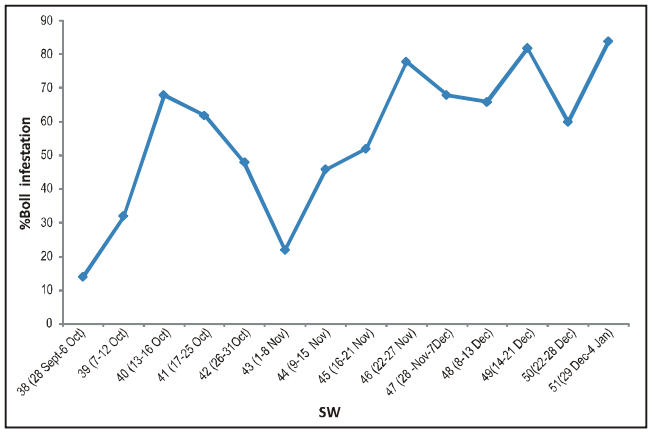


Fig. 3.10.4: Pink bollworm infestation on flowers and bolls of Suraj during 2017-18

Pheromone trap catches at Nagpur

During 2017-18 highest moth catches of American bollworm (5.80 moths/trap/week), spotted bollworm (5.33 moths/trap/week), pink bollworm (99 moths/trap/week) and tobacco caterpillar (26.6moths/trap/week) were recorded at 50SMW (23-29 Dec.), 50SMW (23-29 Dec.), 47 SMW (26 Nov. -1 Dec.) and 45SMW (12-18 Nov.), respectively (Fig 3.10.5).

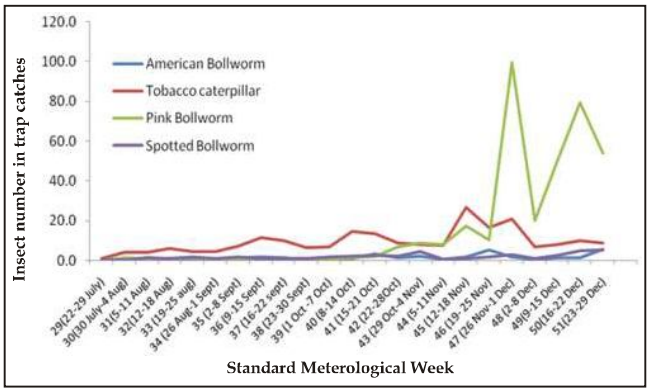


Fig.3.10.5 : Pheromone trap catches at Nagpur (2017-18)

Yellow sticky trap catches

The highest whitefly population (322 whitefly/trap/week) and jassid population (435 jassid/trap/week) was recorded during 37 SMW (15-21 Sept) (Fig. 3.10.6). Non target insects like lady bird beetle trapped highest (11 LBB/traps/week) during 39 SMW (29- Sept-5 Oct). Similarly dipteran flies also trapped in greater number (29 flies traps /week) during 35 SMW (1-7 Sept).

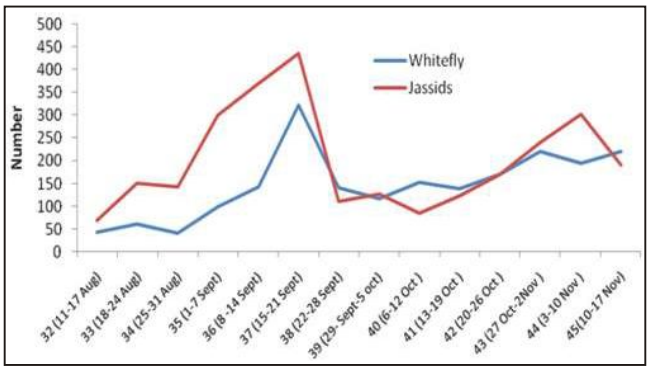


Fig 3.10.6: Jassid and whitefly population trapped in yellow sticky traps

Advancement in whitefly peak occurrence – need change in strategies

The analysis of historical data (2004-05 to 2016-17) was carried out to assess if there is any change in seasonal

dynamics and severity of white fly population in north zone. Data presented for representative locations in Haryana (Hisar), Rajasthan (Sriganganagar) and Punjab (Faridkot) indicate that between 2004-05 to 2016-17, the peak occurrence advanced by 7-9 weeks and the average infestation increased by about 3.4 fold in Hisar and faridkot and by about 1.25 fold in Shriganganagar (Fig. 3.10.7).

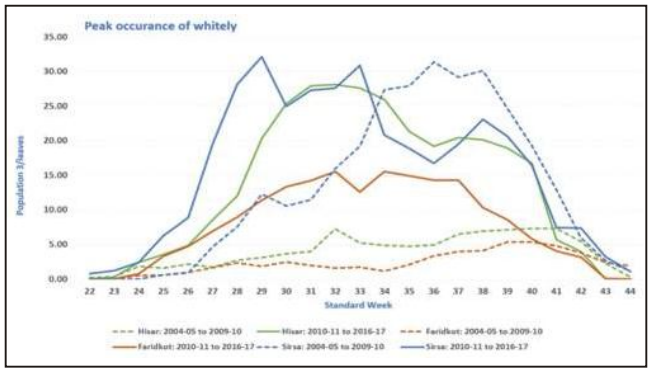


Fig.3.10.7 : Seasonal Dynamic whitefly population for the period 2004-05 to 2016-17

Sirsa

Seasonal Dynamics of Insect Pests:

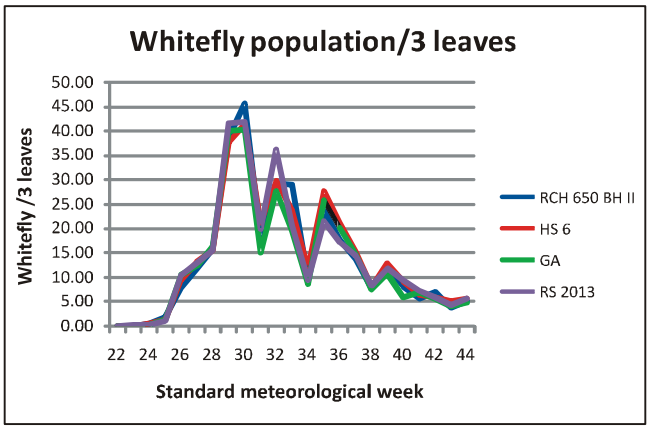
In RCH-650 BGII hybrid, leafhopper population ranged from 0.00 to 6.30 leafhoppers/ 3 leaves. Peak activity of leafhopper was observed in 30th SMW. Population of whitefly was initially observed in 22nd SMW (0.00 whitefly/3 leaves) & peak activity occurred in 30th SMW (45.70 whitefly/3 leaves). Thrips population ranged from 0.00 to 81.20 thrips/3 leaves which were first noted in 25th SMW. Peak activity of thrips was observed in 30th SMW.

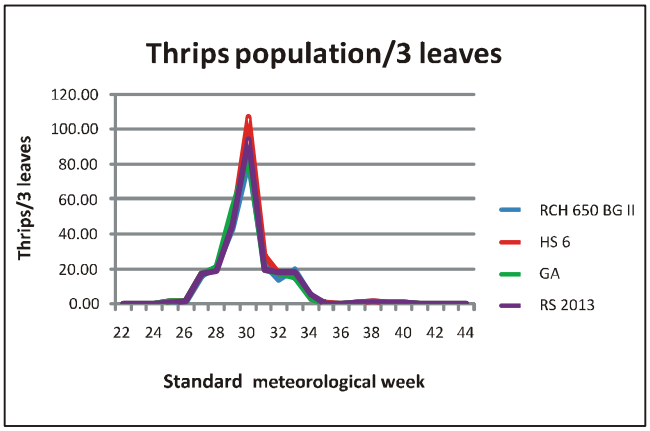
In HS-6, leafhopper population ranged from 0.00 to 6.30/ 3 leaves. Peak activity of leafhopper was observed in 31st SMW. Population of whitefly was initially observed in 22nd SMW (0.00 whitefly/ 3 leaves) & peak activity occurred in 30th SMW (41.30 whitefly/ 3 leaves). Thrips population ranged from 0.00 to 106.80 thrips/ 3 leaves and peak activity of thrips was observed in 30th SMW.

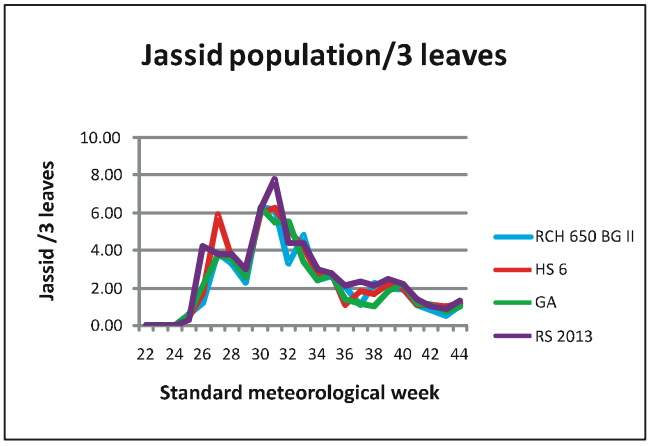
In Ganganagar Ageti, the leafhopper population ranged between 0.00 to 6.30 leafhoppers/ 3 leaves. Peak activity of leafhopper was observed in 30th SMW. Peak activity of whitefly occurred in 30th SMW (40.20 whitefly/ 3 leaves). Thrips population ranged from 0.00 to 84.40 thrips/ 3 leaves and peak was observed in 30th SMW.

In RS-2013, leafhopper population ranged from 0.00 to 7.80 leafhoppers/3 leaves. Peak activity of leafhopper was observed in 31st SMW. Population of whitefly was initially observed in 22nd SMW (0.00 whitefly/ 3 leaves) & peak activity occurred in 30th SMW (41.80 whitefly/ 3 leaves). Thrips population ranged from 0.00 to 94.20 thrips/ 3 leaves and peak was observed in 30th SMW.

Bollworm infestation was not observed on RCH-650 BG II. In non Bt varieties HS-6, GA & RS-2013 first incidence of bollworm was observed in the 37th SMW which ranged from 0.1 to 0.5, 0.30 to 0.90 & 0.23 to 1.20% fruiting bodies damage, respectively.







Within plant distribution of whitefly

Whitefly prefers to feed on lower canopy of the plant as compared to middle and upper canopy. Mean whitefly adults population/leaf recorded during the entire season of 2017-18 on upper, middle and lower strata was 4.77 (2.99-6.63), 12.07 (7.63-21.79) and 15.15 (7.50-33.06), respectively during different time of the day in RCH650 BG-II. Similar trend was recorded cv Ganganagar Ageti and RS2013. Though whitefly prefers to lay eggs on the fresh leaves but the nymphal pattern indicated the equal preference both for middle and lower strata leaves as compared to upper strata leaves.

The life table analysis of whitefly starting from 34-41SMW on its nymphal stage indicated maximum natural mortality due to fungal/bacterial infection (17.93-23.71%) followed by dislodgement (9.33-19.59%) and parasitism (4.77-18.60%). The total natural mortality obtained was 36.81-53.59 percent

Seasonal Dynamics of Diseases

To ascertain the extent of incidence and severity of the CLCuV, a survey was conducted in 8 cotton growing districts namely Sirsa, Fatehabad and Hisar of Haryana, Hanumangarh, Sriganganagar of Rajasthan, Fazilka, Bathinda and Mansa districts of Punjab in North India during the month of August. Disease grading (0-6 scale) technique developed by AICRP on cotton was used to record the per cent disease incidence. Associated Symptoms *viz.,* vein thickening, upward and downward curling (cupping), and cup shape outgrowths or enations on the lower side of the infected leaves were also recorded

CLCV Infected leaf showing vein thickening and enation

The incidence was highest in Fatehabad District followed by Hisar in Haryana. (Table.3.10.1)

Table 3.10.1 : Survey and surveillance of Cotton leaf curl infected field in North India (0 to 6 Grade)

State	District	ClCuV incidence (0-6 scale)
Haryana	Sirsa	2.04
	Fatehabad	2.32
	Hisar	2.06
	Hansi	1.30
Rajasthan	Hanumangarh	2.03
	Sriganagnagar	1.93
Punjab	Fazilka	1.20
	Bhatinda	1.72
	Muktaar	0.70

Biological Diversity of Insect Pests, Pathogens and Natural Enemies

Whiteflies

Whitefly populations from all the three cotton growing zones were taken up to study the genetic diversity of *Bemisia tabaci*. Collected whiteflies were subjected to molecular characterization by mitochondrial COI gene primer. After obtaining sequences from sanger sequencing, the sequence were trimmed in Bioedit software and submitted to NCBI to generate accession number (MG448545 - MG448602). The 58 sequences obtained were used for phylogenetic analysis using Mega 7 software. The phylogenetic tree for 58 Mt COI sequences of *B. tabaci* containing 425 nucleotides each was constructed by using *Trialeurodes vaporariorum* as an outgroup. The analysis involved total of 70 nucleotide sequences including reference sequences. The phylogenetic tree was constructed based on the Jukes-Cantor model. A discrete Gamma distribution was used to model evolutionary rate differences among sites (5 categories (+G, parameter = 0.3485)). The rate variation model allowed for some sites to be evolutionarily invariable ([+I], 29.88% sites). The maximum likelihood phylogenetic tree showed two monophyletic clades with Asia-I belonging to south and central India and Asia-II representing north India whitefly populations. The tree construct supported moderately to strong with bootstrap value range from 50 to 93%.

Nagpur

Biodiversity of natural enemies

To record the abundance and diversity of natural enemies in cotton ecosystem in central, south and north India a study was conducted. Yellow pan trap was used for recording parasitoids and visual count method was adopted to record predators. In central India the study was conducted on Phule Dhanwantari, Suraj, Suvin, RCH-2 and DCH-32. More than 30 different kinds of natural enemies were recorded. Diversity indices such as Shannon Index (H), Shannon evenness Index (E), Simpson Index (D), Sorenson's Coefficient (CC) and Species richness (S) were calculated for above mentioned varieties of cotton. It was observed that species richness and abundance was highest in Phule Dhanwantari (H=1.94, S=20) followed by Suvin (H=2.09 , S=15) and Suraj (S=15) than compared to the RCH-2 and DCH-32. Unprotected cotton varieties carry more species richness than protected ones.

Healthy Whitefly nymph | Parasitized Whitefly pupa | *Eretmocerus sp.* exit hole on Whitefly pupa | Adult *Eretmocerus sp.* | Cheilomenes sexmaculata grubs and pupa | *Rivellia sp.* | *Rivellia sp.*

Monitoring of Pink bollworm field incidence in India

Two bollworms viz., American (*Helicoverpa armigera,* spotted bollworm (*Earias vitttela & E. Insulana)* were recorded in negligible number while, pink bollworm (*Pectinophora gossypiella)* was seen to damage cotton to a greater extent. Pink bollworm infestation varied from place to place and ranged from 40-95% in central and south India.

The per cent infestation of pink bollworm in green bolls of BG-II at 140-180 days after sowing was observed in all cotton growing districts of Maharashtra *Viz.,* Yavatmal (56.63%), Akola (80%), Amaravati (70.67%), Nandurbar (86.7%), Dhule (99%), Jalgaon (92%), Aurangabad (91%), Jalna (79%), Nanded (81%), Parbhani (82%), Hingoli (80%) and Buldhana (99%). Infestation on BG II cotton in Madhya Pradesh was recorded at 68 per cent.

Similarly, infestation on BG II cotton fields of Gujarat were in the range of 20 to 90 per cent, the highest infestation was observed in Amreli (90%) and in the fields of Bharuch (25%) infestation was lower as compared to other districts in Gujarat. However, no pink bollworm infestation was observed in North India (Punjab, Haryana and Rajasthan) on BG-II hybrids. Infestation of pink bollworm in South India was same as in central India. In Andhra Pradesh the infestation ranged from 72 to 84 per cent and in Telangana 69 to 91.2 per cent with highest observed in Adilabad (91.2%). Raichur (28%) district of Karnataka had less infestation as compared to Dharwad (92%). Incidence of pink bollworm on non Bt cotton fields of central India (Maharashtra, Madhya Pradesh and Gujarat) was observed in the range between 36 to 100 per cent, whereas, in North India, it was 7 to 42 per cent. The non Bt bolls from Nandiyal and Dharwad recorded 68 and 100 per cent infestation respectively.

Widespread infestation of the pink bollworm, Pectinophora gossypiella (Saunders) on Bt cotton in Maharashtra

The pink bollworm *Pectinophora gossypiella* (Saundars) has recently re-emerged as a serious menace on Bt cotton in India. An extensive roving surveys were conducted in 71 locations spread across 15 major cotton growing districts of Maharashtra to assess the level of pink bollworm infestation in Bt cotton. The dynamics and severity of pink bollworm damage during the different stages of boll development (90-130 days of crop age) was assessed based on random sampling of green bolls, opened bolls and picked bolls per plant and number of locules damaged per boll. The survey results revealed that there was a widespread infestation of pink bollworm on Bt cotton throughout the surveyed sites in the range of 40 – 95 % (Fig 3.10.8). Yield losses of 20-30% are expected with observed level of infestation. A typical pattern of progressive increase in the level of pink bollworm infestation and intensification of locular damage with the advancement of the crop season was observed. The pink bollworm hitherto supposed to be under control since the introduction of Bt cotton in India, now appears to be widespread, especially on Bt cotton throughout the cotton growing areas of Maharashtra State which accounts for approximately 25 % of country's cotton production.

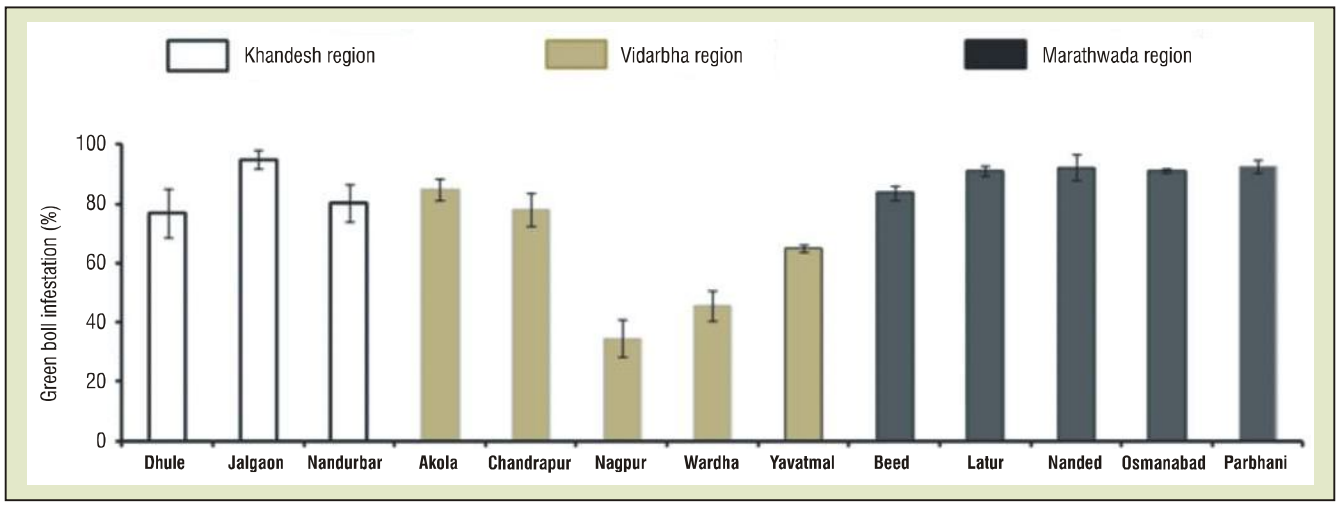


Fig. 3.10.8: Pink bollworm infestation in Bt-cotton in Maharashtra (2017 -18)

Genetic Diversity of pink bollworm

Pink bollworm population from flower and green bolls were collected from Maharashtra and Adilabad. The collected samples were used for diversity studies. In BLAST analysis sequences have shown 99 percent identity with NCBI Accession No.MF044026.1

Emerging fungal pathogens

Marathwada, Khandesh and Vidarbha region of Maharashtra were surveyed to record shifting trend, if any of leaf spot pathogens. Various types of leaf spots were recorded (fig. 3.10.9) and diverse fungal pathogens viz., *Corynespora cassiicola* (15), *Colletotrichum gloeosporioides* (06), *Colletotrichum siamense* (02), *Alternaria spp.* (02) and *Myrothecium roridum* (20) were isolated. Of these, *Corynespora cassicola* and *Colletotrichum siamense* were observed as potential new emerging diseases of cotton. Widespread infestation of *C.cassicola* was recorded from 15 locations from cotton growing regions of Vidarbha, Khandesh and Marathwada of Maharashtra. Identity of fungal species was confirmed by morphological and molecular characters including mycelia growth on media. (fig. 3.10.10)

Fig. 3.10.9 : Various types of fungal leaf spots observed during survey

Fig. 3.10.10 : Mycelial growth of a) *Corynespora cassiicola* b) *Colletotrichum gloeosporioides* c) *Myrothecium roridum* on Sabouraud Dextrose Agar (SDA) medium

Occurrence and distribution of *Tobacco Streak Virus* (TSV) in Cotton

Symptoms expression in *Gossypium barbadense* : The cotton fields at CICR Regional Station Coimbatore were surveyed during 2017 for the presence of TSV infected cotton plants. The presence of disease affected plants in the germplasm of *Gossypium barbadense* were observed at 90 Days after sowing (DAS). The per cent disease incidence ranged between 1.61% (CCB 140) to 26.60% (ICB 71) (Table 3.10.2). The expression of TSV symptoms were also observed in *Gossypium barbadense*. The symptoms were very distinct with necrotic spots dark purple in colour and also drying of squares. The symptom expression in the germplasm of ICB 71, CCB 129, CCB 51 and CCB 141 were given in the Fig.3.10.11.

Table 3.10.2: Per cent disease incidence of TSV in the germplasm of *Gossypium barbadense*

Sr. No	Germplasm	Per cent disease incidence (90 DAS)*
1.	ICB 71	26.6 %
2.	CCB 129	20.5 %
3.	CCB 51	13.9 %
4.	ICB 72 & ICB 73	12.6 %
5.	CCB 141	12.3 %
6.	CCB 29	6.8 %
7.	Suvin	6.7 %
8.	CCB 143b, TCB 49, NDGB 12, NDGB 21, C1, DB 3 & Rhc01R1	6.6 %
9.	ICB 60, ICB 61, ICB 65, ICB 67, ICB 70, ICB 74, ICB 75, ICB 94, ICB 145, ICB 163, ICB 180, ICB 182, ICB 245, ICB 260 & C 7	5.7 %
10.	CCB 11, CCB 11a, CCB 30 & CCB 64	3.6%
11.	CCB 64a, H8, H9R2, H3, H8, TCB 4, DB, GSB 41, C9, ICB 17, ICB 17R2, ICB 25, ICB 183, ICB 209, ICB 210, ICB 222, ICB 224, ICB 238, ICB 241, ICB 248, ICB 263, ICB 271, ICB 275, ICB 276, ICB 290, NDGB 1, NDGB 23, NBGB 31, NDGB 41, NDGB 62, NDGB 63 & NDGB 64	3.3%
12.	CCB 26, CCB 51- 2, CCB 67 & CCB 143	2.9%
13.	CCB 25, CCB 140, HP & SP	1.6 %

*Per cent disease incidence= No. of infected plants / Total no. of plants assessed x 100

Fig 3.10.11: Typical symptoms of TSV showing necrotic spots with purple colour and drying of squares on *G. barbadense* genotypes

Symptoms expression in *Gossypium hirsutum* : The presence of disease affected plants in the varieties and hybrids of *Gossypium hirsutum* were observed at 60 to 70 DAS. The per cent disease incidence varied from 5.0% (Suraj) to 16.6% (Surabhi and RCH659 BG-II) (Table 3.10.3). Typical symptoms observed in *G. hirsutum* were chlorotic with necrotic spots in young leaves and marginal necrotic streaks with leaf deformation while in mature plants veinal necrosis, drying of squares and terminal shoots was observed (Fig. 3.10.12). Yellowing, leaf malformation and necrotic spots were also observed in *G. arboreum* (Fig. 3.10.13).

Table 3.10.3 : Per cent disease incidence of TSV in *Gossypium hirsutum*

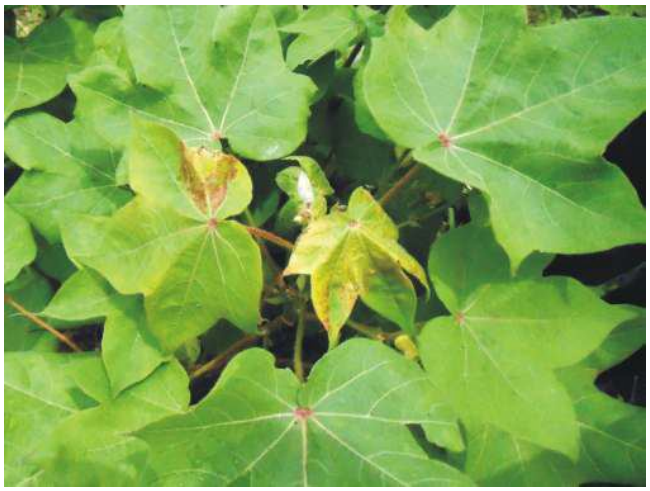
S. No	Variety/ Hybrid	Per cent disease incidence (60 to 70 DAS)
1.	Suraj	5.0 %
2.	Surabhi	16.6%
3.	RCH 659 BG-II	16.6 %
4.	Suraj Bt	7.6 %

Fig. 3.10.12 : Typical symptoms of marginal necrosis and necrotic leaves in young plants

Fig. 3.10.13 : Symptoms expression in *Gossypium arboreum*

For the first time symptoms resembling Tobacco Streak Virus (TSV) on *G. hirsutum* was also recorded in some fields of Fatehabad and Sirsa Districts of Haryana during survey. Further work is underway for confirmation of presence of TSV.

a) Team Conducting survey



b) Symptoms resembling TSV infection on *G. hirsutum*.

Nematode mapping of Vidarbha districts

Soil sampling was done for mapping of 9 districts of Vidarbha and total of 667 samples were collected. The samples were washed by Cobb's sieving and decanting technique and nematode population was estimated qualitative and quantitatively. Initial results show that reniform *nematode Rotylenchulus reniformis* was most frequent and dominant species followed by *Meloidogyne incognita* (Table 3.10.4)

Table 3.10.4: Important nematode species of Vidarbha region of Maharashtra

S. No.	Nematode species	Dominance %
1.	*Rotylenchulus reniformis*	100
2.	*Meloidogyne incognita*	71
3.	*Tylenchorhynchus dubius*	88
4.	*Helicotylenhus dihystera*	63
5.	*Hoplolaimus columbus*	58
6.	*Paratylenchus minutus*	26
7.	*Pratylenchus goodeyi*	85
8.	*Hirschmanniella mucronata*	51
9.	*Hemicycliophora arenaria*	45

Coimbatore

First record of Tea mosquito bug, *Helopeltis theivora* Waterhouse was documented on cotton variety, Suraj under hydroponic nutritional studies conducted with various levels of nutrients at Central Institute for Cotton Research, Regional Station, Coimbatore. Both nymphs and adults suck the sap from leaves, young shoots, squares and bolls which causes black lesions and the leaves get rolled at the edge with brown central black lesions near the main veins. Scars with papery layer appear on the leaves. Retarded growth with shortening of inter nodal length and gradual drying of the shoots were also observed.

3.11: Integrated Pest Management

Nagpur

Phytotoxicity and growth stimulating effect on plants and crop yield

The experiment was conducted to understand phytotoxicity and growth stimulating effect of insecticides on cotton plants and crop yield. Four insecticides viz., Clothianidin 50%WDG, Spiromesifen 22.9%SC, Dinotefuran 20% SG and Flonicamid 50% WG along with control were taken as main plots in split plot design. The dosages of insecticides taken were at x, 2x and 4x. The treatments were imposed at 60, 75 & 90 DAS. There was no noticeable phytotoxicity and growth stimulating effect with the imposed insecticidal treatments. Yields did not vary significantly among the treatments. Jassid population was significantly different in all the insecticides tested at given dosage and was lower in all the treatments as compared control. Among the insecticides tested Dinotefuran 20% SG and Flonicamid 50% WG registered lowest population of jassid. Among the dosage, highest dose (4x) resulted in lowest jassid population (Fig 3.11.1). Whitefly population was lowest in Spiromesifen 22.9%SC and Flonicamid 50% WG. Significantly lower population of thrips was recorded in all the designated insecticides over control. However, not much difference was recorded between different dosages. Mirid population was not impacted much with different insecticides sprayed at different dosages.

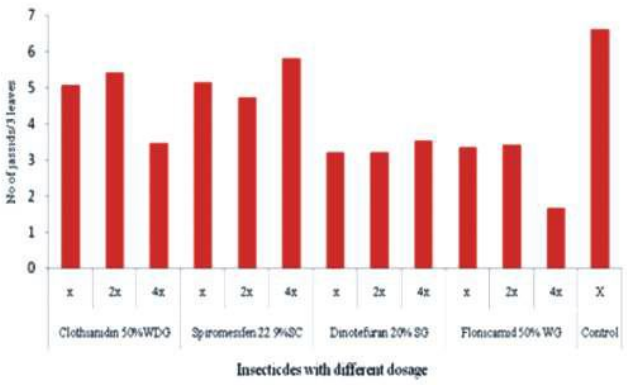


Fig 3.11.1 : Jassid population as a result of insecticidal treatments at different dosages of insecticides

Insecticides:

The field experiment was conducted at ICAR-CICR, Nagpur to study the effectiveness of Quinolphos 25EC, Profenophos 50 EC, Thiodicarb 75 SP, Clorantraniliprole 18.5 SC, Spinosad 45SC, Neem Oil, Cypermethrin 25EC, Deck (Cypermethrin + Profenophos), Spark (Deltamethrin + Triazophos), Traizophos 40EC and Deltamethrin 2.8 EC against Pink bollworm of cotton under High density Planting system (HDPS). The data on exit holes, mines on epicarp, number of larvae and per cent locule damge was observed in 10 green bolls (GB). Data indicated that, lower number of exit holes was noticed in the treatment cypermethrin + profenophos (0.44/10 GB) and it was at par with cypermethrin 25 EC. All other insecticides tested were equally effective and number of exit holes recorded were in the range of 1.11 to 2.33 with 4.56 in untreated control. Similarly, lowest number of larvae per 10 green bolls was observed in the plots sprayed with cypermethrin + profenophos (1.33 larvae) and it was followed by (deltamethrin+triazophos) and cypermethrin 25 EC with 1.67 and 1.78 larvae, respectively. Cypermethrin + profenophos was also highly effective in reducing locule damage (8.62%) while cypermethrin 25 EC (13.60%) was not so effective. Treatment with neem oil was effective in reducing locule damage (17.86%) in comparison with untreated control (38.88). (Fig 3.11.2)

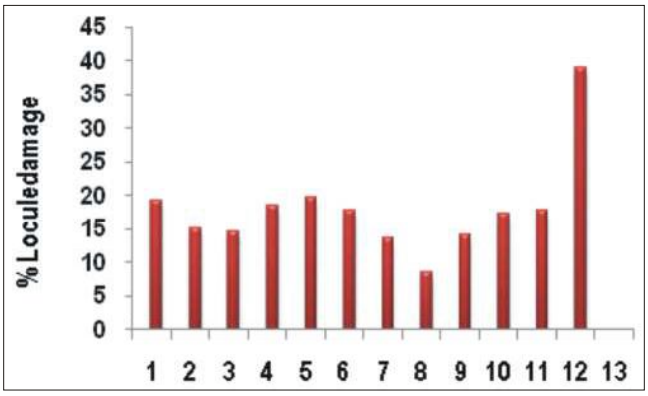


Fig: 3.11.2: Effect of different newer molecules against Pink bollworm (2017-2018)

Sirsa

Compatibility study of entomopathogens with insecticides

The *in vitro* compatibility of 12 pesticides with top ten Entomopathogenic fungi (EPFs) was assessed using their full and half of the recommended dose following poison food technique on Sabouraud Dextrose Agar (SDA) amended with 0.2% yeast. The redial growth of mycelium (per plate), conidial production (5 mm disc) was recorded in all treatments seven days after inoculation, separately. The toxicity of chemicals and botanicals against EPFs was calculated using the formula of Alves *et al.*, (1998): T= [20 (VG) + 80 (ESP)]/100. In this formula, values for vegetative growth (VG) and sporulation (ESP) were given in relation to control (100%). Where toxicity grades were considered as follow: T = 0 to 30 (very toxic); 31 to 45 (toxic); 46 to 60 (moderately toxic); >60 (compatible). Among botanicals, neem oil and pongamia oil were found to be compatible to moderately toxic with all the EPFs except *Beauveria bassiana*-6097, *Beauveria bassiana* -409, *Beauveria bassiana*-4543. The castor oil was found to be toxic to with all EPF's except EPF strain *Paecilomyces javanicus*-89, *Beauveria bassiana*-4565 and *Fusarium monoliformae*-83. Among chemicals flonicamid and diafenthiuron, the insect growth regulators (spiromesifen, pyriproxifen, buprofezin), were found to range between compatible to moderately toxic while organophosphate group of pesticides and fipronil ranged between compatible to very toxic. Overall, EPF strain namely, *Paecilomyces javanicus*- 89, *Paecilomyces javanicus*-102, *Metarhizium anisopliae* -1299, *Beauveria bassiana*-4511 were found to be the most compatible with full and half dose of the chemical and botanicals tested.

Comparative field study of selected entomopathogens

The field trial conducted during 2017-18 revealed that the entomopathogenic fungal strain and chemical treatments were significantly superior over control in terms of nymphal mortality. The highest nymphal mortality seven days post spray was recorded with *B. bassiana* 4511 (83.65%) followed by *P. javanicus* CICRRSS 0102 (81.78%) which were significantly superior to Diafenthiuron 50% WP (1. g/L), Neem oil (300 ppm) and commercial formulation of *L. lecanii* (0.1% WP) (Fig.3.11.3.).

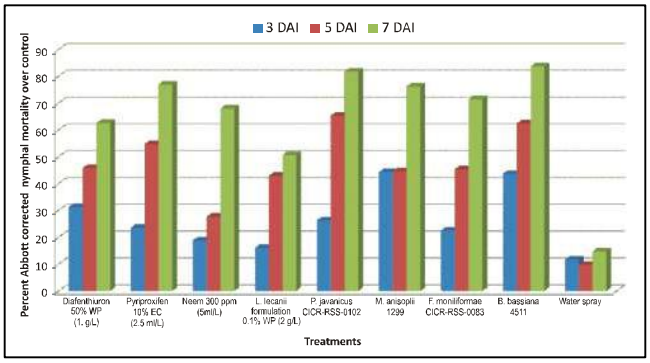


Fig. 3.11.3 : Effect of selected entomopathogenic fungal strains and pesticides on whitefly nymphal mortality under field conditions (*Average, maximum and minimum % RH during the experiment 76.7 (50-87) and 58.5 (40-72) during last week of July and first week of August 2017)

Bioefficacy of insecticides and biorationals against thrips

The efficacy of twelve label claim insecticides and five biorational interventions (castor oil, pongamia oil, sesame oil, 2 neem based formulation) were tested under laboratory conditions against thrips at ICAR-CICR, Regional Station, Sirsa at three dosages during 2017-18. Among the insecticides Spinosad (78% mortality), Fipronil (72% mortality), Spinoteram 11.7 % SC(68%mortality) and Diafenthiuron and Profenphos (66% mortality) gave mortality. Among the biorational approaches, sesame oil (58 & 66 % mortality @10& 15 ml/litre), castor oil (50 & 58% mortality @ 10 & 20ml/liter), pongamia oil (40% mortality @ 10ml/liter) recorded moderately good mortality against thrips.

The efficacy of biorationals against whitefly was studied during 2017-18. Castor oil, pongamia oil and sesame oil reduced whitefly population 42.81, 39.20 and 36.86 percent respectively. The maximum reduction was obtained in standard check Difenthiauron (55.24%) treatment.

Coimbatore

Evaluation of selectivity of insecticides against different mealy bug species and their major natural enemies associated with cotton, tomato, brinjal and papaya

1. Out of eight insecticides tested, Clothinidin was

found to be more toxic to *P. solenopsis*. The descending order of toxicity Clothionidin > Cypermethrin > Pyriproxyfen + Fenpropathrin > Lambdacyhalothrin > Spiromesifen > Flonicamid > Diafenthiuron. The relative resistance (RR) was calculated by keeping the most toxic insecticide as unity (1.00). The study observed that the clothionidin was highly toxic to the mealybug. Based on the RR value it was observed that the insecticides Cypermethrin, Pyriproxyfen + Fenpropathrin, Lambdacyhalothrin, Spiromesifen, Flonicamid, Diafenthiuron were 8.33, 32.70, 60.69,255.05, 555.13 and 625.48 times less toxic respectively as compared to Clothionidin (Table 1).

2. Safety evaluation study of thirteen different insecticides against larvae of *Chrysoperla zastrowii sillamii* revealed that the Thiamethoxam (LC_{50}=7.010mg ai/ L) was found to be more harmful to the larvae of Chrysoperla, whereas Thiodicarb (LC_{50}= 307.75 mg ai/L) was found to be safer to the larvae by this method.
3. Safety evaluation study of fourteen different insecticides against the grubs of *Cryptolaemus montrouzieri* by diet contamination method revealed that the imidacloprid (LC_{50} = 3.70 mg ai/L) was found to be more harmful to the grubs of *Cryptolaemus*, whereas thiodicarb (LC_{50} = 286.51 mg ai/L) was found to be safer to the grubs.

Table 3.11.1: Toxicity of different insecticides against, *Phenacoccus solenopsis* by leaf dip method

Name of the insecticide	No	Slope	LC_{50}mg ai/L	Fiducial limit		RR*	LC_{90}	Fiducial limit	
				Min	Max			Min	Max
Clothionidin	169	1.291	4.84	3.17	6.96	1.00	47.65	27.35	121.54
Cypermethrin	190	3.771	40.34	33.22	45.72	8.33	88.22	73.12	128.07
Diafenthiuron	180	2.072	3027.34	2310.39	3792.32	625.48	1883	8970.8	22123.0
Flonicamid	196	1.838	2686.82	1584.00	3840.05	555.13	13380.0	8072.0	44062.0
Lambdacyhalothrin	182	3.075	293.75	230.76	343.57	60.69	766.98	613.49	1177.33
Pyriproxyfen + Fenpropathrin	210	1.815	158.26	114.08	202.58	32.70	804.68	523.95	1917.48
Pyriproxyfen	210	2.204	5025.08	2608.17	7580.87	1038.24	19164.0	11004.0	0.001947
Spiromesifen	210	1.943	1234.45	848.14	1580.80	255.05	5637.0	3958.0	11044.0

*Relative Resistance = LC_{50} of test insecticide / LC_{50} of reference insecticide

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

The studies on developmental biology of *Phenacoccus solenopsis* under laboratory condition (30 ± 5°C and RH 60-70 %) showed that the mean developmental period of male individuals were higher than that of their female counterpart. The mean developmental period of Punjab population of *P. solenopsis* was 15.0 days for male and 11.0 days for female, which was found to the lowest as compared to Tamil Nadu and Maharashtra population.

Pink bollworm Resistance in India

The resistance development of 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 24 districts namely Wardha, Yavatmal, Washim, Hingoli, Nanded, Parbhani, Aurangabad, Buldana, Akola, Amravati, Rahuri, Jalgaon districts of Maharashtra; Khandwa and Pandhurna districts of Madhya Pradesh, Surat, Bharuch, Vadodara, Anand, Ahmedabad, Bhavnagar, Amreli, Junagadh, Rajkot and Surendranagar districts of Gujarat and 13 districts namely Guntur, Kaddapa, Anantpur, Kurnool and Krishna in Andhra Pradesh; Karimnagar, Adilabad, Warangal and Khammam in Telangana, Srivelliputtur and Coimbatore in Tamil Nadu and Dharwad and Raichur in Karnataka were monitored.

The Pink bollworm populations collected from North India recorded susceptibility to Bt toxins. Pink bollworm populations from Prakasam, Bharuch, Rajkot, Kurnool and Surendrangar recorded 172, 278, 372, 391 and 674 fold resistance to Cry1Ac toxin compared to susceptible check. Populations from Surendranagar, Guntur, Warngal, Yavatmal, Jalna, Buldana, Jalgaon, Anand, Vadodara, Bharuch, Aurangabad, Dhule, Rajkot and Khammam recorded 141, 182, 182, 220, 287, 315, 436, 436, 444, 518, 671, 671, 4214 and 5947 fold resistance over the susceptible check to Cry2Ab.

Insecticide resistance monitoring against jassid

Resistance monitoring against jassid was carried out for 4 locations of Vidarbha region by taking 9 insecticides which are commonly used by the farmers. The LC_{50} ranges of these insecticides were, Flonicamid 50%WG 0.0002 - 0.0009 mg/L, Monocrotophos 36%SL 0.0001-0.185 mg/L, Acephate 75%SP 0.0015-0.1837 mg/L, Imidacloprid 17.8%SL 0.0008 - 0.0074 mg/L, Acetamiprid 20%SP 0.0027 - 0.0307 mg/L, Thiamethoxam 25%WG0.0012 - 0.0034 mg/L, Clothianidin 50%WDG 0.0002 - 0.0043 mg/L, Dinotefuran 20%SG 0.0001 - 0.0004 mg/L, Spiromecifen 22.9%SC 0.0069-0.0488 mg/L. Nagpur populations were more susceptible to Flonicamid while susceptibility of populations from Amravati were more to Clothianidin and Dinotefuran as compared to other populations.

Monitoring of resistance development in sucking pests against newer insecticides *viz.*, Acetamiprid, Clothianidin, Dinotefuran, Flonicamid, Imidacloprid, Monocrotophos, Spiromesifen, Thiamethoxam was taken up with population of Nagpur, Wardha, Amravati and Yavatmal. It was observed that jassid populations of these districts were susceptible to these designated insecticides.

Resistance monitoring against cotton whitefly (*Bemisia tabaci*) for Nagpur population

Resistance monitoring against cotton whitefly (*Bemisai tabaci*) was initiated from 2015-16 for Nagpur population. Twenty one insecticides from 10 groups (Biorationals, Neonicotinoid, Phenylpyrazole, Carbamates, Pyridine, Carboxamide, Insect Growth Regulators, Organophosphate, Tetronic acids, Synthetic pyrethroid) were taken for resistance monitoring during 2015-16, 2016-17 and 2017-18. Over the three years, it was observed that resistance ratio did not exceed > 20 fold. In the current year, resistance was negligible against all the insecticides indicating that susceptibility of whitefly was intact.

Sirsa

Whitefly resistance to insecticides in North zone.

Organophosphate: The Resistance ratio obtained in case of Ethion (2.62-7.38 & 1.84-11.04), Chlorpyriphos (3.64-11.26 & 7.56-10.46) and Triazophos (28.94-43.15 & 11.84-54.56) during 2016-17 and 2017-18 was attributed to the pesticide use pattern on cotton as well as on other alternate hosts crops.

Neonicotinoid : The high resistance to Thiamethoxam (12.8 - 58.96 & 10.34 - 51.48 fold resistance ratio during 2016-17 & 2017-18) was recorded at different locations of the north zone but resistance was low for Acetamiprid, and Imidacloprid and this may be due to insecticide use pattern. Low resistance ratio was recorded against Dinotefuran (0.96-17.80 & 1.46-9.80 during 2016-17 and 2017-18), Thiacloprid and Clothianidin .

Synthetic Pyrethroid : Low to moderate resistances to Cypermethrin were reported in the *B. tabaci* populations, very low or minimal resistance to Fenpropathrin was observed which is again a result of insecticide use pattern in cotton and other crops.

Insect Growth Regulators : Younger stages of insects are generally more sensitive to insecticides as compared to older stages. Among the newer insecticides, Diafenthiuron recorded highest resistance with 70.67-163.30 & 33.33-128 fold resistance during 2016-17 & 2017-18) .

Nematode Management

Nagpur

Induction of Systemic Acquired Resistance against phyto nematode.

Bio formulations (Curcumin water soluble and alcohol soluble extracts, neem oil and cow urine in different combinations) were evaluated for confirmation of induction of systemic acquired resistance against reniform nematode under field conditions. Effect of bio formulations on nematode population in field and on final cotton yield was evaluated. Alcohol soluble curcumin was more effective in suppression of plant parasitic nematodes as compared to water soluble curcumin. In 2017-18, application of bio-formulation with curcumin, cow urine and neem oil on PKV081 reduced nematode population and increased yield by 29%. The spray treatments were better than the corresponding treatments applied to soil in reducing nematode population and increasing seed cotton yield.

Evaluation of bacteria for efficacy against nematodes

Bacterial species isolated as endosymbiont from nematodes were evaluated for efficacy against reniform nematode (Table 3.11.2). *Lysinibacillus sphaericus* used as seed treatment was found to reduce nematode population and also induce resistance against nematodes as evidenced by split root experiment.

Table 3.11.2: Bacterial species evaluated for efficacy against reniform nematode *Rotylenchulus reniformis*.

Bacterial species	NCBI Acc. No.	Bacterial species	NCBI Acc. No.
Aeromonas veronii	KU507539	*Alcaligenes faecalis*	KX808583
Aeromonas veronii	KU507540	*Alcaligenes faecalis*	KX808584
Aeromonas veronii	KU554699	*Ochrobactrum pseudogrignonense*	KC342237
Aeromonas veronii	KU564079	*Bacillus nealsonii*	JQ319066
Enterobacter cloacae	KU738572	*Ochrobactrum pseudogrignonense*	KF312237
Brevundimonas aurantiaca	KU744945	*Alcaligenes faecalis*	KX808583
Brevundimonas aurantiaca	KU755452	*Alcaligenes faecalis*	KX808584
Enterobacter hormaechei isolate CICR-XA	KC759141	*Ochrobactrum pseudogrignonense*	KC342237
Lysinibacillus sphaericus isolate CICR-X12	KC759142	*Brevundimonas aurantiaca* strain CICR-EMA4	KU744945

3.12 : Development of new Detection Methods, Tools and Protocols

Nagpur

Validation of CLCuV LAMP Detection Technique

Development of diagnostic tools which are rapid, specific and sensitive have immense role to play in detection and management of economically important viruses. The protocol for rapid diagnosis of CLCV infected samples by using Loop Mediated Isothermal Amplification (LAMP) has been standardized. Primer synthesized using conserved regions selected by multiple sequence alignment for standardization of LAMP protocol was validated. The temperature and time essential for LAMP assay was standardized at isothermal conditions of 61 ^{0}C for 60 min for set of four primers (F3, B3 and FIP, BIP). The colorimetric detection for diagnostic simplicity of amplified LAMP product by using SYBR safe DNA gel stain has enhanced applicability of this technique. During survey the leaf samples were collected from 8 different cotton growing districts of North zone. The DNA was isolated by using DNeasy plant mini kit and tested for CLCuV infection by using LAMP techniques (Fig. 3.12.1).

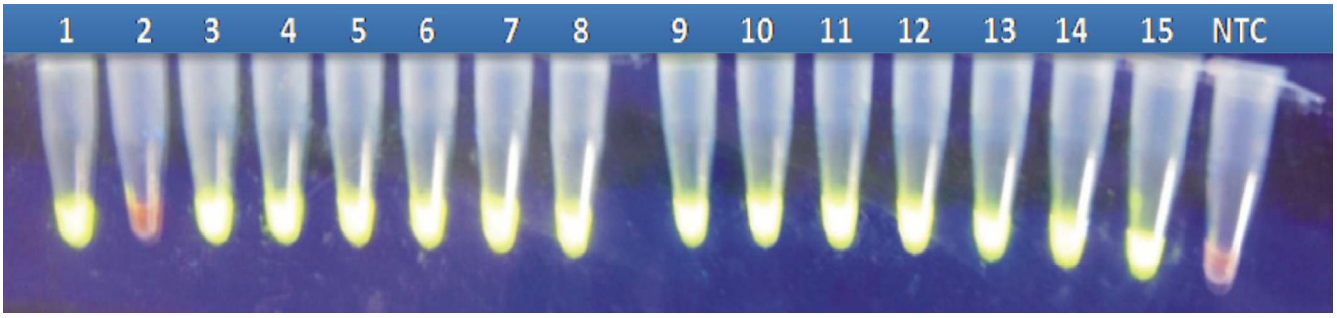


Figure 3.12.1 : Colorimetric detection of CLCV by LAMP technique in samples collected from different locations

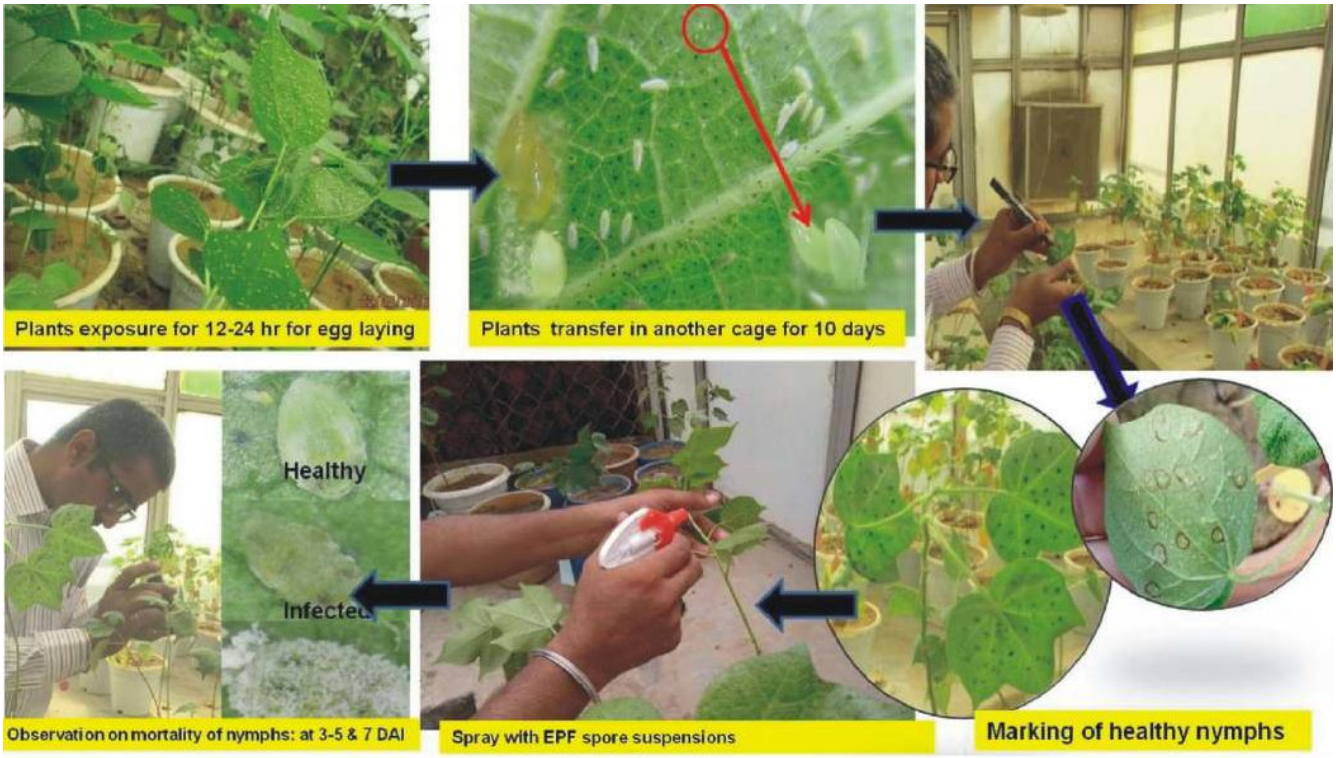
Sirsa

Development of new modified poly house bioassay method against whitefly nymphs

Fungal isolates were evaluated against white nymphs through six different methods including leaf disc method-A , detached leaf method using 0.2% agar plate (detached leaf method-B), detached leaf supported with 0.2% sucrose solution (5 ml vial) (detached leaf method-C), detached leaf supported with 0.2% sucrose solution (15 ml) in plastic cups (detached leaf method-D), detached leaf supported with 0.2% sucrose +0.1% NPK and placed on aluminum mesh to support the leaf in plastic tray (detached leaf method-E) and the new modified polyhouse bioassay method (F). The percent mortality of the whitefly nymphs by all the fungal isolates were consistent under new modified poly house screening method, while in the other method the mortality trend was uneven due to reduced turgidity of the leaves. Hence, the new modified poly house bioassay method was found to be the most suitable method for evaluating entomopathogenic fungi in large numbers.

In the new bioassay method, one month old potted

plants were kept inside the whitefly rearing poly house for egg laying (50-60 whitefly per leaf) (Fig.4.10.2). Twenty four hour post egg-laying, whitefly adults were gently removed from the plants and the plants were transferred to an another nethouse aseptically for next 10 days. Subsequently, the number of nymphs (40-50 nymphs per leaf) was recorded and marked on abaxial surface of the leaf with water proof marker. Freshly prepared conidial suspension (1 x 10^7 ml^{-1}) of EPFs was applied to abaxial surface of leaves at 10 ml per plant (~2 ml per leaf) in the poly house having relative humidity of around 75% and temperature 30 ± 2°C. In control treatment, potted plant leaves were sprayed with 0.01% Tween 80 solution only. The mortality was recorded using 20X hand magnifying lens at 3, 5 and 7 days post treatment. Corrected Abbott's formula was used to correct for control mortality (Abbott, 1925) before subjecting mortality data for analysis of variance.



Entomopathogenic virulence screening method against whitefly nymphs- New modified polyhouse bioassay method

Coimbatore

Optimization of critical medium component for enhanced efficacy of Entomopathogenic fungi

Seven carbon sources at two doses, four surfactants, three salts and four pH were tested to optimize critical medium component for maximum biomass, lipase and metabolite production by three entomopathogenic fungi *viz.*, *Lecanicillium lecanii*, *Metarhizium anisopliae* and *Aspergillus fumigatus*. Maximum biomass and lipase production in *A. fumigatus* was observed at Coconut oil (2%), Tween 80, $FeSO_4$ and at pH 7.0. Maximum biomass and metabolite production of *L. lecanii* was recorded in media containing Castor oil (2%) as carbon source and Tween 80, $FeSO_4$ and at pH-7.0 whereas Coconut oil (2%), Tween 80, $MgSO_4$ and at pH-7.0 supported maximum biomass and metabolite production by *M. anisopliae*. Crude metabolites produced by *L. lecanii* and *M. anisopliae* were screened for their insecticidal activity against Aphids under laboratory condition. Both were found to be effective and caused 100 per cent mortality at higher concentration. Crude metabolites of *Paecilomyces lilacinus* were screened for nematicidal activity against reniform nematode under *in vitro* condition. Nematode mortality was found to increase with increase in concentration of metabolite. Ovicidal activity of metabolite was also observed.

Screening for biotic stress tolerance

Among the 53 genotypes tested for leafhopper resistance, 22 genotypes recorded Jassid Injury Grade of <1 under field conditions. Nymphal emergence studies conducted under laboratory conditions also confirmed the field observations and minimum number of nymphs (1.5 No./3 leaves) that emerged from the above genotypes indicated the level of leafhopper tolerance.

4. TECHNOLOGIES ASSESSED AND TRANSFERRED

Nagpur

Dissemination of Pest Management Technologies

Strategy for management of Pink bollworm was refined, validated and disseminated through awareness workshops, distribution of leaflets, bulletins, press notes, newspaper advisories, press releases and TV shows.

ADVISORY FOR PINK BOLLWORM (PBW) MANAGEMENT ON COTTON

Pink bollworm has become resistant to Bollgard II and has emerged as a major pest of BGII cotton in some parts of India. It has impacted boll opening, coinciding with the second picking of cotton in most areas. The pest is usually monophagous and has few alternate hosts. Availability of cotton round the year promotes rapid buildup of the pest. In light of this development, for the benefit of cotton farmers, ICAR-Central Institute for Cotton Research, Nagpur has formulated following advisories for dissemination and implementation in **Central India**

1. Do not extend the cotton crop beyond January
2. Clean up fields of residual stalks and partially opened bolls. Do not stock stalks on the field bunds.
3. Do not store infested or stained cotton in the godowns.
4. Install pheromone traps with authentic lures near ginneries to trap suicidal emergence of moths, if any.
5. Do not sow cotton crop in the month of April as it would be susceptible to PBW.
6. Timely sowing of early maturing short duration BGII hybrids are recommended for the region.
7. Procure and sow authentic BGII seeds. Do not use authorized or F_2 seeds. Retain the bills with authentic name of purchaser from authorised seed dealer for further claims, if arises.
8. Fields that has suffered heavy damage due to PBW during the previous year may be closely monitored during the subsequent crop season.
9. Monitoring of pink bollworms using pheromone traps may be initiated 45 days after sowing.
10. Install pheromone traps @ 5/ha for monitoring moth activity of PBW. ETL (Economic Threshold Level) of PBW is 8 moths catch per pheromone trap for consecutive 3 days.
11. Use lures of authentic quality and change them at recommended intervals. Beware of spurious lures.
12. Inspect the crop at squaring and flowering stage for presence of PBW larvae within flowers, and the ETL at this stage is 10% damaged flowers (Rosette flowers). If necessary spraying of recommended insecticide (see table below) may be advocated.
13. At boll formation stage, farmers are advised to inspect the presence and damage of PBW by plucking 20 green bolls from different plants randomly. ETL at this stage is 10% damaged green bolls (at least two bolls having white or pink larvae/exit holes).
14. Farmers are advised to collect and destroy the fallen squares, flowers and bolls from the field.
15. Promote the multiplication and release of the parasitoid *Trichogramma bactreae* where ever is available.
16. Sprays of recommended insecticides (see table below) may be undertaken if the pest crosses ETL.
17. Picking of clean and infested cotton may be carried out separately. Clean cotton may be stored or marketed. Infested cotton should be destroyed to contain the pest.
18. Information on PBW Management is available and circulated through ICAR-CICR website, further press notes, leaflets, folders, pamphlets and e-kapas voice messages to manage PBW.

Schedule for insecticides spray wherever necessary

Month	Insecticides	Dose per 10 lit water
September	Quinolphos 20% AF or Thiodicarb 75% WP	20 ml 20 gm
October to November	Chlorpyriphos 20% EC or Thiodicarb 75% WP	25 ml 20 gm
December	Fenvalerate 20% EC or Cypermetherin	10 ml 10 ml

Farmers are advised to strictly comply with the recommendations provided in the advisory to minimize the losses due to PBW infestation in cotton.

High Density Planting System (HDPS) - demonstrations

During *kharif* season 2017-18, 10 tribal farmer's field of Umred Taluka villages (MGMG) were chosen for field demostration experiments of HDPS under TPS (Tribal Sub Plan). The tribal farmers were also given training under NSP-TSP-III in Nagpur district, 27 Feb to 14 March 2018 at Wathoda, Bothli and Parseoni.

Crop Pest Surveillance and Advisory Project (CROPSAP)

Cotton pest management strategies were disseminated through ICT tools as one of the stakeholders in Crop Pest Surveillance and Advisory Project (CROPSAP) 2017-18

in 28 districts of Maharashtra. At the beginning of the crop season, window based pest management strategies were finalized in consultation with all the three Entomology Department Heads of the State Agricultural Universities (SAUs) located at Vidarbha, Marathwada and Western Maharashtra region. Advisory was transmitted as text messages to registered farmer's mobile by the concerned SAU's twice a week. Real time data was constantly monitored and uploaded on CROPSAP portal. Regular visits were made to farmers field to collect first hand information on pest status.

Coimbatore

Front Line Demonstrations

During the summer season, demonstrations were made on Integrated Crop Management in twenty hectares conducted on fifty farmers' fields at Tirupathur, Vellore District. The technologies *viz.*, improved variety Surabhi, popular Bt cotton hybrids, Integrated Weed Management, Integrated Nutrient Management, Integrated Pest Management and application of growth regulators was demonstrated. Similarly, twenty hectares of FLDs on ELS cotton was demonstrated under summer irrigated condition at Uthangarai block of Krishnagiri district. These demonstrations were coordinated by Dr (Mrs) S. Usha Rani, Principal Scientist (Agricultural Extension).

Sirsa

HDPS - demonstrations

FLDs on HDPS with CSH-3129 on 40 hectares involving 100 farmers of 51 villages, CSH-3075 on 80 hectares area involving 200 farmers of 87 villages in Haryana, Punjab & Rajasthan States were conducted.

Highest seed cotton yield (30 q/ha) was recorded of the variety CSH-3129, whereas, seed cotton yield of Bt hybrid grown by corresponding farmers was 25.00 q/ha. The variety recorded 20% SCY increase over the Bt hybrid RCH773. By adopting CSH-3129 farmer was benefitted by Rs 9448/ha as compared to Bt hybrid.

Highest seed cotton yield of the variety CSH-3075 (HDPS in spacing of 67.5×10 cm) was 30 q/ha., as compared to SCY of Bt hybrid (67.5×60 cm) (25 q/ha. The variety gave 20.00 % increase over the Bt hybrid RCH-773. Average seed cotton yield of 200 FLD's on CSH-3075 (HDPS) conducted was 17.31 q/ha. Whereas, average seed cotton yield of Bt hybrids at farmers field was 15.78 q/ha. An average increase of 10.96 % was obtained by the farmers for the variety CSH-3075(HDPS) over the Bt hybrids. The cost benefit ratio of CSH-3075 was 1.20 against the Farmer's (1.02)and the farmer was benefitted by Rs. 12753 /ha by growing CSH-3075 (HDPS) in comparison to Bt hybrid.

View of CSH-3075 at Farmer's field

Whitefly management strategies disseminated

Management strategies implemented to manage whitefly in North zone

1. **Mass campaign :** Awareness and training through mass campaign for early detection of the pest.
2. **Monitoring and management :** Area wide monitoring and management of whitefly should be initiated from February onwards on all the alternate hosts—vegetable, ornamentals and weeds.
3. **Cultivate recommended hybrids/varieties :** Grow recommended high yielding cotton genotype approved by the SAUs/ICAR having tolerance to whitefly and CLCuD.
4. **Timely sowing :** Ensure timely sowing (up to 15 May for the American cotton hybrids/ varieties and upto 30 April for Desi cotton varieties) of the crop as timely sown crop tolerates whitefly and CLCuD. Maintain 8,000 –10,000 plants per acre of the American cotton hybrids in the field.
5. **Promote Desi cotton varieties :** Desi cotton varieties/hybrids are tolerant to the whitefly and immune to the CLCuD.
6. **Fertilizer doses :** Apply recommended dose of fertilizers as per the package of practices recommended by respective SAU and after soil health inspection. Avoid excessive urea (nitrogen) application during early vegetative phase.

7. **Fertilizer application:** Apply half dose of nitrogen up to squaring and remaining half dose may be applied between flowering and boll formation. P&K can be applied as basal dose. Apply 2 - 4 sprays of 2% potassium nitrate (13:0:45) at 7-10 days intervals starting from flower initiation onwards.
8. **Irrigation :** Apply first irrigation at 4-6 weeks after sowing followed by need based irrigation depending on rainfall and stop irrigation at 1/3 of boll opening.
9. **Weed sanitation :** Keep fields, bunds and the vicinity free of weeds before and after the sowing of cotton. Destroy volunteer/ratoon cotton plants as well as the weed hosts growing near the irrigation channel/ canal and fallow lands during the off season.
10. **Barrier crop :** Grow two dense rows of sorghum or pearl-millet or maize as border around cotton fields. Create ecological diversity by growing Desi cotton and other non host crops between the cotton fields.
11. **Yellow sticky traps and suction traps :** Install yellow sticky traps @ 40-50/acre during July to August. Use vacuum adult whitefly suction traps during August when the adult whitefly population is high.
12. **Use botanicals** : Initially apply two sprays with 1.0% neem oil + 0.05-0.10 % laundry detergent emulsion or nimbecidine (0.03% or 300 ppm) @ 1.0litre/acre to reduce whitefly populations and conserve the natural enemies.
13. **Use insect growth regulators** : Insect growth regulators such as diafenthiauron (200 gm/acre), buprofezin (320 ml/acre), spiromesifen (200 ml/acre) and pyriproxifen (400-500 ml/acre) can be used after mid august. These insecticides are effective on whiteflies and are relatively safe to its natural enemies. To manage the second flush of whitefly (during September) restricted use of Ethion (800 ml/acre) is advised. If higher population of eggs and nymphs is observed under the leaves, then application of spiromesifen (250ml/ acre) or pyriproxifen (400-500 ml/acre) is advisable. Diafenthiauron is useful in mixed infection of whitefly adults and thrips.
14. If the mixed infestation of whitefly and leafhopper is observed apply flonicamid 50WG (80 g/acre).
15. Never use synthetic pyrithroids, acephate or any insecticide mixtures. These insecticides are known to aggravate resurgence of whitefly when used indiscriminately.

On Farm Demonstrations

Nagpur

On large plots performance of popular Bt hybrids from private sector along with public sector BGII hybrids (H8 and H10) and desi varieties (Roja and Phule Dhanwantary) were demonstrated under rainfed conditions on deep vertisols at recommended spacings with the approved package of practices. The productivity of different private Bt hybrids ranged from 1839-2644 kg/ha. The yield of public sector BGII hybrids –H8 and H10 was 2426 and 2440 kg/ha respectively. Desi cotton varieties P. Dhanwantary and Roja yielded 1765 and 1492 kg/ha respectively.

Coimbatore

One acre field trial demonstrating all the CICR technologies was conducted for the benefit of visitors to ICAR – CICR, Regional Station, Coimbatore.

5. EDUCATION, TRAINING AND CAPACITY BUILDING

5.1 : Education

5.1.1 : M.Sc. Students and Ph.D Students

ICAR-CICR has signed MOU with State Agricultural Universities and State Universities to undertake research programme and thesis work in the institute premises. During 2017-18, one M.Sc student completed the research programme and submitted his thesis

Name : Ravichanndra MV

Co-Guide : Dr. Mrs. Sandhya Kranthi

Discipline : M.Sc. Ag. Biotechnology

University : **Sam Higginbottom** University of Agriculture, Technology and Sciences (SHUATS)

Thesis : Characterization of the dominant endosymbiont in geographical population of whitefly *bemicia tabaci* (Gennadius)

Abstract

Bemisia tabaci (Gennadius) the cotton, tobacco, okra or sweet potato whitefly has recently become very important to world agriculture as a pest and as a virus vector. Whiteflies are associated with endosymbionts that are universal in nature and are responsible for the evolution of insects for millions of years. Endosymbionts have been stabilized within the host for fulfilling the host's nutritional requirement for their physiological functions and metabolism. Endosymbionts also play a role in virus transmission.

This study identified the dominant endosymbiont present in whitefly populations collected from nine host plants across locations in Nagpur. For identification of primary endosymbiont in whitefly, 16S rRNA universal primers were used to generate the amplicon of interest. Sequence analysis of the 663bp amplicon, indicated that *Portiera* was the dominant endosymbiont present in all populations of whiteflies. *Portiera aleyrodidarum*, was hitherto reported as the first insect endosymbiont identified as capable of supplying carotenoids to the host insect. Using *Portiera* specific primers it was confirmed that *Portiera* was the dominant parasitoid present in whiteflies across crops, sampled across locations of Nagpur. Partial sequences of *Portiera*, varying in similarity, were published on NCBI and their accession numbers are as follows: LN829852.1 LN829841.1 LN829715.2 LN829731.2 HG764142.1 LC159286.1 LN829735.1 LN829733.2 LN829821.2 LN829826.2 LN829847.1 JN204494.1 JN204483.1 JN204490.1 HG764155.1 JN204494.1 JN204487.1 4

The following students were enrolled for M.Sc and Ph.D. programme during 2017-2018 and are pursuing their research work

M.Sc. Students

S. No.	Name	Discipline	Co-Guide	Topic	University
1	Ms. Mayuri V. Tamboli	M.Sc. Biotechnology	Dr. V. N. Waghmare	Assessment of genetic diversity of Cotton (*Gossypium hirsutum*) genotype using molecular (SSR) markers.	RTMNU, Nagpur
2.	Mr. Radhesham Hatzade	M.Sc. Crop Physiology	Dr. Sunil Mahajan	Evaluation of seed vigor tests for predicting field seeding emergence in tetraploid and diploid	Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (SHUATS), UP
3.	Mr. Swapnil Matikhaye	M.Sc. Crop Physiology	Dr. J. H. Meshram	Screening of cotton germplasm accession for drought stress tolerance using (polyethylene glycol) PEG - 6000	
4.	Mr. Satish Raut	Crop Physiology	Dr. J. H. Meshram	Effect of mepiquat chloride on cotton shoot and root growth behavior	

S. No.	Name	Discipline	Co-Guide	Topic	University
5.	Mr. Dinesh Sahu	Crop Physiology	Dr. A. Manikandan	Study on morpho-physiological characteristics of cotton under artificial salt stress condition	Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (SHUATS), UP
6.	Mr. Himanshu Kumar	Crop Physiology	Dr. Pooja Verma	Evaluation of elicitors for physio-biochemical changes in relation to drought in cotton	

Student educational tour and field visit to ICAR-CICR

Sr. No.	College Name	Total No. of students	Class of Students	Date of Visit
1.	Shri Sant Shankar Maharaj College of Agriculture, Amravati	120	B.Sc.	04.12.2017
2.	Nilkanthrao Shinde Science and Arts College, Bhadrawati, Dist. Chandrapur	17	M.Sc.	03.02.2018
3.	Brijlal Biyani Science Collage, Amravati	80	M.Sc. and B.Sc. Department of Botany, Zoology, Biotechnology	22.02.2018
4.	Vidhya Vikas College of Science, Samudrapur, Wardha	64	M.Sc. and B.Sc.	07.03.2018

5.2 : Training and Capacity Building

5.2.1 : Training Received

Scientists

Sr. No.	Name	Course / Training	Place	Period (days)
1.	Dr. Shah Vivek	DST-SERB workshop on chemical ecology	NCBS, Bangalore	03-17 Jul 2017 (15 Days)
2.	Dr. Ramkrushna G.I.	Analytical tools and techniques for development of soil health card	ICAR-NBSS & LUP, Nagpur	02-11 Aug 2017 (10 Days)
3.	Dr. V. S. Nagrare	Sixth IBO training workshop	Bangalore	10th Sept 2017 (one day)
4.	Mr. Prabhulinga Tenguri	Recent developments in statistical modeling and forecasting in agriculture	ICAR – IASRI, New Delhi	28 Dec 2017 - 17 Jan 2018 (21 Days)
5.	Mr. Madhu T.N.	Insect resistance to Bt toxins and insecticides in cotton	ICAR-CICR, Nagpur	18 Jan - 07 Feb 2018 (21 Days)
6.	Dr. A Mannivannan	Recent advances and accomplishments in heterosis breeding of crops	TNAU-CPBG, Coimbatore	31 Jan - 20 Feb 2018 (21 Days)
7.	Dr. Neelakanth Hiremani	Bio-pesticides for crop protection and improvement : Emerging technology to benefit farmers	GBPUA & T, Pantnagar (Uttarakhand)	02-22 Feb 2018 (21 Days)
8.	Dr. V. Chinna Babu Naik	Fundamental of plant health management for plant health doctors	NIPHM, Hyderabad	13 Feb - 05 Mar 2018 (21 Days)
9.	Dr. Jayant H. Meshram	Program on competency enhancement program for effective implementation of training function by HRD Nodal Officer of ICAR	ICAR-NAARM, Hyderabad	15-17 Feb 2018 (3 Days)

Technical Staff :

Sr. No.	Name of the Officials	Name of the Course / Training	Place	Period
1.	Mr. R.M. Lokhande	Value addition to cotton seed	ICAR – CIRCOT, Mumbai	20-22 Jul 2017 (3 Days)
2.	Mr. R.K. Chaturvedi			
3.	Mr. R.K. Chaturvedi	Enhancing efficiency and effectiveness of institutional administrations management and effective implementation of official language policy in ICAR system	ICAR – IIHR, Bangalore	11 Aug 2017 (1 Day)
4.	Mr. R.M. Ramteke	Layout and maintenance of field experiments and recording observations	ICAR-IARI, New Delhi	03-12 Oct 2017 (10 Days)
5.	Mrs. Sunita N. Chauhan	Capacity building of home science experts	ICAR – ATARI-PUNE KVK, JALNA(MS)	27-29 Nov 2017 (3 Days)
6.	Mr. Mayurkumar R. Meshram	Agro meteorological data collection, analysis and management	ICAR – CRIDA, Hyderabad	11-23 Dec 2017 (13 Days)
7.	Mrs. Swati Dixit	Training program on KOHA for Library staff	ICAR-NAARM, Hyderabad	31 Jan - 09 Feb 2018 (10 Days)

Administrative Staff :

Sr. No.	Name of the Officials	Name of the Course / Training	Place	Period
1.	Mr. Nandkishor V. Dhande	Enhancing efficiency and effectiveness of institutional administrations management and effective implementation of official language policy in ICAR system	ICAR – IIHR, Bangalore	11 Aug 2017 (1 day)
2.	Mrs. Rama Gajanan Iyer	Enhancing efficiency and behavioral skills of Stenographers Grade-III, PA, PS, PPS and Sr.PPS of ICAR	ICAR-NBSS & LUP, Regional Station, Kolkata	05-11 Jan 2018 (7 Days)
3.	Mr. Mahesh Tiwari	Enhancing efficiency and behavioral skills of stenographers grade -III, PA, PS, PPS and Sr.PPS of ICAR	ICAR – CIFE, Mumbai	03-09 Aug 2017 (7 Days)

5.2.2: Training Imparted

5.2.2.1 International Training

In-country training programme on bio-pesticide laboratory operations and research at Uganda

A five-day in-country training programme on "Bio-pesticide laboratory operations and research" was organized by Government of India under Cotton-Technical Assistance Programme (TAP) for Africa by ICAR-Central Institute for Cotton Research from 22 to 26 August, 2017 at National Semi-arid Resources Research Institute (NaSARRI), Serere, Uganda. This led to the establishment of a modern facility with amenities for mass rearing of the locally available biopesticides and biofertilizers. Thirty two scientists, technical officers and communication development officers of Cotton Development Organization, National Semi-arid Resources Research Institute (NaSARRI), Makerere University and Gulu University of Uganda were trained by Dr. S K Sain, Senior Scientist (Plant Pathology) and Dr. A. Manikandan, Scientist (Soil Science) of ICAR-CICR. The programme commenced with the welcome address by Dr. Michael Ugen, Director, NaSARRI, Serere on 22 August 2017. Training comprised theory and hands-on practice on bio-pesticide and biofertilizer production. The biopesticide laboratory was inaugurated on 28 August 2017 by Shri. Ravi Shankar, High Commissioner of India to Uganda. The following dignitaries were present at the inaugural programme which includes Personnel Secretary, Minister of Agriculture Animal Industry & Fisheries, Director General, National Agricultural Research Organization (NARO), Mrs. Jolly. Sabune, Managing Director, Cotton Development Organisation and Board of Directors (CDO), Dr. Michael Ugen, Director, NaSARRI, Serere, Officers Member of Parliament Local County Member and officials from NARO. The training implementing agency was IL&FS Clusters (P) Ltd, India.

5.2.2.2 National Training

i) Training to State seed testing officials :

Training program of "Molecular Technologies for Transgene detection in GM cotton" for seed testing officers from Maharashtra State Agriculutre department was conducted at Biotech Lab. Division of Crop Improvement from 16-18 Oct. 2017. Six participants from State seed testing laboratory, Nagpur, 3 from SSTL, Pune and 3 from SSTL, Parbhani was participated in the training.

The training was co-ordinated by the following scientist - Dr G. Balasubramani, Dr J. Amudha, Dr Raghavendra K.P., Dr. Chandrashekhar N. and Sh Joy Das of the Institute.

ii) Training to Students

Scientists of ICAR-CICR imparted 1 month (5-30th June, 2017) training to the following students to upgrade their skills

S. No.	Name of Student	Training Co-ordinators & Supervisors	Topic	University
1.	Mr. Nikhat Shakeel Siddique	Dr. S. P. Gawande , Dr. D. T. Nagrale	Basic techniques of Microbiology and Plant Pathology	Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (SHUATS), UP.
2.	Mr. Shrikant Pravinrao Tiwaskar	Dr. A. Manikandan, Dr. Savitha Santosh	Basic laboratory techniques & Instrumentation in Microbiology	Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (SHUATS), UP.
3.	Mr. Abhishek Shrikrishna Ghanwat			
4.	Mr. Mahesh Vilasrao Thombare			

iii) Training to Farmers

Nagpur

Precautions to be taken by the farmer/farm labourers while handling pesticides

A team comprised of Dr V. N. Waghmare, Director, Dr A. R. Raju, Principal Scientist (Agronomy) and Dr Vishlesh Nagrare Principal Scientist (Entomology) visited Savargaon village, Kalamb Taluka in Yavatmal district on 13.10.2017 and demonstrated the precautions to be taken by the farmer/farm labourers while handling pesticides. The programme was organized by IFFCO. Precautionary aids/safety kits and a booklet on pink bollworm management in local language recently published by ICAR-CICR were distributed.

Farmer Workshops and Seminar on Integrated Management of Pink bollworm organized

At Jambha Khurd village, Akola (Maharashtra)

One day workshop on "Integrated Management of Pink bollworm" was organized by CICR in collaboration with Namdev Maharaj Agro Producer Company and Janamanch on 16th January, 2018 at the Chakrapani Udyog Sankul, Jambha Khurd, Tal. Murtijapur, Dist. Akola. Speaking on the occasion Dr V. N. Waghmare, Director, CICR mentioned that widespread infestation of pink bollworm in Bt cotton in Maharashtra state has added to the woes of farmers and it is necessary to implement pink bollworm management strategies devised by ICAR-CICR. He pointed out that different stakeholders including farmers, seed producers, ginners, State Agriculture Department, social organizations, NGO's, KVKs, State Agriculture Universities etc. need to work in tandem through their collective efforts for effective management of Pink bollworm in the coming season.

Dr. Vishlesh Nagrare gave detailed information to the stakeholders about integrated management of pink bollworm. Dr. Chinna Babu Naik briefed about past and present situation of pink bollworm. Dr Babasaheb Fand spoke about safe use of pesticides and advised farmers for strict adherence to label claims, avoiding mixtures and overuse of pesticides and need based spray of only recommended chemicals. Dr. Nandini Gokte-Narkhedkar, Head, Division of Crop Protection, welcomed all the participants and briefed about organizing farmers' workshop. Dr. S.M. Wasnik, Principal Scientist (Extension), acquainted the farmers about the program of e-Kapas and "Mera Gaon Mera Gaurav" and appealed them to register under e-kapas programme. Dr. Jayant Meshram, Dr. Rachna Pandey, Dr. S. P. Gawande, Dr D.T. Nagrale, and Mr Madhu T.N. interacted with farmers and answered queries raised by the participants. Dr. Shailesh Gawande proposed the vote of thanks. More than 500 farmers from Murtijapur Tehsil participated in training programme.

At Girad, Wardha (Maharashtra)

Farmers workshop on Integrated Management of Pink bollworm was organized on 28th Dec, 2017 at the Magan Sangrahalaya of Natural Farming Development Center, Girad, Tal. Samudrapur, Dist. Wardha. Dr V. N. Waghmare, Director, ICAR-CICR, Nagpur in his remarks pointed out that different stakeholders including farmers, seed producers, ginners, state agriculture department, social organizations, NGO's, KVKs, State Agriculture Universities etc. need to work in tandem for effective management of Pink bollworm in the next season. Dr. S. M. Wasnik, Principal Scientist (Extension), acquainted the farmers about the program of e-Kapas and "Mera Gaon Mera Gaurav".

Dr. Nandini Gokte-Narkhedkar, Head I/C, Division of Crop Protection, ICAR-CICR welcomed all the participants and briefed about organizing farmers workshop at Girad. Dr. Vishlesh Nagrare, Principal scientist (Entomology) gave detailed information to the stakeholders about integrated management of pink bollworm. Dr Babasaheb Fand, Scientist (Entomology) delivered a lecture on 'Safe use of pesticides'. More than 500 farmers from 72 villages in Samudrapur Tahsil of Wardha District participated in this workshop. Dr. Vishlesh Nagrare, Dr. Jayant Meshram, Dr. M. Saravanan, Dr. Ramkrishna G. I., Dr. Chinna Babu Naik, Dr. S. P. Gawande, Dr D. T. Nagrale, Dr. Vanita Salunkhe, Dr. Vivek Shah, Dr. Neelkanth Hiremani and Mr Madhu, T. N. interacted with farmers and answered queries raised by the participants.

At Wani, Yavatmal (Maharashtra)

Farmer's workshop on Integrated Management of Pink bollworm in collaboration with white cotton group Wani was held on 24th Jan, 2018 at Shetkari Mandir Sabhagruha, at Wani, Dist. Yavatmal. Dr V. N. Waghmare, Director(Acting), ICAR-CICR, Nagpur pointed out that different stakeholders including farmers, seed producers, ginners, state agriculture department, social organizations, NGO's, KVKs, State Agriculture Universities etc. need collective efforts for effective management of Pink bollworm in the ensuing season.

Dr. Vishlesh Nagrare, Principal scientist (Entomology) explained in detailed about integrated management of pink bollworm. He discussed the importance of several points like termination of crop latest by first fortnight of January, crop rotation, adoption of early maturing varieties, sowing of next season's crop in mid-June, installation of pheromone traps after 45 days of sowing, etc. for the management of pink bollworm in the next kharif season.

Dr Shailesh Gawande, Scientist (Plant Pathology) delivered a lecture on 'Safe use of pesticides'. He called farmers attention mainly towards strict adherence to label claims, avoiding mixtures and overuse of pesticides and need based spray of only recommended chemicals. More than 1200 farmers from Wani Tahsil of Yavatmal District were participated in this workshop. Dr. Nandini Gokte-Narkhedkar, Head I/C, Division of Crop Protection, ICAR-CICR welcomed all the

participants and Shri. Yuvraj Jangle AO panchayat Samitee Wani proposed the vote of thanks.

At Daryapur, Amravati (Maharasthra)

A seminar on "Advanced techniques of cotton farming and pink bollworm management" was jointly organized by ICAR-Central Institute for Cotton Research, Nagpur, All India Maheshwari Samaj, Daryapur and Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola on 15 February, 2018. Dr Sharad Naimbalkar, former Vice Chancellor of PDKV inaugurated the seminar and spoke on the current issues in cotton farming. ICAR-CICR Director Dr. V.N. Waghmare and Scientists Dr. S.M. Wasnik, Dr. Vishlesh Nagrare and Dr. Babasaheb Fand participated and guided the farmers. Dr. Waghmare, while calling the attention of participants towards the issue of widespread damage caused by pink bollworm infestation in Bt cotton this year, expressed a need for collective efforts from all the stakeholders of the cotton farming for effective management of this dreaded pest. Extension specialist Dr. Wasnik appealed the farmers to register their mobile numbers with the institute for availing the benefit of cotton advisories provided as voice messages through mobile. Dr. Nagrare gave detailed presentation on measures to be followed throughout the cotton-growing season for effective management of pink bollworm. Dr. Fand delivered his talk on safety measures to be taken while handling the pesticides. About 450 cotton farmers from Daryapur and the vicinity participated.

Coimbatore

NFSM Trainig

The ICAR- Central Institute for Cotton Research, Regional Station, Coimbatore in collaboration with the Directorate of Cotton Development, Ministry of Agriculture and Farmers' Welfare, Government of India, Nagpur had conducted one day farmers' training program under NFSM-CC-Cotton 2017 on 22.09.2017. The program was convened by Dr. A.H. Prakash, Project Coordinator and Head and Co-convened by Dr. S. Usha Rani, Principal Scientist and Dr. M. Sabesh, Senior Scientist. The main purpose of the programme is to provide knowledge to cotton farmers of Tamil Nadu state on the best package of practices of cotton cultivation, particularly pests' management including pink bollworm to accelerate the production and productivity of cotton. A total of fifty seven farmers from 20 villages of Coimbatore district, Tamil Nadu had participated. A total of 12 lectures were delivered by the Scientists on various aspects of "Best Package of Practices for Cotton Cultivation". Dr. Sukumar Mandi, Joint Director, DCD, Nagpur distributed certificates to the participants.

iv) Training to Scientists / Technical / Govt. Officials/NGO's

National Training on "Bt Resistance monitoring of pink bollworm on cotton"

Three day National Training on "*Bt Resistance monitoring of pink bollworm on cotton*" was held at ICAR-CICR, Nagpur from April 20-22, 2017. Purpose of this

training was to enable cotton researchers to detect and manage resistance to Bt toxins in Pink bollworm populations as Pink bollworm is re-emerging as major pest of cotton. The training aimed to provide hands on experience on pink bollworm rearing and monitoring of pink bollworm resistance to Cry toxins. A total of 35 participants from 9 cotton growing states including Scientists, Research scholars and personnel from Industries participated. The programme was inaugurated by Dr VN Waghamare, Head Division of Improvement, CICR, Nagpur. In his inaugural address, Dr. Waghmare briefed about importance of Pink bollworm resistance management. Dr Blaise, Head Division of Production, Head PME Cell and Head Biotechnology section also addressed the participants.

The three day training programme included lectures on various topics as Current Scenario of Pink bollworm on Bt cotton, Sampling and rearing procedure for PBW, Bioassays methods Pink bollworm management on cotton, Production Strategies for limiting damage by Pink bollworm and immuno diagnostic tests for detection of Bt (cry) toxins.

The Valedictory session was graced by Dr. S.V Sarode, Ex Director of Research, PDKV, Akola as Chief Guest. Dr. Sarode informed about damage caused due to pink bollworm in extended cotton crop and strategies for its management. Dr.M.S. Ladaniya Director, ICAR-CICR, Nagpur emphasized on importance of early sown, early maturing, short duration cotton (150-160 days) varieties to escape the pink bollworm in cotton. Dr S. Kranthi explained about the current scenario of pink bollworm on Bt cotton in India and also remedial measures for its management.

This training was coordinated by Dr Sandhya Kranthi, Principal Scientist, Head /Ic, Division of Crop Protection, CICR, Nagpur and Dr V. Chinna Babu Naik, Scientist (Entomology).

ICAR sponsored Winter School on Insect resistance to Bt toxins and insecticides in cotton

ICAR-Central Institute for Cotton Research, Nagpur conducted an ICAR sponsored 21 days Winter School on "Insect resistance to Bt toxins and insecticides in cotton" during 18 January - 07 February, 2018. The winter school was aimed at providing hands on training to the participants on recent advances in IRM such as monitoring techniques for resistance development, mechanism of resistance, case histories of emerging and re-emerging pest problems and strategies for IRM. A total of 25 participants from ICAR institutes, Agricultural Universities, KVKs, etc. across eight major cotton growing states of the country participated in the training.

The training programme was inaugurated at the hands of Dr. S.A. Nimbalkar, Ex. Vice Chancellor, Dr. PDKV, Akola. Dr. Nimbalkar in his inaugural address highlighted the importance of IPM in bringing down the insect resistance and restoring the susceptibility. He further stressed that any single technology cannot be viewed as sole and permanent solution to the agricultural pest problems; because it may lead to aggravation of resistance problems in the context of innate desire of every living being to survive.

Dr. Sudhir Meshram, Ex. Vice Chancellor, North Maharashtra University, Jalgaon was the chief guest for valedictory session of the winter school held on 07 February 2018. Dr. Meshram in his address expressed a need for inclusion of lab to land programmes as one of the activity under training programmes to percolate the knowledge to the neglected sections of the society. Dr. V.N. Waghmare, Director (Acting), ICAR-CICR chaired both the inaugural and the valedictory sessions. Dr. Waghmare in his remarks expressed a gratification over successful conduct of the winter school and advised the

participants to keep a good track of recent developments in their respective research fields.

Dr. Blaise Desouza, Head, Division of Crop Production expressed his indulgence on coverage of all the relevant topics in the training course and thrown light on importance of agronomic measures in insect resistance management.

Dr. Nandini Gokte-Narkhedkar, Head, Division of Crop Protection briefed about the importance of this winter school in the present context of increasing challenges of insect resistance in cotton. Dr. V. Chinna Babu Naik, Course-Director briefly explained about the lectures and practicals covered in the winter school. Dr. Vishlesh Nagrare, Principal Scientist (Agril. Entomology) proposed vote of thanks.

Sirsa

Seminars/Conferences/Symposia/ Workshops/ Meetings	Place	Date
Workshop on whitefly management for extension officials sponsored by USIEF Alumni Award	ICAR-CICR Regional Station, Sirsa	16.06.2017
Workshop on whitefly management for farmer s sponsored by USIEF Alumni Award	ICAR-CICR Regional Station, Sirsa	16.08.2017

Trainings Organized

Name of training	Date & Venue	Organised by
Training for champion farmers adopted by Bayer Crop Sciences on cotton production and protection technology	May 4-6, 8-9, 2017 at ICAR-CICR, Sirsa	Dr. D. Monga, Dr Rishi Kumar, Dr. S.K. Sain
Training cum exposure visit on whitefly for the scouts of Bharat Cotton factory and Ambuja Cement Foundation under the aegis of Better Cotton Initiative (BCI)	22.07.2017 at CICR, Sirsa	Dr. D. Monga and Dr. Rishi Kumar
Training cum exposure visits cum training for the scouts of Bharat Cotton factory and progressive farmers	17.10.2017 at CICR, Sirsa	Dr. D. Monga and Dr. Rishi Kumar
Training on surveillance and scouting of cotton insect pests	08.08.2017-10.08.2017 at CICR, Sirsa	Dr. D. Monga and Dr. Rishi Kumar

Meeting

Meeting to review, evaluation and refinement of strategy for effective management of whitefly in north zone	Sept 13, 2017, at CICR Regional Station, Sirsa	Dr B. Rajender, IAS, Joint Secretary, Dr. Monga, Dr S.S. Siwach, Dr N.S. Bains and scientists from SAU's and officers of Dept. of Agriculture Punjab /Haryana /Rajasthan

5.2.2.2 Mera Gaon Mera Gaurav Programme

Under the 'Mera Gaon Mera Gaurav (My Village My pride)' programme, the Scientists remain in touch with the adopted villages and provided information to farmers on technical and other related aspects in the time frame through personal visits to hasten the process of Lab to Land. ICAR-CICR has implemented the programme through the team of scientists. The programme is now being implemented in 71 adopted villages with 14 clusters i.e. nine, four and one respectively from Nagpur, Coimbatore and Sirsa. Dr. S. M. Wasnik, Principal Scientist, Extension over see's the activity as a Nodal Officer.

Major Problems Identified in MGMG villages

During the year, in majority villages problem of pink bollworm attack was recorded in addition to illlegal cultivars of HT cotton by the cotton growers. The other problems identified were, lack of technological interventions, low productivity due to undulating topography, lack of soil and water conservation measures, leaf reddening & sucking pest problem in cotton, yellow mosaic virus in soybean, virus problem in vegetables , scarcity of water for irrigations, lack of knowledge for drip/sprinkler, more marginal farmers, marketing network for disposals of farm produce, price fixation for agricultural products, summer drinking

water shortage, wide spread unemployment, lack of allied enterprises, stray animals (Nilgai, wild pig etc.). In addition, some cluster villages adopted are situated under forest area with major population belongs to tribal families of resource poor category. They are not in a position to adopt new technological interventions unless it is supported by the line department. Again, they mostly have to depend on rainfall, on many occasions. Due to erratic distribution of monsoon rains their kharif crop suffers from deficit moisture during the crop growing period.

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 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
- Awareness cum skill development on subsidiary income generating activities- dairy, horticulture, poultry etc.
- Soil Health Card and its use to rationalise fertilizer application.

The various teams organised interactive meet with farmers at MGMG villages to discuss issues farmers are facing on regular basis. The farmers and scientists interacted on various issues related to insect pest management of agricultural, horticultural crops and animal husbandry issues. A training and demonstration was given to the farmers for the collection of soil samples from the field with due precautions. The farmers also been advised to protect the crops from wild animals by fencing with iron wires and old colourful sarees or strips.

Soil health awareness training and distribution of soil health cards

ICAR- Central Institute for Cotton Research (CICR) Nagpur organised one day workshop at Muradpur, Umred tahsil in Nagpur District on 17 August 2017 for the tribal farmers of Umred-Bela Cluster under Mera Gaon Mera Gaurav (MGMG) programme. On the occasion, training was imparted to the farmers on importance of soil testing, analysis and soil health card . The team of scientists comprising of Dr. S.M. Wasnik Principal Scientist, Extension and Nodal Officer, MGMG, CICR Nagpur; Dr. S.B. Nandeshwar, Principal Scientist (Biotechnology), Dr. A. Manikandan Scientist (Soil Science), Mr. T. Prabhulinga Scientist (Entomology), Dr. U.V. Galkate, SMS (Veterinary Science) & Dr. S. S. Patil, SMS (Extension), KVK CICR Nagpur participated in the programme. The lectures on the importance of the soil health card in maintaining soil fertility, the animal husbandry enterprise for income generation, technical guidance on how to prepare farmyard manure (FYM) by different methods and its appropriate use in rainfed areas. Sixty Six Geo-referenced soil samples were collected during April 2017 from seven villages; namely Muradpur, Suraburdi, Chargaon, Khapri, Nissanghat, Bendoli, Bothali of Umred Taluka. The soil health cards were prepared on twelve soil parameters and distributed to the farmers on the occasion.

Activities undertaken under MGMG

Date	Village cluster	District	Programme conducted (Participants)
18.04.2017	--	Coimbatore	Advisory on integrated crop management
29.06.2017	Navegaon	Nagpur	Distribution of cotton hybrid (H-8) and cluster bean seeds to the tribal farmers
11.08.2017	Kalmeshwar	Nagpur	Campaign on the awareness among the farmers about informal and indiscriminate use of herbicide tolerant cotton.
05.08.2017	Girad	Wardha	Farmers' meet for guidance on Animal Husbandry and discussion on Soil Health Cards
12.10.2017	Umred	Nagpur	Farmers meet and distribution of leaflets for the pink boll worm management
30.10.17	Kanjappalli block	Annur Taluk, Coimbatore district	Symptoms of Tobacco streak virus (TSV) in *G. hirsutum* was observed in farmer's field at Kanjapalli village and management options were suggested to control the problem
23.11.17	Kanjappalli block	Annur Taluk, Coimbatore district	Sucking pest management
11.12.17	Parseoni	Nagpur	To distribute Cotton Picking bags through TSP-NSP funds

Table 1: Updated lists of Scientists involved cluster wise

Team	Name of scientists with discipline	Name of village	Name of block	Name of district
1	2	3	4	5
Nodal Officer: Dr S. M. Wasnik, Principal Scientist, Extension				
Team 1	Dr. Nandini Gokte Narkhedkar (Nematology) Dr. Shailesh Gawande (Pathology) Dr. Saravanan (Breeder) Dr. Joy Das (Biotechnology)	Arvi Jogingumpha Shivanphal Faridpur Mohgaon	Samudrapur	Wardha
Team 2	Dr. S.B. Nandeshwar (Genetics & Cytogenetics) Dr. Vinita Gotmare (Genetics & Cytogenetics) Dr. Manikandan, (Soil Science) Dr. Prabhulinga T. (Entomology) Dr Chandrashekar N (Biotechnology)	(Murathpur) Nissanghat Khapri Suraburdi Kawdapur	Umred - Sarandi	Nagpur
Team 3	Dr. R. B. Singandhupe Agronomy Dr. P.R. Vijaykumari (Seed Technology) Dr T. R. Loknathan (Plant Breeding) Dr. K. P. Raghvendra (Biotechnology) Dr. Vivek Shah (Entomology)	Narhar Kolitmara Nehara Banera Dhawalpur	Parseoni	Nagpur
Team 4	Dr. Suman Bala Singh (Plant Breeding) Dr. Dipak Nagrale (Plant Pathology) Dr HB Santosh (Plant Breeding) Dr Rakesh Kumar (Biotechnology) Dr Savitha Santosh (Agril. Microbiology)	Junewani Nanda Khurd Ukhadi Salaimanda Mangli	Hingna	Nagpur
Team 5	Dr. Punit Mohan (Economic Botany) Dr. G. Balasubramani (Biotechnology) Dr. J. H. Meshram (Plant Physiology)	Ganeshpur Digras Zadgaon	Ganeshpur	Wardha

Team	Name of scientists with discipline	Name of village	Name of block	Name of district
1	2	3	4	5
	Dr A. R. Reddy (Agril. Economics) Mr. Madhu TN (Entomology)	Belgaon Borgaon(Sawali)		
Team 6	Dr. S. M. Palve (Plant Breeding) Dr. M.V. Venugopalan (Agronomy) Dr. V. Shanthy (Seed Technology) Dr. V.S. Nagrare (Entomology)	Nagapur Karanji(Bhoge) Madani (Dindoda) Karanji(Kanji)	Nandura	Wardha
Team 7	Dr. A.R. Raju (Agronomy) Dr. J. Amudha (Biotechnology) Er. G. Majumdar (Agril. Engg) Dr. Anuradha Narala (Agril. Economics) Dr Babasaheb Fund (Entomology)	Sonegaon Pohi Ladai Linga Uparwahi	Kalmeshwar	Nagpur
Team 8	Dr. D.V. Patil (Plant Breeding) Dr. V. Chinna Babu Naik (Entomology) Dr. Pooja Verma (Plant Biochemistry) Dr Vanita Salunkhe (Plant Pathology)	Navegaon (Sadhu) Thana Karhandla Sev Tirkhura	Navegaon, Umred	Nagpur
Team 9	Dr Ramkrushna GI (Agronomy) Mr. Neelkanth Hiremani (Plant Pathology) Dr Rachana Pande (Entomology) Dr. Sunil S. Mahajan (Seed Technology) Dr K. Velmourougane (Agril. Microbiology)	Tumdi Sukali Navarmari Lodhi panjri Mangrul	Dongargaon Nagpur	Nagpur
CICR, Coimbatore				
Team 10	Dr. N. Gopalakrishnan, (Plant Biochemistry) Dr. Isabella Agarwal (Agril. Economics) Dr. K.P.M. Damayanthi (Plant Breeding) Dr. K.Sankaranarayanan (Agronomy)	Vadapudhur, Kallapuram (Kuthirampalayam) Singaiyanpudur Solavampaslayam Sikalampalayam	Eluru(post) Eluru(post) Kinathukadavu (post) Kinathukadavu (post) Sokkanur Panchayat	Coimbatore
Team 11	Dr. K. Rathinavel (Seed Technology) Dr. M. Amutha (Entomology) Dr. C.Karpagam, (Extension) Dr. M. Sabesh, (Ag Statistics/computer)	Sokkanur Muthugoundanpudur Palapathy Veerappagoundanur Rangayagoundanputhur	Sokkanur Panchayat	Coimbatore
Team 12	Dr. P. Nalayini (Agronomy) Dr. S. Manickam, (Plant Breeding) Dr. D. Kanjana (Soil Science) Dr. J. Gulsarbanu (Nematology)	Kanjapalli Dhasarpalayam Oothupalayam Kumaragounderpudur Neelagoundarpudur	Kanjapalli Panchayat	Coimbatore
Team 13	Dr. B. Dharajothi (Entomology) Dr.R.Raja, (Agronomy) Dr. S. Usha Rani, (Extension) Dr. Manivannan (Plant Breeding) Dr Annie Sheeba, (Plant Physiology)	Konarpalayam Ruthirampalayam Mathireddypalayam Ammachettipudhur (Pasur block) Allapalayam	Allapalayam Panchayat	Coimbatore

Team	Name of scientists with discipline	Name of village	Name of block	Name of district
1	2	3	4	5
CICR, Sirsa				
Team 14	Dr. O.P.Tuteja (Plant Breeding) Dr. R.A.Meena (Seed Technology) Dr. S.K.Verma (Plant Breeding) Dr. Rishi Kumar (Entomology) Dr. S.K.Sain (Plant Pathology)	Jhonpra Alika Nezadela Kalan Rangari Khera Begu	Jhopra Alika Nezadela Kalan Sirsa Begu	Sirsa

Table - 2 : Activities organised under MGMG 2017-2018

S. No.	Name of activity	CICR - Nagpur		CICR - Coimbatore		CICR - Sirsa		Grand Total	
		No. of activities conducted	No. of farmers participated / benefitted	No. of activities conducted	No. of farmers participated / benefitted	No. of activities conducted	No. of farmers participated / benefitted	No. of activities conducted	No. of farmers participated / benefitted
1	Visit to village by teams	78	1232	22	435	10	203	110	1870
2	Interface meeting/ *Gosthies*/ training	71	3145	30	485	13	243	114	3873
3	Demonstrations conducted	251	589	0	0	0	0	251	589
4	Mobile based advisories (No.)	625	1138	5	40	0	0	630	1178
5	Literature support provided	45	1694	8	300	5	504	58	2498
6	General Awareness created	69	2196	11	365	3	292	83	2853
7	Facilitation for new varieties, seeds, technology (ha)	230	344	76	124	15	8	321	476
	Grand Total	**1369**	**10338**	**152**	**1749**	**46**	**1250**	**1567**	**13337**

Table 3: Field Days/Farmers Training/workshop (2017-18)

S No.	Name of village/ cluster	Scientists participated	Farmers workshop / Training / Field visits	Date	No of farmers
1	Umred Cluster, Nagpur	7	Farmers Training on soil sample	8.3. 2018	200
2	Umred Cluster, Nagpur	5	Farmers training & seed distribution	23.6.18	50
3	Umred Cluster, Nagpur	5	Field visits of scientist in their cluster to provide advice to farmers on specific issues of the concern	7.7.2017 17.8.2017 29.9.2017 18.10.2017	200

S No.	Name of village/ cluster	Scientists participated	Farmers workshop / Training / Field visits	Date	No of farmers
4	Navegaon Cluster, Umred Nagpur	7	Soil health cards distributed	17.08.17	50
5	Navegaon cluster Umred Taluk, Nagpur Dist	3	Training on the awareness and protection of crops from wild animals by fencing with old sarees	16.06.2017	20
6	Navegaon cluster Umred Taluk Nagpur Dist	3	Training on the awareness among the farmers about indiscriminate use of pesticides.	28.06.2017	22
7	Navegaon cluster Umred Taluk Nagpur Dist	2	Training on the awareness among the farmers about unauthorized use of herbicide tolerant cotton seeds	19.07.2017	23
8	Allapalayam cluster Panchayat, Annur Block, Coimbatore TN	5	Field visits of scientist in their respective cluster to provide advice to farmers on specific issues of the concern	26.4.2017 12.5.2017 29.6.2017 22.7.2017 17.8.2017 1.9.2017 28.10.2017 10.11.2017 5.12.2017	450
9	Kanjappalli cluster Annur Block, Coimbatore TN	5	Field visits of scientist in their respective cluster to provide advice to farmers on specific issues of the concern	-	192
10	Alika, Sirsa District, Haryana	1	Field visits of scientist in their respective cluster to provide advice to farmers on specific issues of the concern	04-08-17	50

6. AWARDS AND RECOGNITIONS

Awards

Nagpur

Dr. K. Velmourougane, Scientist, Crop Production Division, ICAR-CICR, Nagpur received IARI merit medal from Honourable President of India for his outstanding academic performance in Ph.D. programme during 56th Convocation (9th Feb 2018) of IARI, New Delhi. For his doctoral programme, he worked on the research area "Interspecific cooperation among microbial partners in biofilm development and rhizosphere colonization" under the guidance of Dr. Radha Prasanna, Principal Scientist, Division of Microbiology, IARI, New Delhi.

Dr. T. Madhu was awarded **"Best oral presentation award"** at International Conferences on "Recent trends in Agriculture, Biotechnology and Food processing", College of Agriculture, 5-7 July 2017, Hassan, Karnataka.

Coimbatore

CICR Regional Station, Coimbatore bagged "Best stall award" in the Farmers' Day organised by TNAU, Coimbatore during 9-10, February 2018.

Dr. B. Dhara Jothi was recognized as a mentor by SERB, to guide a student for NPDF for a project proposal entitled "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", for the candidate to undergo the course (2018-2020) at CICR, RS, Coimbatore.


Tamil Nadu Agricultural University
Directorate of Extension Education
Coimbatore - 641 003

Farmers' Day
(February 9 & 10, 2018)

Certificate

This is to certify that CENTRAL INSTITUTE OF COTTON RESEARCH, COIMBATORE has been awarded as the Best Stall in the Farmers' Day held at Tamil Nadu Agricultural University, Coimbatore during February 9 & 10, 2018.

Director of Extension Education

Vice Chancellor

Dr. J Gulsar Banu acted as mentor for one National Post Doctoral Fellow (N-PDF) funded by DST-SERB on project entitled "Potential application of wax degrading microorganisms as an effective bio-pesticide formulation for the control of Mealybugs on cotton (*Gossypium* spp.)".

Sirsa

Award of Appreciation

SK Sain has been presented with award of appreciation Cotton Development Organization and National Agriculture Research Organization, Uganda for providing the training on Biopesticide Laboratory Operation and Research and the assistance in establishment and operationalization of the laboratory and associate equipment (22-28 August 2017)

Best Poster Paper Award

Rishi Kumar, Monga, D. Naveen Rao and Sain, S.K. bagged best paper award for their research paper entitled "Within Plant Distribution of Whitefly in Cotton and its Implication on Management Strategies" INDO-US symposium-2017 on Curbing Whitefly-Plant Virus Pandemics: The Departure from Pesticides to Genomics Solutions " December 4-6, 2017 at PAU Ludhiana

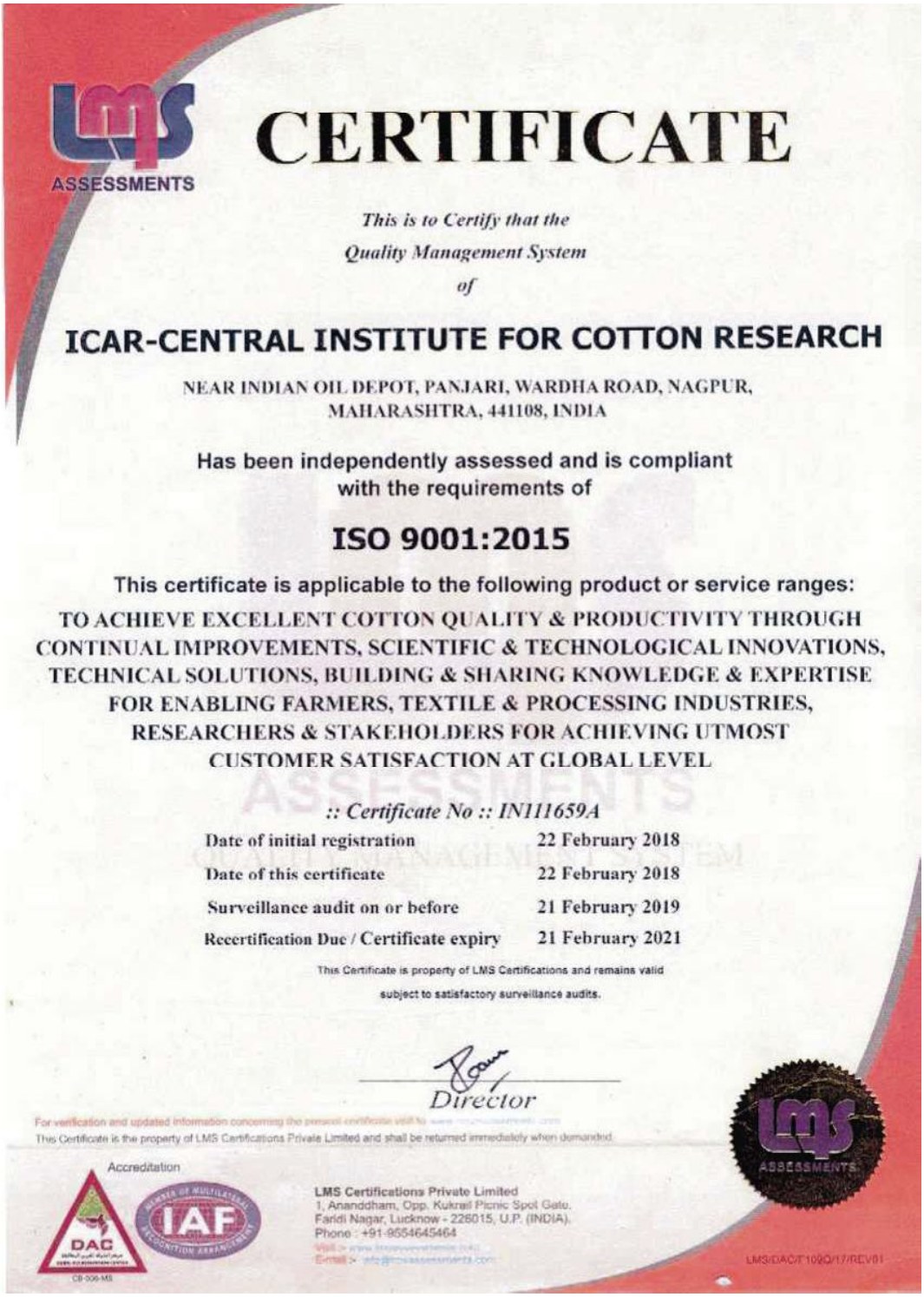
Best Oral Paper Award

Sain SK and Monga D. awarded with best oral paper

award for a research paper entitled "Resilience and relative virulence of entomopathogenic fungi against *Bemisia tabaci* with IPM components in cotton" in an International Congress on Cotton and other Fibre Crops." at ICAR Research complex for NEH Region, Umiam, Shillong (Meghalaya). February 20-23, 2018

Recognitions

ICAR-CICR was formally awarded the ISO 9001:2015 certificate on 22nd February, 2018. The certification was based on an independent assessment by LMC Certification Pvt. Ltd., Lucknow. The certificate would remain valid till 21 February, 2021.



LMS ASSESSMENTS

CERTIFICATE

This is to Certify that the
Quality Management System
of

ICAR-CENTRAL INSTITUTE FOR COTTON RESEARCH

NEAR INDIAN OIL DEPOT, PANJARI, WARDHA ROAD, NAGPUR, MAHARASHTRA, 441108, INDIA

Has been independently assessed and is compliant with the requirements of

ISO 9001:2015

This certificate is applicable to the following product or service ranges:

TO ACHIEVE EXCELLENT COTTON QUALITY & PRODUCTIVITY THROUGH CONTINUAL IMPROVEMENTS, SCIENTIFIC & TECHNOLOGICAL INNOVATIONS, TECHNICAL SOLUTIONS, BUILDING & SHARING KNOWLEDGE & EXPERTISE FOR ENABLING FARMERS, TEXTILE & PROCESSING INDUSTRIES, RESEARCHERS & STAKEHOLDERS FOR ACHIEVING UTMOST CUSTOMER SATISFACTION AT GLOBAL LEVEL

:: Certificate No :: IN111659A

Date of initial registration	22 February 2018
Date of this certificate	22 February 2018
Surveillance audit on or before	21 February 2019
Recertification Due / Certificate expiry	21 February 2021

This Certificate is property of LMS Certifications and remains valid subject to satisfactory surveillance audits.

Director

This Certificate is the property of LMS Certifications Private Limited and shall be returned immediately when demanded.

Accreditation

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Phone : +91-9554645464

LMS/DAC/T109Q/17/REV01

7. LINKAGES AND COLLABORATIONS

Linkages

Areas of Linkages	Institution
NATIONAL	
Fibre testing, fibre quality evaluation and nanotechnology	CIRCOT, Mumbai
Multi-location testing of promising cultures, Bt cotton evaluation	AICRP on Cotton (21 centers) State Agricultural Universities of 11 cotton growing states
Germplasm collection, maintenance and plant quarantine clearance	NBPGR, New Delhi
Seed technological research and breeder seed production	NSP, New Delhi, ICAR-IISR, Mau
Cotton Genomics	NBRI-Lucknow, TNAU-Coimbatore, UAS-Dharwad
Technology for pink bollworm resistance monitoring and management	SAU's and State Department of Agriculture of all cotton growing states, KVKs, NCIPM, etc.
Crop pest surveillance and advisory for cotton pests in Maharashtra	Agriculture Department, Government of Maharashtra, Dr. PDKV-Akola, VNMAU-Parbhani, MPKV-Rahuri
Cotton mechanization	Precision tooling, Nagpur, ICAR-CIAE-Bhopal, GTC-CIRCOT, Nagpur
Vision-based expert system for picking of cotton	IIIT & M, Gwalior; Jamia Milia Islamia University, Delhi; CMERI-CoEFM, Ludhiana
HDPS and sustainable pest management strategies	Better Cotton Initiative
National Carbon Project	NRSC, (IFFCO), Hyderabad
Participatory Nutrient Management under cotton + pigeonpea intercropping system	IFFCO
Seed production programme of other crops under Mega Seed Project (MSP)	Maharashtra State Seed Corporation and Haryana State Seed Corporation
Research guidance to the Students	RTMU, Nagpur, Dr. PDKV, Akola, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (SHUATS), UP
Transgenic : New events	Delhi University, Delhi, TNAU-Coimbatore, UAS-Dharwad, NRCPB- New Delhi
Bio-Agents, Insect biodiversity	ICAR-NBAIR,Bangalore
Micro-Organism biodiversity	ICAR-NBAIM-Mau
INTERNATIONAL	
Organisation of ACRDN-7 meeting	ICAC, Washington DC
Establishment of bio-pesticide laboratory	NASSARI, Uganda

8. AICRP ON COTTON

Notification of Cotton varieties and hybrids

Fourteen cotton varieties/hybrids have been notified for various agro-climatic zones

Name	Species	Average yield (q/ha)	State/Zone
DHB 915	H x B	17.00	Karnataka
MRC 7377	H x H	20.07	South Zone
CSH 3129	G. hirsutum	23.00	North Zone
CSH 3075	G. hirsutum	24.67	North Zone
LD 949	G. arboreum	24.79	North Zone
RHH 0917 (Phule Asmita)	H X H	25.09	Central Zone
GAM 162	G. arboreum	15.14	Central Zone
RHB 0812 (Phule Prabha)	H X B	24.71	Central & South Zone
Central Cotton NHH 250	H x H	14.00	Central Zone
MR 68	G. hirsutum	22.65	North Zone
DHB 1071	H x B	17.00	Karnataka
GN Cot Hy 14 (GSHH 2729)	H x H	25.52	Gujarat
K 12	G. arboreum	11.93	Tamil Nadu
GJ COT 111 (GAM 162)	G. arboreum	15.14	Central Zone

Bt Varieties released (*G. hirsutum*):

Eight Bt varieties with deregulated event MON 513 were approved for cultivation during 2017.

Varieties/ Hybrids	Average Yield (kg/ha)	Area of adaptability
CICR Bt-6 (RS 2013)	2234	Irrigated Conditions of North Zone States of Haryana & Punjab under HDPS
ICAR-CICR GJHV 374 Bt	2525	Maharashtra
ICAR-CICR PKV 081 Bt	2476	Maharashtra
ICAR-CICR Rajat Bt	2283	Maharashtra & South Rajasthan
ICAR-CICR Suraj Bt	2149	Maharashtra, Gujarat, Madhya Pradesh
ICAR-CICR Bt 9	2934	Maharashtra
ICAR-CICR Bt 14 (CPT 2)	2699	Maharashtra
PAU Bt 1	2752	Punjab & Rajasthan

Breeder Seed Production

The Breeder seed production, as per the indent of Department of Agriculture, Cooperation and Farmers Welfare for the year 2017-18, was taken up at different centres of AICRP on Cotton and at ICAR-CICR, Regional Station, Coimbatore. The breeder seed production was 115.64 quintals as against indent of 79 quintals.

Front Line Demonstrations (FLD) under NFSM-Commercial Crops

During the year 2017-18, under NFSM - Commercial Crops, a total of 448 Front Line Demonstrations on Integrated Crop Management on cotton, 170 Front Line Demonstrations on Desi / ELS cotton / ELS cotton seed production and 138 Front Line Demonstrations on intercropping with cotton were conducted by fifteen centers with a budget outlay of 54.62 lakh rupees.

Significant Research Findings

Crop Improvement

- Under irrigated conditions, the genotypes viz., PBH 116, Phule Yamuna, and PBH 116 were the best for yield, whereas for fibre quality, TCH 1828, SHJ 23 and RAH 0603, were the best under normal spacing. Similarly, in rainfed situation, CPD 1751 and GSHV 191 were the best for yield and CPD-1751 showed promise for bundle strength.
- The compact genotypes- PBH 115, RHC HD 1420 and CSH 1613 were the best for yield in irrigated situation and RAHC 1039 was showing promise for fibre quality under closer spacing. In rainfed conditions, ARBC 1651 and DSC 1651 were the best for seed cotton yield.
- ELS *G. barbadense* cultures like DB-1701 and CCB 143B were promising for yield. ELS interspecific hybrid RHB 1002 was the best in both Central and south Zone.
- In North Zone, the *G. hirsutum* genotype F 2462 showed promise for yield (2663 kg/ha) under normal spacing while RS 2814 (2869 kg/ha) was promising in closer spacing trial.
- In Central Zone, RHC 1217 (yield of 2319 kg/ha) was the best in preliminary variety trial and GSHV172 (yield of 2251 kg/ha) was the best in coordinated variety trial under irrigated conditions with normal spacing. Under rainfed conditions, CPD 1652 an d ARBH 1551 were the top yielders. For closer spacing, ARBC-1601 (yield of 1931 kg/ha) was the best in central zone in irrigated situation and GISV 272 (yield of 1704 kg/ha) was the best in rainfed condition.
- In Central zone, ELS *G. barbadense* cultures like DB 1602 and ARBB 1502 were the best yielders. Similarly, ELS interspecific hybrid RHB 1008 was the best in central zone for yield.
- Among desi varieties, CNA 1031 was the best for yield and PAIG 373 was the best for quality. Desi hybrid BDAA 011 was showing promise in central zone under rainfed condition.
- In South zone, under irrigated condition, HS 298 (yield of 2024 kg/ha) and BGDS 1033 (yield of 1887 kg/ha) were promising hirsutum cultures in different trial under normal spacing and LHDP 1 (yield of 1571 kg/ha) was the best under closer spacing. In rainfed conditions, CPD 1652 (yield of 1080 kg/ha) and ARBH 1551 (yield of 1357 kg/ha) were promising for yield in normal spacing and ARBC 1651 (yield of 1133 kg/ha) was promising in closer spacing.
- Among ELS cultures, RHcb 1014 was promising for yield and interspecific hybrid ARBHB1602 was promising for yield.
- Among desi cultures, JLA 110 was showing promise for yield and PA 812 and PA 808 were promising for fibre quality.
- The naturally coloured cotton genotypes were evaluated in AICRP for the first time belonging to both hirsutum and arboreum. The culture 16301 DB was promising for yield in hirsutum and DDCC1 was promising in arboreum.

Crop Production

- Agronomic requirements of HS294 in North Zone; GJHV497, SCS 1061, ARBB 1401, RHB 1122 and PA 785 in Central Zone; GSHV 177,CCH 14-1, DHB 1009, RHB 1122 and AKA 2008-7 in South Zone were worked out.
- Nutrient and geometry requirements were worked out for RS2727, GTHV 13/32, GISV 272, RAHC 1011, ANGC 1451, ANGC 1452, GTHV 13/32 and RAHC 1012 under High Density Planting System (HDPS).
- Research on reducing nitrogen dose and enhancing of nitrogen use efficiency in Bt cotton were workout at Faridkot, Bathinda, Junagarh and LAM. There are possibilities of reducing 25 % N for Bt cotton by making Spot application in four splits of 75 %RDF + Foliar application of 1% urea at three times. In Hisar, Rahuri, Khandwa, Banswara, Raichur and Dharwad, it is reported that there is saving of 25 % of N by applying 75 % of RDN in spot application of four splits and raising of Sun hemp between rows incorporated before flowering.
- 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 Sunhemp/fodder cowpea between rows registered significantly higher seed cotton yield at Akola (1543 kg/ha) , Banswara (2279

kg/ha), Bhawanipatna (1434 kg/ha), Rahuri (1406 kg/ha), Dharwad (2010 kg/ha), Coimbatore (1067 kg/ha) and Srivilliputtur (1701 kg/ha).

- Labour saving package including land shaping by machine, pre and post emergence application of weed control, intercultural operation by animal and boom / other sprayer for spraying registered the least labour requirement of 26.7, 113.2, 86, 70, 115 and 70 respectively at Bhawanipatna, Nanded, Kanpur, Akola, LAM and Nandyal respectively, which was 34.7, 27.9, 40.3, 19.5, 50.4 and 48.9 per cent less for one hectare of cotton cultivation as compared to control.
- Canopy management in HDPS cotton cultivation using growth retardant found that mepiquat chloride application @ 20 g a.i. / ha. at 60 and 75 DAS reduced sympodial length by 28.3, 22.2 and 16.2 per cent respectively at Faridkot, Bathinda and Hisar.
- Spraying of human hair product could not offer any significant impact on seed cotton yield at Faridkot, Bathinda, Sriganganagar, Bhawanipatna, Coimbatore and LAM, Guntur. However, spraying @ 9 ml/l of human hair product at two times on 65-70 and 80-90 DAS showed increased seed cotton yield at Khandwa and Banswara.
- Significantly higher seed cotton yield was recorded with Super absorbent application @ 18 kg/ha than control at Akola (1504 kg/ha), Nanded (2033 kg/ha) and Khandwa (1104 kg/ha).
- The Genotypes viz., CPD 1602, GSHV 520, GSHV-523, PH- 071, SIMA-5 and TCH-327 at Guntur, CPD-1652, Sahana, CPD-1651, GJHV-523, RAH-1071, L-1060, CNH-7012 and NDLH-2027 at Dharwad were identified for drought tolerance. The genotypes, H 1489, H 1524 and H 1506 were known for drought tolerance at Hisar. Chlorophyll stability index was found significantly high in CPD-1702, RHC-1346 and GSHV-199 at Surat. Genotypes TCH-1199 at Khandwa was known for drought tolerance.
- The genotypes viz., PA 255, PA 528, L 1060, GSHV 497 and LHDP 2 identified as saline tolerant at Guntur. High K/Na ratio was found with ARBB-1401 and GJHV-497 at Surat. H 1518 and H 1523 were screened for salinity tolerance at Hisar.
- The management of climate change was attempted by using genetic variability associated with cotton. The results found that *arboreum* genotypes recorded significantly higher yield at different environments than *hirsutum* and Bt cotton hybrid at Guntur (Phule Dhanwanthari), Surat (G.Cot-15 and G.Cot-19), Hisar (HD432) and LAM (AKA 2004, AKA 7 & Srinandi). At Dharwad, *hirsutum* genotypes (Sahana and ARBH-813) showed least reduction in yield under less suitable environment.

Entomology

- Pest dynamics was recorded in all the three zones under experimental field conditions. In north zone leafhopper was above ETL during 25th to 32nd SW in all centres, except in Sriganganagar. Whitefly and Thrips were above ETL during few standard weeks in all the centres. Boll worm infestation was negligible and adult moth catches of all the boll worms in pheromone traps were recorded in north zone centres.
- In central zone, among the sucking pests, leaf hopper was the major pest which was observed above ETL and occurred throughout the cropping season in Surat. Infestation of whitefly was above ETL in Nanded and Banswara for a short period during the crop season. Thrips were below ETL, however in Nanded, Rahuri and Surat the population crossed ETL during mid-August to mid-September. Activity of natural enemies namely Spiders, *Chrysopa*, *Chryptolaemus*, Syrphids and Coccinellids were observed at all centres. Among the bollworms, pink bollworm *Pectinophora gossypiella* was the prominent pest in all the centres except Banswara and Bhawanipatna. The pest was recorded on *Bt* hybrids in Akola, Nanded, and Junagadh. Adult moth catches of all the bollworms were observed.
- In south zone, leaf hopper was the major sucking pest in all the centres, infestation of whitefly and Thrips was below ETL. However, in Dharwad Thrips crossed ETL during mid-August to mid-October. Mirid bug infestation was noticed at moderate level at Dharwad and Chamarajanagar. Peak infestation of flower bud maggot was observed during November only in Dharwad. Among the bollworms, *P. gossypiellla* was the prominent pest and it occurred in DCH 32, in Andhra Pradesh and Karnataka, which remained below ETL in Tamil Nadu. Pheromone trap catches of adult boll worms was also recorded.

- New formulation Pyrifluquinazone (RIL – 125/F (20%WG) @ 75 and 100 g a.i /ha) tested against sucking pests in north and central zones were comparable in terms of efficacy with the standard insecticides. Population reduction of natural enemies was recorded in the chemical treatments when compared to biopesticides and control.
- New combination insecticide molecules *viz.*, Spinetoram + Sulfaxaflor 40% WG @120 and 140 g a.i., / ha and Pyriproxyfen 5% EC + Fenpropathrin 15% EC@ 37.5 +112.5 g a.i., / ha and its individual molecules were effective in reducing the sucking pest population in all the three zones.
- Among the different pheromone traps evaluated, higher number of moth catches with lower larval infestation and locule damage with maximum good opened bolls were recorded in Phero-sensor TM-SP and TM-BB sleeve traps at densities 20 and 8 followed by PCI delta traps with replacement of sticky liner (season long).
- Percentage reduction of whitefly population in the whitefly adult suction trap operated plots was comparable with the insecticide treated plots.
- Phero-sensor TM-SP Sleeve trap performed better in reduction of larval population of pink bollworm, damage to green boll and locule and yielded higher compared to PCI-Delta Trap fitted with Pectino-lure SL in all the centres.
- Infestation of pink bollworm, boll and locule damage were significantly low in insecticides treated plots which was on par with *Trichogramma bactrae* released plots.

Plant Pathology

- Cotton leaf curl virus in north zone, *Alternaria* leaf blight, bacterial blight and tobacco streak virus in central zone and *Alternaria leaf blight*, bacterial blight, grey mildew and rust in south zone were the major diseases reported during 2017-18 crop season.
- The maximum leaf curl disease was noted in Punjab followed by Rajasthan and Haryana during the 2017 season. In Punjab, maximum CLCuD was noted in Fazilka district followed by Muktsar and Faridkot. The Minimum PDI was observed in Bhatinda district. In Rajasthan, Sriganganagar district showed maximum CLCuD followed by Hanumangarh. In Haryana the maximum CLCuD was recorded in Fatehabad followed by Sirsa and Hisar.
- The occurrence of Tobacco streak virus (TSV) was observed from second fortnight of July on most of the Bt cotton hybrids sown on farmers fields in Rahuri, Maharashtra up to a maximum incidence of 23 per cent. Tobacco Streak Virus disease incidence was very low in Andhra Pradesh (< 1% only). The incidence of TSV was found in Tamil Nadu only in TNAU Coimbatore (5-10%).
- In trials on IDM, Module 6 (ST - PF CICR @ 10 g/ kg of seed + Soil Application of *Trichoderma viride* @ 2.5 kg/ ha *Trichoderma viride* (TNAU1) in 250 kg of Compostor FYM and foliar spray with Kresoxim methyl @ 1 ml/ litre followed by Captan +Hexaconazole @ 1.5 g/ litre for fungal diseases or COC (0.3 %) + Streptocycline(0.01 %) for BLB) showed lowest incidence of Bacterial blight, *Alternaria*, Greymildew and Wilt with higher seed cotton yield at Nanded. At Surat also this module showed the best results against Bacterial blight and ALB.
- Pooled results of five sprays of different interventions showed lowest CLCuD PDI in Cow urine + Calcium nitrate treatment followed by Cow urine, Buttermilk and Neem oil treatments at Hisar, Sirsa, Bhatinda, Faridkot and Sriganganagar. Highest seed cotton yield was observed in treatment Cow urine + Calcium nitrate followed by Calcium Nitrate, Digitalis and Buttermilk treatments.
- Two sprays of Copper oxychloride 50WP @ 2.5g/L & Mancozeb 50WP @ 2.0g/L in poly house experiment of sooty mould control at Sirsa, showed maximum reduction of sooty mould followed by Copper oxychloride 50WP @ 1.25g/L & Propiconazole 25EC @ 1ml/L. In field trial at Hisar, Faridkot and Coimbatore, the maximum reduction was observed at Copper oxychloride 50WP @ 2.5g/L followed by Propiconazole 25EC @ 1ml/L & Copper oxychloride 50 WP @ 1.75g/L.
- Pooled data obtained from Hisar, Faridkot and Rajasthan showed that seed cotton yield reduction (Grade wise from 1-6) due to CLCuD in different Bt hybrids varied from 10.97 to 72.46, 7.30 to 69.72, 9.89 to 57.72 and 7.94 to 71.02 percent in Bt hybrids Bioseed 6588 BG II, RCH 650 BG II, Ankur 3028 BG II and MRC 7017 BG II, respectively.

9. KRISHI VIGYAN KENDRA

9.1 Salient achievements

9.1.1 Trainings

9.1.1.1 On campus and Off campus training

Eighty short duration (1 to 3 days) on-campus and off-campus training courses were conducted in different disciplines for practicing farmers, rural youth and extension functionaries. In all 2472 participants including 840 SC/ST participants benefitted from the training programs.

Table 9.1 : Details of training conducted

Sr. No.	Disciplines	No. of Trainings	No. of Total Participants	SC/ST Participants
1	Crop Production	10	471	128
2	Horticulture	08	316	71
3	Plant Protection	15	462	121
4	Veterinary Science	17	533	211
5	Home Science	13	280	123
6	Extension	17	410	186
	Total	**80**	**2472**	**840**

9.1.1.2 Sponsored training programme

Nine sponsored training programmes were organized in the field of Crop Production, Horticulture, Plant Protection, Veterinary Science and Home Science for farmers and extension functionaries, deputed by State Agriculture Department of Maharashtra, ATMA, CIPMC, Nagpur, RCF, MAFSU Nagpur, MCED & ICDS Nagpur, NGOs. In all 512 participants attended these courses.

KVK expert delivering lecture to the farmers in a training program sponsored by GTC, CIRCOT, Nagpur

9.2 : Cluster Front Line Demonstrations on Oilseed and Pulses

9.2.1 Crop enterprises

Three CFLD on oilseed & pulses were conducted on farmer's field at adopted villages of Nagpur district viz. Chargaon, Muradpur, Hiwra, Saleghat and Ambazhari. 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 under Cluster Front Line Demonstration. Data on important production parameters as well as feedback from farmers and visitors were recorded.

KVK expert delivering lecture to the farmers in a training program sponsored by TAO, Kamptee

Table 9.2 : Details of technologies demonstrated under Cluster Front Line Demonstrations (2017-18)

Sr. No	Crop	Technology demonstrated	No. of farmers	Area (ha)	Mean yield (q/ha)		Increase over FP (%)
					FLD	FP	
1	Soybean (MAUS-158)	INM/IPM	50	20	14.72	11.9	23.69
2	Pigeonpea (PKV-TARA)	IPM/INM	50	20	12.30	9.7	26.8
3	Chickpea (Digvijay)	IPM/INM	50	20	17.75	14.65	21.16

FLD on chickpea at village Hiwra, Umred block

FLD on Pigeonpea

FLD on soybean (MAUS-158) at village Hiwra, Umred block

FLD's on Livestock Enterprises

Enterprise	Breed	No. of farmers	No. of animals	Performance parameters / indicators	Data on parameter in relation to technology demonstrated		% change in the parameter
					Demo	Local check	
Disease management	Local goat	10	40	Body weight gain in kg/2 months	4.90	3.67	34.33
				B:C ratio	1.96	1.66	
Nutrition management supplementation of mineral lick block	Local goat	10	40	Body weight gain in kg/1 months	1.95	1.650	18.18
Feed & fodder management- Feeding of bag silage to milking cows @ 6kg/cow/day	Jersey Crossbred cows	10	20	a. Avg. Milk yield (lit/cow/day)	7.77	7.10	9.44
				b. fat %	4.25	3.90	
				c. B:C Ratio	1.53	1.44	
Nutrition management inclusion of by-pass fat in the diet of just calved cows @ 200 g/cow/day x 90 days	Jersey Crossbred cows	10	20	a. Avg. Milk yield (lit/cow/day)	10.87	9.20	18.15
				b. fat %	4.25	3.90	
				c. B:C Ratio	2.10	1.75	

FLD on feeding of bypass fat

FLD on mineral lick blocks

9.2.3 Home Science Enterprises

Enterprise	Name of the technology demonstrated	No. of farmers	No. of units	Data on parameter in relation to technology demonstrated		% change in the parameter
				Demo	Local check	
Nutrition management	Nutrition garden	16	-	Rs. 120 (week/family earning/100 m^2)	Rs. 86 (week/family earning/100 m2)	39
Recycling of agro residue	Cotton pellet as alternative cooking fuel	18	18	2.5g (ash recovered /200g cotton pellet)	6 g (ash recovered /200g coal)	50
Pomegranate sheller	Pomegranate shelling	18	18	3 min	3.89 min	20.67

Demonstration of proper technique of holding pomegranate sheller

9.3. On Farm Trials (OFT)

Assessment of livestock production technologies on farmer's field

S. No	Animal	Technology demonstrated	No. of farmers	No. of animals	Parameters studied	Yield		% Increase over Farmers Practice
						Demo.	Farmers Practice	
1	Cows	Supplementation of pro-biotic (*Saccharomyces cervisiae*) to pre - rumunan cross breed calves	15	30	1. Mean body wt. (kg/month)			
					a) First month	9.36	9.09	93.0
					b) Second month	13.57	12.15	11.69
					c) Third month	17.41	15.36	13.34
					2. Incidenc e of scours (No.)	1	4	300.00 (%decrease)
					3. Starter/feed intake (g/day)	410.20	370.40	10.75
2	Cows	Feeding of urea specific mineral mixture @ 50 g/cow/day	15	30	a) Milk yield (l/cow/day)	9.25	8.75	5.71
					b) Fat content (%)	4.5	4.0	12.5
					c) No of cows conceived	29	23	26.09
					d) BC Ratio	1.69	1.54	-

Assessment of Cotton Pellets : An alternative cooking fuel

Sr. No.	Description N=10	Traditional method	Cooking with Bio-briquette	% saving over traditional method
1	Quantity of raw rice & dal (g) for cooking	250	250	
2	Quantity of coal required (g)	310	260	19
3	Cost of coal (Rs)	8.7	3.9	56
4	Time required for cooking (minute)	29	23	21
5	Ash recovered (%)	06	2.5	58

Food cooked through cotton pallets is cost effective and eco-friendly by 56% & 58% respectively

Assessment of Protein rich diet provided under sabla for reducing protein calorie malnutrition adolescent girls 11-15 yr. (N=20)

Technology demonstrated	Av. Weight (Kg)			Av. Hb		
	Before	After	Change in weight %	Before	After	Change in Hb %
T-1: Local Diet Cereals 553g, pulses 30g, GLV 14g, Other vegetables 51g. Fruits 35g, Milk and Its products 70ml, Fish and Flesh foods 10g, Fats & Oils 9ml, Sugar & Jaggary 19g,	30	32	6.66	11.2	11.9	5
T-2 : Local diet + 50g/day Sattu + 50g green leafy vegetables	30	33	10	11.2	12.2	9.8

9.4. Diagnostics Surveys Conducted

During the period April, 2017 – Mar, 2018, KVK conducted several diagnostic survey to understand the problems faced by the farmers of the district and gave on the spot recommendations for its remedy.

Sr. No.	discipline	Date	Crop	Title	Area Covered (ha)	No. of farmers benefitted
1	Plant protection	14,17,21,30.07.17	Bt-cotton	Sucking pests under ETL	35.0	75
2	Horticulture	09,14,23,31.08.17	Chilli	Dying of seedlings in nursery	10 nursery	42
3	Plant protection	04,15,22,29.08.17	Bt-cotton	Sucking pests incidence	32.0	62
4	Agronomy	07,16,24,31.08.17	Cotton	INM in cotton	15.0	22
5	Vet. science	09,22,31.08.17	Cows	Infertility in cows	47 cows	24
6	Vet. science	06,15,25.09.17	Cows	Low milk yield in cross breed cows	52 cows	35
7	Agronomy	14,27,30.09.17	Cotton	Para wilt in cotton	18.0	32
8	Agronomy	12,19,27.10.17	Cotton	Leaf reddening in cotton	16.0	31
9	Horticulture	12,20,30.10.17	Nagpur mandarin	Pre harvest fruit drop in Nagpur mandarin	24 orchards	38
10	Plant protection	17,25,31.10.17	Redgram	Less incidence of wilting	38.0	52
11	Plant protection	19,25,31.10.17	Bt-cotton	Sucking pests incidence	36.0	63
12	Plant protection	9,18,30.11.17	Redgram	Helicoverpa incidence	41.0	66
13	Plant protection	04,14,22.12.17	Chickpea	Helicoverpa incidence	30.0	48
14	Plant protection	10,20.01.18	Chickpea	Helicoverpa incidence	23.0	45
15	Plant protection	07,14,29.01.18	Nagpur mandarin	Sucking pests incidence, fruit drop	17.0	24
16	Home science	19,23.01.18	Soybean processing	Curdling of Soymilk	-	19
17	Home science	29,30.01.18	Soybean processing	Hardening of Tofu	-	26
18	Home science	13,14.02.18	Fruit processing	Colour maintenance of lemon squash	-	41
19	Vet. science	23.02.18	Goats	Low weight gain in kids	40 kids	27

9.5. Organized Awareness campaign and Kisan Mela

9.5.1 New India Manthan : "Sankalp Se Siddhi" program

Krishi Vigyan Kendra and ICAR-Central Institute for Cotton Research, jointly organized the Central Government-sponsored New India Manthan: "Sankalp Se Siddhi" program on August 26th, 2017. On this occasion, Mr. Krupalji Tumane, Member of Parliament (Ramtek Constituency) and Dr. S.K. Chaudhary, Assistant Director General (Soil and Water Management), ICAR, New Delhi, Dr. Shivaji Sarode, Former Director of Research, PDKV, Akola, Mr. Milind

Sankalp Se Siddhi program

Shende, District Agriculture Officer, Nagpur and Dr. M. S. Ladaniya, Director, CICR (Addl. Charge) and Dr. R. B Singandhupe, PC, KVK, Nagpur were present. The programme began with the oath for "Sankalp Se Siddhi". Dr. Ladaniya in his welcome speech explained the concept and purpose of "Sankalpa Se Siddhi". He also explained the significance of the seven-point program for agriculture development. Mr. Krupalji Tumane in his speech highlighted the irregularities of the rains and the problems faced by the farmers and explained the importance of agro based allied business in agriculture for doubling of famer's income and importance of organic farming. With the help of the Central Government and NABARD, the warehouses and cold storage facilities need to be made available to the farmers. Dr. Shivaji Sarode explained that the initiative of 'Sankalp Se Siddhi' aimed at empowering farmers by giving strength to them. Dr. S. K. Chaudhary elaborated the importance of soil health testing, soil and water conservation and integrated nutrient management for the maximization of farmers income. Mr. Milind Shende SAO Nagpur and Dr. Yogiraj Jumde, Taluka Agriculture Officer, Nagpur informed the farmers about the different state government's welfare schemes, importance of farmers producer's company and water conservation and harvesting. SMS from KVK-CICR, Nagpur explained about various agricultural enterprises being adopted by the farmers of Nagpur and Wardha districts. About 350 farmers along with the officials from State Agriculture Department including ATAMA participated in this event. The program was anchored by Mrs. Sunita Chavan and vote of thanks was proposed by Dr. R. B Sigandhupe.

9.5.2 Mahila Kisan Diwas organized

KVK-CICR, Nagpur celebrated Mahila Kisan Diwas on 15.10.2017 at CICR Training Hall. Around 100 farm women & 30 officials participated. Dr. Blaize Desouza, Director I/c & HOD, Crop Production talked about importance of this programme. Dr. Jayshree Pendarkar, Dietician CIIMS, Hospital, Nagpur was the Chief Guest and Sh. Prafulla Dehankar a successful berries product entrepreneur was present. On the occasion they suggested that as some of the agricultural by –products plays very important role in human diets and feeding of the nutritious and balanced diet to the farm woman may increase the working efficiency of the rural woman who are engaged in various farm activities.

Mahila Kisan Diwas

9.5.3 World Soil Day Organized

Krishi Vigyan Kendra, ICAR-CICR, Nagpur organized "World Soil Day" at Village Brahmanwada, Taluka Nagpur on December 5, 2017. On this occasion Dr. Blaise, Head, Crop Production Division CICR, Nagpur was the Chief Guest. Five hundred soil health cards were distributed to the farmers. Emphasis was given by the officials / dignitaries to maintain soil health in a sustainable manner as the Bt cotton is highly nutrients exhaustive crop. The intercropping with leguminous crops is one of the important technologies, through which areas for better crop yield.

World Soil Day

9.6. Kisan Mela/Kisan Goshti

9.6.1 Krishi Vigyan Kendra, ICAR-CICR, Nagpur organized 'Kisan Mela' at Narhar village, taluka-Parseoni, Dist. Nagpur on 13.03.2018. This programme was organized in collaboration with Mera Gaon Mera Gaurav (MGMG) programme run by ICAR-CICR, Nagpur. In Soneghat, Ambazari and Narhar villages in Parseoni block, fifty cluster front line demonstrations on red gram (variety PKV TARA) on various crop components like INM and IPM was conducted to improve the productivity of this crop in the tribal villages. In this area, cotton is major kharif crop, the crop production technology including insect pest management, plant nutrient management, varieties being grown under highly undulating soil topography with best management practices were also

demonstrated for the farmers benefit.

9.6.2 Krishi Vigyan Kendra, ICAR-CICR, Nagpur organized 52 "Kisan Ghoshti" in adopted villages of Nagpur district. In all 3822 farmers, rural youth and extension functionaries participated. In this programme all the farm activities including the entrepreneurship were focused to the farmers for improving their farm income and liveli hood.

Kisan Mela/Kisan Goshti

Attracting and retaining rural youth in Agriculture (ARYA)

The project has been initiated in the year 2015-16 by DDG Extension, ICAR, New Delhi and the KVK-CICR, Nagpur is one of the centre operating three enterprises for livehood of rural youth.

1) Developments of disease free sampling of pomegranate and Nagpur mandarin.
2) Fruits and vegetable processing.
3) On the spot soil testing.

During the year 2017-18, the KVK trained 42 rural youth for production of disease free seedlings of pomegranate and Nagpur mandarin. Eighty six rural youth of different self help groups for custard apple processing its value addition, preparation of pickels, citrus juice and solar drying of vegetables. Forty rural youth were trained for soil analysis and interpretation of results.

Additionally, KVK gave technical support to rural youth of Katol block for multiplication of Nagpur mandarin seedlings. About 19 rural youth have developed their nursery on Nagpur mandarin and are generating significant income by developing the sampling materials at their own nursery field.

Solar Drying of Vegetables

Value addition of Citrus fruits

Development of Pomegranate Seedlings

Training on Soil Analysis

Other Activities of KVK

Fruits crops at KVK farm

Krishi Vigyan Kendra, ICAR-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

Three thousand seven hundred fifty nine soil samples were collected and analyzed 12 soil nutrients parameters including micronutrients from Ramtek taluka, Nagpur district and Morgaon Arjuni taluka, District Gondia. In total 11932 soil health card distributed to the farmers of the above districts and recommended the management practices based on the nutrient status of their soils. From the analysed soil samples of Ramtek block, it has been observed that about 97.4% of the collected soil samples had pH in the range of 7.01 to 8.3 , 99.9% had EC less than 1.00 dS/m. Regarding major plant nutrients, about 81.6 % soils were very low to low in available nitrogen, 89.3 % soil samples were medium to slightly high in available phosphorus and 96.2% soil samples were high to very high in available potassium out of 3000 soil samples analysed. Regarding soil micro nutrients, the Boron and Iron were deficit and other micro nutrient were medium to high. Similar trends were observed in Morgaon Arjuni block as the cropping pattern is rice followed by vegetables, gram, wheat wherever irrigation facility exists during rabi season. KVK has received Mobile Soil Testing Van under Human Development Program of Nagpur district which is being used effectively for the said purpose as per the man-date.

KVK's soil testing lab has been upgraded for analyzing 9800 soil samples per year by a committee headed by Divisional Joint Director of Agriculture by assessing the facilities and expertise available in KVK's STL.

Advisory Services

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. Through the advisory services 27672 clients in Nagpur district were benefited.

Participation in Exhibitions :

KVK , CICR Nagpur participated in the following events to display various research findings of ICAR-CICR for the benefit of farmers, farm women, students, entrepreneurs, bureaucrats, line department officials during the report period.

Name of event	Location	Date
Agro Expo Exhibition	Kanhan, Nagpur	28.04.2017 to 01.05.2017
Textile India Expo	Gandhinagar (Gujarat)	30.06.2017 to 02.07.2017
Dharmmachakra Pravartan Din	Deekshabhoomi, Nagpur	29.09.2017 to 01.10.2017
Agro-Vision	Reshimbagh, Nagpur	10-13.11.2017
Agro-Tech	Dr. PDKV, Akola	27-29.12.2017

Meetings Attended

KVK , CICR Nagpur represented in the following meetings/workshop/seminars/conferences

Name of the officials	Name of event	Location	Date
Meetings			
Dr. R. B. Singandhupe	National Food Security Mission	Mantralaya Mumbai	17.3.2018
	Meeting with Hon'ble Agriculture Minister Sh. Radhamohan Singh	Ravi Bhavan, Nagpur	4.6.2018
	International Conference on "Nature Fibre"	Gandhinagar (Gujarat)	2-3. 07. 2017
	National Water Mission	CGO Complex, New Delhi	10.8.2017
	Training on Cluster Front line Demonstration on Pulses and Oilseed crops	KVK Solapur (Maharashtra)	16.1.2018
Smt. Sunita Chauhan	ATMA Governing Body meeting	Nagpur	21.11.2017
	Quarterly meeting of All India Radio	AIR, Nagpur	27.02.2018
Workshop/Conference/Training			
Programme Coordinator, all SMS and Programme Assistant	Action Plan Workshop	Dr. PDKV, Akola	19-20.04.2017
Dr. R. B. Singandhupe	Annual Zonal workshop	YCMOU Nashik	23-25.07.2017
	Workshop on "State –wise Coordination Committee meeting for doubling farm income by 2022	College of Agriculture Pune, NRC Grape, Pune & CCRI, Nagpur	03.04.2017, 27.04.2017 & 23.11.2017
	ARYA workshop	Gujarat Agricultural University, Navsari	31.01.2018
	Workshop on CFLD Oilseed & Pulses	KVK Solapur	16-17.01.2018
Dr. S. S. Patil	ZREAC Rabi Workshop	Yeotmal	12.10.2017
Smt. Sunita Chauhan	Workshop on "Capacity Building	KVK Jalna	27-29.11.2017
	Action plan workshop	KVK Akola	12.04.2017
Guest Speaker			
Dr. R. B. Singandhupe	Water Management and Mulching in Cotton	GTC CIRCOT, Nagpur	19.07.2017, 04.08.2017, 07.09.2017, 21.09.2017, 05.10.2017
Dr. S. S. Patil	Integrated pest management in cotton	GTC CIRCOT, Nagpur	21.09.2017, 05.10.2017
Dr. U. V. Galkate	Best Method for Cottonseed Feeding to Livestock	GTC CIRCOT, Nagpur	19.07.2017, 04.08.2017, 07.09.2017, 20.09.2017, 04.10.2017
	Rural Goat Farming & Management on Non-Descript Cows by using Local	Muradpur, Nagpur	17.08.2017
	Rural Goat Farming	Gadchoroli	17.02.2018

Radio Talks:

- Smt. Sunita Chauhan delivered a radio talk on "Kitchen Gardening" in Marathi and telecasted by AIR, Nagpur on 24, Nov, 2017.
- Dr. S. S. Patil delivered a radio talk on "Biological Control of Pests and Diseases in chickpea" telecasted by AIR, Nagpur on 12 Dec, 2017

10. GENERAL

10.1 List of Publications

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

1. Abd El-Moghny M, Santosh HB, Raghavendra KP, Sheeba JA, Singh SB and Kranthi KR (2017). Microsatellite marker based genetic diversity analysis among cotton (*Gossypium hirsutum*) accessions differing for their response to drought stress, *Journal of Plant Biochemistry and Biotechnology*, 26 (3): 366–370. (NAAS rating: 6.95)
2. Ali S, Chandrashekar N, Rawat S, et al. (2017). Isolation and molecular characterization of pathogenesis related *PR2* gene and its promoter from *Brassica juncea. Biologia Plantarum*, 61(4): 763-773. (NAAS rating 2017: 7.67)
3. Ali S, Mir ZA, Bhat JA, Tyagi A, Chandrashekar N, Yadav P, Rawat S, Sultana M and Grover A (2018). Isolation and characterization of systemic acquired resistance marker gene *PR1* and its promoter from *Brassica juncea 3 Biotech*, 8: 10. (NAAS rating 2018: 7.36).
4. Ali S, Mir ZA, Tyagi A, Bhat JA, Chandrashekar N, Papolu PK, Rawat S and Grover A (2017). Identification and comparative analysis of *Brassica juncea* pathogenesis-related genes in response to hormonal, biotic and abiotic stresses. *Acta Physiologiae Plantarum*, 39: 268. (NAAS rating 2017: 7.56).
5. Arunkumar N, Gulsar Banu J, Gopalakrishnan N and Prakash AH (2018). The biochemical correlation between the epicuticular wax of upland cotton (*Gossypium hirsutum* L.) and the wax of different mealybug species. *Phytoparasitica*, doi:10.1007/s12600-018-0656-8. (NAAS rating 6.88).
6. Asha Bharti, Velmourougane K, Prasanna R (2017). Phototrophic biofilms: diversity, ecology and applications. *Journal of Applied Phycology*, 29(6): 2729-2744. (NAAS rating: 8.62).
7. Kranthi S, Satija U, Pusadkar P, Kumar Rishi, Shastri CS, Ansari S, Santosh HB, Monga D and Kranthi KR (2017). Non Bt seeds provided by seed companies in India- are they suitable as refuge for Bt-cotton? *Current Science*, 112 (10): 1992-1993. (NAAS rating: 6.84).
8. Kumari M, Wankhede DP, Verma M and Verma Pooja (2017). Genome wide identification of calcium dependent protein kinase and related kinase gene families in *Solanum melongena* L. *Indian Journal of Horticulture*, 74(4): 526-532. (NAAS rating: 6.15).
9. Kumawat RN, Misra AK, Mounir L, Mahajan SS and Venkatesan K (2017). Seed germination behaviour as influenced by physical and chemical treatments in *Grewia tenax* (Forssk.). *Range Management and Agroforestry*, 38 (1): 134-138. (NAAS rating: 6.39).
10. Naik Chinna Babu, Nagaharish Giri, Sujit Kumbare, Kranthi S and Nirmal Kumar (2017). New report of *Oxycetonia versicolor* Fabricius, as a pest on cotton from Central India. *National Academy Science Letters* (NAAS rating: 6.8).
11. Rawat S, Ali S, Nayankantha NNC, Chandrashekar N, Mittra B and Grover A (2017). Isolation and expression analysis of defensin gene and its promoter from *Brassica juncea*. *Journal of Plant Diseases and Protection*, 124:591–600. (NAAS rating 2017: 6.48).
12. Sharma AK, Gawande SP, De RK, Mitra S, Satya P, Saha D, Sinha MK, Mahapatra BS and Satpathy S (2017). Ramie Variety R 1411 (Hazarika): In Variety notification. *Indian Journal of Genetics and Plant Breeding*, 77(3). (NAAS rating: 6.32).
13. Thapa S, Ranjan K, Ramakrishnan B, Velmourougane K and Prasanna R (2017). Influence of fertilizers and rice cultivation methods on the abundance and diversity of phyllosphere microbiome. *Journal of Basic Microbiology*, doi:10.1002/jobm.201700402 (NAAS rating: 7.44).
14. Thapa S, Prasanna R, Ranjan K, Velmourougane K and Ramakrishan B (2017). Nutrients and host attributes modulate the abundance and functional traits of phyllosphere microbiome in rice. *Microbiological Research*, 204: 55-64. (NAAS rating: 9.04).
15. Velmourougane K and Prasanna R (2017). Influence of L-amino acids on aggregation and biofilm formation in *Azotobacter chroococcum* and *Trichoderma viride*. *Journal of Applied Microbiology*, 123 (4): 977-991. (NAAS rating: 8.10).
16. Velmourougane K and Blaise D (2017). Impact of

transgenic Bt cotton on soil health. *CAB Reviews*, 12(046), doi: 10.1079/PAVSNNR201712046. (NAAS rating: 6.73).

17. Velmourougane K, Prasanna R, Saxena AK, Shashi Bala Singh, Gautam Chawla, Kaushik R, Ramakrishnan B and Nain L (2017). Modulation of growth media influences aggregation and biofilm formation between *Azotobacter chroococcum* and *Trichoderma viride*. *Applied Biochemistry and Microbiology, 53 (5): 546-556.* (NAAS rating: 6.66).
18. Velmourougane K, Radha Prasanna, Shashi Bala Singh, Rajesh Kumar and Supradip Saha (2017). Sequence of inoculation influences the nature of extracellular polymeric substances and biofilm formation in *Azotobacter chroococcum* and *Trichoderma viride*. *FEMS Microbiology Ecology,* 93 (7): doi: 10.1093/femsec/fix066. (NAAS rating: 9.72).
19. Velmourougane K, Radha Prasanna, Surender Singh, Gautam Chawla, Arun Kumar and Anil Kumar Saxena (2017). Modulating rhizosphere colonisation, plant growth, soil nutrient availability and plant defense enzyme activity through *Trichoderma viride-Azotobacter chroococcum* biofilm inoculation in chickpea. *Plant and Soil*, 421: 157-174. (NAAS rating: 9.05).
20. Velmourougane K, Prasanna R and Saxena AK (2017). Agriculturally important microbial biofilms: Present status and future prospects. *Journal of Basic Microbiology*, 57(7): 548-573. (NAAS rating: 7.44).

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

21. Amutha M (2017). Establishment of *Beauveria bassiana* (Balsamo) Vuillemin as an Endophyte in Cotton. *International Journal of Current Microbiology and Applied Sciences,* 6(6): 2506-2513. (NAAS rating: 5.38).
22. Awatade SC, Ghosh S and Singandhupe RB (2017). Agricultural information needs and their fulfillment as perceived by the farmers in changing agricultural scenario in Maharashtra. *Indian Journal of Agricultural Extension*, 53(2): 11-17. (NAAS rating: 5.32).
23. Awatade SC, Shah A, Ghosh S and Singandhupe RB (2018). Agricultural information sources used by Onion farmers in Akola district of Maharashtra, India. *International Journal Current Microbiological Application Science*, 7(03): 1-5. (NAAS rating: 5.38).
24. Das J, Raghavendra KP, Santosh HB, Sabesh M and Kranthi KR (2017). Cotton DNA Traceability Technologies, *ICAC Recorder*, 35(3): 5-15.
25. Dhamayanthi KPM and Rathinavel K (2017). Heterosis and combining ability studies in extra-long staple inter-specific (*G. hirsutum x G. barbadense*) hybrids of cotton. *Electronic Journal of Plant Breeding* 8(2): 494-500. (NAAS rating 4.97).
26. Kumar M, Kumar RR, Goswami S, Verma P, Rai RD, Chinnusamy V and Praveen S (2017). miR430: the novel heat-responsive microRNA identified from miRNome analysis in wheat (*Triticum aestivum* L.) *Indian Journal of Plant Physiology*, 22(4): 566–576. (NAAS rating: 5.18).
27. Saravanan M, Das J, Misra RC, Mohan P, Waghmare VN and Kranthi KR (2016). Genetic diversity analysis using SSR markers for *desi* cotton (*G. arboreum*) landraces collected from Arunachal Pradesh. *Cotton Research Journal*, 7(2):91-96. (NAAS rating: 3.45).
28. Mandhyan PK, Patil PG, Sankaranarayanan K, Gurjur RM, Ghadge SV and Nachane RP (2017). Cotton Value Chain. *Cotton Research Journal*. 7(1):1-17 (NAAS rating 3.45).
29. Manikandan A and Subramanian KS (2017). Sorption characteristics of nitrogen forms on microporous adsorbents for novel fertilizer. *Journal of the Indian Society of Soil Science*, 65(2): 130- 137. (NAAS rating: 5.23).
30. Manikandan A and Subramanian KS (2017). Study on mitigation of ammonia volatilization loss in urea through adsorbents. *Journal of Applied and Natural Science,* 9 (2): 688-692. (NAAS rating: 4.84).
31. Nalayini P, Sankaranarayanan K, Velmourougane K and Suveetha M (2017). Biodegradable mulching for moisture conservation, weed control and enhanced productivity of winter irrigated cotton maize system. *Journal of Cotton Research and Development*, 31 (2): 205-212. (NAAS rating 4.69).
32. Pandagale AD, Baig KS, Venugopalan MV and Rathod SS (2018). Moisture conservation measures and nutrient requirement for cotton under HDPS for changing climatic conditions. *Journal of Agricultural Research and Technology* (accepted).
33. Prabhulinga T, Rameash K, Madhu TN, Shah Vivek and Ruchika Suke (2017). Maximum entropy modelling for predicting the potential distribution of cotton whitefly *Bemisia tabaci* (Gennadius) in North India. *Journal of Entomology and Zoology Studies*. 5(4):1002-1006. (NAAS rating : 5.53).

34. *Raju AR* (2017). Leaf reddening in short duration rainfed Bt hybrid cotton-A review. *Cotton Research and Development*, 31 (2): 256-261. (NAAS rating: 4.69).

35. Rathinavel K, Priyadharshini C and Kavitha H (2018). Characterization, diversity studies and clustering of tetraploid *Bt* cotton hybrids using morphological markers. *Journal of Cotton Research and Development*, 32 (1): 13-22. (NAAS rating : 4.69).

36. Rathinavel K (2017). Exploration of genetic diversity for qualitative traits among the extant upland cotton (*Gossypium hirsutum* L.) varieties and parental lines. *International Journal Current Microbiological Application Science*, 6(8): 2407-2421. (NAAS rating : 5.38).

37. Rathinavel K, Priyadharshini C and Kavitha H (2017). Multivariate analysis on extant *desi* cotton genotypes (*G. arboreum* and *G. herbaceum* L.) employing qualitative characteristics. *International Journal Current Microbiological Application Science*, 6(11): 724-734. (NAAS rating : 5.38).

38. Rathinavel K, Priyadharshini C and Kavitha H (2017). Assessment of genetic variability and correlation analysis of seed and seed cotton yield attributing traits of tetraploid cotton genotypes (*G. hirsutum* L.). *Electronic Journal of Plant Breeding*, 8(4): 1275-1283. (NAAS rating : 4.97).

39. Rathinavel K (2017). Effect of seed treatments on viability and vigour of cotton seeds (*Gossypium hirsutum* L.) under ambient storage. *Journal of Cotton Research and Development*, 31(1):1-6. (NAAS rating 4.69).

40. Sankaranarayanan K, Prakash AH and Rajendran K (2018). Glyphosate selectivity by non-transgenic methods and efficacy of weed control in cotton (*Gossypium hirsutum* L). *International Journal of Chemical Studies*, 6(1): 521-526. (NAAS rating :5.31).

41. Singandhupe R.B (2017). Sensitivity analysis of reference evapotranspiration (ETo) models for irrigation requirement of crops and impact of irrigation on climate changes in semi-arid of India. *Advance in Research* 11(6): 1-16. (NAAS rating : 4.80).

42. Chinna Babu Naik V, Kranthi S and Rahul Viswakarma (2017). Impact of newer pesticides and botanicals on sucking pest management in cotton under high density planting system (HDPS) in India. *Journal of Entomology and Zoology Studies*, 5(6):1083-1087. (NAAS rating : 5.53).

43. Chinna Babu Naik V, Prasad NVVSD, Vani Sree K, Upendhar S (2017). Frequency of sucking pest complex on different transgenic events of cotton hybrids. *Journal of Entomology and Zoology Studies*, 5(6):1947-1953. (NAAS rating : 5.53).

44. Venugopalan MV, D Blaise, Shubhangi Lakade, Rathod N, Tandulkar NR (2017). Evaluation of agrotechnoiques to improve boll weight of cotton under HDPS. *Cotton Research Journal*, 7(1): 12-16. (NAAS rating : 3.45).

45. Venugopalan MV, Shaikh AJ and Kranthi KR (2017). Proceedings and Recommendations of the 7th Meeting of the Asian Cotton Research and Development Network – ACRDN. *ICAC Recorder*, 35 (4): 33-38.

46. Verma SK, OP Tuteja and SL Ahuja (2017). Combining ability estimates for seed cotton yield and quality characters of parents and crosses based on genetic male sterility in Asiatic cotton *(Gossypium arboreum L.)* Electronic Journal of Plant Breeding, 8(4): 1046-1052. (NAAS rating : 4.97).

Books/Book Chapters

1. Dhanashree Pable, Chatterji S, Sen TK, Venugopalan MV and Giri JD (2017). Land evaluation for rainfed cotton: A case study from Central India. In: In: *Sustainable Management of Land Resources: An Indian Perspective*, Eds. Obi Reddy GB, Patil NG and Arun Chaturvedi. Apple Academic Press, pp. 699-716.

2. Kanjana D (2017). Advancement of nanotechnology applications on plant nutrients management and soil improvement. In: *Book on Nanotechnology: Food and Environmental Paradigm*, Springer, pp. 209-234.

3. Velmourougane K and Blaise D (2017). Soil health, crop productivity and sustainability challenges. In: *Sustainability Challenges in the Agrofood Sector*. Eds. Rajeev Bhat. John Wiley & Sons Ltd. Sussex, UK. pp. 509-531.

4. Velmourougane K, Garima Saxena and Radha Prasanna (2017). Plant-Microbe Interactions in the Rhizosphere: Mechanisms and Their Ecological Benefits. In: *Plant-Microbe Interactions in Agro-Ecological Perspectives Volume 2: Microbial Interactions and Agro-Ecological Impacts*. Eds. Singh DP, Bahadur H and Ratna P. Springer. pp. 193-219.

5. Venugopalan MV, Reddy AR, Kranthi KR, Yadav MS, Vandana Satish and Dhanashree Pable (2017). A decade of Bt cotton in India: Land Use Changes and Other Socio-Economic Consequences. In:

Sustainable Management of Land Resources: An Indian Perspective, Eds. Obi Reddy GB, Patil NG and Arun Chaturvedi. Apple Academic Press, pp. 669-698.

Technical Bulletins:

1. Chinna Babu Naik V, Kranthi S, Kumbhare S, Nagrare VS, Narkhedkar NG and Waghmare VN (2018). *Pink bollworm Management* (Hindi), ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010, p. 20.
2. Chinna Babu Naik V, Kranthi S, Nagrare VS, Shah V, Fand BB, Narkhedkar NG (2018). Practical Manual of ICAR Sponsored Winter School: *Insect resistance to Bt toxins and insecticides in Cotton*, ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010, p. 41.
3. Chinna Babu Naik V, Kranthi S, Nagrare VS, Shah V, Fand BB, Narkhedkar NG (2018). Lecture Notes of ICAR Sponsored Winter School: *Insect resistance to Bt toxins and insecticides in Cotton*, ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010, p. 210.
4. Monga D, Meena RA, Ahuja SL, Tuteja OP, Verma SK, Rishi Kumar and Sain SK (2017). Kendriya Kapas Anusandhan Sansthan Khestria Station Sirsa dwara viksit kapas utpadan prodogikiya. Published by Director, CICR Nagpur.
5. Monga D, Meena RA, Ahuja SL, Tuteja OP, Verma SK, Rishi Kumar and Sain SK (2017). *Cotton Production Techniques* developed by ICAR-CICR Regional Station, Sirsa. CICR Bulletin No.1. pp. 28.
6. Nagrare VS, Chinna Babu Naik V, Fand BB and Narkhedkar NG (2018). *Pink bollworm Management* (Hindi), ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010.
7. Nagrare VS, Chinna Babu Naik V, Fand BB and Narkhedkar NG (2018). *Pink bollworm Management* (English), ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010.
8. Nagrare VS, Chinna Babu Naik V, Fand BB and Narkhedkar NG (2018). *Pink bollworm Management* (Marathi), ICAR-Central Institute for Cotton Research, Post Bag No.2, Shankar Nagar, Nagpur-440010.
9. Rishi Kumar, Sain SK, Monga D (2017). Pocket note on "*Kapas ki fasal safed makhi tatha patta marod rog ka samekit prabandhan*" Integrated management of whitefly and CLCuD in cotton pp. 4.

10.2 : List of ongoing projects (2017-18)

S.No.	Type	Project title, PIs and Co-PIs	Duration
Division of Crop Improvement			
1	Institute	Improvement of tetraploid and diploid cottons for fibre properties through population improvement approaches. **V.N. Waghmare (PI)**, Vinita Gotmare (PA), O. P. Tuteja (PA), S. K Verma (PA), D. V. Patil (PA)	2000-20
2	Institute	Breeding of upland cotton for improved fibre quality and resistance to biotic stress (Jassid). **S.M. Palve (PI)**	2005-21
3	Institute	Development of *G. hirsutum* genotypes with high yield and high GOT. **S.L. Ahuja (PI)** , R.A. Meena (PA), D. Monga (PA), Rishi Kumar (PA)	2012-18
4	Institute	MAS/MAB for Waterlogging in Cotton. **Vinita Gotmare (PI)** , S.E.S.A. Khader (PA), M. Saravanan (PA), J. H. Meshram (PA), J.Annie Sheeba (PA)	2012-20
5	Institute	Breeding for early maturity compact plant type and jassid tolerance in cotton. **H.B. Santosh (PI)**, S. Manickam (PA), Raghavendra KP (PA)	2014-19
6	Institute	Identification of male sterile plants in genetic male sterility (GMS) using molecular markers. **O.P. Tuteja (PI)** , S.B. Singh (PA), M. Sarvanan (PA)	2012-18
7	Institute	Development of Cotton leaf curl virus resistant genotypes using *G.arboreum*/ *G.herbaceum* through introgression. **S.K. Verma (PI)**, O. P. Tuteja (PA), D.Monga (PA), Rishi Kumar (PA), Vinita Gotmare (PA), H. B. Santosh (PA), V.N. Waghmare (PA), S. M. Palve (PA), S. B Nandeshwar (PA), Rakesh Kumar (PA)	2015-21
8	Institute	Breeding to improve performance of *Gossypium herbaceum* for adaptation to climate change in central India. **D.V. Patil (PI)**, Punit Mohan (PA)	2015-20
9	Institute	Development of high yielding, early maturing Asiatic cotton (*Gossypium arboreum)* genotypes suitable to south Zone. **A. Manivannan (PI)**, Punit Mohan (PA), M. Saravanan (PA), V. N. Waghmare (PA)	2015-20
10	Institute	Development of high strength cotton genotypes by reducing the short fiber content. **S. Manickam (PI)** , A. H. Prakash (PA), B. Dharajothi (PA), J. Gulsar Banu (PA)	2017-20
11	Institute	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 (PA), K. Rameash (PA)	2017-20
12	Institute	Development of varieties of upland cotton having better fibre traits and tolerance to CLCuD. **O.P. Tuteja (PI)**, V. N. Waghmare (PA), S. K. Verma (PA), D. Monga (PA), Rishi Kumar (PA)	2017-20
13	Institute	Development of compact plant type with improved quality traits through selective mating system. **Suman Bala Singh (PI)**, T. R. Loknathan (PA), J. H. Meshram (PA)	2017-20
14	Institute	Collection, conservation, evaluation, documentation and maintenance of germplasm of cultivated species of *Gossypium.* **Punit Mohan (PI)** , S. Manickam (PA), R. A. Meena (PA), K. P. M. Damayannthi (PA), Sunil S. Mahajan (PA), M. Saravanan (PA)	2006-18
15	Institute	Conservation, characterization and utilization of wild species, races of cultivated species and synthetic polyploids of *Gossypium.* **Vinita Gotmare (PI)**	2008-18
16	Institute	Exploration, collection and conservation of land races of desi cotton and perennials and from different regions of India. **M. Saravanan (PI)**	2011-18
17	Institute	DUS characterization and DNA finger printing of public sector cotton varieties. **V. Santhy (PI)** , H. B. Santosh (PA)	2012-18

S.No.	Type	Project title, PIs and Co-PIs	Duration
18	Institute	Studies to improve the seed and boll setting efficiency in cotton. **R.A. Meena (PL)**, Rishi Kumar (PA), K. Rathinavel (PA)	2012-18
19	Institute	Strategies to augment quality and storability of cotton seed under different environmental conditions. **S.S. Mahajan (PI)**, V. Santhy (PA), P. R. Vijayakumari (PA)	2017-18
20	Institute	Deployment of biotechnological tools for enhancing cotton seed by-product utilization: Reduction of gossypol content using CYP6AE14 gene. **K.P. Raghavendra (PI)**, Sandhya Kranthi (PA), G. Balasubramani (PA), K. Velmourougane (PA), Savita Santosh (PA)	2014-18
21	Institute	Basic Studies on Somatic embryogenesis of Cotton. **Joy Das (PI)**, Rakesh Kumar (PA), S.B. Nandeshwar (PA), Chandrashekar N (PA)	2015-18
22	Institute	Development of novel methods for gene delivery into cotton. **Rakesh Kumar (PI)**, Joy Das (PA)	2015-18
23	Institute	An efficient regeneration system for transformation studies with *CICRcry2Ab1Ac* and fiber strength genes in Cotton (*G. hirsutum*). **G. Balasubramani (PI)**, J. Amudha (PA), K. P Raghavendra (PA), Joy Das (PA), Rakesh Kumar (PA), Chandrashekar N (PA)	2017-20
24	Institute	Targeted mutagenesis of ghPHYA1 through CRISPR/Cas9 in Cotton. **Chandrashekar N. (PI)**, Raghavendra, K. P. (PA), Joy Das (PA), Rakesh Kumar (PA)	2017-20
25	DBT	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 (CoPI)	2017-20
26	CRP	Natural Fiber. Development of tissue culture technology for cotton fibre initiation. **S.B. Nandeshwar (PI)**, Rakesh Kumar (PA), Joy Das (PA)	2015-18
27	NSP	National Seed Project (Crops). **K. Rathinavel (PI)**	1999-18
28	DUS	Implementation of PVP legislation 2001 and DUS testing of cotton under ICAR-SAU system. **K. Rathinavel (PI)**	2003-18
29	MSP	ICAR project on Seed Production in Agricultural Crops and Fisheries. **P.R.Vijayakumari (Nd Offi)**, V. Santhy (PA), K. Rathinavel (PA), R. A. Meena (PA)	2007-18
Division of Crop Production			
30	Institute	Allelopathy as an alternative weed management strategy in cotton. **Blaise Desouza (PI)**, P. Nalayini (PA), A. Manikandan (PA), Pooja Verma (PA)	2012-18
31	Institute	Alleviating soil compaction – a production constraint in cotton. **Blaise Desouza (PI)**, Gautam Majumdar (PA), A. Manikandan (PA), Savita Santosh (PA)	2017-20
32	Institute	Identification and characterization of water deficit period under various agro climatic regions with reference to cotton growing states of India. **R.B. Singhandhupe (PI)**, A. Manikandan (PA), S. Chattraj (PA) (NBSS&LUP)	2017-20
33	Institute	Exploring the productivity potential of long-linted *G. arboreum* cotton. **M.V. Venugopalan(PI)**, K. Sankarnarayanan (PA), J.H. Meshram (PA), G.I. Ramakrushna (PA), Pooja Verma (PA), S.S. Mahajan (PA), Madhu T.N. (PA), Neelakanth Hiremani (PA), M Sabesh (PA)	2017-20
34	Institute	Participatory evaluation of technology for improving profitability in calcareous soils. **A.R Raju (PI)**, RB Singandhupe (PA), Anuradha Narala (PA) A. Manikandan (PA)	2016-20
35	Institute	Integrated farming system to double income of cotton farmer. **G.I. Ramkrushna (PI)**, R. B. Singandhupe (PA), A. Manikandan (PA), Rachna Pande (PA)	2017-20

S.No.	Type	Project title, PIs and Co-PIs	Duration
36	Institute	Efficient nitrogen fixing legumes for cotton based cropping systems. **A. Manikandan (PI)**, P. Nalayini (PA), V. S. Nagrare (PA)	2015-20
37	Institute	Evaluation of Structured water for cotton production. **P. Nalayini (PI)**	2014-19
38	Institute	Identifying edaphic & climatic factors influencing Fibre quality parameters in cotton and low micronaire management in ELS Cotton. **K. Sankaranarayanan**	2017-20
39	Institute	Development of remunerative cotton based cropping systems based on conservation agriculture principles. **R. Raja (PI)**, D. Kanjana (PA)	2015-19
40	Institute	Evaluation of nano-formulated micronutrients foliar spray for yield maximization in different cotton genotypes. **D. Kanjana (PI)**	2012-18
41	Institute	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 (PA), Amarpreet Singh (PA)	2017-23
42	Institute	Phenotyping of root system architecture in cotton (*Gossypium hirsutum* L.) for adaption to Drought tolerance. **J.H. Meshram (PI)**, S. S. Mahajan (PA)	2017-19
43	Institute	Exploiting the epigenetic transgenerational inheritance of stress responsive traits for imparting abiotic stress tolerance to cotton. **J. Annie Sheeba (PI)**	2016-21
44	Institute	Metabolite exploration of drought stress in cotton. **Pooja Verma (PI)**, G.I. Ramkrushna (PA)	2017-19
45	Institute	Development of microbial biofilm formulations for cotton: effects on yield, pests, diseases and soil health". **K. Velmourougane (PI)**, Savitha Santosh (PA), Rachna Pande (PA), Dipak Nagrale (PA)	2017-20
46	Institute	Microbial interventions for potassium nutrition in cotton. **Savitha Santosh (PI)**, G. I. Ramkrushna (PA), A. Manikandan (PA)	2017-19
47	Institute	Dynamics of cropping pattern in cotton growing districts of Maharashtra. **A.R. Reddy (PI)**	2017-19
48	Institute	Impact analysis of shift in global cotton trade on Indian cotton scenario. **Isabella Agarwal (PI)**	2017-19
49	Institute	Impact of Institutional Credit on Cotton Farming in Vidarbha Region of Maharashtra. **Anuradha Narala (PI)**, S M Wasnik (PA), Nandini Gokte (PA), Vinita Gotmare (PA)	2016-18
50	Institute	e- Communication: Dissemination of Cotton Technology. **S.M. Wasnik (PI)**, S. Usha Rani (PA), O. P. Tuteja (PA)	2017-20
51	Institute	Development of transfer of technology innovations for bridging up the yield and knowledge gap in Cotton. **S. Usha Rani (PI)**, S. Manickam (PA), R. Raja (PA), M. Amutha (PA), S. M. Wasnik (PA)	2017-20
52	Institute	Socio-technological analysis of drip irrigation in cotton cultivation. **C. Karpagam (PI)**, K. Sankaranarayanan (PA), K Rameash (PA)	2017-20
53	Institute	Development of interactive decision support systems for cotton pest management with prerecorded voice modules. **M. Sabesh (PI)**, C. Karpagam (PA)	2016-19
54	Institute	Refining, up scaling and large-scale evaluation of Tractor mounted ICAR-Mahindra Brush type Cotton harvester vs. available cotton harvesting techniques. **Gautam Majumdar (PI)**, S. K. Shukla GTC (PA)	2017-19
55	NCP	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, (Project Manager)**, A. Manikandan (PA)	2017-20

S.No.	Type	Project title, PIs and Co-PIs	Duration
56	IFFCO	Validation of impact of input on economics of Bt –hybrid cotton+ pigeon pea strip cropping. **A.R. Raju (PI)**	2017-20
Division of Crop Protection			
57	Institute	Gene discovery for useful traits. **K.P. Raghavendra (PI)**, Sandhya Kranthi (PA), K. Velmourougane (PA), J. Annie Sheeba (PA), A. Sampathkumar (PA), Rakesh Kumar (PA), S. P. Gawande (PA)	2014-19
58	Institute	Development of Bt cotton varieties for bollworm management by introgression of indigenous events including Tg2E13 event through backcross breeding. **Sandhya Kranthi (PI)**, H. B. Santosh (PA), S. Manickam (PA), B. Dhara jyoti (PA), Shah Vivek (PA), K. P. Raghavendra (PA)	2017-20
59	Institute	Elucidating eco-toxicity and resistance development in sucking pests against newer insecticides used in cotton. **V.S. Nagrare (PI)**, V. Chinna Babu Naik (PA)	2017-20
60	Institute	Push-pull strategy for management of pink bollworm in cotton. **Vivek Shah (PI)**, Pooja Verma (PA)	2016-19
61	Institute	Diversity analysis of Whitefly (*Bemisia tabaci*), predators and parasitoids. **Prabhulinga T. (PI)**, Sandhya Kranthi (PA), Rishi Kumar (PA) , M. Amutha (PA), V. Chinna Babu Naik (PA)	2016-18
62	Institute	Studies on chemical cues mediating sucking pests and natural enemy interactions in cotton eco-system. **Madhu. T.N. (PI)**, Rishi Kumar (PA), Shankarganesh (PA), K. Rameash (PA)	2016-18
63	Institute	Enhancing the efficacy of yellow sticky traps using essential oils against sucking pests in cotton. **Madhu T.N. (PI)**, Rishi Kumar (PA), Shankarganesh (PA)	2016-18
64	Institute	Investigations into exacerbation of pest status of cotton pink bollworm *Pectinophora gossypiella* (Saunders) in the context of climate change through development of phenology model. **B.B. Fand (PI)**, V.S. Nagrare (PA), V. Chinna Babu Naik (PA)	2017-20
65	Institute	Identification of oviposition deterrent for ethological management of Cotton Boll worm *Helicoverpa armigera* Hübner. **Rachna Pande (PI)**, Vivek Shah (PA)	2017-20
66	Institute	Identification of resistant genetic sources with mechanism of resistance against cotton leafhopper (*Amrasca biguttula biguttula*) (Ishida). **B. Dhara jothi (PI)**, A. Manivannan (PA), D. Kanjana (PA)	2017-20
67	Institute	Exploring novel dispensers to enhance the trapping efficacy of gossyplure in managing pink bollworm in cotton. **K. Rameash (PI)**, B. Dharajothi (PA)	2016-19
68	Institute	Isolation and characterization of endophytes in cotton and endo-symbionts in bollworms. **M. Amutha (PI)**	2012-18
69	Institute	Diversity, Ecology and Improvement of eco-compatible management of Thrips in cotton ecosystem. **M. Amutha (PI)**, K. Sankaranarayanan (PA), S. P. Gawande (PA)	2017-20
70	Institute	Molecular characterization, virulence and genetic diversity analysis of *Alternaria* leaf spot disease of cotton. **A. Sampath Kumar (PI)**	2017-20
71	Institute	Development of reverse transcription loop mediated isothermal amplification (RT- LAMP) for early detection of cotton leaf curl and tobacco streak viruses of cotton (*G. hirsutum*). **S.P. Gawande (PI)**, Dilip Monga (PA), K.P. Raghvendra (PA)	2015-18
72	Institute	Evaluation of cotton PGPR for broad-spectrum resistance against insect pests and diseases. **Dipak T Nagrale (PI)**, T. Prabhulinga (PA)	2016-19

S.No.	Type	Project title, PIs and Co-PIs	Duration
73	Institute	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 (PA), S.K. Sain (PA), Pooja Verma (PA)	2017-19
74	Institute	Role of plant defence activators for management of cotton leaf spot diseases. **Vanita N. Salunkhe (PI)**, S. P. Gawande (PA), J. H. Meshram (PA), Pooja Verma (PA)	2017-20
75	Institute	Studies on symptom expression, host range, transmission and spread of *Tobacco Streak Virus* infecting Cotton. **P. Valarmathi (PI)**, M. Amutha (PA), S. P. Gawande (PA), S. K. Sain (PA)	2017-20
76	Institute	Studies to identify the most virulent strains of entomopthogenic fungi for whitefly control. **S.K. Sain (PI)**, D. Monga (PA), Sandhya Kranthi (PA), Rishi Kumar (PA), Prabhulinga T. (PA), Dipak Nagrale (PA)	2016-19
77	Institute	Studies to understand occurrence of parawilt, root rot and the effect of rhizosphere microorganism, biological control agents and chemicals on their management in North India. **S.K Sain (PI)**, D. Monga (PA), Pooja Verma (PA), S. K. Bishnoi (PA), Amarpreet Singh	2017-19
78	Institute	Standardization and integration of strategies for sustainable nematode management. **Nandini Narkhedkar (PI)**	2017-20
79	Institute	Inventorying potential fungal metabolites for the management of sucking pests and nematodes of cotton. **J. Gulsar Banu (PI)**, A. H. Prakash (PA), M. Amutha (PA)	2017-20
80	NICRA	Development of IPM strategies to combat whitefly and other emerging pests of cotton. **Sandhya Kranthi (PI)**, V.S. Nagrare (PA), Prabhulinga T (PA), D. Monga (PA), Rishi Kumar (PA), M. Sabesh (PA)	2016-19
81	Mahyco	Monitoring changes in baseline susceptibility to Cry toxins in the cotton bollworm, *H. armigera,* pink bollworm and *Spodoptera litura.* **Sandhya Kranthi (PI)**, V. Chinna Babu Naik (CoPI)	2012-18
82	GEAC	Event based approval mechanism. Sandhya Kranthi (PI)	2010-18
83	CROPSAP	Maha. Govt: Crop pest surveillance and advisory project (CROPSAP) in Maharashtra. **V.S. Nagrare (PI)**	2010-18
84	DST SERB	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 (CoPI)	2017-20
85	DST SERB	Genetic diversity in geographical Population of Pink bollworm *Pectinophora gossypiella* (Saunders) in India. **V. Chinna Babu Naik (PI)**	2017-21
86	DST	Entomopathogenic-endophytes mediated plant defense as a novel approach for the management of bollworms in cotton. **M. Amutha (PI)**	2013-18
87	DST-SERB	Evaluation of selectivity of insecticides against different mealy bug species and their major natural enemies associated with cotton, tomato, brinjal and papaya. **K. Shankarganesh (PI)**	2016-18
88	DST-SEED	Exploration and development of thermal tolerant strain of biocontrol agent, *Acerophagus papayae* for sustainable management of papaya mealybug, *Paracoccus marginatus* in crops. **K. Shankarganesh (PI)**, C. Karpagam	2016-19
89	DST-SERB	Effect of thermal stress on fitness traits of two mealybug pests, Phenacoccus solenopsis, and *Paracoccus marginatus* and their parasitoids *Aenasius bambawalei* and *Acerophagus papaya.* **K. Shankarganesh (PI)**, Sandhya Kranthi (CoPI), K. Rameash (CoPI)	2016-19

10.3: Consultancy, Patents, Commercialization of Technology

Patent:

A complete patent application was submitted by Dr. A.R. Raju on "Bt Cotton Leaf Reddening Prevention Kit 1-5 Series" (Filling under process).

Revenue Generation

Particular	Amount (Rs.)
Sale of farm produce	29,74,381
Licence Fee	2,95,750
Application fee from candidates	1,05,000
Interest earned loans & advances	5,01,769
Miscellaneous Receipts	25,70,723
Total	**64,47,623**

MoU signed:

- ICAR-CICR has signed MoU with IFFCO on 25th July 2017 for a sponsored project on "Validation of impact of inputs on economics of Bt-Hybrid cotton + pigeon pea strip cropping".
- ICAR-CICR has signed MoU with M/s. Smartchem Technologies Ltd., Mundhwa, Pune on 16th Aug. 2017 for a sponsored project on "Validation of CNS fertilizer grade mixture subsidiary companies inputs in Bt Hybrid cotton".
- ICAR-CICR has signed a tri-party MTA with UAS, Dharwad and NRCPB, New Delhi on 18th Aug. 2017 for "Testing and introgression of the transgene contained in event 'UASD Event No 78' into varieties and hybrids of cotton".
- ICAR-CICR has signed MoU with National Remote Sensing Centre, Hyderabad on 20th Dec. 2017 for a collaborative project on "Quantitative estimation of carbon and moisture fluxes over the cotton based agro eco system: Integrating ground observation, satellite data and modelling".
- MoU was signed between ICAR-CICR, Nagpur and M/s. Bharat Seeds on 1st March 2018, for Commercialization of CICR varieties viz., CSH-3075 and CSH-3129.
- MoU was signed between ICAR-CICR, Nagpur and M/s. Maharashtra Hybrid Seed Co. Pvt. Ltd on 7th March 2018 for collaborative project on "Monitoring for shifts in susceptibility in populations of the cotton boll worms *viz.*, *Helicoverpa armigera* and *Pectinophora gossypiela* and leaf eating caterpillar (*Spodoptera litura*) against *Cry2Ab* and *Cry1Ac* + *Cry2Ab* Protein in various cotton growing regions of the country"
- MoU was signed between ICAR-CICR, Nagpur and M/s. Maharashtra Hybrid Seed Co. Pvt. Ltd on 7th March 2018 for collaborative project on Monitoring for shifts in susceptibility in populations of cotton boll worms *viz.*, *Helicoverpa armigera* and *Pectinophora gossypiela* against *Cry1AC* proteins in various cotton growing regions of the country.

10.4 : Significant Decisions of RAC, IRC, PMC

Research Advisory Committee Review Meeting

The first meeting of the reconstituted Research Advisory Committee (RAC) of ICAR-Central Institute for Cotton Research (CICR), Nagpur was held from 4-5 January 2018 under the Chairmanship of Dr. C.J. Dangaria, Hon'ble Vice Chancellor, Navsari Agricultural University, Navsari. The following RAC members and officials attended the meeting:

- Dr. R.K. Singh, Assistant Director General (Commercial Crops), ICAR, New Delhi and Member, RAC
- Dr. S. V. Sarode, Ex Director Research, Dr. PDKV, Akola and Member, RAC
- Dr. A. J. Shaikh, Ex-Director, Central Institute for Research on Cotton Technology, Mumbai and Member, RAC
- Dr. S. S. Patil, Ex-Senior Cotton Breeder & Professor, Dept of Genetics & Plant Breeding, UAS, Dharwad and Member, RAC
- Dr. G. Ravindra Chary, Project Coordinator (Dryland Research), AICRPDA, Hyderabad and Member, RAC
- Dr. V.N. Waghmare, Director (Acting), ICAR-CICR, Nagpur
- Dr. A.H. Prakash, Project Coordinator (Cotton) & Head, ICAR-CICR, Regional Station, Coimbatore
- Dr. D. Monga, Head, ICAR-CICR, Regional Station, Sirsa
- Dr. M.V. Venugopalan, Principal Scientist, ICAR-CICR, Nagpur and Member Secretary, RAC
- Dr. K.P. Raghavendra, Scientist, ICAR-CICR, Nagpur - Rapporteur
- Dr. K. Velmourougane, Scientist, ICAR-CICR, Nagpur - Rapporteur

At the outset, Dr. M.V. Venugopalan, Member Secretary, introduced the Chairman and members of the RAC and Dr. V.N. Waghmare, Director (Acting), ICAR-CICR extended a formal welcome. After the introductory remarks by the Chairman and Members of RAC, Dr. M.V. Venugoplan presented the Action Taken Report on the recommendations of the last RAC meeting held on 1-2 Dec 2016 and the same was accepted. Dr. V.N. Waghmare, Director ICAR-CICR presented the cotton scenario and the salient achievements of the institute during the 12th Plan period. Later, the Heads of the Divisions and Regional Stations presented the research highlights of their respective Divisions/ Stations.

RAC members visiting the experimental fields

Dr. C. J. Dangaria, Chairman, RAC conducting the proceedings

On 5th January, 2018 the members of RAC visited the experimental fields, bio-control laboratory and poly-house facilities. A joint interaction session with all the scientists was held where the scientists expressed their views on the current problems and researchable issues on cotton.

Based on the presentations and discussions, field visits, laboratory visits and interaction with the scientists, the committee made the following specific recommendations:

1. Wild species garden maintained at ICAR-CICR is a diverse treasure for several genes imparting stress tolerance and fibre quality. A special programme on development of pre-breeding materials can be taken up using wild species so that valuable traits that are hidden in wild species can be utilized.
2. Irrigation using structured has been shown to improve yield of cotton. All the scientific data right from the point of field delivery of structured water to the soil and in the plant system should be generated so that the precise reasons for yield improvement could be elucidated
3. Impact of extreme climatic events on cotton and pest damage in relation to abiotic factors for past 30 years needs to be studied as a project. Studies on climate change/variability on production, productivity, pest dynamics on irrigated/rainfed cotton production system can be studied.
4. ICAR-CICR has developed a number of drought tolerant lines in the past. These drought tolerant lines identified in all the earlier programme needs to utilized in regular breeding programmes of the institute.
5. Diploid cotton is hardy and is known to perform well under adverse soil conditions. The diploid (*G arboreum*) cotton should be tried for their adaptability and performance on calcareous soils
6. The profits of cotton farmers are ultimately linked to the prices realized. Research on market intelligence for benefit of the farmers to forecast the price at pre-sowing, pre-harvest and post harvest to be formulated on priority
7. Pink boll worm has gained resistance to Bt toxins in several areas of central and south India. Genetic diversity and population structure of Pink Boll-worm needs to be studied in order to understand the differential nature of resistance among the PBW populations of north, central and southern India.
8. Infestation period, race diversity and microclimatic data of PBW need to be studied and to be utilized for design of management strategy to control PBW. Research may be intensified for investigation of intrusive and extrusive factors responsible for occurrence, severity, spread and damage due to PBW.

9. Push Pull strategy / molecules which attract the female moths for egg laying should be identified and formulated to address the Pink Boll-worm problem. Research on the deployment of semio-chemicals/kairomones/oviposition deterrents for the management of pink bollworm may be prioritized.
10. Minicore collection group of germplasm of *G. hirsutum* and *G. arboreum* should be generated based on the morphological as well as molecular marker data.
11. Gene based marker should be explored for fibre quality traits and their utilization in MAS.
12. GVS lines procured from USA are being used for crossing to incorporate CLCuV tolerance. The progenies must be tested for their reaction to sucking pests.

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

Institute Research Committee (IRC) meeting 2017

The Annual Institute Research Committee (IRC 2017) meeting of CICR was held on 1-3 April 2017 at CICR, Nagpur. Dr M.S. Ladaniya, Director (Additional Charge) CICR Nagpur chaired the meeting. Dr V.S. Nagrare Secretary IRC welcomed all dignitaries and scientists. Chairman in his introductory remarks, mentioned that research should be focused on strategic and basic aspects which would be the basis to support farmers of this country. He narrated some of the issues like resistance in pests against Bt-cotton that emerged in the recent years. Dr M S Kairon Ex- Director ICAR-CICR invited expert expressed concern over of increased cost of production. He mentioned that production increased to more than 400 lakh bales; however, net profit of farmers has not gone up. He appreciated the HDPS initiative. He suggested re-establishment of permanent manurial/rotation trials at all sites. He mentioned that labour cost has gone very high and every operation now has become costly which needs switching over to mechanization and diversification. He mentioned that before independence, majority area was under desi cotton but now >98% area is under hirsutum hybrids. This condition favours the risk of outbreak of pests and diseases in case of hybrids. Dr S. V. Sarode Ex-Director of Research (Dr PDKV, Akola) another invited expert, remarked that scientific findings should lead to recommendations. He exhorted that research should not be of only academic interest and it should have some practical utility. He expressed concern on depletion of natural resources like water and soil. All the Heads of the Divisions and Regional stations made a brief mention on research activities being carried out and the outcome of pre-IRC meetings held at respective Divisions and Regional stations. Dr M.V.Venugopalan presented the recommendations of Research Advisory Committee meeting held on 1-2 December 2016. Dr Vinita Gotmare presented the report of Research Framework Document (RFD) of the Institute. Dr V. S. Nagrare presented the Action Taken Report of the IRC 2016. New projects were discussed at length and completed & ongoing projects were reviewed critically. On this occasion IRC felicitated Dr N. Gopalakrishnan, Principal Scientist (Plant Biochemistry) CICR RS Coimbatore & EX ADG (Cash Crops) ICAR, who was due to be superannuated in the month of May 2017. Dr N. Gopalakrishnan presented life time achievements. Scientists from CICR, Nagpur, CICR RS Coimbatore and CICR RS Sirsa who attended the meeting took active part in discussions, finalization of projects and preparing the plan of work for 2017-18. A Booklet "Technologies generated from the Regional station during the past decade for the benefit of farmers (Hindi)" a publication by CICR RS Sirsa, Haryana was released at the hands of Chairman, IRC. In concluding remarks, Dr Sarode requested the scientists to take suggestions of the house in right spirit. He stressed on the need for discussing any technical programme thoroughly in the pre IRC meetings so that concrete programme can be designed. Dr M.S. Kairon suggested testing the technology at farmer's field to get correct feedback. In concluding remarks, Dr Ladaniya suggested following points for strict compliance.

- All the germplasm accessions should be properly maintained at institute as well at NBPGR.

- Breeding projects must include scientists from Pathology/ Entomology/ Agronomy.
- Biotechnology scientists should work in close association with the breeder.
- Socio-economic problems and impact of our technologies with relevance to cotton cultivation need to be studied.
- More emphasis should be given to utilize mechanical harvester due to low labour availability and high efficiency
- Design gene constructs for particular trait in relation to biotic and abiotic stress.
- Desi cotton with long staple to be evaluated thoroughly under HDPS.
- Registration of the Biopesticides and botanicals developed by the institute.
- Exploiting early maturing varieties to overcome pink bollworm infestation in cotton.
- Priority to be given to pheromone technology, preparing diagnostic kits (LAMP) and other ecofriendly approaches for cotton pest management
- He cautioned the scientist against pre-mature disclosure of information to the press and other media.

Dr V. S Nagrare, Secretary IRC and Dr J. H. Meshram Joint Secretary IRC coordinated the meeting.

Institute Research Committee (IRC) meeting 2018

The Annual Institute Research committee (IRC) meeting of ICAR-CICR was conducted as a combined IRC for CICR, Nagpur and CICR, RS, Sirsa from 22-24 March 2018 at CICR, Nagpur. Dr V.N. Waghmare, Director, (Acting) chaired the meeting. Dr M.V. Venugopalan, Incharge PME Cell and Member Secretary, Research Advisory Committee (RAC) presented the recommendations of RAC meeting held on 4-5 Jan 2018. Dr. K.Velmourougane, Secretary IRC presented the Action Taken Report of the previous IRC (2017). The IRC confirmed the minutes of the last IRC meeting.

The Chairman in his introductory remarks praised the remarkable contributions made by the scientists of CICR in Cotton Research and Development especially in creating awareness on pink bollworm and its management. He also applauded the scientist's role in analysis and documentation of Roundup Ready (RR Flex) or BG II (herbicide tolerant cotton) problem in cotton growing regions of India. Director urged all the scientists to address the new challenges in cotton production.

The IRC felicitated Dr S.L.Ahuja, Principal Scientist (Plant Breeding) CICR, RS, Sirsa who was due for his superannuation in the month of April 2018. Dr S.L.Ahuja presented his lifetime achievements in cotton research before the house.

Dr. K. Velmourougane, Secretary IRC and Dr. Dipak Nagrale, Joint Secretary IRC coordinated the meeting.

Project Monitoring and Evaluation Committee (PMEC)

The Project Monitoring and Evaluation committee (PMEC) meeting was held on 23rd September, 2017 at ICAR-CICR, Regional Station, Sirsa, Haryana, under the Chairmanship of Dr. V. N. Waghmare, Director (Acting) of ICAR-CICR, Nagpur. Dr. M.V. Venugopalan (Member Secretary), Dr. Nandini Gokte Narkhedkar, Dr. Punit Mohan and Dr. Vinita P. Gotmare members of the PMC were also present. Dr. Dilip Monga Head, ICAR-CICR-RS and all the scientific staffs namely, Dr. S. L. Ahuja, Dr. Ramavatar Meena, Dr. Om Prakash Tuteja, Dr. S. K. Verma, Dr. Rishi Kumar, Dr. Satish Kumar Sain and Dr. Amarpreet Singh presented their Institutional Research project activities. Each project activity was explained and discussed by their respective PI & Co-PI in detail. The field, Poly house and laboratory experiments being conducted at ICAR-CICR, Regional Station, Sirsa were visited and monitored by the PMEC members. PME Committee gave certain recommendations for improving the research programmes.

Dr. V.N. Waghmare, Director (Acting) of ICAR-CICR, Nagpur appreciated the research activities being undertaken by the scientists of ICAR-CICR, Regional Station, Sirsa, Haryana. The meeting ended with a vote of thanks by Dr. Dilip Monga, Pr. Scientist and Head, ICAR-CICR, Regional Station, Sirsa, Haryana.

10.5 : Other Important Workshop/ Symposia/Meetings/Visits

Visit of Hon'ble Agriculture Minister Shri Radha Mohan Singhji

Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers Welfare, Govt. of India visited ICAR-CICR, Nagpur on 04th June, 2017. He visited the farm and laboratories. He addressed the CICR staff and appreciated the good work being done on developing cotton production and protection technologies and its dissemination to the farmers across the country.

Meeting on "Breakdown of resistance of Bt cotton BG II to pink bollworm"

A meeting was held on "Breakdown of resistance of Bt cotton BG II to pink bollworm" at, ICAR-CICR, Nagpur on 18th August 2017 under the Chairmanship of Dr. R. K. Singh, Asst. Director General (Commercial Crops), ICAR, New Delhi. Dr Nandini Gokte Narkhedkar, Principal Scientist and HoD I/c Crop Protection Division welcomed the participants. Dr M. S. Ladaniya Director ICAR-CICR (Additional charge) highlighted the issue of pink bollworm. Dr R. K. Singh in his opening remarks, highlighted the concern about reports on pink bollworm resistance development at various parts of India. Issues related to breakdown of Bt cotton BG II resistance to bollworm discussed at length. On this occasion, a booklet on "Pink bollworm management in Cotton" (Marathi) was released at the hands of Dr. R.K. Singh. Dr V.N. Waghmare, Head, Division of Crop Improvement, Dr Blaise DeSouza, Head i/c Crop Production Division, Dr Nandini Gokte-Narkhedkar, Head i/c, Division of Crop Protection, Dr A.H. Prakash, PC and Head i/c, CICR RS Coimbatore, Dr Dilip Monga, Head, CICR RS Sirsa attended the meeting. Among the scientists Dr R. B. Singandhupe, Dr S.M. Wasnik, Dr Dhara Jothi, Dr Vishlesh Nagrare, Dr G. Balsubramani, Dr Rishi Kumar, Dr V. Chinna Babu Naik, Dr Shailesh Gawande and Dr Dipak Nagrale participated in the discussion. Dr Vishlesh Nagrare proposed vote of thanks.

Visit to pink bollworm affected areas of Yavatmal district on 26.09.2017

Dr Vishlesh Nagrare, Dr V. China Babu Naik and Shri Bhausaheb Naikwadi visited the pink bollworm affected area of Maregaon, Dist Yavatmal.

Seventh Asian Cotton Research and Development Network Meeting (ACRDN) at Nagpur

The Indian Society for Cotton Improvement (ISCI) Mumbai, in collaboration with International Cotton Advisory Committee (ICAC), ICAR-Central Institute for Cotton Research (CICR), Nagpur and ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai, organized the 7th Asian Cotton Research and Development Network meeting at Nagpur, Maharashtra, India during September 15-17, 2017.

The meeting was inaugurated by Dr Terry Townsend, Former Executive Director, International Cotton Advisory Committee, Washington DC on 15 Sept. 2017. Dr. AK Singh, Deputy Director General (Crop Science),

Indian Council of Agricultural Research delivered the presidential address.

The theme of the 7th ACRDN meeting was "Production of quality fibre and doubling cotton farmers' income". Two hundred and thirty nine delegates comprising of researchers, Government officials, experts from trade and industry and farmers representing India, Bangladesh, Egypt, Australia and USA participated in the meeting.

Dr. Mrs. Kavita Gupta, Textile Commissioner, Government of India, chaired the valedictory session and delivered the valedictory address. She spoke on the rich heritage of cotton in Asia and the current relevance of cotton production and utilization to the development of the region. Dr. Kavita Gupta emphasized on the need for doubling farm income and suggested a pathway for doing so through a combination of low cost yield enhancement technologies.

Dr. P.G. Patil, Director, ICAR- CIRCOT was elected as the Chairman of the Network until the next ACRDN meeting. The meeting ended with a vote of thanks proposed by Dr. C. Sundaramoorthy, Senior Scientist, ICAR-CIRCOT, Mumbai.

Spread over 3 days, there were 29 technical sessions including 1 plenary session, 1 panel discussion, 1 open forum for young researchers, two open sessions, 1 poster session and 24 concurrent sessions. Out of 126 abstracts received, 40 were presented in poster session and 72 were presented in oral sessions.

Yavatmal visit on pesticide poisoning on 28.9.2017

A team comprising of four scientists had a joint visit with officials from Dr. Panjabrao Deshmukh Krishi

Interaction with Shri Madan Yerrawar, Guardian Minister, Yavatmal on 28.09.2017

Vidhyapeeth, Akola; Krishi Vigyan Kendra, Yavatmal; Zilla Parishad, Yavatmal; Agriculture department, Govt of Maharashtra. Total 19 members were in joint survey team. The survey team discussed the issue of insecticide poisoning with Shri Madan Yerrawar, Guardian Minister, Yavatmal.

The survey team also participated in a meeting convened under the Chairmanship of Shri Kishor Tiwari, Chairman, Vasantrao Naik Shetakari Swavlamban Mission at Revenue Bhawan, Office of the District Magistrate, Yavatmal. The meeting was attended by Shri Madan Yerrawar, Guardian Minister, Yavatmal; Vice President of Zilla Parishad, Yavatmal; Secretary, Department of Health; District Magistrate, Yavatmal; Chief Executive Officer, Zilla Parishad, Yavatmal and all the members of survey team. The issue of insecticide poisoning to farmers/ farm labourers was discussed. It was instructed that the related machineries at district level such as Zilla Parishad, Agri Department, Health Department, etc. should work in coordination to handle the issue and also to take initiatives regarding creating awareness about safety measures, making available antidotes as first aid for insecticide poisoning at primary health care centers at village levels.

Scientist teams visited Yavatmal on 13.10.2017

Six teams comprising of 24 scientists visited Wardha, Chandrapur and Yavatmal districts and collected information on cotton pest situation, insecticide usage in relation to pesticide poisoning cases. The team of Scientists visited cotton fields, interacted with farmers and farm labourers involved in the spraying of insecticides and also met with the families affected with insecticide poisoning.

A report on pesticide poisoning in Vidarbha region of Maharashtra has been prepared based on the surveys, interaction with farmers/farm labourers, research

experiences, published reports in scientific journals and extracts from media reports/ coverage/ interactions. Yavatmal, Wardha, Chandrapur, Amaravati, Akola, Buldhana, Washim and Nagpur are the major cotton growing districts of Vidarbha region of Maharashtra.

Meeting with Shri Sharadji Pawar and Shri Anil Deshmukh

Dr V. N. Waghmare Director (Acting), CICR, Nagpur , Dr Nadini Gokte Narkedkar and Dr V. S. Nagrare in a meeting with Shri Sharad Pawar, Former Union Minister, Ministry of Agriculture and Farmers Welfare and Shri Anil Deshmukh Former Cabinet Minister for Food, Civil Supplies and Consumer Protection, Maharashtra on 18thNovember 2018 at Nagpur Airport discussed Pink bollworm infestation situation in Maharashtra. Dr. Waghmare appraised them about the strategies developed by CICR to tackle the Pink bollworm problem and steps being undertaken by CICR in creating awareness about the management strategies among the farmers. He also updated them about pesticide poisoning cases from the district of Yavatmal in Maharashtra.

Visit of State Agriculture Minister to ICAR-CICR

Shri. Sadabhau Khot, Honourable Minister of State for

Agriculture, Horticulture and Marketing, Govt. of Maharashtra visited ICAR-CICR, Nagpur on 12th December, 2017. The In-charge Director, Dr. D. Blaise explained about the various proactive steps taken by ICAR CICR Nagpur from the time the occurrence of the Pink bollworm on Bt cotton was reported. The minister visited experimental fields and laboratories of CICR along with the scientific staff and interacted with them regarding various measures to be taken to prevent Pink bollworm infestation in cotton. He also visited the Pink bollworm resistant monitoring laboratory and interacted with Entomology Scientists, Dr. V. Chinna Babu Naik, Dr. Vishlesh Nagrare and Dr. Babasaheb Fand. Dr. Balasubramani, Principal Scientist, Biotechnology explained about the method of detection of cry toxins from Bt cotton samples during the visit to Bt referral and Biotechnology laboratories. Honourable Minister in his remarks, appreciated the work done by ICAR- CICR in Pink bollworm management. Dr. Suman Bala Singh, proposed the vote of thanks. Mr. N.T. Shisode, Joint Director of Agriculture, Maharshtra State also attended the meeting. Smt. Rama Iyer, Private Secretary, to the Director, CICR contributed a lot for arranging the meeting.

High level Meeting on Pink bollworm

In view of Pink bollworm damage on cotton crop in Maharashtra during the current year, a high-level meeting was organised at Maharashtra Chief Minister's residence, Ramgiri, Nagpur on 17th December, 2017. On this occasion, Sh. Radha Mohan Singh, Honb'le Union Minister of Agriculture and Farmers Welfare, Govt. of India; Sh. Devendra Fadnavis, Chief Minister, Maharashtra, Sh. Nitin Gadkari,. Union minister for Transport; Sh Pandurang Fundkar, Agriculture Minister, Maharashtra, Sh. Subhas Deshmukh, Minister, Cooperative Maharashtra, Sh. Pasha Patel, Chairman of Maharashtra State Commission for Agriculture and Prices, Sh Krupal Tumane, MP; Sh. Sadabhau Khot, Minister of State (Agriculture), Sh. Anil Bonde, MLA; Mr Bijay Kumar, Principal Secretary (Agriculture), Maharashtra, Mr S. P. Singh, Agriculture Commissioner and Mr Sanjay Patil were present. Union Agriculture Minister appreciated the steps taken by the ICAR-CICR for the management of PBW in Gujarat. Mr Sharad Pawar, Former Union Minister of Agriculture joined the discussion through video conferencing. From ICAR, Dr A.K. Singh, DDG (Crop science); Dr P.K. Chakrabarty, ADG (PP); Dr R. K Singh, ADG (CC); Dr V. N. Waghmare, Director (Acting), CICR; Dr V.S. Nagrare, Principal Scientist (Entomology), CICR were participated. Dr Venkateshvarulu, VC VNMAU Parbhani, Dr Vilas Bhale, VC Dr PDKV Akola and Dr Vishvanath, VC MPKV Rahuri also attended the meeting. Among the special invitees Dr C.D. Mayee, Former Chairman, ASRB and Dr Sharad Nimbalkar, Ex Vice chancellor made it convenient to attend the said meeting. After discussion, it was decided to send proposal for relief fund from Central Govt.

Visit of Shri Bijay Kumar, Principal Secretary (Agriculture) and Shri S.P. Singh, Agriculture Commissioner

Shri Bijay Kumar, Principal Secretary (Agriculture) and Shri. S. P. Singh, Agriculture Commissioner, Agriculture Department Government of Maharashtra visited ICAR-CICR along with Sh. Vijay Ghavate, Mrs. Pradyna Golghate, SAO, Nagpur, Mr Milind Shende, SAO, on 25th January, 2018. Dr. V.N. Waghmare,

Director (Acting), CICR, Dr. V. S. Nagrare, Dr. Chinna Babu Naik, Dr. R.B. Singandhupe, Dr. G. Balasubramani explained the details to the dignitories on the issue of pink bollworm and herbicide tolerant (HT) cotton. They visited biotechnology lab, Bt referral lab, tissue culture lab and insectary. Scientists Dr. K. P. Raghavendra, Mr. Rakesh Kumar, Dr. Vivek Shah explained the research work on these aspects.

Awareness workshop on agricultural inputs to dealers at CICR

Awareness workshop to 40 agricultural input dealers from Chandrapur districts was organized on 30th December, 2017. Dr. V.N. Waghmare, Director (Acting), ICAR-CICR, Nagpur in his address dealt with issues associated with Bt cotton cultivation. Dr. Waghmare urged the input dealers to supply input in proper way so that judicious use of agrochemicals and fertilizers can be done at the farmers end. In this context, recent insecticides poisoning cases happened in Yavatmal and other cotton growing districts of Maharashtra were highlighted. Dr. B.B. Fand Scientist (Entomology) presented integrated Pink bollworm management strategies devised by ICAR-CICR. Dr. Vishlesh Nagrare, Principal Scientist (Entomology) advised strict adherence of label claim, avoid chemical mixture and excessive use of pesticides. Dr. Jayant Meshram, Senior Scientist (Plant Physiology) and Dr. S.P. Gawande, Scientist (Plant Pathology) also interacted regarding abiotic and biotic stresses and their management respectively. A visit was arranged to Bt referral laboratory by Dr. Vivek Shah, Scientist (Entomology).

Training on seed production at ICAR-CICR RS, Coimbatore

Awareness cum training programme on cotton cultivation and seed production was organised at Elagiri hills, Jolarpettai, Thirupattur Taluk, Vellore District, Tamil Nadu on16.3.2018 under the Tribal sub plan of National Seed Project (crops) 2017-18. Scientists of ICAR-CICR, Regional Station, Coimbatore delivered lecture on various aspects of cotton seed production and cultivation. 126 tribal farmers attended the training. Inputs such as seeds and pesticides were distributed to farmers for use in the ensuing crop season.

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

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
1.	Annual Group Meeting of All India Coordinated Cotton Improvement Project	TNAU, Coimbatore April 08-10, 2017	V.N. Waghmare, Punit Mohan, S.M.Palve, S.S. Mahajan, M. Sarvanan, H.B. Santosh, G.Balasubramani, J. Amudha, J.H.Meshram, S.Kranthi A H Prakash, K Rathinavel, S Manickam, B Dhara Jothi, K P M Dhamayanthi,

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
			J Gulsar Banu, K Sankara Narayanan, P Nalayini, Isabella Agarwal, S Usha Rani, R Raja , K Rameash , M Sabesh , C. Karpagam, M Amutha, K Shankar Ganesh , D Kanjana, A. Manivannan, D.Monga, Rishi Kumar, SK Verma, MV Venugopalan
2.	State–wise Coordination Committee meeting for doubling farmers income by 2022 organized by ICAR -NIASM Baramati (Maharashtra)	College of Agriculture Pune on 3.4.2017. NRC Grape, Pune on 27.4.2017 and at CCRI , Nagpur on 23.11.2017	RB. Singandhupe
3.	Attended Meeting of interstate consultative committee for the management of whitefly in North Zone	Bahinda/Abohar 02 May, 2017, 03 June, 2017, 17 & 18 July, 2017, 29 July, 2017	D.Monga Rishi Kumar
4.	A meeting on "Present status and future strategies to promote coloured cotton" chaired by Hon'ble DG	DG's Committee Room, Krishi Bhawan, New Delhi 08 May 2017	Vinita Gotmare
5.	*Desi* cotton workshop	Karanja Washim. 16th May, 2017	S.M Wasnik
6.	21st Cotton TAP steering committee meeting.	Udhyog Bhavan, New Delhi 17 May 2017.	SK Sain
7.	Meeting with agriculture commissioner on resistance development by pink bollworm	Pune, 22 May 2017	V. S. Nagrare,
8.	Interface meeting on enhancing preparedness of agricultural contingencies in *Kharif* 2017 for Maharashtra	Central Building, Pune, 2 June, 2017	Ramkrushna G.I.
9.	Textile India 2017	Mahatma Mandir, Gandhinagar, Gujarat June 30 to July 2, 2017	Blaise Desouza MV. Venugopalan RB. Singandhupe

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
10.	International Conference on "Recent trends in Agriculture, Biotechnology and Food processing	College of Agriculture, Hassan, Karnataka July 5-7, 2017.	Savitha Santosh Pooja Verma Madhu T. N.
11.	Institute Management Committee Meeting of ICAR-CRIJAF	ICAR-CRIJAF, Kolkata July 6, 2017	R. Raja
12.	International Conference on Recent trends in Science and Technology ICRTS-2017	Shivaji Science College, Nagpur July 12-14, 2017.	Raghavendra K.P, Rakesh Kumar Joy Das, Chandrashekar N, Vinita Gotmare, Santosh, H. B., Savitha Santosh, Pooja Verma, Madhu T. N.
13.	Annual Zonal workshop of KVK's	YCMOU, Nashik, 23-25 July 2017	RB. Singandhupe
14.	Curriculum Development workshop for the Doctoral degree programme at Department of Nano Science & Technology, TNAU	TNAU, Coimbatore July 26- 27, 2017	K. Rameash
15.	Nation Water Mission Programme on cotton crop	CGO Complex New Delhi 10 August, 2017.	RB. Singandhupe
16.	Third national conference on "Agriculture Scientific Tamil"	TNAU, Coimbatore August 12-13 , 2017	K. Sankaranarayanan C. Karpagam
17.	Visited the AICRP trials at Nanded, Parbhani and Akola centres	Nanded, Parbhani & Akola 19-20 August 2017	R K Singh, ADG (CC) V.N.Waghmare A H Prakash
18.	Specifying sample size and Tolerance level for testing transgene purity of Bt Cotton seed lots	Seed Centre, TNAU, Coimbatore August 28, 2017	K Rathinavel
19.	Meeting on "Mobile app for pest identification and dissemination of pest management methods"	New Delhi 28 Aug 2017	V. S. Nagrare
20.	SANKALP SE SIDDHI programme	KVK MYRADA, Gobi, August 29, 2017	C. Karpagam
21.	Review meeting of DUS, submission on seed and planting material under DAC organized at	Seed Centre, TNAU, Coimbatore August 30, 2017	K Rathinavel

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
22.	7th Asian Cotton Research & Development Network Meeting	ICAR-CICR, Nagpur September 15-17, 2017	V. N. Waghmare, S.M.Palve, Raghavendra, K.P, Rakesh Kumar, Joy Das, Chandrashekar N, Santosh H.B., Vinita Gotmare, Blaise Desouza, MV. Venugopalan, RB. Singandhupe, S.M Wasnik, G. Majumdar, P. Nalayini, JH. Meshram, K. Velmourougane, G.I. Ramkrushna, A. Manikandan, Pooja Verma, Nandini Gokte Narkedkar, V. S. Nagrare, Madhu T.N., Dipak Nagrale, Neelkanth Hiremani, ChinnaBabu Naik,, S. Manickam, P. Nalayini, K. Sankaranarayanan, R. Raja, S. Usha Rani, M. Sabesh, K.Shankarganesh, D Monga, S.L. Ahuja,. R.A. Meena, S.K. Verma, Rishi Kumar, S.K. Sain.
23.	Monitoring of the cotton DUS trials at the Department of cotton	CCSHAU on September 20, 2017 PAU on Sep. 21, 2017	K Rathinavel
24.	Participation & presentation of EFC Memo of the Institute	ICAR, Krishi Bhawan, New Delhi 21 September 2017	V.N.Waghmare M V Venugopalan
25.	Brainstorming on "Thrips: Challenges and Management Options"	New Delhi, 22 Sept 2017	V. S. Nagrare
26.	Evaluation of unique germplasm lines by Germplasm Identification Committee & implementation and monitoring the progress of technical programme of ICAR-CICR Regional Station, Sirsa	ICAR-CICR Regional Station, Sirsa 23 September 2017	V.N.Waghmare Nandini Narkhedkar M V Venugopalan Vinita Gotmare Punit Mohan
27.	Meeting with Shri Hansaraj Ahir, Hon'ble Minister of State for Home affairs, Govt of India for discussion on pesticide poisoning in Yavatmal.	Nagpur 9th & 16th October , 2017	V. N Waghmare, Nandini Gokte Narkhedkar, V. S. Nagrare, V. Chinna Babu Naik

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
28.	NICRA expert review committee meeting and presented the progress report of NICRA project on IPM of Whitefly	NASC Complex ,Delhi 23-24 October,2017	Rishi Kumar
29.	Meeting in connection with the Pink bollworm project under the chairmanship of DDG (CS)	ICAR, Krishi Bhawan, New Delhi. 24-25 October 2017	V.N.Waghmare Nandini Narkhedkar A H Prakash B Dhara Jothi V S Nagrare V Chinna Babu Naik D Monga Rishi Kumar
30.	Special Investigation Team meeting on Pesticide issues in Vidarbha Region	Commissioners Office, Amravathi 25 October 2017	Vinita Gotmare M V Venugopalan
31.	Review meeting on breakdown/susceptibility of BGII cotton to pink bollworm and its increasing infestation in State of Maharashtra, Telangana and Gujarat	Krishi Bhavan, New Delhi, 25th October 2017	V.N.Waghmare D. Monga, A. H Prakash, Nandini Gokte Narkedkar, B. Dharajothi, V. S. Nagrare, V. China Babu Naik Rishi Kumar
32.	Special Investigation Team (SIT) meeting (Constituted by Govt. of Maharashtra) in connection with death of farmers / farm labourers due to insecticide poisoning under the chairmanship of Commissioner (Revenue), Amravati Division	Revenue Bhawan, Yavatmal 30 October 2017	V.N.Waghmare V S Nagrare
33.	SIT's meeting in connection with death of farmers / farm labourers due to insecticide poisoning under the chairmanship of Commissioner (Revenue), Amravati Division	Commissioner (Revenue), Amravati Division, at Revenue Bhawan, Amravati. 1 November, 2017, 6 November 2017, 21 November 2017 and 27 November 2017	V.N.Waghmare
34.	Workshop for Liaison Officers of SC/ST organised by Department of Personnel and Training	ISTM, New Delhi. 2nd to 3rd November, 2017	S.M Wasnik
35.	SIT's meeting in connection with death of farmers / farm labourers due to	Divisional Commissioner	V.N.Waghmare

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
	insecticide poisoning under the chairmanship of Divisional Commissioner (Revenue) at Akola.	(Revenue) at Akola. 3 November 2017	
36.	Regional Agriculture Workshop organised by Field Publicity Dept, Min of Information & Broadcasting, GOI	Hotel Tuli Imperial, Nagpur 10 Nov. 2017	S.M Wasnik
37.	Brainstorming Session & Assessment Survey to assess the efficacy of mating disruption technology against pink boll worm	UAS, Raichur on November 10, 2017	K. Rameash
38.	Meeting of the Field Inspection & Scientific Evaluation Committee (FISEC) regarding spread of unapproved Herbicide Tolerant (HT) cotton in the country held in	Biosafety Support Unit, Lodhi Road, NBC Building, New Delhi 15 November 2017 & 29 November 2017	V.N.Waghmare
39.	24th ITMU meeting of Sugarcane breeding Institute	SBI, Coimbatore on November 16, 2017	K Rathinavel
40.	Meeting with DDG on trait value ofvBGII	New Delhi 21 Nov 2017	V. S. Nagrare, V. China Babu Naik
41.	Joint Workshop: on "Experience sharing in plant variety protection" under bilateral co-operation between Germany and India on Seed Sector Development	New Delhi, November 21-22 2017	Sunil S. Mahajan
42.	Rural advisory programme committee meeting of AIR	Akashwani, AIR. Nagpur 24 November, 2017	S.M Wasnik
43.	CROPSAP steering committee meeting pink bollworm management in next season chaired by Ag commissioner, Maharashtra	Pune, 29 Nov 2017	V. S. Nagrare,
44.	"INDO-US symposium on Curbing Whitefly-Plant Virus Pandemics: The Departure from Pesticides to Genomics"	PAU Ludhiana 4-5th Dec 2017.	D. Monga Rishi Kumar,
45.	Meeting of the Committee for Preparing Quality Research Data Acquisition Guidelines	KAB-II, New Delhi, December 05, 2017	MV Venugopalan
46.	Meeting regarding illegal sale of herbicide tolerant cotton crop and decreased resistance of Bt cotton to Pink bollworm under the chairmanship of Hon'ble Chief Secretary, Govt. of Maharashtra	Mantralaya, Mumbai 8 December 2017	V.N.Waghmare

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
47.	Consultative Committee meeting of the Cotton Advisory Board and Main Committee Meeting of CAB under the chairmanship of Dr. Kavita Gupta, Textile Commissioner	Mumbai. 11-12 December 2017	V.N.Waghmare M V Venugopalan
48.	International seminar on Global Climate Change: Implications for Agriculture and water sectors	WALMI, Aurangabad, December 14-16,2017	SB Singh JH. Meshram
49.	Review Meeting on "Progress on ZTMC (Zonal Technology Management Centre) Activities in ICAR Crop Research Institutes in the Southern Indian Zone"	IIMR, Hyderabad 16th Dec. 2017	G. Balasubramani
50.	Review meeting on pink bollworm status and management chaired by Chief Minister of Maharashtra	Nagpur 17 Dec 2017	V.N.Waghmare Nandini Gokte Narkedkar, V. S. Nagrare, V. China Babu Naik
51.	Review Meeting of ICAR Institutes of Nagpur	Ramgiri (CM's residence), Nagpur December 17, 2017	V N Waghmare, G Balasubramani Suman Bala Singh Raghavendra K.P., Santosh, H. B.
52.	Meeting regarding the discussion of the results obtained under common zonal trials during 2017-18	PAU Ludhiana 18 Dec. 2017	D.Monga S.K.Verma Rishi Kumar
53.	Group Monitoring Workshop organized by Science for Equity, Empowerment and Development (SEED) Division, Department of Science and Technology	Fakir Mohan University, Balasore, December 29-30, 2017	K. Shankarganesh
54.	Visited Buldhana and Jalna in connection with the evaluation of sampling done on HT Bt cotton seeds of the MAHYCO Seed Godown as per the committee constituted by the Director General, ICAR.	Buldhana & Jalna 6–7 January 2018	R K Singh (ADG-CC) V.N.Waghmare M V Venugopalan G Balasubramani
55.	Academia	GTC, Nagpur 11 Jan. 2018	Blaise Desouza
56.	ICAR-CICR Nominee in the central team of 'Field Inspection & Scientific Evaluation Committee' (FISEC) to ascertain the extent of spread of unapproved Herbicide Tolerant (HT) cotton	Cotton growing regions of Gujarat & Telangana January 11-12 2018.	Balasubramani, G. Raghavendra, K. P

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
57.	Workshop cum Training on Cluster Front line Demonstration on Pulses and oilseed crops	KVK Solapur (Maharashtra), 16 Jan 2018	RB. Singandhupe
58.	21 days winter school training on Insecticide Resistance to BT toxins and insecticides in cotton,	ICAR-CICR, Nagpur, 18th January 2018 to 7th February, 2018	K. Shankarganesh
59.	CAFT training on Recent advances and accomplishments in heterosis breeding	CPBG, TNAU, Coimbatore January 31 February 20, 2018	A. Manivannan
60.	International Conference on Biocontrol and Sustainable Insect Pest Management	Agricultural College and Research Institute, Killikulam, 29-31, January 2018	M. Amutha
61.	ARYA meeting	Gujarat Agricultural University, Navsari, 31 January , 2018	RB. Singandhupe
62.	Meeting w.r.t. Formulation of Price Policy for *Kharirf* season (2018-2019) under the chairmanship of Chairman, Commission for Agricultural Costs and Prices (CACP)	Krishi Bhawan, New Delhi 1 –2 February 2018	V.N.Waghmare
63.	13th meeting of the Inter Regional Network on the Mediterranean and Middle East regions	Luxor, Egypt February 2-6, 2018	S. Usha Rani S.M.Palve, MV Venugopalan
64.	Programme on Competency Enhancement program for effective implementation of training function by HRD Nodal Officer at ICAR	NAARM, Hyderabad Feb.15-17, 2018	JH. Meshram
65.	International Congress on Cotton and other fibres	ICAR research complex for NEH region, Meghalaya February 20-23, 2018	Vinita Gotmare, S M Palve, P. Nalayini, S. Usha Rani, C. Karpagam, K.Shankarganesh, D Monga, OP Tuteja SK Sain, JH. Meshram, Nandini Gokte Narkhedkar
66.	International conference on Emerging synergies in Agriculture, Food processing, Engineering and Biotechnology	Karunya Institute of Technology and Sciences, Coimbatore, February 21-23, 2018	M. Amutha D. Kanjana
67.	National science day celebration	PSG Tech, Coimbatore, February 27, 2018	C. Karpagam

Sr. No.	Seminars/Conferences/Symposia/ Workshops/ Meetings	Place and Date	Participants
68.	Tribal Farmers Training program	Dhaga, Karanja Ghadge organized by Suyash Charitable Trust March 5 2018	P R Vijayakumari
69.	Tribal Farmers Training Program	Umred Cluster under Mera Gaon Mera Gaurav of TSP-MSP March 8 2018	Vinita Gotmare A R Raju P R Vijayakumari S M Wasnik Prabhulinga T Chandrashekar N A Manikandan U Galkate R Ramteke
70.	International Conference on "Invigorating Transformation of Farm Extension towards Sustainable Development: Futuristic Challenges and Prospects" INTFES 18	TNAU, Coimbatore March 9-10, 2018	S. Usha Rani
71.	International Extension Conference	TNAU, Coimbatore, March 9-10, 2018	C. Karpagam
72.	Meeting on sponsored programs on Doordarshan, Mumbai	Pune, 13 March 2018	V. S. Nagrare
73.	National Workshop on 'Revisiting FOCARS: Reflections and Feedback of Trained Scientists'	ICAR-NAARM, Hyderabad. March 15-16, 2018	Neelkanth Hiremani
74.	National Food Security Mission "programme of Maharashtra	Mantralaya Mumbai, 17 Mar 2018	RB. Singandhupe
75.	International Cotton Conference	Bremen , Germany March 21-23, 2018	D.V.Patil
76.	State Level Biosafety Capacity Building Workshop	TNAU, Coimbatore March 23, 2018	S. Manickam
77.	Metting on pink bollworm resistance on BGII cotton	Krishi Bhavan, New Delhi	V.N.Waghmare A H Prakash Nandini Narkhedkar B Dhara Jothi V S Nagrare V Chinna Babu Naik D Monga Rishi Kumar

Field days

Sr. No.	Field days	Place and Date	Participants
01	Field day on cotton in villages adopted by Better Cotton Initiative (BCI)	02.08.2017 at Bharu Khera (100 farmers), Ganga (150farmers) Abubshahar (150farmers)	Dr. D.Monga and Dr Rishi Kumar
02	Field day on cotton in BCI adopted villages	03.08.2017 at Chatha(70), Desu (100), Sakta Khera(50)	Dr D.Monga and Dr Rishi Kumar
03	Field day on cotton organized by Department of Agriculture, Sirsa	28.09.2017 at Gauriwala (Sirsa)	Dr Rishi Kumar
04	Field day on cotton organized by Rasi Seeds	09.10.2018 at Matdadu (Sirsa)	Dr D.Monga and Dr Rishi Kumar

10.7 : Distinguished Visitors

Nagpur

Ethiopian Delegation headed by Asfawesen Alene, DG, EIIDE and other officials representing EIIDE, ETIDI and CPGEA visited ICAR-CICR, Nagpur on 3 May, 2017 to understand the production and post harvest technologies, value addition, pricing and marketing structure

Name & Designation	Organisation	Date
Coimbatore		
Dr. M. S. Kairon	Former Director, ICAR- CICR, Nagpur	11th April 2017
Dr. S. V. Sarode	Former Director of Research, PDKV, Akola	11th April 2017
Dr. Asfawesen Alene	DG, EIIDE	3rd May 2017
Sh. Radha Mohan Singh	Hon'ble Minister for Agriculture & Farmers Welfare	4th June, 2017
Dr. R. K. Singh	ADG (Commercial Crops)	18th August 2017
Dr. C.D. Mayee	Former Chairman, ASRB	9th September 2017
Dr. A.K. Singh	Deputy Director General (CS)	15th September 2017
Shri Sadabhau Khot	Hon'ble State Minister of Maharashtra for Agriculture & Horticulture	12th December 2017
Shri. Bijay Kumar	Principal Secretary (Agriculture), Maharashtra State	25th January, 2018
Shri. S. P. Singh	Agriculture commissioner, Maharashtra State	25th January, 2018

Sirsa

Visit of Monitoring teams at ICAR-CICR Regional Station, Sirsa.

AICRP Monitoring Team

The monitoring team comprising of Dr S.M. Palve, (Plant Breeding), Dr N.V.S. Durga Prasad, Senior Scientist (Entomology), Dr K.B. Pawar, Junior Pathologist and Dr. C. Karpagam, Senior Scientist (Agricultural Extension) visited ICAR-CICR Regional Station, Sirsa on 07.10.2017

Monitoring team for AICRP Trial on cotton during field visit

10.8: Personnel

Name of the Officers/Scientists	Designation
MS Ladaniya	**DIRECTOR (Additional Charge) relieved on 08.09.2017**
VN Waghmare	**DIRECTOR (Acting) joined on 08.09.2017**
AH Prakash	**PC & Head (Acting), CICR RS, Coimbatore**
Dilip Monga	**Head, ICAR-CICR Regional Station, Sirsa**
CROP IMPROVEMENT DIVISION	
V N Waghmare	**Head**
1 GENETICS & PLANT BREEDING	
Nagpur	
V N Waghmare	Principal Scientist
Smt. S B Singh	Principal Scientist
S B Nandeshwar	Principal Scientist **(Retired on 31.08.2017)**
T R Loknathan	Principal Scientist
S M Palve	Principal Scientist
Smt. Vinita Gotmare	Principal Scientist
DV Patil	Senior Scientist
M Saravanan	Scientist
HB Santosh	Scientist
Coimbatore	
Smt. K P M Damayanthi	Principal Scientist
S Manickam	Principal Scientist
Manivannan A	Scientist
Sirsa	
S L Ahuja	Principal Scientist
O P Tuteja	Principal Scientist
S K Verma	Principal Scientist
2 ECONOMIC BOTANY & PLANT GENETIC RESOURCE	
Nagpur	
Punit Mohan	Principal Scientist **(Retired on 31.01.2018)**
3 SEED SCIENCE & TECHNOLOGY	
Nagpur	
Smt. P R Vijayakumari	Principal Scientist
Smt. V Santhy	Principal Scientist
SS Mahajan	Senior Scientist
Coimbatore	
K Rathinavel	Principal Scientist
Sirsa	
RA Meena	Principal Scientist
4 AGRIL. BIOTECHNOLOGY	
Nagpur	
G Balasubramani	Principal Scientist
Smt. J Amudha	Principal Scientist
K P Raghavendra	Scientist
Joy Das	Scientist **(on study leave from 28.12.2017)**
Rakesh Kumar	Scientist
Chandrashekhar N	Scientist
CROP PRODUCTION DIVISION	
Blaise Desouza	**Head (Acting)**

Name of the Officers/Scientists	Designation
1. AGRONOMY	
Nagpur	
Blaise Desouza	Principal Scientist
R. B. Singandhupe	Principal Scientist
MV Venugopalan	Principal Scientist
A R Raju	Principal Scientist
Ramkrushna I Gandhiji	Scientist
Coimbatore	
Smt P Nalayani	Principal Scientist
K Shankaranarayanan	Principal Scientist
D Raja	Senior Scientist
Sirsa	
Amarpreet Singh	Scientist **(Joined on 17.07.2017)**
2. SOIL SCIENCE	
Nagpur	
A Manikandan	Scientist
Coimbatore	
Smt D Kanjana	Scientist
3. FARM MACHINERY & POWER	
Nagpur	
G Majumdar	Scientist
4. PLANT PHYSIOLOGY	
Nagpur	
JH Meshram	Senior Scientist
Coimbatore	
A. H. Prakash	Principal Scientist
Smt. Annie Sheeba	Scientist
5. PLANT BIOCHEMISTRY	
Nagpur	
Ms. Pooja Verma	Scientist
6. AGRIL. MICROBIOLOGY	
Nagpur	
K Velmourougane	Scientist **(Joined on 19.08.2017 after study leave)**
Smt. Savitha Santosh	Scientist
7. AGRIL. EXTENSION	
Nagpur	
S M Wasnik	Principal Scientist
Coimbatore	
Smt. Usha Rani	Principal Scientist
C Karpagam	Senior Scientist
8. AGRIL. ECONOMICS	
Nagpur	
AR Reddy	Principal Scientist
Smt. Anuradha Narala	Scientist
Coimbatore	
Smt. Isabella Agarwal	Principal Scientist
9. COMPUTER APPLICATION IN AGRICULTURE	
Coimbatore	
M Sabesh	Scientist

Name of the Officers/Scientists	Designation
CROP PROTECTION DIVISION	
Nagpur	
Smt. Sandhya Kranthi	**Head (Acting)**
Smt. Nandini Narkhedkar	**Head (Incharge)**
1 AGRI. ENTOMOLOGY	
Nagpur	
Smt. Sandhya Kranthi	Principal Scientist
V S Nagrare	Principal Scientist
Chinna Babu Naik V	Scientist
Smt. Rachna Pande	Scientist
Babasaheb Fand	Scientist **(Joined on 01.06.2017)**
Prabhulinga Tenguri	Scientist **(on study leave from 27.08.18 to 26.08.21)**
Madhu TN	Scientist **(on study leave from 11.09.18 to 10.09.20)**
Vivek Hanskumar Shah	Scientist
Coimbatore	
Smt. B Dhara Jothi	Principal Scientist
K Rameash	Senior Scientist
Smt M Amutha	Senior Scientist
K Shankarganesh	Scientist
Sirsa	
Rishi Kumar	Principal Scientist
2 PLANT PATHOLOGY	
Nagpur	
SP Gawande	Scientist
DT Nagrale	Scientist
Smt. Vanita Salunkhe	Scientist **(Joined on 05.06.2017)**
Neelakanth Hiremani	Scientist
Coimbatore	
A Sampath Kumar	Scientist
Smt. P Valarmathi	Scientist **(Joined on 27.06.2017)**
Sirsa	
Satish Kumar Sain	Senior Scientist
3. NEMATOLOGY	
Nagpur	
Smt. Nandini Narkhedkar	Principal Scientist
Coimbatore	
Smt. J Gulsar Banu	Principal Scientist
ICAR-CICR, KVK, Nagpur	
R B Singandhupe	Principal Scientist & Co-ordinator
S. S. patil	SMS (Extension)
U. V. Galkate	SMS (Vet. Science)
Smt. Sunita Chauhan	SMS (Home Science)
ADMINISTRATION	
Sachin Agnihotri	Senior Administrative Officer (Relieved on 01.04.2017 for Joining at ICAR-IIWBR, Karnal)
SM Sahare	Senior Administrative Officer (Joined on 01.04.2017) & (Retired on 31.07.2017)
AA Goswami	Senior Administrative Officer (Joined on 30.12.2017)
G. C. Prasad	Finance & Accounts Officer (Relieved on 10.04.2017 for Joining at ICAR-CPRI, Shimla)
Ms. Aruna Sharma	Finance & Accounts Officer (Joined on 04.05.2017)

10.9 : Other Information

Agro Expo Exhibition at Kanhan

ICAR CICR Nagpur Participated in a four day long district-level agriculture 'Agro Expo Exhibition 2017' held during April 28th to May 1st, 2017 at Kanhan, Tashil Parshioni district, Nagpur, Maharashtra. The event was sponsored by the Maharashtra Chamber of Commerce, Industry and Agriculture (MACCIA), Agriculture Department of Central and State Governments. More than 75 exhibitors displayed their products. ICAR-CICR displayed the technologies such as coloured cotton, Bt express kit, e-Kapas, management of cotton reddening and the farm implements developed by the institute. The team consisted of eight scientists, two subject matter specialists and two technical officer guided the visitos. More than five thousand farmers attended the event. Dr. S.M. Wasnik, Principal Scientist, Extension co-ordinated the activities

'Textile India 2017' at Gandhinagar, Gujarat

ICAR-CICR, Nagpur participated in the three day global textile and handicrafts event "Textile India 2017" organized at Gandhinagar, Gujarat from 30th June to 2nd July, 2017. Honourable Prime Minister, Shri. Narendra Modi inaugurated the mega trade event at Mahatma Mandhir, Gandhinagar on 30th June, 2017. Hon'ble Minister for Agriculture and Farmers Welfare Shri. Radha Mohan Singh, Hon'ble Textile Minister Smt. Smriti Irani, Chief Ministers of Gujarat and Andhra Pradesh, other ministers, representative from different private textile industries and foreign delegates attended the inaugural ceremony. Dr. Saravanan, M., Scientist (ICAR-CICR), Dr. S. S. Patil, SMS (KVK ICAR-CICR), Dr. U. V. Galkate, SMS (KVK ICAR-CICR) attended the visitors and explained about various exhibits displayed by CICR in the three days programme. Posters, pamphlets, displays about successful stories, Bt detection kits, colour cotton materials including seeds, bolls, lint and jackets were displayed in the exhibition stall. Hon'ble Agricultural Minister, Shri. Radha Mohan Singh visited the stall and appreciated all the activities of the institute, including the jacket made from natural eco-friendly coloured cotton developed by the institute. Different stakeholders of textile industry visited the stall of ICAR-CICR and appreciated the efforts of the institute in service and welfare of cotton farmers. Dr. S. M. Wasnik, Principal Scientist, Extension co-ordinated the activities.

'World Soil Day'

ICAR-Central Institute for Cotton Research, Nagpur celebrated 'World Soil Day' on 5th December 2017. The programme was organized to raise awareness on soil testing and importance of soil health card (SHC) scheme in agriculture. Dr. Milind Mane, MLA (North Nagpur) was the Chief Guest. Dr. T.H. Hajare (Former Principal Scientist, ICAR-NBSS & LUP, Nagpur) delivered a special lecture on soil health and quality. Dr. V.N.

Waghmare, Director (Acting), CICR, Nagpur introduced the guests and delivered welcome address. Dr. Hajare in his address pointed out that the improper use of fertilizers makes human susceptible to diseases. Dr. Mane in his address highlighted consequences of over use of pesticides, fertilizers and the associated environmental problems. He also emphasized on crop rotation and use of legumes for enhancing soil productivity. A short documentary film received from the ICAR providing Hon. Prime Minister Modi's address on soil health testing and its importance in livelihood security was shown and pamphlets were distributed. Farmers from Bela and Muradpur village who got benefitted from SHC scheme along with officials of the ICAR-CICR, Nagpur participated. Dr. D.Blaise (I/C Head, Crop Production division), Dr. Nandhini Gokte-Narkhedkar (I/C Head, Crop Protection division) also participated. Dr. S.M. Wasnik (Principal Scientist, Ag. Extension) proposed the vote of thanks while Dr. A. Manikandan (Scientist, Soil Science), Mrs. Rachana Desmukh and Ratnadeep Ramteke, Technical Assistant assisted the activities and compered the program

Krishi Unnati Mela and Scientists – Farmers Interface Meet

One day Agri-Exhibition cum Scientists – Farmers

Interface Meet was held at ICAR-CICR, Nagpur on 17th March, 2018 as a part of nationwide Scientist and farmers interface meet on occasion of Krishi Unnati Mela inaugurated by Hon. Prime Minister of India at ICAR headquarter Pusa, New Delhi. The programme was inaugurated at the hands of VIPs namely Dr. Rajiv Podar, District President (Rural) BJP, Shree Dilip Jadhao and Corporator of Nagpur NMC Sh Avinash Thakre. Dr.V.N. Waghmare, Director (Acting) ICAR-CICR, Nagpur in his opening remarks mentioned that the programme was organized in view of doubling the income of farmers through dissemination of advanced technologies and urged the participants to take the benefit of technology exhibition and lecture series organized during the event. Dr. Poddar observed that the socio-economic development of farmer can be

possible by bringing awareness about the Government schemes and technologies developed, which ultimately boost the confidence of the farmers. Shree Dilip Jadhao emphasized on the agri-processing of small-scale industries by encouraging the rural youth. Sh Avinash Thakre, Corporator stressed upon the demand of value added farm products used in urban areas. Smt Pradnya Golghate Divisional Supt. Agril Officer, Govt. of Maharashtra, Nagpur suggested the farmers to go for crop rotation and mixed farming to maintain the fertility of the soil and reap more income simultaneously. Shri Milind Shende, SAO Nagpur urged the farmers to smartly select the available Government schemes for the better benefits of the farming community.

After the inaugural session, the live webcast of Hon. Prime Minister's address to the Farmers, Agricultural Scientists and Other Stake holders in Krishi Unnati Mela – 2018 was telecasted. Prime Minister after opening the agri-exhibition in his address asked the farmers to visit exhibition stalls.

In ICAR-CICR Agri-Exhibition was organized to get farmers an opportunity to see various technologies developed by ICAR-CICR showcased for the farmers. A series of lectures were organized in the Scientists-Farmers interface meet. Dr. A.R. Raju, Principal Scientist (Agronomy) delivered a talk on "Improved cotton production techniques". Detailed overview of problem of pink bollworm infestation in Bt cotton and integrated strategies for its management was presented by Dr. Vishlesh Nagrare, Principal Scientist (Agril. Entomology), Dr. Babasaheb B. Fand, Scientist (Agril. Entomology) guided the farmers on safe handling of pesticides, while, Dr S.M. Wasnik, Principal Scientist (Extension) delivered talk on e-Kapas: An ICT initiative of CICR. Around 1000 farmer, State Agril Dept officials and other stakeholders participated in this daylong function. Dr D. Blaise, I/C HOD Crop Production,, Dr Nandini Narkhedkar I/C HOD Crop Protection were also present on the dais. Dr S.M. Wasnik, Principal Scientist proposed vote of thanks while Babasaheb B. Fand compered the programme.

Sports

ICAR-Western Zone Tournament-2017

Gold Medal

Samir S. Chalkhure, Personal Assistant, Shri R. M. Lokhande, ACTO, Dr. S.S Patil, SMS and Dr. U. V Galkate, SMS, CICR, Nagpur bagged Gold Medal in Table Tennis in the ICAR-Western Zone Tournaments - 2017 organized at ICAR-Central Arid Zone Research Institute, Jodhpur from 16-20th January, 2018.

Silver Medal

Sh Sujit Kumbhare, Technical Assistant T 1, CICR Nagpur bagged **Silver Medal** in Athletics (Race 200 mtr) (15.33 sec) during ICAR-Western Zone Tournaments organized at ICAR-Central Arid Zone Research Institute, Jodhpur from 16-20th January, 2018.

ICAR-Inter Zonal Tournament-2017 : Runner Up Trophy

Samir Chalkhure, Personal Assistant, Shri R.M. Lokhande, ACTO, Dr. S.S. Patil, SMS and Dr. U.V. Galkate, CICR, Nagpur bagged **Runner Up**

Trophy (Silver Medal) in Table Tennis during **ICAR-Inter Zonal Tournament - 2017** organized at ICAR-National Academy of Agricultural Research Management, Hyderabad from 21-25th February, 2018.

Bronze Medal

Sh Sujit Kumbhare, Technical Assistant T1, CICR Nagpur bagged **Bronze** Medal in running competition of 200m (15.33 sec) organized at ICAR-National Academy of Agricultural Research Management, Hyderabad from 21-25th February, 2018.

Library

Additions

In the period from 2017-18, the CICR Library purchased 112 new books, 17 Hindi books and 16 Marathi books. The Library subscribed to 11 Foreign Journals and 17 Indian Journals.

Documentation Services

Library has developed computerized biblio-graphic database on Cotton to provide comprehensive and updated in formation on cotton. About 5015 bibliographic references along with abstracts have been stored in it. Based on this bibliographic database, the Library publishes a current awareness bulletin namely *"COTTON RESEARCH ABSTRACTS"*. The Bulletin is circulated to all the scientists of the Institute and to all AICRP on Cotton Centers in India. In the reported period, two issues of *COTTON RESEARCH ABSTRACTS (V31, (No. 1-2), January – December 2017)* 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 Web OPAC 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) are 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:// 10.0.0.52/w20/

Progressive Use of Hindi

राजभाषा (हिंदी) का प्रचार–प्रसार

भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में वित्तीय वर्ष 2017–18 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 2017–18) की त्रैमासिक बैठकों का आयोजन निम्नानुसार किया गया।

राजभाषा कार्यान्वयन समिति की बैठकों की तिथि :

क्र.	दिनांक	विषय
1	02.08.2017	राजभाषा कार्यान्वयन समिति की प्रथम बैठक त्रैमासिक रिपोर्ट की समीक्षा।
2	16.08.2017	संस्थान राजभाषा कार्यान्वयन समिति की बैठक एवं हिंदी पखवाडा–2017 के आयोजन की रूपरेखा बनाने के संदर्भ में।
3	28.08.2017	संस्थान के राजभाषा कार्यान्वयन समिति की बैठक एवं संस्थान की गृह पत्रिका के प्रकाशन के संदर्भ में।
4	27.10.2017	त्रैमासिक प्रगति रिपोर्ट की समीक्षा एवं नये मदो पर विचार विमर्श के संबंध में।
5	06.03.2018	राजभाषा कार्यान्वयन समिति की बैठक एवं संस्थान की वेबसाइट को द्विभाषी अंग्रेजी एवं हिंदी किये जाने के संदर्भ में।

हिंदी पखवाडा :

भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, वर्धा रोड, नागपुर में दिनांक : 14–28 सितम्बर, 2017 के दौरान "हिंदी पखवाड़ा–2017" मनाया गया। हिंदी पखवाड़ा उदघाटन समारोह (दिनांक : 14/09/2017) की अध्यक्षता का पदभार डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.

(हिंदी पखवाडा उदघाटन समारोह के मुख्य अतिथि डॉ. सतीश वटे, कार्यक्रम अध्यक्ष, निदेशक डॉ. विजय नामदेव वाघमारे, विभाग प्रमुख डॉ. नंदिनी नरखेडकर, डॉ. सिध्दार्थ वासनीक, डॉ. पुनित मोहन, रजनीकान्त चतुर्वेदी (हिंदी अधिकारी), पूर्व हिंदी अधिकारी डॉ. उल्हास नंदनकर उपस्थित थे।)

–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ने संभाला। इस कार्यक्रम के मुख्य अतिथि के रूप में डॉ. सतीश वटे, अध्यक्ष, भर्ती एवं मूल्यांकन बोर्ड, वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद एवं पूर्व निदेशक, नीरी, नागपुर संस्थान की ओर से सादर आमंत्रित थे। साथ ही इस अवसर पर संस्थान के विभिन्न विभागों के अध्यक्ष, वैज्ञानिक, अधिकारी एवं कर्मचारी उपस्थित थे। इस कार्यक्रम के संयोजक श्री रजनीकान्त चतुर्वेदी, राजभाषा कार्यान्वयन समिति के सदस्य सचिव थे। हिंदी पखवाड़ा–2017 के दौरान राजभाषा (हिंदी) संबधित विभिन्न प्रतियोगिताओं का आयोजन किया गया जिसका विवरण निम्नानुसार है।

उदघाटन समारोह का आयोजन दिनांक 14.09.2017 को किया गया और तद उपरांत राजभाषा हिंदी संबधित विभिन्न प्रतियोगिता का आयोजन निम्ननिधारित कार्यक्रमानुसार किया गया। भाषण प्रतियोगिता आयोजन दिनांक : 19.09. 2017 को किया गया जिसका विषय "हिंदी भाषा का महत्व" था। निबंध प्रतियोगिता का आयोजन दिनांक : 20.09.2017 को किया गया जिसका विषय विमुद्रीकरण था। इन दोनों प्रतियोगिता में क्रमशः 20 एवं 30 प्रतिभागियों ने भाग लिया। हिंदी अनुवाद प्रतियोगिता एवं श्रुत–लेखन प्रतियोगिता का आयोजन दि. 21.09.2017 को किया गया। पथ नाट्य दि. 23.09.2017 को तथा एक मिनिट कौशल्य विशय तात्कालिक वाद एवं प्रश्नोत्तरी प्रतियोगिताएं भी आयोजित की गयी। दिनांक : 26.09.2017 को चित्र आधारित प्रतियोगिता का आयोजन किया गया जिसमें सभी वर्ग के 35 प्रतिभागियों ने भाग लिया। कार्यक्रम का समापन दिनांक : 28.09.2017 को एक भव्य समारोह में किया गया। इन प्रतियोगिताओं में संस्थान के सभी वर्गों के वैज्ञानिकों, अधिकारियों एवं कर्मचारियों ने बड़ी संख्या में बढ़–चढ़कर भाग लिया। इन प्रतियोगिताओं के आंकलन के लिए मोंटफोर्ट स्कूल से निर्णायक मण्डल सदस्यों को आमंत्रित किया गया था।

हिंदी पखवाड़ा–2017 का समापन समारोह का आयोजन 28.09.2017 को संस्थान के सभागार में प्रभारी निदेशक डॉ. ब्लेज डीसूजा के अध्यक्षता में सम्पन्न हुआ। इस कार्यक्रम के मुख्य अतिथि प्रो. मिथिलेश अवस्थी (प्रख्यात साहित्यकार) सहायक आचार्य एवं अध्यक्ष (हिंदी विभाग), पी.डब्लू.एस. कला एवं वाणिज्य महाविद्यालय, नागपुर में कार्यरत हैं। इस अवसर पर मुख्य अतिथि, प्रभारी निदेशक एवं मंच पर उपस्थित महानुभवों ने डॉ. पुनीत मोहन द्वारा लिखी गई "प्राकृतिक रंगीन कपास" पत्रिका का विमोचन किया गया तथा निदेशक एवं मुख्य अतिथि द्वारा प्रधान वैज्ञानिक डॉ. पुनीत मोहन जी, को हिंदी में उत्कृष्ट कार्य एवं योगदान के लिए सम्मान पत्र देकर सम्मानित किया गया।

(प्राकृतिक रंगीन कपास पत्रिका का विमोचन करते हुए प्रो. मिथिलेश अवस्थी (मुख्य अतिथि), डॉ. ब्लेज डिसूजा (प्रभारी निदेशक), डॉ पुनीत मोहन (पत्रिका के लेखक), डॉ. सुमन बाला सिंह (वैज्ञानिक), डॉ नंदिनी गोकटे (वैज्ञानिक) एवं रजनीकान्त चतुर्वेदी (हिंदी अधिकारी)

जो संस्थान कपास को रंगीन बना सकता है वो संस्थान आस–पास के वातावरण को भी रंगीन बना सकता है। उन्होंने कहा कि हिंदी हमारी राष्ट्रभाषा है हमे उसका सम्मान करना चाहिए। किसी भी देश की पहचान उसकी भाषा होती है। हमारे भारत देश में विभिन्न प्रांतों की अलग अलग भाषाएँ बोली जाती है। विश्वपटल में हमारी पहचान हिंदी भाषा से होती है। हमे ऐसी हिंदी भाषा बोलनी या प्रयोग में लानी चाहिए जो सबके समझ में आए और जो सरल हो जिससे सामने वाले को संवाद में कठिनाई का सामना न करना पड़े।

कार्यक्रम के अध्यक्ष डॉ. ब्लेज डिसूजा ने सभा को संबोधित करते हुए बताया की हिंदी विश्व के सबसे अधिक बोले जाने वाले भाषा है। हम सब भारत वासियों को क्षेत्रीयता, प्रांतवाद, धर्म एवं जाती–भेद से उठकर एकता के लिए एक भाषा को अपनाना चाहिये।

संस्थान में राजभाषा शिक्षण योजना के अंतर्गत वर्ष–2015 एवं वर्ष–2016 में प्रबोध, प्राज्ञ, प्रवीण, एवं पारंगत कक्षा का आयोजन किया गया था। जिसकी परीक्षा ली गई थी जिसमें 50 प्रतिभागी शामिल हुए और 39 प्रतिभागियों ने परीक्षा उत्तीर्ण की। इस अवसर पर उत्तीर्ण प्रतिभागियों को पुरस्कार

एवं प्रमाणपत्र दिये गए। कार्यक्रम के अंत में संयोजक एवं राजभाषा कार्यान्वयन समिति के सदस्य सचिव श्री रजनीकान्त चतुर्वेदी, हिंदी अधिकारी द्वारा धन्यवाद प्रस्ताव प्रेषित किया गया।

एक दिवसीय हिंदी कार्यशाला :

भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर कार्यालय में बड़े ही उत्साहपूर्ण वातावरण में डॉ. ब्लेज डिसूजा, प्रभारी निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में तथा मुख्य अतिथि महोदया डॉ.(श्रीमती) नंदिता महेंद्र साहू, हिंदी अधिकारी, भारतीय मानव विज्ञान सर्वेक्षण, नागपुर तथा सादर मंचासीन डॉ. नंदिनी नरखेडकर गोकटे, विभागप्रमुख (फसल संरक्षण विभाग), श्री. पी. पी. गोकुलपुरे, प्रभारी वरिष्ठ प्रशासनिक अधिकारी, कु. अरुणा शर्मा, वित्त एवं लेखा अधिकारी तथा डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) की गणमान्य उपस्थिती में प्राशासनिक एवं तकनीकी संवर्ग के कार्मिकों हेतु एक दिवसीय हिंदी कार्यशाला (दिनांक : 08/12/2017) का सफलता पूर्वक आयोजन किया गया । इस हिंदी कार्यशाला में प्रशासनिक/तकनीकी संवर्ग के लगभग 50 अधिकारियों एवं कर्मचारियों ने भाग लिया ।

सर्वप्रथम संस्थान के प्रभारी निदेशक डॉ. ब्लेज डिसूजा ने दीप प्रज्ज्वलित कर विधिवत इस हिंदी कार्यशाला का उदघाटन किया। श्री. पी. पी. गोकुलपुरे, प्रभारी वरिष्ठ प्रशासनिक अधिकारी ने मंचासीन महानुभवों एवं सभागार में उपस्थित हिंदी प्रेमी अधिकारियों एवं कर्मचारियों का हार्दिक स्वागत करते हुए उदघाटन सत्र मुख्य अतिथि महोदया डॉ. (श्रीमती) नंदिता महेंद्र साहू, हिंदी अधिकारी, भारतीय मानव विज्ञान सर्वेक्षण, नागपुर के व्यक्ति परिचय से सभा को अवगत कराया। उदघाटन सत्र की मुख्य अतिथि महोदया डॉ.(श्रीमती) नंदिता महेंद्र साहू, ने अपने मुख्य सम्बोधन में हिंदी को एक राष्ट्रीय अस्मिता की भाषा बताते हुए कहा कि एक सच्चे भारतीय नागरिक होने के नाते हमारा यह नैतिक उत्तरदायीत्व बन पड़ता हैं कि हम राष्ट्रीय उत्थान हेतु हिंदी का अधिक से अधिक उपयोग कर इस देश का गौरव बढ़ाएँ। अपने अध्यक्षीय सम्बोधन में डॉ. ब्लेज डिसूजा ने सभा को संबोधित करते हुए कहा कि हिंदी इस देश की राजभाषा होने के नाते हमारा यह संवैधानिक उत्तरदायीत्व बन पड़ता हैं की हम अपने दैनिक कार्यालयीन कार्यों में हिंदी को अपनाकर इसका गौरव बढ़ाएँ। हिंदी कार्यशाला के उदघाटन सत्र का कुशल संचालन डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) ने किया और आभार श्री पी. पी. गोकुलपुरे, प्रभारी वरिष्ठ प्रशासनिक अधिकारी ने माना।

हिंदी कार्यशाला के प्रथम व्याख्यान सत्र की अतिथि व्याख्याता डॉ.(श्रीमती) नंदिता महेंद्र साहू, ने 'हिंदी वर्तनी' विषय पर बड़े ही रोचक एवं मनोरंजक ढंग से कार्याशाला में सहभागी अधिकारियों कर्मचारियों को विषय संबंधीत महत्वपूर्ण जानकारी दी।

हिंदी कार्यशाला के द्वितीय व्याख्यान सत्र के अतिथि व्याख्याता डॉ. जगदीश प्रसाद, प्रधान वैज्ञानिक, राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो, नागपुर ने 'वैज्ञानिक/तकनीकी लेखन कार्य में हिंदी का प्रयोग क्यों और कैसे ?' विषय पर कार्यशाला में सहभागी अधिकारियों कर्मचारियों को संबोधित करते हुए कहाँ कि इस देश के आमजनों एवं किसानों की भाषा हिंदी हैं। अतः इस दृष्टिकोण से हमारे वैज्ञानिक/तकनीकी अनुसंधान कार्यों की सार्थकता तभी है जब हम उन्हें यह जानकारी हिंदी में दें। भाषा विज्ञान के दृष्टिकोण से हिंदी एक बहुत ही सशक्त भाषा है और उसके माध्यम से हम बडी ही आसानी के साथ अपने वैज्ञानिक/तकनीकी अनुसंधान संबन्धित कार्यों को हिंदी में अभिव्यक्त कर सकते हैं। हिंदी इस देश की राजभाषा होने के नाते हम सबका यह दृष्टिकोण होना चाहिए की देश का बहुमुखी विकास हेतु हम अपने कार्य व्यवहार में हिंदी को अपनाएँ।

हिंदी कार्यशाला के समापन समारोह की अध्यक्षता का पदभार संस्थान के प्रभारी निदेशक डॉ. ब्लेज डिसूजा ने संभाला और उन्होंने अपने अध्यक्षीय सम्बोधन सभा को संबोधित करते हुएँ कहाँ कि संस्थान द्वारा प्रशासनिक/तकनीकी संवर्ग हेतु आयोजित इस हिंदी कार्यशाला में दो महत्वपूर्ण विषयों पर अतिथि व्याख्याताओं ने कार्यशाला में सहभागी अधिकारियों कर्मचारियों को बड़ी ही महत्वपूर्ण जानकारी दी, जिससे निःसंदेह उनका ज्ञानवर्धन हुआ जो उन्हें हिंदी में अपना कार्य करने हेतु प्रेरित करेगा। तदहेतु उन्होंने अपनी ओर से और संस्थान की ओर से इस हिंदी कार्यशाला के अतिथि व्याख्याता डॉ. जगदीश प्रसाद एवं डॉ. (श्रीमती) नंदिता महेंद्र साहू तथा इस कार्यशाला में सहभागी अधिकारियों एवं कर्मचारियों का हार्दिक आभार माना।

हिंदी कार्यशाला के समापन सत्र का संचालन डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) ने किया और आभार श्री पी. पी. गोकुलपुरे, प्रभारी वरिष्ठ प्रशासनिक अधिकारी ने माना।

डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में आयोजित एक दिवसीय हिन्दी कार्यशाला दिनांक 12/03/2018 का परिदृश्य।

भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर कार्यालय में बड़े ही उत्साहपूर्ण वातावरण में डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर की अध्यक्षता में एवं मुख्य अतिथि वक्ता डॉ. जय प्रकाश, हिंदी अनुवादक, कर्मचारी राज्य बीमा निगम, नागपुर की मुख्य उपस्थिति में तथा सादर मंचासीन श्री अ. अं. गोस्वामी, वरिष्ठ प्रशासनिक अधिकारी एवं डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) की गणमान्य उपस्थिति में संस्थान में प्रशासनिक एवं तकनीकी संवर्ग के कार्मिकों हेतु एक दिवसीय हिंदी कार्यशाला दिनांक : 12/03/2018 का सफलता पूर्वक आयोजन किया गया। इस हिंदी कार्यशाला में प्रशासनिक/तकनीकी संवर्ग के लगभग 35 अधिकारियों एवं कर्मचारियों ने सहभागी होकर इस आयोजन को सफल बनाया ।

सर्वप्रथम अपने स्वागत भाषण में डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) ने कार्यक्रमाध्यक्ष डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर एवं इस कार्यशाला में सहभागी समस्त हिंदी प्रेमी अधिकारियों एवं कर्मचारीयों का हार्दिक स्वागत करते हुए अतिथि वक्ता डॉ. जय प्रकाश, हिंदी अनुवादक, कर्मचारी राज्य बीमा निगम, नागपुर के व्यक्ति परिचय से सभा को अवगत कराया।

अपने उदघाटीय संबोधन में डॉ. विजय नामदेव वाघमारे, निदेशक, भा.कृ.अनु.प.– केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ने इस अवसर पर सभा को संबोधित करते हुए कहा कि हिंदी इस देश के जनसम्पर्क की मुख्य भाषा है और संवैधानिक रूप से इसे राजभाषा का दर्जा प्राप्त है। अतः इस दृष्टिकोण से हमारा यह संवैधानिक उत्तरदायित्व हो जाता है कि इसे हम अपने दैनिक कार्यालयीन कार्यों में अपनाकर राष्ट्र विकास को गति प्रदान करें।

हिंदी कार्यशाला के अतिथि वक्ता डॉ. जय प्रकाश, हिंदी अनुवादक, कर्मचारी राज्य बीमा निगम, नागपुर ने बड़े ही रोचक एवं मनोरंजक तरीके से राजभाषा हिंदी की संकल्पना को स्पष्ट करते हुए कार्यालयीन कार्यो में राजभाषा हिंदी की महत्वपूर्ण भूमिका को स्पष्ट किया। कार्यशाला के अंतिम चरण में सहभागी प्रतिक्रिया स्वरूप अपने विचारों को स्पष्ट करते हुए श्री एजाज अहमद, प्रभारी (भंडार विभाग) ने कहा कि यह कार्यशाला अपने लक्ष्य को हासिल करने मे पूर्ण रुप से सफल रही हैं। साथ ही अतिथि वक्ता के मार्गदर्शन से कार्यशाला में सहभागी अधिकारियों/कर्मचारियों को अच्छी जानकारी मिली है जिससे निसंदेह उन्हें अपना दैनिक कार्यालयीन कार्य हिंदी में करने हेतु बढ़ावा मिलेगा। संस्थान में आयोजित इस एक दिवसीय हिंदी कार्यशाला का कुशल संचालन डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा) ने किया एवं आभार श्री एजाज अहमद, प्रभारी (भंडार गृह) ने माना।

10.10 : Weather

Nagpur

Month	Temperature (°C)		Relative Humidity (%)		Rain fall (mm)	No. of Rainy Days
	Max	Min	Max	Min		
June, 2017	36.92	26.26	68.72	54.37	132	7
July, 2 017	30.93	24.27	85.75	69.65	246	19
August, 2017	31.43	24.45	84.02	73.02	276	11
September, 2017	32.57	23.92	82.05	68.13	99	9
October, 2017	33.55	20.23	78.95	48.68	15	6
November, 2017	30.67	14.52	79.31	40.73	0	0
December, 2017	28.86	10.29	77.34	35.53	0	0
January, 2018	29.01	10.12	69.07	31.95	0	0
February, 2018	31.76	14.64	67.11	33.86	25	1
				Total	793	

Coimbatore

Month	Temperature (°C)		Relative Humidity (%)	Evaporation (mm)	Rainfall (mm)	Rainy days	Sun shine (hours)	Solar radiation (cal/cm2/day)
	Max	Min						
July, 17	32.3	23.5	83	7.1	27.8	3	6.0	336.4
August, 17	31.4	23.4	88	5.5	38.5	4	4.4	291.8
September, 17	30.6	23.1	88	5.2	218.1	9	6.2	327.8
October, 17	31.3	22.5	89	4.3	132.6	5	5.7	306.3
November, 17	30.1	22.3	88	4.3	78.1	5	5.0	302.4
December, 17	29.8	20.6	88	4.3	1.2	0	6.2	356.9
January - 18	29.8	18.9	88	4.3	2.2	1	5.8	346.4
			Total		498.5			

Sirsa

Month	Temperature (°C)		Rain Fall (mm)	Rainy days
	Maximum	Minimum		
April 2017	45.2	17.5	0.0	0.0
May 2017	46.8	18.5	0.0	0.0
June 2017	47.0	20.6	135.6	8.0
July 2017	41.0	23.0	28.0	1.0
August 2017	39.0	25.2	55.4	6.0
September 2017	37.6	20.2	62.3	5.0
October 2017	38.0	13.5	1.4	1.0
November 2017	33.8	4.6	2.8	1.0
		Total Rainfall	285.5	22

10.11 : Cotton Scenario

State-Wise Cotton Area, Production and Productivity

State	Area (Lakh ha)		Production* (Lakh bales)		Yield (kg/ha)	
	2016-17	2017-18 (P)	2016-17	2017-18 (P)	2016-17	2017-18 (P)
Punjab	2.85	2.91	9.00	11.50	536.84	671.82
Haryana	5.70	6.69	20.50	22.50	611.40	571.75
Rajasthan	4.71	5.84	16.50	22.00	595.54	640.41
Total North Zone	**13.26**	**15.44**	**46.00**	**56.00**	**589.74**	**616.58**
Gujarat	23.82	26.23	95.00	104.00	678.00	674.04
Maharashtra	38.00	42.07	88.50	85.00	395.92	343.48
Madhya Pradesh	5.99	6.03	20.50	20.50	581.80	577.94
Total Central Zone	**67.81**	**74.33**	**204.00**	**209.50**	**511.43**	**479.15**
Telangana	14.09	18.97	48.00	55.00	579.13	492.88
Andhra Pradesh	4.72	6.44	19.00	20.50	684.32	541.15
Karnataka	5.10	5.31	18.00	18.00	600.00	560.44
Tamil Nadu	1.42	1.85	5.00	5.50	598.59	505.41
Total South Zone	**25.33**	**32.72**	**90.00**	**99.00**	**604.03**	**514.36**
Odisha	1.36	1.45	3.00	3.50	375.00	410.34
Others	0.50	0.50	2.00	2.00	680.00	680.00
All-India	**108.26**	**124.29**	**345.00**	**370.00**	**541.75**	**505.46**

Source : Cotton Advisory Board, Ministry of Textile, Govt. of India.

* - Provisional as estimated by CAB in its meeting held on 16.06.2018

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