Executive Summary

2.1 Crop Improvement

Nagpur

- *Twelve* germ plasm lines including 8 *Gossypium hirsutum*-race *latifolium, Gossypium arboreum* race - *cernuum* (3) and one *Gossypium arboreum* race- *bengalense* of unique and *novel* traits were added to the Gene Bank, CICR, Nagpur.
- Three genetic stocks of G. *arboreum* race *cernuum,* immune to Grey Mildew *(Ramularia areola Atk)* disease *viz.,* 30814 (INGR No. 09117), 30826 (INGR No. 09118) and 30856 (INGR No. 09119) were evaluated and registered with NBPGR, New Delhi.
- Five new interspecific hybrids developed using wild species were added to the existing collection.
- G. *arboreum* culture CNA 1003 having medium staple length and good strength (23 g/tex) with promising yield was promoted in South zone for Agronomy trial.
- Evaluation of 63 breeding lines for drought tolerance in G. *hirsutum* revealed four lines *viz.* DTS 155-09, DTS 108-09, DTS 100-09 and DTS 104-09 to be drought tolerant with high seed cotton yield.
- G. *hirsutum* variety, CNHO 12 - an early maturing, jassid tolerant cotton with relatively high oil content and synchronous boll bursting habit was released for the central zone under irrigated conditions.
- One new GMS line, ABGMS-developed by induced mutation and one restorer line CIR 1-18 with partial pigmentation and frego bract has been registered with NBPGR.
- Population of Anjali Bt (G. *hirsutum),* PA 255 and RG 8 Bt was *advanced* for commercialization following characterization of the events.
- A new method of gene transfer through pollen tube pathway was standardized and used for development of transgenic *event* with *cry* 1F gene.
- An unique Class I chitinase gene was cloned from LRA 5166 and transformed in G. *arboreum* variety, PA255.
- Two antisense approach based transgenic events for CLCuV resistance in cultivars HS6 and H777 proved tolerant against the virus when tested in Green house at Sirsa.
- Inverted repeat constructs for *five* target regions of CLCuV were constructed for development of virus resistant cotton through RNAinterference.
- Seed size with respect to seed index significantly influenced field emergence and seed cotton yield.
- Quality seeds of cotton, wheat and redgram were produced and resources to the tune of Rs. 6.72 lakhs were generated under Mega Seed Project..

Coimbatore

- Three superior G. *barbadense* accessions *viz.,* ICB-167, ICB-274 and ICB-129 had better yield and fibre quality attributes than Suvin.
- The extra long staple interspecific (G. *hirsutum* x G. *barbadense)* hybrids like CCHB-110 (2423 kg/ha), CCHB-215 (2404 kg/ha), CCHB-260 (2400 kg/ha) and CCHB-123 (2391 kg/ha) showed consistent performance during last three years overthe check DCH-32 (1997 kg/ha).
- Two years study indicated superiority of CCH 815 and CCH *816 over* the check variety Suraj by 25 to 28 per cent..
- Medium Staple culture CCH 2623 tested in the Preliminary Varietal Trial, ranked second and first in the South Zone and Central Zone trials, respectively.
- The compact genotypes *viz.,* HCT 8 and HCT 12 were found superior by *over* 20 per cent to the best check variety Anjali.
- Extra long staple G. *hirsutum* culture CCH 818 with a mean seed cotton yield of 1957 kg/ha was found superior to Surabhi by 30 per cent..
- Breeder seeds of the varieties *viz.,* LRA 5166, Surabhi,

Suraj,, Supriya and Suvin were produced in sufficient quantities to meet the National Indent..

- Distinctiveness, Uniformity and Stability testing of tetraploid cotton genotypes were taken up in two trials comprising 5 and 23 candidate varieties, respectively. Similar trial was conducted for diploid cotton with one candidate and two reference varieties. For registering cotton varieties under PPV&FR Act, 2001,61 applications comprising new and extant cotton varieties were submitted through NBPGR..
- By coating pre cleaned seeds with polykote @ 3 ml/kg combined with carbendazim @ 2 g lkg, seed deterioration can be prevented up to 18 months retaining the viability to the extent of 77 per cent..

Sirsa.

- Variety CISA31 0 of *Gossypium arboreum* has been notified for cultivation in entire north zone. The variety CISA 614 was also identified by Variety Identification Committee Meeting (AICCIP) held at ANGRAU, Hyderabad 6-8 April .. 2009 and notified vide Gazette of India NO.608 dated Apnl 1,2010 forthe same zone.
- In theAICCIP North Zone trials, based on three years mean performance (2007-09), GMS based hybrid CSHG 1862 recorded the increase of 13 % for seed cotton yield and 18.1 % for lint yield over the conventional check hybrid CSHH 198 and was identified for agronomy trial in North Zone.
- CSH 3158 and CSH 10 were promoted to Br 03a zonal trial.. The genotype CSH 3129 was promoted to Br 04a zonal trial for further testing. The intra *hirsutum* hybrid CSHH 3008 was promoted to Br 05a zonal trial.. The intra *arboreum* hybrid CISAA 15 was promoted to south zonal trial Br 25a.
- Significantly higher plant stand (up to 98 %) and yield (30.35 q/ha) than normal sown crop on the date of transplanting (85% and 25.1 q/ha) was recorded when 25 day old seedlings raised in big containers were transplanted.

2.2 Crop Production

Nagpur

- Under rainfed condition, intercropping of mung in Bt cotton (1:1) was found superior from soil moisture conservation and system productivity point of view.
- Application of 75% N through inorganic + 25% N through organic source and addition of Zn (10 kg/ha) and B (10 kg/ha) with RDF (90: 45: 45) recorded significantly higher seed cotton yield than RDF alone.
- On Vertisols, seed cotton yield of NCS 145 (Bt) was optimized with drip irrigation at 0.8 Etc and application of the recommended Nand K (120 kg Nand 60 kg K_2O *1* ha) through fertigation and P (60 kg P_2O_5 *lha)* as soil application (basal).
- On shallow black soils (Inceptisols), combined application of Zn (10 Kg/ha) and B (3 Kg/ha) alongwith recommended NPK increased the seed cotton yield by 200 Kg/ha over recommended NPK. On medium to deep black soils (vertic Inceptisols and Vertisols) when this was supplemented with 2 irrigations the yield gain was 500 kg/ha over recommended NPK.
- Bt cotton can be profitably intercropped with *Portuluca oleracia* +field bean *(Dolichos lablab)* and fennel..
- The optimum spacing for rainfed BN-Bt cotton on shallow (48 cm) vertic Inceptisols of AESR 10.2 (hot dry sub humid climate) was 60 x 20 cm. Similarly, the optimum spacing for rainfed NHH 44 Bt hybrid on deep Vertisol was 90 x 30 cm and at this spacing the optimum N dose was 60 kg N/ha. The mean apparent recovery of N decreased with increase in the rates of N application and increased with a decrease in intra row spacing. N use efficiency declined with increase in N application and increased with decline in intra row spacing. Further improvement in N utilization efficiency may be possible at high planting density, only if Harvest Index is improved.
- The Bt hybrids possessed a variable range of Cry protein. With respect to nitrogen treatment, no definite trend was observed. However, there was a perceptible decline in Cry protein content with advancement in the ag~ of the crop and the cry protein content in the leaves were higher than In the squares.
- Land use systems under high management recorded higher microbial counts of general and functional microflora than those under low management system. The mean urease activity across 5 benchmark spots from black soil region was 11.28 (ug NH_4-N *lg)* under low management system and 16.63 (ug NH_4-N *lg)* under high management system. Similarly the mean dehydrogenase activity was 0.96 (ug TPF/g) under low management system a~d 1.~4 (ug TPF/g) under high management system. Microbial population was the highest in the top 15 cm layer and declined drastically with depth, irrespective of the management level or land use system or bio-climatic regime. Urease activity declined with soil depth In most of the land use systems.
- Long term studies indicated that on rainfed conditions vertisols, cotton-soybean rotation compared to cotton - cotton is more suitable from crop productivity and soil health point of view. Similarly nutrient management to cotton through INM imparts sustainability.
- A value chain in cotton fibre, seeds and stalks, long staple cotton production was under taken in 60 acres on 30 farmers' fields in Yavatmal district with integrated cotton production technology developed by CICR.. The results indicated that the yield under this integrated cotton production technology was 2172 kg/ha as compared to 1458 kg/ha with farmers' practice. Tips for clean cotton picking, handling, transporting and storage were also provided to the farmers.
- A solar powered knapsack sprayer was evaluated for the sustenance of pressure under solar spraying cum charging against the normal battery operated operation. This sprayer sustained a pressure of 20+ 10 % psi for a significantly longer time over the battery operated sprayer, thus generating uniform droplet size spectrum over a longer period of time.
- The prototype of 2 row fertilizer applicator for blade harrow as an attachment was developed with a view to save time and labour by combining two operations in one pass especially for the rainfed cotton farmers using bullock power. Rate of application of the fertilizer was found to vary from 70 to 140 kg/ha.
- Growing Bt cotton does not affect selected soil biological properties both in shallow and medium deep soils ?f A~SR 10.2 (hot, dry sub humid climate) under ralnfed situations as compared to non Bt cotton and bulk soils. Interestingl~, higher soil biological properties were recorded In sOil planted with Bt cotton as compared to Non Bt cotton.
- Majority of cotton farmers from distress areas had high level of alienation from land as compared to non distress area. The perception of farmers studied towards use of pesticide shows that farmers have very fav~urable perceptioin to the positive statements-spraying of pesticides as need based as per the ETL level and also

avoiding frequent sprayings of insecticides. However, majority of farmers in non distress area also expressed positive opinion. The economic viability of cotton farming was slightly lower in distress area compared with that of non distress area.

- Analysis of data from Marathwada and Vidarbha regions of Maharashtra showed that total factor productivity of cotton increased at the rate of 2.78 per cent per annum, whereas total output index increased at the rate of 3.38 per cent per year. During the over all period no district registered negative growth of total factor productivity. Highest total factor productivity growth was observed in Amravati followed by Wardha and Jalna districts.
- The three years experimentation indicated that there was no adverse / deterious effect of feeding of Bt cotton leaves on the health of goats. There was no mortality and the survivability of experimental goats was 100 per cent..

Coimbatore

- Introduction of grain jowar as a sequential crop in cotton fallows enhanced seed cotton yield and total biomass yield. The Production Efficiency and Stability Index were higher under cotton-jowar than cotton-fallow system. Balanced fertilization (RDF) and more appropriately, INM (i.e., NPK+FYM) was helped maintain a steady growth, development and yield. Highest water use efficiency and water productivity were also observed with INM practice. The higher nutrient use efficiency (17.8 kg seed cotton/kg NPK uptake) was recorded under cotton-sorghum in comparison to cotton-fallow.
- Underthe existing semi arid condition, 3 splits ofN only was needed for desired efficiency and out put (with maximum yield).
- The cuticular absorption of moisture in cotton was more in 4^{th} to 7^{th} leaf from the top compared to the first 3 leaves from the tip and lower leaf at the bottom. When 1 % potassium was given as foliar spray, maximum potassium was absorption by 4^{th} to 8^{th} leaf compared to other leaves within one hou r of spray.
- The water requirement for ELS cotton was 489, 671 and 832 mm at 0.4 Etc, 0.8 Etc and conventional irrigation. When no mulch was given, the crop responded up to 0.8 Etc while with mulch combinations, the yield level started decreasing beyond 0.4 Etc. The highest water use efficiency was recorded at poly mulch + drip at 0.4 Etc. Poly ethylene mulching was on par with biodegradable poly ethylene mulching.
- Mulching enhanced the seed cotton yield of RCH 20 Bt under rain fed condition. Poly mulching recorded the highest seed cotton yield and was on par with biodegradable mulching, sub soil coir mulching and gunny sheet mulching.
- Drip irrigation scheduled at 0.6 ETc resulted in the highest water expense efficiency, water productivity and the least quantity of water used for production of unit quantity of seed cotton in the ELS Bt cotton (RCHB708Bt). Fertigation of 100% RDF (90:45:45 kg of N, P_2O_5 & K_2O/ha) in six splits registered the highest water expense efficiency, water productivity and the least quantity of water required to produce unit quantity of seed cotton.
- Soil moisture conservation by opening of alternate furrow registered higher seed cotton yield and net return than intercropping with soybean (seed cotton yield and *in-situ* green manuring of sunhemp.
- Multi-tier cropping system of cotton + radish + beetroot + coriander with hand weeding thrice at 15, 30 and 60 DAS resulted in the highest net return, seed cotton equivalent yield, relative production efficiency, relative economic efficiency and per day profitability.
- Bt cotton + coriander inter cropping system resulted in highest gross return, net return and benefit cost ratio. Bt cotton followed by maize recorded the highest seed cotton equivalent yield (4168 kg/hal, gross return, net return and per day productivity.
- The mean weight diameter (MWD) and water stable aggregats (WSA) in cotton-sorghum system were significantly higher than cotton-fallow system. The soil dehydrogenase activity was not significantly influenced by the cropping systems. However, it was maximum with 15t FYM/ha. The effect of cropping systems was not significant on cumulative CO_2 evolution from soil in a period of 30 days. Application of organic sources of nutrient resulted in significantly higher cumulative CO_2 evolution over control..
- To control the late emerging weeds, herbigation (applying herbicide through drip) was found to be more effective method than conventional spraying. Herbigation of herbicide rotation with pendimethalin 1.0 kg on third day followed by 1 hand weeding + metalachlor 1.0 kg on 30DAS recorded significantly less weed dry matter and higher weed control efficiency (WCE) at 60 DAS.
- The validation of the simulation modelInfocrop showed that the deviation between the observed and simulated seed cotton yield ranged from 6.0 to 34.2% (mean 20.1 %) for RCH2 Bt cotton whereas the deviation was from -8.0 to 23.1 % (mean 5.8%)forRCH2 Non Btcotton.
- In Bunny Bt genotype, there was a significantly higher seed cotton yield with foliar application of ethrel @ 5.7 mM (19.1 g/pl), followed by mechanical removal of squares and the least in control.. In Bunny NBt genotype the treatment (Ethrel @ 8.56 mM) yielded highest seed cotton yield. Similar results were observed in Mallika Bt, Mallika NBt and JKCH 99 Bt.
- Detopping at 95 DAS followed by nipping of monopodia and sympodia at 105 DAS yielded the highest seed cotton yield (1850 kg/ha) followed by foliar application of maleic hydrazide, while the least in control..
- Modified Hoagland nutrient solution sprayed during the water logging and recovery period brought about a significant change in alleviating the water logging stress.
- Preliminary studies using MCU 5 and its lint less mutant indicated the role of peroxidase enzyme in fibre initiation process. Further, catalaze enzyme might be one of the important enzyme associated with fibre development..
- Impact on yield, the value of output and profit as a per cent of revenue is significantly higher in Bt cotton as compared to non-Bt cotton ranging from 20 % to 34%. The average number of sprays reduced from 9 to 4 with reduction in cost by 48 % and yield enhancement of 14% in Bt cotton as compared to Non-Bt cotton.
- In North Zone, growth rate ofTotal Factor Productivity (TFP) was higher after the year 2000-01 compared during the year from 1990-91 to 1999-00. The same pattern was observed in Central Zone but in South Zone not significant growth in TFP.
- Cotton + other crops + dairy farming system yield higher economic efficiency as well as ecological efficiency.
- Post Evaluation of Farmers Field Schools (FFS) revealed that the beneficiaries had significantly higher identification; functional; ecological knowledge and decision making ability than Non-FFS.
- Attitude towards cultivating Bt cotton and organic cotton was highly favorable compared to cultivating conventional cotton. The average cost of cultivation for one acre for

organic, Bt, and conventional cotton respectively, RS.14,338/-, *Rs.16,7301-* and *Rs.17,404/-* and average yield under organic, Bt, and conventional cotton cultivation are 8.35,9.30 and 7.20 *q/acre* respectively.

- Cotton information repository developed and maintained and Information Retrieval System was also developed and floated at CICR website for public access. Search Engine Optimization (SEO) tools were incorporated in Cotton Portal for clear visibility of CICR website in global cyber network. Two separate sub domains were created for TMC andAICCIP.

Sirsa

- The performance of Bt hybrid RCH 134 with and without intercrop combinations was evaluated. The yield (3121kgl ha) and number of bollsl plant (53.9) were significantly higher in sole cotton at spacing 67.5 cm X 75 cm as compared to paired row cotton with and without intercrops.
- The number of opened boil/plant (42.1) were significantly higher in the crop sprayed with lowest concentration i.e. 1500 ppm of defoliant at 145 DAS than control unsprayed crop (37.7) and because of higher number of opened bolls, the yield *I* ha was significantly higher in crop sprayed with 1500 ppm at 145 DAS (2855 kg/ha) than unsprayed crop.

2.3 Crop Protection

Nagpur

- The safflower caterpillar, *Perigea capensis,* was recorded as an emerging pest on Bt cotton and it was found in cotton fields adjoining soyabean in Amravati and Hingoli districts ofVidarbha.
- Jasmine perfume (2.5 milL), ocimene (3 milL), limonene (3m lIL) were effective in reducing jassid populations. Jasmine perfumel ocimene can be used between 45-50 DAS, while limonene may be used at 60 DAS, thereby preventing repeated use of the same molecule.
- A novel non- phytotoxic, botanical bio- emulsifier (soap nut) was identified and evaluated (at 5%) in combination with limonene, ocimene and jasmine perfumes for the control of sucking pests.
- Mealy Kill, a botanical formulation developed by CICR, was found to be as effective @ 10 milL as conventional biopesticides in AICCIP trials of Sirsa and Faridkot and superior to conventional biopesticides at Raichur and Coimbatore.
- Native Bt *(Bacillus thuringiensis)* strains from Yavatmal, Jalna and Hingoli caused a mortality of 28%,64% and 58% respectively of 2 day old *H. armigera* but were less effective than theAhmedabad Bt strain.
- Jassids, *Empoasca devastans,* collected on cotton, across cotton growing regions of the country demonstrated resistance of 110 fold, 57 fold, 2500 fold and 5450 fold, respectively to acephate, monocrotophos, thiomethoxam and imidacloprid.
- The variability in susceptibility of *H. armigera* to *Cry1Ac* was 4.71 fold across North India, 152 fold across Maharashtra, 62.8 fold across Gujarat and 1.91 fold in South India.
- The variability in EC_{50} of *Cry 1Ac* against *H. armigera* ranged from 0.01 ug/ml of diet in Yavatmal, Maharashtra to 0.593ug/ml in populations from Bhavnagar, Gujarat..
- Enhanced degradation of Cry1 Ac by gut proteases of field tolerant strain of *H. armigera* was observed in populations collected from Bhavnagar (Cry1Ac, LC_{50} 0.99 ug/ml of diet).
- Germplasm lines A678, G.Cot 10, GRS *60/15,* IC 671 Sel, K8199, Kekchi Red, Kemp, L-604, L-751 , Macha, Meade 9030D, PRS-72, Tamcot SP 21, Tamcot SP 37, *5/44,* UA-Bk-4-84, 9-1487 and UPA(57)-1 were resistant to reniform nematode. Application of maleic hydrazide, Hydroxyproline and aminopurine a kinetin inhibitor was found to impart resistance to root-knot nematode.
- dsRNA for ten parasitism genes was synthesized using Ambion megascript kit. Out of these, dsRNA for two genes *viz.* protein 40 and Aminopeptidase reduced penetration of the root-knot juveniles by 40 and 53% respectively and reduced the formation of females by 35 and 49%.
- Insecticidal toxin obtained in the fraction collected using 50-100 kDa cut off filter disc was found to have intrahaemocoelic and oral toxicity against *H. armigera.* 50K fraction was characterized further to reveal the presence of a total of 5 subunits of 70 and 48 kDa.
- A biocidal formulation developed from bacteria and plant products , effectively caused mortality of mealy bug crawlers. Bacterial symbionts found effective against insect pests, were characterized biochemically. Optimum conditions for culturing of bacterial symbionts of EPN, were standardized.
- Jassid damage exceeded Grade II, thrips and aphid damage exceeded Grade I throughout the season on Bt and non Bt cotton. Jassid population on Bt cotton was maximum (4 per 3 leaves) in the 40th SW while thrips population was maximum in the 37th Sw.. Population of mealybug was negligible irrespective of genotype. Pink bollworm population was negligible until crop senescence.
- An increasing mirid population during the 38'h to 42nd SW was observed at different locations and cotton raised adjacent to fallow land recorded minimum mirid incidence.
- Hundred and six host plants of *P so/enopsis* spreading across 27 families were recorded in cotton + pigeon pea cropping system. The major families of host with severe infestation and wide host range were Asteraceae, Malvaceae, Solanaceae, Fabaceae, Amaranthaceae, Euphorbiaceae, Poaceae, Labiateae and Apiaceae.
- Taxonomic biodiversity of cotton entomofauna was documented through record of eleven species of Hemipterans- one of Lygaeidae, three of Miridae, four of Pentatomidae and four of Pseudococcidae, *viz., Phenacoccus so/enopsis, Maconellicoccus hirsutus, Nipaecoccus viridis* and *Para coccus marginatus* were recorded infesting cotton in different cotton growing zones of the India during 2009 crop season.
- *P so/enopsis* was the sole species that dominated Cotton-wheat and Cotton + Pigeon pea- fallow system of North zone and Central zone respectively while, *P marginatus* was dominant in cotton+ pulse- maize cropping system of South zone. Mealy bugs M. *hirsutus* and *N. viridis* were observed in negligible number in Central zone.
- Two Hymenopteran parasitoids *viz. Aenasius bambawa/ei* and *Metaphycus* sp. on *P so/enopsis* and *Promuscidea unfasciativentris* on *N. viridis* were documented in Central zone.
- Coccinellids - *Brumoides sutura/ais* (F.), *Chei/omenes sexmacu/ata* (F.), *Scymnus coccivora* and *Crypto/aemus montrouzieri* on *P so/enopsis* were documented as predators while *Gitonides perspicax* Knab was recorded as predator on *N. viridis 1M,hirsutus.*
- Simple protocols were developed for lifecycle studies on mealybug and mirids in cotton to assist in insect phenology based simulation modelling.
- Sampling techniques and sample size for mirids *Campy/omma livida* was standardized. Top *1/3'd* plant

portion of plant (Bunny Bt) harbored more number of nymphs and adults than the middle and bottom portions. A sample size of 10 plants/acre was found appropriate for sampling nymphs.

- Developmental rates of *P Solenopsis* at constant temperatures *viz.* 25, 27, 30 and 32°C were studied in **central zone. Fecundity was maximum (434.4 eggs +** crawlers) at 25 DC and was found to decrease with increase in temperature. The number of eggs observed per female showed an increasing trend.
- Out of 382 lines, 10 lines were found to be promising with respect of tolerance to sucking pest as well as bollworms, earliness (150-155 days), yield. These are 8 x Suvin (B)- - 2,6 x 20 (C), 13 x 2 (B) - V, Code 1150 -I, Code 420 (A), Code 426 (A), Code 446 (A), 16 x 74Ax 8,3917 x 74A(B)x 8-B,L-11 (A)x7xA(B)x8.
- In a trial at farmer's field, the number of bio-agents was high in IPM with dominance of spider population from 38 to 40'h SW corresponding to the increasing mirid population. Increased returns of Rs. 3330/- per hectare were obtained in IPM plot over RPP indicating the superiority IPM.
- Six bacterial isolates were found effective in inhibiting the growth of. *Fusarium oxysporum* f.sp. *vasinfectum* and A. *alternata* and four bacterial isolates exhibited an inhibition of M. *phaseolina.*
- Fifteen cultures with resistance to bacterial blight / grey mildew have been identified in comparison to local check in seed cotton yield and other yield imparting characters.
- Maximum losses due to diseases were 11.13 - 13.11 per cent in Bt hybrids as compared to 7.53 - 9.37 per cent in non-Bt hybrids H 10 and NHH 44 under unprotected conditions.
- Genetic diversity was observed in 29 isolates of *Fusarium oxysporum* with 9 SSR primers used for characterization and diversity analysis on the basis of virulence, species specificity, growth, pigmentation.
- Distinct cultural variability in sporulation, spore types, growth pattern and pigmentation was observed in the isolates of A. *macrospora,* A. *alternata* and A. *gossypina.*

Coimbatore

- Acephate, Chlorpyriphos, Mealy quit and Fish Oil Rosin Soap were found moderately effective in reducing the mealybug *(P marginatus)* causing a reduction of 39.6,37.3, 36.2 and 30.4 %, respectively. Acephate, Chlorpyriphos, Fish Oil Rosin Soap and Detergent Powder recorded higher yield by 56.5,50.8,46.1 and 45.4kg/ha, over control.
- Six insecticides, namely Confidor, Thiamethoxam, Acephate, Monocrotophos, BYI-2960 and Victor at six doses (0.01,0.05,0.2, 1.0,2.0 and 10 ml/lit.) were tested for jassid resistance. Among the six insecticides, Acephate and Monocrotophos, maximum survival was recorded after 72 hrs at 0.01 and 0.05 ml/lit respectively.
- Repeated application of profenophos increased the jassid population with a resurgence ratio of 0.59-1.05 followed by Acetamiprid with 0.24-.98 resurgence ratto. No indication of resurgence with four insecticides against aphids, thrips, mealy bugs and mirids was observed. Mealy bug population in all the treatments except Profenophos was on par with the control.
- Six Bt hybrids recorded significantly less mean locule damage by *Pectinophora gossypiella* (0.88-4.85/10bolls) and average larval number (0.15-0.70/10 bolls) as compared to NBt hybrids with 22.04-26.24/10 bolls and 1.80-3.55/10 bolls of locule damage and larval number, respectively. Within Bt and NBt hybrids, no significant difference was recorded on locule damage and larval population.
- The yield loss due to the sucking pests including the emerging pests was 8.6, 12.6, 17.2 and 17.5 q/ha in RCH B708 Bt, Mallika Bt, Bunny Bt and RCH2 Bt respectively.
- Among the three hundred and fifty germplasm accessions of G. *hirsutum* screened, six entries *(viz.,* ICGH250, 252, 276,288,341, & 410) and one entry (ICGH 370) were found less susceptible and susceptible to mealy bug respectively. Five *(viz.,* ICGH 474, 480,509,610 and 630) and 1 entry (ICGH 328) recorded minimum and maximum number of mirid bugs, respectively.
- Natural predation of S. *epius* was recorded up to 28% on mealy bug *Paracoccus marginatus* on cotton. Among the 3 stages of the predator larvae, 3,d instar larvae consumed maximum number of crawlers followed by 4th instar larvae. Among the 2,d and 3,dinstar larvae of the predator, 3rd instar predated the maximum number of egg masses of 9.6/ day as compared to 2,d instar (6.3) and this difference was statistically significant.
- Two native isolates of *Trichoderma viride and* one isolate of *T. harzianum* were found antagonistic to Alternaria leaf spot pathogen.
- Survey on entomopathogenic nematodes in cotton ecosystem revealed wide spread distribution of *Steinernema siamkayai* Stock, Somsook, and Reid, 1998.
- Out of 43 fungi screened, *Lecanicillium lecanii* (Zim, Zare & Gam) was found to be highly virulent against *Phenacoccus solenopsis* and *Paracoccus marginatus.* Natural occurrence of *L. /ecanii* and *Cladosporium c1adosporoides* was reported forthe first time in India.

Sirsa

- The reduction in yield of cotton plants was estimated to be 14.87,30.09,34.53 and 51.86 percent for Grade I, II, III and Grade IV mealy bug infestation levels, respectively during 2009.
- The population of *H. armigera* monitored with pheromone trap was observed to be low in North India during 2009.
- ETL of *H. armigera* on Bt cotton was 4.35 and 3.85 larvae /plant, respectively after 120 and 135 DAS release. Resistance monitoring in jassid populations of North India against the commonly used insecticides revealed relatively low resistance problem till date to neonicotinoids.
- Studies on inoculum source and economic damage caused by cotton leaf curl virus disease showed per cent seed cotton yield reduction ranging from 9.85 to 36.31 with 5% to 60% graded POI in case of Bt hybrid Bioseed -6488 BG-I and 8.25to 59.52% reduction with Bt hybrid 6317.
- *F pallidoroseum* at 1% was effective two weeks after application causing 94% mortality of mealy bug.
- Among various insecticides and biopesticides, acephate (72.86%) and chlorpyriphos (69.13) resulted in maximum reduction of mealy bug after spray followed by *Metarrhizium anisoplae* (41.53 %), *Beauveria bassiana* (37.71 %), new botanical (34.81) and *V./ecanii(33.79%).*
- The average number of sprays in IRM villages in Sirsa, Hisar and Fatehabad were 2.67, 2.37 and 2.94, respectively where as it was 3.18, 3.88 and 3.32 in case of Non IRM villages. The net profit per ha of IRM farmers over Non IRM was 7125,9483 and 9145 rupees in the respective districts.