2. Executive Summary

2.1 Crop Improvement

Nagpur

- The total cotton germplasm holding at CICR is 10375 accessions that include all four cultivated species i.e., *Gossypium hirsutum* (7523), *G. barbadense* (287), *G. arboreum* (1907) and *G. herbaceum* (565), 26 wild species, 15 races and 32 interspecific derivatives and 20 perennials.
- Twenty three exotic accessions (*G. hirsutum* – 18 and *G. arboreum* – 5) were procured from Pakistan under Reciprocal Germplasm Exchange Agreement.
- Twenty-three morphological variants of *G. arboreum* race cernuum having high boll weight (5 g to 7 g), high GOT (42% to 48%), short medium staple (16 mm to 19 mm) and coarse fiber were collected from Tribal region of West Garo Hills, Meghalaya.
- Six genetic stocks with novel and unique traits (*G. hirsutum* - 4, *G. arboreum* - 2) were identified and registered with NBPGR, New Delhi.
- Eighty-six genotypes suited to High Density Planting System were identified from the global germplasm selected on the basis of short internodes, compact fruiting branching habit, early maturing and bolls retentivity.
- Fifteen *G. aridum* based CMS, 137 *G. harknessii* based CMS, 57 restorer, 20 GMS line were maintained by crossing to its fertile counterpart (B-line) by selfing and sibmating.
- Sixty-four genotypes of *G. hirsutum* are in various generations of backcross under conversion of elite genotypes using approved BN-Bt event by conventional method.
- A new variety CNHO 12 (Saraswati) developed at CICR, Nagpur released in 2009 for the irrigated condition of Central zone was notified in the Gazette of India.
- CNA 1003 (ROJA) (*G. arboreum*) has been identified for cultivation in rainfed situation of South Zone by Central Variety Identification Committee during AICCIP Workshop held at CCSHAU, Hisar on April 6-8, 2011.
- CNA 1007 that ranked first in lint yield (608 kg/ha) and third in seed cotton yield was retained for 2nd year in Br.24 (a/b) trial in South Zone. CNA 1008 has been promoted to Br.24(a/b) in Central and South Zone during the crop season 2011-12.
- Four *G. arboreum* entries namely CNA 397, CNA 398, CCA 1014 and CCA 1015 were sponsored for Initial Evaluation Trial Br. 22 (a/b) of AICCIP for crop season 2011-12.
- Six new advance selections of *G. hirsutum* namely, CNH 14, CNH 44, CNH 50, CNH 1107, CSH 121 and CSH 1111 were sponsored for IET Br. 02(a/b) and 3 selections namely, CNHO 12, CNH 1108 and CNH 1109 were also sponsored for compact plant type trial Br. 06(a/b).
- Seven events of T_5 generation (*G. hirsutum* variety LRK 516), 3 events of T_2 generation (Anjali Ac Bt having Bt *cry1Ac*) and 2 of T_1 generation (Anjali FBt- having Bt *cry1F*) were taken to event selection trial.
- New transformation events were generated with *G. hirsutum* cultivars Suraj and LRA 5166 using *cry1Ac* and *cry1F* genes.
- Molecular characterization and insect bioassay were conducted on RG 8 Bt plants.
- Transgenic plants of the three genotypes H 777, HS 6 and F 846 with Sense and Antisense coat protein and Antisense replicase protein were grown in the contained trial of RCGM for event selection.
- Four gene constructs AC2, CP, βC1 and βV4 were used in Agrobacterium mediated transformation for CLCuV resistance by RNA i approach. The plants containing AC2-sense primer were confirmed by PCR for the presence of gene.
- Four drought tolerant events of *DREB 1 A* and *BcZF1* genes were grown in the confined greenhouse RCGM trial.
- Detailed morphological characterization was performed in the germplasm lines belonging to eleven working groups. The variation in gossypol gland density in leaves hold promise to consider gossypol gland density as a special character in DUS testing.
- Quality seeds of cotton, soybean, redgram and Bengal gram were produced under Mega Seed Project.

Coimbatore

- Two superior cultures were tested in Initial Evaluation Trial of AICCIP under irrigated condition viz., CCH 820 (Long Staple Culture) and CCH 10-1 (Medium Staple Culture).
- Culture CCH 2623 tested in the Coordinated Varietal Trial under irrigated conditions recorded a mean seed cotton yield of 1515 kg/ha and 1910 kg/ha in south and central zone, respectively and it was superior to check Surabhi (1277 kg/ha) and LRA 5166 (1489 kg/ha). This culture has been retained in Coordinated Varietal Trial for one more year of testing in both zones.
- Ninety-two NDGB lines and 14 USAGB lines of *G. barbadense* germplasm were maintained and variability was studied during 2010-11 crop season.
- Twenty-two exotic *G. barbadense*, accessions were field evaluated during 2009-10 and 2010-11. Accessions EC-617836 (631 kg/ha), EC-617837 (629 kg/ha) and EC-617840 (614 kg/ha) gave higher seed cotton yield than the control Suvin (371 kg/ha).
- Nine interspecific hybrids viz.; CCHB-2, CCHB-6, CCHB-7, CCHB-8, CCHB-11, CCHB-13, CCHB-20, CCHB-21 and CCHB-22 (SCY ranges from 2632 to 2799 kg/ha) showed significantly higher seed cotton yield over the check hybrids RCHB-708 Bt (2113 kg/ha) and DCH-32 (1927 kg/ha). Hybrids CCHB-22 and CCHB-11 recorded more than 30% yield compared to check RCHB-708 Bt.
- Distinctiveness, Uniformity and Stability testing was taken up in two trials comprising 23 and 19 candidate varieties of tetraploid cotton and one candidate alongwith two reference varieties of diploid cotton.

- In total, 87 application forms comprising of new and extant cotton varieties were submitted to PPV&FRA through NBPGR for registration under PPV&FR Act, 2001.
- Electrophoretic analysis of cotton seed proteins was compared using Tris Soluble Proteins, Salt Soluble Globulins and Methanol precipitated fraction separated by SDS-PAGE. Electrophoretic estimation using Salt Soluble Globulins was found better than other two methods.

Sirsa

- Three hundred and thirty germplasm lines (working collection) were evaluated and their DUS characters were recorded. Superior accession for boll weight : MEADE 9030 D(3.8), UPA (62) 31-65(3.8), CSH 911 (3.7); for yield/plant : CNH 151(153 g), 9-1487(150 g), DELTAPINE C 5(150 g); for boll number : DELTAPINE C 5(56), CNH151(51), 359754(45); for seed index : WC 12 NL(11.6), S 344(11.6), COKER 100 STAPLE(11.5); for GOT RED 5-7(40.3), MLL(40), AURBURN OKRA 213 – OBP – SPB 1978(39.4); for Lint Index: B 61 – 2038(7), L-147(7), BJR JK-97-16-4 (7) were identified.
- *G. arboreum* Variety CISA 614 (CICR-2) has been notified by Ministry of Agriculture for its cultivation in entire north zone.
- Based on 3 years performance, intra-*hirsutum* GMS hybrid CSHG 1862 was promoted for agronomy trial in North zone and it has been identified during the AICCIP Workshop held at CCSHAU Hisar from 6-8 April, 2011. CSHG 1862 showed superiority for seed cotton yield by 11.5%, tolerance to CLCuD and better fibre quality spinning at 50's count.
- The GMS hybrid CISAA 14 recorded seed cotton yield of 2773 kg/ha against zonal check 2617 kg/ha, ranked 4th and was retained in Br.25(a) zonal trial for further testing. It possesses 38.0% GOT, 2.5% span length of 22.9 mm and strength of 17.7 g/tex.
- *G. hirsutum* entry CSH-3129 (SCY 22.8 q/ha) ranked 4th in position and was promoted to Br04 (a) trial.
- *G. hirsutum* entry CSH-3158, with average seed cotton yield of 26.15 q/ha ranked 6th and has been promoted to Br03(a) trial.
- Intra-*hirsutum* hybrid CSHH 3008 was promoted from Br 05(a)-1 National trial to Zonal trial Br05(a)CHT.
- Following eight entries (*G. arboreum*-2, *G. hirsutum*-2, GMS based *G. arboreum* hybrids-2, GMS based *G. hirsutum* hybrid-1, Intra *hirsutum* hybrid-1) were sponsored in AICCIP trials namely *G. arboreum*-CISA 7R, CISA 105; *G. hirsutum*-CSH 2810, CSH 3114;GMS based G. arboreum and *G. hirsutum* hybrids- CISA A17, CISA A18, CSHG 3118 and Intra *hirsutum* hybrid CSHH 4007.
- Forty-seven *G. hirsutum* cultures were evaluated and the CLCuD resistant cultures CSH 2934 with highest GOT (35.0%) and CSH 2936 with highest seed cotton yield of 2723 kg/ha were identified.
- Breeder seed of female and male parent of Hy. CSHH 198, CSHH 243, CSHH 238, CICR 2, and *desi* cotton varieties CISA 310 and CISA 614 was produced.

2.2 Crop Production

Nagpur

- On rainfed Vertisols, the genotype PKV 081 was found most suitable for high density planting system (HDPS) (166000 plants/ha) based on yield (1921 kg/ha), morphological features, earliness, tolerance to sucking pests and boll weight. In *G. arboreum* on the basis of yield, CINA 404 (2174 kg/ha) performed best under HDPS (222000 plants/ha). However other high yielding genotypes viz., JK-5 (1842 kg/ha) and AKA-07 (1815 kg/ha) were dwarf and more compact than CINA-404. Across the genotypes a spacing of 45 x 13.5 cm (166000 plants/ha) was optimum for short compact types. Similarly a spacing of 45 x 10 cm (222000 plants/ha) was optimum for short compact plant types of *G. arboreum*.
- In both *G. hirsutum* and *G. arboreum* application of 25% extra fertilizer dose is essential to sustain higher yield under HDPS. Application of Maleic hydrazide (@ 500 ppm at 45 DAS (days after sowing) and Mepiquat chloride (@ 60 ppm at 45 DAS) showed promise to further enhance the yield under HDPS.
- The physical nipping of plants reduced the plant height in Bt hybrids and foliar application of maleic hydrazide also brought about the same effect by effectively inhibiting the meristem growth in both main stem and sympodial branches.
- Bt cotton intercropped with Roselle produced higher cotton equivalent yields, nutrient use efficiency, C:B ratio and net returns than sole Bt cotton on rainfed Vertisols.
- Controlling weeds by harrowing once before sowing or Roundup 2.5 l ha^{-1} + pendimethalin 1.0 kg a.i. ha^{-1} alongwith three inter-cultures and two hand weeding was effective for weed control in rainfed cotton on Vertisols.
- Stance was effective in reducing the plant height by reducing the internodal distance in Bt hybrids. Defoliant Dropp effected 90-100 % defoliation after 15 days of spray and it was superior to Ethrel exhibiting 73- 90% defoliation.
- Receding moisture and high light intensity induced reddening of leaves. Foliar application of nutrients, hormones and fungicide could not control leaf reddening, but the intensity of reddening varied. Plants sprayed with monocrotophos showed no reddening all through the season. With foliar application of Methomyl, the whole plant turned red within 24-48 hours after application.
- Improved cotton production technologies were demonstrated in the villages, Nandura and Loni (District Yavatmal) in 66 acres by 33 farmers under NAIP (cotton value chain) project. Higher seed cotton yield (2350 kg/ha) was recorded in closer spacing (75 x 60 cm) followed by INM practices (2165 kg/ha) as compared to farmers' practice (1190 kg/ha). Technology on protective irrigations with 90 x 60 cm spacing produced higher yield (2400 kg/ha).
- Under mechanization of cotton cultivation, a small sized manually operated cotton planter was developed for planting cotton seed and an adjustable cultivator was designed and developed for intercultural operation for narrow spaced cotton crop and a fertilizer applicator has been modified for equal distribution of fertilizer from both

tubes. Field efficiency manually operated small hand picker varied from 56 % to 100 % of the manual.

- Knowledge assessment and adoption of cotton intercropping practices revealed that around one third respondents (34%) in the districts of Akola and Khandwa were placed under full knowledge group while one forth respondents (26%) had fully adopted various components of intercropping.
- The sociological problems faced by the cotton farmers were family responsibilities, family conflicts, increasing alcoholism/ drug abuse. The overall percentage of sociological factors for agrarian distress among the farmers was noted to be 68.81 per cent (71.59% in Yavatmal and 66.15% in Jalgaon). Among economical factors, the majority of the respondents expressed that, the rising cost of cultivation, yield uncertainties, labour problem, inadequate irrigation facilities and increasing dependency on others in farming leads to distress among them.
- In Yavatmal district, highest achieved cotton yield among the sample was 2750 kg/ha whereas average yield was 1730 kg/ha. Yield gap was estimated to be 1020 kg/ha. In Jalgoan district, yield gap was estimated to be 1302 kg/ha. Important constraints which are contributing to this yield gap were ranked based on the loss associated with them. Incidence of sucking pests, weeds problem and leaf reddening, delayed sowing due to late onset of monsoon and water logging were the main constraints.

Coimbatore

- Cotton plants responded to foliar application of nutrients better under irrigated condition than under moisture stress. Nutrient consortia of DAP 1% + KCl 0.5% + $MgSO_4$ 0.5% + $FeSO_4$ 0.25% + $ZnSO_4$ 0.25% + other micronutrients increased yield significantly both under irrigated and moisture stress condition.
- Genotypes viz., LRA 5166, Anjali and H777 more tolerant to heat stress than Bt cotton (RCH 2, RCH 20, Bunny, MRC 6918, Mallika and Thulasi. Among the Bt cotton hybrids MRC 6918 and Mallika were more sensitive to heat stress.
- 125% RDF with foliar spraying of DAP 1.5% + K 0.5% + Mg SO_4 0.5% + boron as solubor 0.15% recorded the higher seed cotton yield (3653 kg/ha), net return and B/C ratio under Bt cotton + coriander system compared to sole Bt cotton in winter irrigated tract.
- Stale seed bed technique (SSBT) using a mixture of pendimethalin 1.0 kg + glyphosate 1.0 kg one week after irrigation (one week before sowing) recorded the highest weed control efficiency of 86.6% on 35- 45 DAS and on par seed cotton yield with HW thrice under SSBT.
- The pre emergence application of pendimethalin followed by one hand weeding at 35 - 40 DAS and post emergence application of either phenoxy-p-ethyl 100 g or quizalofop-ethyl 50 g on 60 DAS recorded better control of weeds and on par seed cotton yield with hand weeding thrice (20, 40 and 60 DAS).
- On an average, Bt cotton growers of Karnataka are incurring an expenditure of Rs. 37582.62 per ha towards cultivation. Human labour is the major cost item accounting for 50.01 per cent of working expenses. Fertilizers and manures occupy second and third place accounting for 16.19 per cent and 11.09 per cent respectively of working cost. On an average cotton farmers are producing 1800 to 2200 kg of seed cotton per ha. B:C ratio was worked out to be 1.39. An increase of 26 per cent in net returns was observed in Bt cotton cultivation when compared with non Bt cotton.
- In the post WTO period between 1995-96 to 2010-11, the area, production and yield had grown at 0.85, 7.35 and 6.45 % respectively. During the post WTO period, the quantity of imports almost remained stagnant at 13 lakh tonnes and gradually reduced during post Bt era from 22 lakh bales of 170 kgs each to 5 lakh bales. The export increased from 17 lakh bales during 1999-00 to almost 83 lakh bales of 170 kgs each during 2009-10.
- From the Marlow Chain analysis, it is evident that China has been the only stable importer of Indian cotton, as reflected by the high probability of retention that increased from 0.04 during the pre-reforms period to 0.62 during the post-WTO pre Bt period to 0.71 during post Bt era. Italy and Thailand have depicted low probability retention of 0.67 and 0.54, respectively.
- The yield gap ranged from 600 to 716 kg/ha in Coimbatore and Perambalur districts of Tamil Nadu. Weed infestation, non-availability/ shortage of hired labour and inadequate irrigation facilities are major constraints affecting cotton production.
- Assessment of the livelihood changes perceived by the growers in different production systems were analysed using Sustainable Livelihood Analysis. The biotech cotton production system had created significant changes in the livelihood of cotton growers.
- With the use of "Multi Criteria Decision Analysis" and GIS tools attempt has been made to develop Decision Support System for selection of suitable genotype for the specific agro climatic conditions.

Sirsa

- The net income of Rs. 65190 with MRC 7017 and Rs. 65340 with Bioseed 6488 was higher in sole cotton followed by paired row with 3 rows of mungbean with Rs. 61100 with MRC 7017 and Rs. 61350 with Bioseed 6488.

2.3 Crop Protection

Nagpur

- Field dynamics of mealybug *Phenacoccus solenopsis* in 3 cotton cropping systems of India have been studied. Field dynamics of mealybug *Paracoccus marginatus* and *Creontiades biseratense* has been studied in cotton + pulses –maize cotton cropping systems while population dynamics of *Campylomma livida* was studied in cotton + pigeon pea –fallow cropping system of India.
- Sampling techniques for *C. livida* indicated that top one – third portion of plants harboured highest number of mirids and a sample size of 15 plants per acre was found to be optimum to assess mirid population.
- Growth parameters of *P. solenopsis* were studied at constant temperatures of 20 °C and 35 °C at Nagpur.
- Biology of leaf hopper *Amarasca devastans* was studied.

Nymhal period of instar I, II, III and IV was in the range of 2-4 1-5, 1-3 and 1-4 days with average period of 2.58, 2.14, 2.03 and 1.84 days respectively. The total nymphal period was 8.59 days which was less than the adult period of 13.37 days. The total life cycle of male and female was 21.38 and 23.19 days respectively.

- Population dynamics for mirid *Campylomma livida* was studied at 6 different locations. The highest population was recorded during 37th SW (6.16 per plant) in cotton intercropped with citrus followed by cotton adjacent to water canal. The mean population during the season was maximum in unprotected field (1.61 per plant) and minimum (1.08 per plant) in cotton surrounded by soybean and sorghum.
- Record of 166 host plants of *P. solenopsis* has been made during season and off season across India.
- The Ahmadabad native Bt strain was effective against *H. armigera,* efficacy was on par with the standard strains HD1 and Btk. It belongs to the *cry2A* class.
- Native Bt strains isolated from the saline soils of Barrackpore and from Pasighat of the North east were found effective against *Spodoptera*. Some of these Bt strains belong to *cry2A* class while some belong to the *cry9* class. Atleast two strains carry *cry2A* and *cry9* genes together.
- Leaf hoppers on cotton in North India are genetically different from populations of South and Central India. Evidence is provided based on the CO1 sequences of 258 single insect samples.
- Comparing sequences of COI, COII and NADH1 regions using MEGA 4 it was observed that transversion was predominant in the COI region while transitions occurred in the NADH1 and COII regions.
- Twenty-four haplotypes based on the CO1 sequences were identified in the leaf hopper.
- Neonicotinoid resistance is high in Central and South Indian cotton leaf hopper populations as compared to populations of North India. Resistance ratios to imdacloprid and thiomethoxam was highest in Haveri (6,200 fold and to thiomethoxam 56.5 fold).
- Interspecific variation in the toxicity of *cry2Ab* was observed with *Spodoptera. S. exigua* is several folds more susceptible to the toxin as compared to *S. litura*.
- The variability in toxicity of *cry1Ac* to *H. armigera* was 58 fold across the country.
- dsRNA for three genes, Protein 40, Aminopepetidase and pectate lyase reduced reniform nematode penetration by 37-46%. Of these two genes, protein 40 and Aminopeptidase have also been found to reduce penetration of root-knot nematode indicating that the two genes, Protein 40 and Aminipeptidase have potential for their use in RNAi mediated management of phytonematodes.
- Bt Adapt II a stochastic two gene resistance prediction model was developed and validated.
- Lectin detected in ELISA kit developed for CEA and AMTL. CEA banana lectin and AMTL in combination showed neither addictive nor synergistic effects on aphids, jassids and white flies, indicating the probability of relatively common spectrum of related reception for these lectins.
- IRM strategies implemented in 19 districts, covering 236 villages reaching out to 13,990 cotton farmers cultivating cotton over an area of 25,476 ha.
- Biochemical and molecular characterization required for CIB registration was carried out for four bacterial isolates (NG, D6, G1 and G5) belonging to *Photorhabdus, Xenorhabdus spp*. symbiotically associated with entomopathogenic nematodes and which have been found effective against insect pest including mealybug.
- Insecticidal toxin genes Tcc2, TcdA, TcdB, TcdAb and TcdA2 with amplicon size ranging between 750-1000bp were amplified from bacterial symbiont of entomopathogenic nematodes using primer pairs designed. The sequences had similarity with *Photorhabdus* toxins having oral and intrahaemocoleic toxicity.
- Positive correlation (r=0.901) was observed between incidence and severity of BLB in PKV081.
- Though substantial amount of genetic diversity exists in CLCuV strains of North India, there is no relation between genetic diversity and geographical distribution as observed using beta DNA sequences.
- A new RNA virus member of Luteovirideae was identified occurring on cotton by RT-PCR for the first time in India.
- 16SrRNA sequences of 6 bacterial biocontrol agents showed that three belonged to *Pseudomonas aeruginosa*, two to *Bacillus subtilis* and one to *Ochrobactrum anthropii.*
- A record of 9 species of parasitoid and 8 species of predator was made. Among the parasitoids, *A. bambawalei* (Hymenoptera: Encyrtidae) parasitised mealybug *P. solenopsis* between 5 to 100 % in the three cotton growing zones of India.
- Genotypes tolerant to sucking pests including leaf hopper, leaf reddening with high yielding potential were identified as Ankur Jai BG II, Ankur – 3042 BG II, Atal BG II, Express Fusion Bt (NCEH – 14 Bt) and VICH – 303 Bt (BG II).
- Validation of IPM versus recommended package of practices was carried using 6 Bt genotypes. IPM interventions were beneficial over RPP in all treatments, except sole Express fusion Bt.
- Cotton pest surveillance was carried out in 29 districts of Maharashtra and advisory was issued as and when required, based on the pest situation.

Coimbatore

- Seasonal dynamics of mealybug and mirid bug revealed 32.1 – 40.7% and 18.2 – 27.7% mean infestation respectively on cotton in five project villages of Tirupur district.
- Out of twenty eight Bt cotton hybrids (27 BG II & 1 BG), three BG II Bt hybrids viz., MRC 7583 BG II, Akka BG and Ankur 5642 BG II were found tolerant to leaf hopper with hopper injury grade of 1.0 and significantly higher yield of 1645, 1611 & 1435 kg/ha as compared to check hybrid DCH 32 which recorded 1088 kg / ha.
- Three entries *viz*., SP 911 BG II, SP1037 BG II and Ankur 1976 were tolerant to mealybug with 0.2 to 0.4 grade level of

infestation and recorded significantly higher yield of 2013, 1662 and 1546 kg/ha as against 1704 kg/ha in MRC 7351(Check Hybrid).

- Six *hirsutum* genotypes *viz*., CCH 809, CCH815, LRA 5166, CCH 819, CCH 820 and CCH 825 were found tolerant to leaf hopper and recorded less than 1.0 grade injury as against 2.37 injury grade in ICGH 630. Six entries *viz*., ICGH 341, 370, 410, 474, 480 and 630 were identified as tolerant to bollworms and recorded yield ranging from 71 to 111 g/plant. Twenty three entries *viz*., CCB 20, CCB 23, CCB 24, CCB 25, CCB 26, CCB 27, CCB 28, CCB 29, CCB 31, CCB 32, CCB 33, CCB 34, Suvin (C), CCB – 1-1, CCB 5, CCB 11, PIMA 121, SUDON 436, ICB 125, GSB 39, CCB 17, CCB 18 and ICGH 370 were found free from leaf roller as against standard varieties LRA 5166, MCU5VT and Suraj which recorded 57.5, 60.0 and 67.5% infestation, respectively.
- Imidacloprid, Acephate 75SP (750 g), Acetamiprid, and Acephate 95% SG (562.5 g) were effective against leaf hopper with a reduction of 53.2, 51.0, 37.2 and 35.0%, respectively and increased seed cotton yield significantly by 11.6 to 25.0%, over control.
- Mirid bug *Creontiades biseratense* occurred from October second fortnight to January first fortnight, under cotton with pulses cropping system. Significantly minimum and maximum population of nymphs and adults were recorded during last week and second week of November and January respectively. Occurrence and its correlation to abiotic factor has been worked out.
- Status of sucking pests *viz*., aphid, leafhopper, thrips and whiteflies population were below threshold level and averaged 3.93, 1.16, 0.73 and 0.32 and 1.23, 0.73, 0.50 and 0.24 /3 leaves in IRM and Non IRM fields respectively at Tirupur District, Tamilnadu.
- Number of surviving larvae *P. gossypiella* on NBt hybrids were significantly higher as compared to the larvae in Bt hybrids, within three BG, BG II and NBt hybrids of RCH, MRC and Bunny genotypes.
- Cotton seed based artificial diet has been standardized for rearing pink bollworm *P. gossypiella*.
- Establishment of parasitoid *A. papayae* on mealybug *P. marginatus* in cotton was recorded at CICR, RS, Coimbatore. High intensity of parasitisation and adult emergence were recorded on twigs alone and twigs with leaves, respectively as compared to leaves alone.
- Pheromone trap catches of *P. gossypiella* was recorded from December to February 2011. Average adult catch per trap per night was maximum during the last week of January (165.75/trap) and the larval population recovered from the bolls in that particular field was maximum during this period only in two non Bt hybrids of RCH 2 NBT (19.75/5 bolls) and Bunny NBT (16.75/5 bolls).
- Bioassays conducted with *cry1Ac* (0.1,1 and 10 ppm concentrations) on F_1 population of field collected Pink bollworm *P. gossypiella* from Dharward, Coimbatore and Nandyal, indicated LD_{50} and LD_{90} values 0.060 and 0.092, 0.058 and 0.089, 0.069 and 0.105 respectively.
- During 2010-2011, the IRM strategies were successfully implemented in 15 villages of Gudimangalam Block at Tirupur district under the project TMC MM II IRM. A total number of 188 farmers from 15 villages with an area of 143 ha were covered. Implementation of IRM strategies in the project villages resulted in the reduction of number of sprays from 7 to 4 and the plant protection cost from Rs.7248/ha to 4483/ha besides an increase in yield from 3230 to 3340 kg/ha between Non IRM and IRM farmers.
- The Per cent Incidence (PI) and Severity Index (SI) of *P. marginatus* ranges from 02 to 80 and 1.00 to 2.07 respectively. Higher SI and PI recorded during the month of January and February.
- Cotton field adjacent to weedy road recorded with highest mean PI (48.08) and SI (2.06) followed by sole cotton (PI-41.15 and SI -1.07) and field surrounded by fallow land with weeds (PI-41.54 and SI-1.13).
- Growth parameters of cotton mealybug *viz*., *P. marginatus* and *P. solenopsis* at 20°C and 25°C indicated rate of increase is high at 25°C compared to 20°C. While comparing all the growth parameters of *P. solenopsis* and *P. marginatus*, growth is favoured at 25°C than 20°C and *P. marginatus* more susceptible to temperature changes than *P. solenopsis*.
- Chitin added medium shows higher activity of pathogenesis related enzymes than other sources. Among the entamo-pathogens, *M. anioplea* shows high enzymes activities followed by *B. bassiana* and *V. lecanii*. Saccharose containing medium gave high biomass production irrespective of the entomopathogen.
- Foliar application of *B. bassiana* gives maximum endophytic colonization percentage of 32 at 10^8 concentrations.
- *Fusarium solani* and *Fusarium oxysporum* are predominant endophytes. *B. bassiana* readily forms an endophytic relationship in Bt and Non Bt cotton and causes no plant pathological symptoms.
- Two bacterial antagonists *viz*., *Psuedomonas flourescens* and *Bacillus subtilis* were isolated from nematode suppressive soils. Both bacteria significantly reduced the hatching and survival of reniform nematode.
- Evidence was provided for nematicidal property of *Anonas comosus*, *Chromolena odorata* and *Mimosa invisa* against reniform nematode.
- Bacterial cells alone and cell free extracts of bacterial symbiont (*Xenorhabdus stockiae*) of a native entomopathogenic nematode, *Steinernema siamkayai* was tested against *H. armigera*, *S. litura*, *Sylepta derogata* and *P. marginatus* under in vitro condition. Both bacterial cells and extracts were pathogenic to test insects.
- A maximum of 70% viability and virulence of spores was recorded when a native isolate of *Lecanicillium lecanii* was multiplied on SDAY medium and formulated in talc. Oil in water emulsion based formulation of *L. lecanii* stored at 9 $\pm$ 1°C recorded 78.33 % viability at the end of six months of storage.

Sirsa

- The resurgence (8.29%) in whitefly population due to fipronil was recorded after 10 weekly spray applications but in case of individual spray round, the 2nd spray resulted into maximum resurgence (77.31% after one day and 47.89%

after seven day of spray application) in whitefly population.

- Among various insecticides and biopesticides tested, imidacloprid (53.63%) resulted in maximum reduction of jassid population and neem oil + nirma powder resulted in maximum (52.95%) reduction of whitefly population. Maximum thrips population was reduced by biopesticide, Pest guard L 50EC (45.37%). The biopesticides and entomopathogens were found safer to generalist predators.
- Peak infestation due to mealybug in cotton–wheat system was highest during the June –July and October-November, 2010. Weed species, *Kanghi buti*, *Xanthium* and *Congress grass* were found to be the major starter host for the onset of infestation on cotton season. From 20 Ground truth data collection locations of different blocks, mean average mealy bug seasonal incidence (%)-15.37, severity index-0.91 and parasitization due to *A. bambawalie* (%)-11.20 was recorded.
- Infestation and observations on Pink bollworm larval recovery were recorded from four locations of North Zone (Faridkot, Sriganganagar, Sirsa and Hisar through examinations of 150 green bolls thrice at 140, 160 and 175 DAS from Bt and non Bt cotton. The PBW larval recovery from non Bt cotton ranged between 6 to 120 from the bolls collected at different intervals and % recovery was 6.67 to 80%, whereas no larval recovery was recorded.
- Reduction in insecticide spray from 20.73-39.5% in twenty IRM villages and yield increase of around 270 kg/ha leading to net increase in income of 14000/- per ha was observed in Sirsa and Hisar districts.
- On the basis of 3 sprays applied in chemical control of sucking pests through foliar application at 75, 90 and 105 days after sowing the maximum reduction (58.08%) in jassid population was recorded in case of imidacloprid 200 SL; in whitefly population (51.40%) was recorded in acephate 75% SP @ 750 g a.i./ha and in thrips (51.18%) was observed in case of fipronil under AICCIP.
- The entomopathogen *F. pallidoroseum* did not show any adverse effect on beneficials.
- *Spinacea*, *Chenopodium*, *Solanum nigrum*, *Lantana camara* and *Convolvulus arvensis* were identified as new weed hosts as they tested positive for CLCuV with Coat protein primer.
- Seed cotton yield reduction with 60%PDI varied from 27.45% (NECH-6) to 43.52% (Bioseed-6488) and with severity grade 4, it varied from 35.59% (RCH-134) to55.0% (Bioseed-6488), due to CLCuV.