

2. Executive Summary



2.1 Crop Improvement

Nagpur

- One hundred and nineteen cotton germplasm, including 82 perennials, 14 land races and 23 traditional cotton belonging to *G. arboreum* and *G. barbadense* species were collected from states of Maharashtra, Madhya Pradesh, West Bengal, Andhra Pradesh, Tamil Nadu, Punjab, Meghalaya, Assam and Mizoram.
- Twenty three varieties of cotton, including 17 *G. hirsutum* and six *G. arboreum*, were procured from Pakistan under Reciprocal Germplasm Exchange Agreement and evaluated.
- Species garden with 26 wild species, 15 races and more than 40 synthetic polyploids of *Gossypium* and related species were maintained and used in introgression breeding.
- Drought tolerant culture of *G. hirsutum* CNH 301 was registered with Plant Germplasm Registration Committee (Regd NO.INGR 11061 and IC No. 0587405).
- Four genetic stocks of *G. hirsutum* with unique morphology viz. CNH-CB 215, CNH-CB 211, CNH-CB 212 and CNH-CB 205 and one inter-racial pigmented *G. arboreum* line CAN 5, identified for registration.
- 137 *G. harknessii* based CMS, 15 *G. aridum* based CMS, 57 restorers and 20 GMS lines were maintained. GMS lines of PKV 081, AK 32, L 147, Suman and Sharda developed.
- Promising *G. arboreum* cultures CNA 389 and CNA 390 and *G. hirsutum* culture CNH-315 identified / developed in the Institute was sponsored in National trial of AICCIP based on their performance in Institute trial.
- CNA 398 that ranked first among the *G. arboreum* cultures and CNH 14 ranking fourth among *G. hirsutum* cultures in the central zone were promoted for further evaluation in the zone.
- Sixty one genotypes under conversion to Bt background were advanced to subsequent generations of back-crossing with populations existing in various generations from BC₂ to BC₃F₃.
- Fifty single plant progenies were selected based on tolerance to jassid, earliness and yield potential and advanced to F₆ generation.
- Two hundred thirty five working germplasm accessions of *G. hirsutum* were characterized using 44 SSR markers.
- Out of 335 SSR primers surveyed to screen polymorphism between bacterial blight susceptible and resistant parents, 30 SSR markers were found polymorphic between the parental genotypes, Ganganagar Ageti and S 295.
- Confined field trial was conducted with seven transformation events of *Bt-cry1Ac* gene to characterize and select effective events. Three new events of *cry1Ac*

and two events of *cry1F* were generated in *G. hirsutum* variety Anjali.

- Confined field trial was conducted to select and characterize effective events of *cry1Ac* gene in *G. arboreum*. Besides, 22 new events of *cry1Ac* and *cry1F* genes were generated in cvs RG 8 and PA402 by *in planta* transformation.
- Five out of eight events generated using dsRNA interference construct of CP gene in *G. hirsutum* cvs F 846, LH 2076 and HS 6, were found PCR positive for the transgene.
- Putative transformants of *G. hirsutum* cvs LRA 5166 and LRK 516 generated with *DREB 1A* and *ZF1A* genes were characterized and evaluated for drought tolerance in confined field trials.
- Seed-specific legumin (beta globulin) promoter sequence from cotton (*G. hirsutum*) was identified; PCR amplified and sequenced.
- Potassium Chloride @ 2% and Hydrogen peroxide @ 40mM promoted superior seedling growth under soil moisture stress conditions.
- About 4.37 quintal TFL seeds of *G. hirsutum* and *G. arboreum* cultures/cultivars of cotton besides, 1.78 quintals of certified seeds of Gram and Kabuli Chana were produced under Mega Seed Project. Revenue of 13.0 lakhs was generated through sale of these seeds.

Coimbatore

- Cernuum race of *G. arboreum* was characterized for stem, leaf, flower and boll characters as per germ plasm index card.
- Three exotic lines of *G. barbadense* viz., EC-617836, EC-617837 and EC-617840 recorded significantly higher yield than the check Suvin. Three exotic genotypes EC-617836, EC-617840 and EC-617844 had better GOT compared to Suvin (27%).
- Medium staple culture CCH 2623 based on its superior performance in central zone and south zone locations has been recommended for testing the agronomic requirements in both the zones.
- Nine *G. hirsutum* x *G. barbadense* hybrids were identified with superior seed cotton yield over the check hybrid RCHB-708 Bt. CCHB 12 documented the highest seed cotton yield (24.75 q/ha) and bundle strength (33.5 g/tex), while CCHB 11 had the highest staple length (38 mm). Hybrid CCHB-6 recorded highest GOT (35%) with suitable micronaire value (4.21J/inch).
- A promising *G. hirsutum* x *G. barbadense* hybrid CCHB-4 was sponsored in multi-location yield evaluation trial under AICCIP.
- Breeder seeds (336 kg) for cultivars Suraj, LRK 516 and LRA 5166, well beyond the target to meet the requirement of DAC indenters, were produced.

- Plant variety registration certificate for 21 extant cotton varieties have been obtained from PPV&FRA.
- Working group of 333 cotton germplasm was characterized for distinctiveness, uniformity and stability as per the National test guidelines for tetraploid cotton.
- Polymer coating of seeds with Polykote (3 ml/kg) diluted in 5 ml of water containing Imidacloprid (6 ml/kg) or Royal flow 40 SC (2.4 ml/kg) + Imidacloprid (6 ml/kg), supported improved seed viability under ambient storage conditions.

Sirsa

- 3954 accessions of cotton were evaluated in north zone and ten superior genotypes each with superior yield, boll weight, number of bolls / plant were identified.
- Cytoplasmic male sterile local adapted cultivars and parents of promising hybrids of cotton having cytoplasm of *G. harknessii* and new restorer lines identified were maintained through sibmating.
- Studies on development of heterotic pools showed that in *G. arboreum* male parents CISA-6-187, CISA 9, CISA 8 and female parents OS 5 were good general combiners for seed cotton yield while in *G. hirsutum* the male parents OK 2885, CSH 2912, CSH 3129, CSH 2907 and female parents GMS 26, GMS 17, GMS 27 were good general combiners for seed cotton yield and GMS 17 for ginning percentage.
- Intra-hirsutum* GMS hybrid CSHG 1862 with 11.68% increase in yield over the zonal check was identified for release in irrigated tracts of north zone.
- In the first year trial, 20 *G. hirsutum* cultures were evaluated against CLCuV alongwith check. Cotton leaf curl virus resistant advanced cultures viz. CSH 2833, CSH 2811 and CSH 2844 showed 9.28 and 6.66 per cent yield superiority over the local check variety RS 2013 (1652 kg/ha)
- One hundred kilogram breeder seeds of male and female parents of four released hybrids and 82 kg breeder seeds of two *desi* cotton varieties were produced during 2011-2012.
- The seed cotton yields of Bt cotton sown as sole crop was significantly higher than the paired row sole cotton with intercropped *khariflegumes* under irrigated condition.
- In general, 3-5 q/ha higher seed cotton yield was realized in *desi* cotton at a spacing of 67.5 x 20 cm as compared to 67.5 x 10 and 67.5 x 30 cm spacing.

2.2 Crop Production

Nagpur

- Out of 13 American cotton varieties evaluated under organic conditions, NH 615, Suraj, PKV 081, LRK 516 and AKH 8828 performed better and had acceptable fibre properties. Among the *desi* varieties, JLA 794, CNA 347 and AKA 7 were the high yielders. These varieties also possessed good staple length of 26.2 to 27.9 mm.
- G. hirsutum* varieties namely Suraj, ADB 39, PKV 081 and 28 I were found promising in terms of yield, morphology, earliness and nutrient use efficiency under high density planting system (HOPS) on rainfed Vertic Inceptisols of Nagpur. Averaged over ten genotypes, mean yield in HOPS with 125% RDF was 1409 kg/ha as against 1088

kg/ha under normal planting with normal RDF indicating a 29% advantage with HOPS.

- Among 8 genotypes of *G. arboreum* evaluated, on the basis of yield, plant type and growth characteristics CINA 404, HD123 and JLA 505 performed well under high density planting (2,22,000 plants/ha).
- Bt hybrid cotton intercropped with either roselle, soybean and marigold produced similar cotton equivalent yields and was significantly greater than sole cotton.
- On bench mark locations of black soil regions, soil microbial diversity i.e. Shannon diversity index (H') was similar in both legume-based and cereal-based cropping system. All other diversity indices (Simpsons index (D), Simpsons reciprocal index (1/D), and Simpson evenness (E)) were found to be significantly ($p < 0.05$) higher in cereal-based cropping system over legume-based system.
- Foliar applications of maleic hydrazide (500 ppm) at 85 days after sowing (DAS) recorded highest plant height, leaf area and Leaf Area Index (LAI) of 82.3, 6964.0 cm² and 1.3 respectively and produced significantly higher yield than detopping main stem at 95 DAS and sympodial meristem at 105DAS.
- Foliar application of ethrel at 39 DAS increased the photosynthetic leaf area, leaf area index and produced more bolls on the cotton plants than control.
- Foliar application of potassium silicate (40, 60, 80 IJI/l) done at 30 and 60 DAS positively influenced the leaf water relations in terms of relative water content (RWC) and leaf water potential.
- A wick applicator was developed to smear the weeds with herbicide solution in between the rows of cotton plants for HOPS system since spraying chemicals has the risk of killing nearby cotton plants by drift of the weedicides.
- Conceptual design of a cotton picking machine to be operated by a pair of bullocks or a person behind the machine was prepared in CAD. Machine, plant and soil parameters were analysed to design the cotton picking machine. CAD drawing and 3D solid model of the picker were made. Fabrication of all the components was completed after testing the assembly for its strength and stability in the standing crop of cotton at each stage of fabrication, and suitable modifications thereof.

Coimbatore

- Application of arbuscular mycorrhizae and phosphorus solubilising bacteria along with recommended dose of fertilizers improved germination percentage and plant growth compared to application of 50% dose of fertilizers along with bioinoculants.
- New plant geometry (120 x 45 cm) for the Bt cotton + coriander, Bt cotton + radish and sole cropping system had greater seed cotton equivalent yield, net return and benefit cost ratio than the normal spacing of 90 x 60 cm.
- Among genotypes, under high density planting system, KC-3 recorded higher seed cotton yield (2655 kg/ha) followed by PKV 081 (2253 kg/ha), Anjali (2215 kg/ha) and NH 615 (2121 kg/ha) than the control RCH 2 Bt (1596 kg/ha). The highest gross return (Rs. 79,650/ha) was obtained with KC-3, and Anjali registered the highest net

- return (Rs. 39,805/ha) and benefit cost ratio (2.1) because of higher market price.
- Genotypes x nutrient interaction results revealed that Anjali planted at 45 x 15 cm and applied with 150 per cent of RDF registered significantly highest seed cotton yield (24.91 q/ha), gross return (Rs. 94,658/ha), net return (Rs. 54,730/ha) and benefit cost ratio (2.37).
 - Sowing under high density planting system is labour intensive. An alternate strategy of sowing using tractor drawn inclined plant planter (1918 kg/ha) was similar to manual method of sowing (2003 kg/ha)
 - Stale Seed Bed Technique (application of pendimethalin 1.0 kg + glyphosate 1.0 kg with one hand weeding at 35-40 DAS) produced maximum seed cotton yield and net return.
 - Weed control by application of residual chemical, pendimethalin @ 1.25 kg a.i./ha as pre emergence followed by post emergence application of quizalofop ethyl @50g.a.i./ha and pyriithiobac sodium @ 75 g a.i./ha at 30 and 35 DAS respectively registered significantly highest yield (2116 kg/ha), gross return (Rs. 74,043/ha) and net return (Rs. 37,506/ha), which was on par with pendimethalin @1.25 kg a.i./ha followed by post emergence application of tank mixing of quizalofop-ethyl @ 50 g a.i./ha + pyriithiobac sodium @ 75 g a.i./ha at 30 DAS and pre emergence application of pendimethalin @1.25 kg a.i./ha + HW at 30 DAS.
 - Pendimethalin 1.0 kg as pre emergence herbicide on third day followed by HW 35 - 40 DAS and pyriithiobac sodium 50 g + quizalofop-P-ethyl 50 g on 60 DAS recorded the highest seed cotton yield, net return and B:C ratio. It was on par with pendimethalin followed by HW and pyriithiobac sodium 50 g + fenoxoprop-P-ethyl 50 g on 60 DAS and Hand weeding thrice (20, 40 and 60 DAS).
 - Percentage increase in yield due to foliar application of nutrient consortia was about 12-13% in non- Bt genotypes while Bt recorded an increase of 15 to 19%. Irrespective of non- Bt genotypes and Bt cotton, Nitrate reductase activity was significantly more in nutrient sprayed plants. Photosynthetic activity was significantly higher in Bt cotton than conventional genotypes.
 - Nutrient consortia spray revealed that Bt cotton was more affected by water logging and responded more favourably to nutrient consortia spray than conventional genotypes. Yield was significantly more in Bt cotton (86 to 109 g/plant) than conventional genotypes (62 to 70 g/plant). This reduction in yield per plant due to water logging could be improved by 5-9% in conventional genotypes while the improvement in yield was 29 to 46% in Bt cotton through nutrient consortia spray.
- ### 2.3 Crop Protection
- #### Nagpur
- Highest population of sucking pests was recorded during 2nd to 3rd week of September. Mealybugs *Phenacoccus so/enopsis* and *Nipaeococcus viridis* were recorded in some fields with negligible population during late season of crop. Negligible population of all the three bollworms and *Spodoptera litura* was recorded during the year.
 - Diversity of four mealybug species viz, *P so/enopsis*, *N. viridis*, *Ferrisia virgata* and one unidentified mealybug species (Homoptera: Pseudococcidae) was recorded. They were found infesting cotton with Grade- IV infestation in cotton+ pigeon pea-fallow cropping system of central India.
 - With six new parasitoids recorded during the year, a cumulative of 16 parasitoids and 9 predators have been recorded on mealybugs in India.
 - Weevil *Tanymecus pronceps* (Faust) (Coleoptera: Curculionidae) was recorded infesting non-Bt cotton during off-season. Mirid bug *Creontiades biseratense* which is predominant in southern cotton growing states especially Tamil Nadu and Karnataka is now observed in central India although in lesser number.
 - Comparatively higher sucking pest population was recorded in cotton field adjacent to soybean and in unprotected fields.
 - Out of twelve under-release Bt hybrids, GK-228 BGII and PCH-66 were tolerant to aphids; PCH-44 and KDCHH-553 BGII to leafhoppers and PCH-55 and PCH-22 to whiteflies. No significant difference was observed with respect to thrips, mirid and spider population on Bt hybrids.
 - Sampling from top 1/3rd plant canopy with 15 plants/acre was found to be optimum for assessing field population of *C. livida*.
 - At constant temperature of 27°C and RH 60%, highest fecundity of *P so/enopsis* was observed on congress grass (268 eggs) followed by hibiscus (239 eggs), okra (200 eggs) and tomato (186 eggs).
 - Aphid, whitefly and mirid populations were significantly higher in IPM as compared to RPP over the season, whereas no significant difference in population of leafhoppers and thrips was observed. Spider population was significantly higher in IPM while coccinelids were at par. Statistically there was no difference in yield.
 - Cotton pest management strategies were disseminated through ICT tools (computer, internet and mobile) as CICR was one of the stakeholders in Crop Pest Surveillance and Advisory Project (CROPSAP) 2011-12 in Maharashtra.
 - Insecticidal toxin genes - tcaA (4.5 kb), tcaC (2.5 kb), tccA (3 kb), tccC (around 3 kb) and W14tccC (around 3 kb) could be amplified with long range Taq (Promega). tcaA, tcaC, tccA were amplified from *Xenorhabdus indica* and *X. poinarii* isolates, while W14tccC was amplified from *Photorhabdus*.
 - Molecular characterization of 16sRNA and 18sRNA of bacterial and fungal antagonists for DNA fingerprinting of potential fungal (*Fusarium pallidoroseum*, *Metarhizium anisopliae*, *Lecanicillium lecanii* Coimbatore and NBAll isolates) and bacterial bioagents (*Xenorhabdus* and *Bacillus spp.*) was carried out and the sequences were deposited in the gene bank.
 - Biochemical and molecular characterization was carried out for six isolates of bacteria *Xenorhabdus* and *Photorhabdus* symbiotically associated with entomopathogenic nematodes which were effective against sucking pests and mealy bug.

- Multiplex PCR protocol was standardized for detection of all cotton pathogens in one PCR reaction. This technique can be used for quick detection and identification of cotton pathogens in soil as well as plant sample.
 - *Thrips palmi* is predominant on cotton in north India, especially Haryana, during the early vegetative stage while *Scirtothrips dorsalis* is dominant on cotton in Maharashtra during early reproductive stage.
 - Acephate and Imidacloprid at the recommended doses were compatible with microbial consortia and *T viride* for use as seed treatment.
 - The incidence of pink bollworm moths was moderate in the third week of January in Nagpur with 15.53 moths/trap/week.
 - BG, BGII were free of pink bollworm incidence and damage as compared to the non Bts in India.
 - Survival of pink bollworm on extended BG crop was observed in pockets of Nandurbar, Dhule and Jalgaon.
 - Trait purity with reference to *cry2Ab* was an issue in fields recording pink bollworm incidence on BGII of this region.
 - Translation of COI sequences of leaf hopper populations from different regions of India showed little variation.
 - Transmission of CLRDV (Cotton Leaf Roll Dwarf Virus) from cotton to chickpea was successful but transmission from chickpea to cotton was not established.
 - Five collateral hosts of *Myrothecium rorridum* have been identified.
 - Three genes encoding man nose-specific lectins have been identified in the *Trichoderma virens* genome.
 - No genetic differences were found between CLCuV infected plant samples showing upward and downward curling.
 - Silencing chitin synthase A and trehalose phosphate synthase was found to be promising in terms of their mortality and growth regulating effects on *H. armigera*.
 - A robust replicable bioassay protocol for evaluating the direct and indirect toxicity of lectins to *Chrysoper/a* sps and *Mallada boniensis* was standardized.
 - Leaf hopper samples from 10 locations were subjected to resistance monitoring studies. LC₅₀ to imidacloprid ranged from 0.00012 mg/L (Bhatinda) to 0.128 mg/L (Buldana). LC₅₀s of thiamethoxam ranged from 0.00013 mg/L (Bhatinda) to 0.145 mg/L (Buldana). Seven populations of leaf hoppers were subjected to bioassays with acephate and monocrotophos and its LC₅₀s ranged from 0.0008 mg/L to (Bhatinda) 0.1622 mg/L (Nagpur) and 0.008 (Bhatinda) to 0.0779 mg/L (Jalna) respectively.
- Coimbatore**
- Nymph and adult population of mirid bug *Creontiades bisetate* (Distant) build up was observed from the second week of December, lowest and highest nymphal population was recorded during 50th std week (0.36 nymphs/plant) and 1st std week (4.17 nymphs/plant) respectively. Lowest and highest adult population was recorded during 50th standard week (0.14 adults/plant) and 2nd std week (1.39 adults/plant) respectively. The percentage of green boll damage and square damage varied from 1.85 to 17.14 % and 2.37 to 18.55 %, respectively.
 - No mealybug infestation (*Paracoccus marginatus* and *Phenacoccus so/enopsis*) was observed throughout the observation period (September – February) on cotton or other alternate hosts in experimental and farmers fields.
 - Under IRM farmers fields at Tirupur district of Tamil Nadu sucking pests viz., aphids, leafhoppers, thrips and whiteflies population were below threshold level. Mirid and mealybug population were negligible. Incidence of bollworms was nil.
 - Cotton seed based artificial diet has been standardized for continuous rearing of pink bollworm *Pectinophora gossypiella* and the ingredients of the diet are easily available and cost effective. The per cent recovery, egg hatchability, adult emergence were superior than the other available diets.
 - Monitoring for development of resistance against Bt hybrids in *Pectinophora gossypiella* revealed that among RCH 2 Bt, RCH 20 Bt and RCH 2 NBt, number of exit holes and damaged locules were maximum in NBt than Bt. Mines on the epicarp were minimum in Bt as compared to NBt. No significant difference was recorded in the number of warts observed in the epicarp of the bolls in Bt and NBt hybrids. Maximum number of surviving and dead larvae were recorded in NBt hybrid and Bt hybrids respectively.
 - Recovery of *P gossypiella* larvae was significantly higher in NBt hybrids than Bt hybrids collected from different centres of south zone from Tamil Nadu (Srivilliputhur), Karnataka (Dharwad, Haveri) and Andhra Pradesh (Nandyal).
 - Among the insecticides tested (Imidacloprid, Confidor and Victor), Thiamethoxam (Actara), Acephate (Asataf) and Monocrotophos for resistance against leaf hopper *Amrasca devastans* Dist., Victor registered the minimum LD₅₀ value (0.0035 ml/L) followed by Confidor (0.0050 ml/L), Monocrotophos (0.0054 ml/L), Thiomethoxam (0.0130 ml/L) and Acephate (0.0184 ml/L).
 - Bioassays with *cry2Ab* against *P gossypiella* from Dharwad recorded LD₅₀ and LD_{g0} values as 0.002 ppm and 0.087 ppm respectively and Coimbatore population recorded LD₅₀ and LD_{g0} values of 0.0623 ppm and 0.095 ppm, respectively.
 - Twenty four isolates of bacteria and five isolates of fungi were collected from soil samples. Dual culturing of bioagents, revealed that there was no mutual antagonism between the two bioagents viz., isolates of *Trichoderma* spp. and *Pseudomonas*.
 - Two isolates of *Trichoderma* spp. and an isolate of *Pseudomonas* (from soil samples) were found effective against *A/ternaria* spp.
 - Molecular characterization of five native Entomopathogenic fungi (*L. attenuatum* (Gene Bank Accession No. JQ327150), *M. anisop/iae-ARSEF-9613* (Gene Bank Accession No. JQ062986), *M. anisop/iae-ARSEF-9612* (Gene Bank Accession No. JN712743), *L. araneico/a* (Gene Bank Accession No. JN255572) and *L. fusisporum* (Gene Bank Accession No. JF 427909) isolated from mealybug were submitted to Gene Bank.

- Mass multiplication of a native entomopathogenic fungus, *L. /ecanii* using six nitrogen sources (Peptone, Ammonium Nitrate, Sodium Nitrate, Beef extract, Urea and Thio Urea) revealed that Ammonium Nitrate and Thio Urea supported maximum growth and sporulation of *L./ecanii*.
- Effective temperature for the growth of two isolates of *M. anisop/iae* (ARSEF 9612 and 9613) was recorded as 35 °C.
- *L. /ecanii* multiplied in SDAY Broth and formulated in talc supported maximum spore viability of 70 per cent at the end of six months storage under refrigeration.

Sirsa

- 'Seasonal dynamics' of insect pests and diseases was studied where the infestation of mealybug was observed in the month of October onwards indicating late initiation of infestation. In north, during 2011 crop season on cotton, presence of a single species i.e, *Phenacoccus so/enopsis* Tinsley was observed. But at four locations the *Droschiella* spp. of mealybug was also recorded with minimal economic damage. One predator was recovered from the mealybug i.e *Droschia* spp. and was identified at Entomology Division, IARI, New Delhi as *Rodo/ia fumida* (Mulsant) (Coleoptera:Coccinellidae). Till date 71 alternate hosts of mealybug have been recorded. Parasitisation of cotton mealybug due to *A. bambawa/eiwas* also reported.
- A total of 31 Bt cotton cultivars (newly released) and popular were sown at CICR, RS, Sirsa to study their association with emerging and key pests. No mealybug incidence was observed in any of 31 Bt cotton hybrids. The hybrids did not differ significantly for leafhopper incidence but the difference for whitefly incidence was statistically significant. CLCuV incidence (0.84-10.53%) and root rot (0.00-29.50%) was recorded from 31 Bt cotton cultivars.
- Out of 3954 germplasm accessions evaluated under north zone, 2159 lines free from CLCuD were recorded at experimental area of CICR, RS, Sirsa.
- Among various insecticides and biopesticides, maximum thrips population was reduced by biopesticide, Pest guard L₅₀EC(56.97%). The biopesticides and entomopathogens were found safer to generalist predators. Entomopathogen, *Fusarium pallidroseum* for mealybug management was identified. The efficacy of the entomopathogen was also tested at various AICCIP centres.
- In development and validation of IPM/IRM strategies for Bt cotton hybrids carrying different events against sucking pest complex, observations on the population of leafhoppers ranged between 2.78 to 3.18, average whitefly ranged between 4.64 to 6.36 and average thrips population recorded in different hybrids was 4.09 to 5.84 per 3 leaves under IPM practices where eco friendly strategies like spray of neem oil, *V /ecanii* were practiced which were less than RPP (Recommended package of practices), where only insecticides were used for the management of insects.
- Among different treatments whey protein @ 5% found most effective in managing disease (9.8 % incidence, PDI-3.8) followed by calcium nitrate @ 0.5% (10.1 %,5.4), neem oil

@ 1% (12.5 %, 5.5) and strobilurin @ 0.1 % (13.5 %, 6.4) as compared to control (31.5 %, 14.3) in innovative interventions applied for leaf curl management. White fly reduction was observed only in case of neem oil and Acephate.

- Insecticide Resistance Management strategies were demonstrated in the districts of Sirsa (2540 ha) and Hisar (5215 ha) of Haryana, fifteen villages were selected for this purpose in each district. IRM farmers sprayed 3.59 and 2.38 as compared to 4.22 and 3.82 sprays in non IRM farmers' fields. Insecticide consumption was reduced upto 27.1 and 31.4% respectively in IRM farmers of Sirsa and Hisar. A saving from insecticides by around Rs. 1100/- per ha and an improvement in yield by around 4 q/ha of IRM farmers showed an overall C: B ratio of 1:3.72 and 1:3.65 over 1:3.00 and 1:2.93 at Sirsa and Hisar respectively.
- To monitor the resistance in bollworms to Cry toxins, during 2011 total 42 bioassays were conducted from Haryana, Punjab and Rajasthan where for *cry1Ac* the LD₅₀ ranged between 0.125 IJg/ml to 2.026 IJg/ml and for *cry2Ab* LD₅₀ value of 0.36 IJg/ml to 712.596 IJ9/miwas recorded. Pink bollworm larval recovery from north zone was 4.17 - 20.37 % from non Bt cotton. In Bt cotton bolls, no larval recovery was observed at any stage of crop growth. Pheromone trap catches reveal mean male moth catch per trap per week during the 2011 were 3.58 for pink bollworm, 2.43 for American bollworm, 3.79 for spotted bollworm and 14.22 for tobacco caterpillar on CICR farm.
- Technology assessed and transferred through front line demonstration during 2011-12 on hybrid seed production and production technology. In 20 FLD for hybrid seed production of hybrid CICR 2, around 30 q seed of CICR- 2 (*desi* cotton hybrid) was produced by the farmers trained at this centre in hybrid seed production technology. Fifty five FLDs on production technology were conducted.
- Evaluation of entries for insect pests and diseases was done under various trials in AICCIP. In station trials of 7 *G. hirsutum* entries, promising *G. hirsutum* cultures CSH 2932 and CSH 3114 out yielded the check H 1226 with 10-20% higher yield. These entries were sponsored in Br.02a AICCIP trial. In station trial of 6 *G. arboreum* entries promising cultures CISA 111 and CISA 8 out yielded the check and were sponsored in Br.22a/b AICCIP trial, CSH 3088 was promoted to Br.03a trials of north and south zone. CSH 3129 has been recommended for Agronomy after its performance over 4 years in AICCIP trials. The GMS based hybrid CSHG 4207 was sponsored in AICCIP trial Br.05 PHT.
- Effect of defoliant on physiological parameters and seed cotton yield, the experiment on effect of defoliant Thiadiuron 36% SC + Diuron 18% SC on cotton showed that the yield/ha was significantly higher in MRC 7017 (31.2 q/ha) and MRC 7361 (31.0 q/ha) than F 1861 (28.1 q/ha). The uniformity in opening of bolls with both the concentration of Thiadiuron 36% SC + Diuron 18 % SC at both the intervals was observed but the difference for number of unopened green bolls was non-significant as compared to unsprayed control.