### **CROP IMPROVEMENT AND BIOTECHNOLOGY**

### **ORAL PRESENTATIONS**

### **Crop Improvement**

1.1

## Genetic diversity analysis of CGMS lines A, B and restorer lines in tetraploid cotton (*Gossypium hirsutum L*.) using RAPD markers

### S. K. VERMA, BABITA, RENU AND O. P. TUTEJA

Central Institute for Cotton Research, Regional Station, Sirsa-125055

Random amplified polymorphic DNA (RAPD) analysis was employed in 5 CGMSlines, 5 B-lines and 8 restorer lines of tetraploid cotton (Gossypium hirsutum). The 20 primers selected generated 572 amplification products. All primer producedpolymorphic amplification products. Statistical analysis was carried out using NTSYS- pc software and a dendrogram was generated using Jaccard's similarity coefficients. The values for similarity coefficients ranged from 0.05 to 0.99. The cluster tree analysis showed the grouping of 18 genotypes in two major A and B groups at similarity coefficient of 0.35. The major group A consists of twelve genotypes and group B consists of remaining six genotypes. Cluster analysis showed clear-cut separation of the CGMS lines, B-lines and restorer lines. The primer RAPDIDT # I with 4 unique bands could distinguish K34007A and K34007 B line and similarly Jhorar B and Jhorar A line. The primer RAPD-IDT # I i could distinguish restorer lines CIR 28 and CIR 38 scoring 4 and 3 unique bands respectively. The primers RAPD-IDT # 12 and 20 also distinguished restorer lines CIR 28 and CIR 38. The primers RAPD-IDT # 15 and I6 could distinguish restorer lines CIR 26 scoring I and 2 unique bands respectively.

### 1.2

## Genetic variation for seed cotton yield, some yield components and fiber properties in *Bt* cotton hybrids (*G. hirsutum L.*)

#### S. M. PALVE, V. V. SINGH, AND NITA KATE Central Institute for Cotton Research, Nagpur-440 010

Recently released Bt. Hybrids of upland cotton (G. *hirsutum*) for central zone have opened up new opportunities to cotton farmers in selecting suitable Bt. hybrids of their choice. This study was conducted to evaluate recently released 36 Bt hybrids for Central zone under rainfed condition for seed cotton yield and fiber properties. These hybrids were sown in randomized block design with two replications on June 30, 2007. Plot size was four rows 6 m long with row spacing of 90 cm and plant-to-plant 60 cm. The objective was to identify Bt hybrids suitable under rainfed conditions of Vidarbha region. Among the Bt hybrids tested, hybrids MRC 7347 BG-II (3066 kg/ha), ACH-11-2 BG-II (2689 kg/ha), RCH 386 (2657 kg/ha), GK 205 (2513 kg/ha), Brahma (2495 kg/ha) and JKCH 99 (2370 kg/ha) were identified as promising hybrids for seed cotton yield and fibre properties at Central Institute for Cotton Research, Nagpur. In addition to this, most of the Bt hybrids (BG I & BG II) were at par with conventional hybrids NHH 44, NCS 145 (Bunny) and Ankur 09. The highest fibre bundle strength (25.0 g/tex) was shown by RCH 386 Bt hybrid and it had micronaire of 3.0 and seed cotton yield 2657 kg/ha. The yield of conventional hybrids NHH 44 (1806 kg/ha), PKV Hy 2 (1444 kg/ha), NCS 145Bunny (1930 kg/ha) and Ankur 09 (1925kg/ha) were comparable to most of the Bt hybrids. Thus, selection of Bt hybrids by the farmers should be based on potential seed cotton yield and fibre properties obtained under test conditions by the government agencies with recommended package of practices.

## **1.3** Evaluation of *Bt* cotton hybrids for yield, quality and biochemical traits

#### S. MANICKAM, N. GOPALAKRISHNAN AND K. C. KALPANA Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Cotton is one of the important commercial crops cultivated in India for fiber and oil. Cotton, the "White Gold" is cultivated in different agro-climatic conditions in India constituting about 62 per cent of the raw material requirement of Indian textile industry. The Indian cotton crop is the most diverse in the world, both in terms of botanical status and fibre quality range. The world today has suddenly turned its attention towards the natural fibres that are environment friendly and biodegradable. It is important to note here that the research and technology initiatives, safe cultivation practices and their on-farm demonstrations on a large scale have resulted in increase in cotton yield. The cotton production (310 lakh bales) and the productivity (599 kg/ha) in 2007-08 bears testimony for this. The cotton hybrids, especially Bt cotton hybrids, occupies as much as 75 per cent of the total area under cotton cultivation. Ever since three Bt cotton hybrids of M/S. Mahyco have been approved for commercial cultivation in India during 2002, there was sharp increase in area under cultivation of such hybrids from a mere 30,000 ha in 2002-03 to a projected area of 63,30,000 ha in 2008-09. So far, 280 Bt cotton hybrids belonging to Private R & D firms and BN Bt of ICAR (CICR, Nagpur) have been approved in different cotton growing zones by GEAC (Genetic Engineering Approval Committee, Government of India) after extensive field trials by All India Coordinated Cotton Improvement Project centres and RCGM trials in farmers' fields. During the year 2007-08, sixty hybrids comprising popular non-Bt and Bt hybrids (of all the four events approved for commercial cultivation) of south zone were field evaluated for yield, agronomic traits, fibre quality and biochemical traits (oil percentage and gossypol content). Analysis of data indicated significant difference between the hybrids for yield. The highest seed cotton yield was recorded in the Bt hybrid MRCH 7351 BG II (3887 kg/ha) followed by Tulasi 117 Bt (3747 kg/ha). Wide variability was observed for agronomic traits, fibre quality attributes and also for biochemical traits like oil percentage and gossypol content. The oil percentage ranged from 18 to 26% and gossypol content ranged between 0.5 and 1.1%.

### 1.4

### Evaluation of genetic stock of *desi* cotton (*Gossypium arboreum*) for yield and its component traits

#### R. S. SANGWAN AND S. S. SIWACH Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125004

Cotton is the most important commercial crop of India. It is mainly grown for fibre. Its seeds are an important source of food oil and meal as a protein rich by-product for ruminant livestock. Plant germplasm is the basic raw material for any crop improvement programme. Conservation and use of genetic resources have great significance. The precise evaluation of genetic stock and dissemination of findings is important for their utilization in breeding programme. The systematic evaluated genetic resources of crop plays pivotal role in crop improvement. In the present study 138 accessions of *Gossypium arboreum* of diverse origin, grown in a single row of 6 m length during Kharif, 2007. Observations were recorded on seven yield related traits i.e. days to first flower, plant height (cm), number of monopods, number of bolls / plant, boll weight (g), seed cotton yield / plant (g), ginning percent and morphological traits like plant body colors, leaf shape and flower colors were also observed. The mean seed cotton yield of best yielding 13 genotypes was 199 g per plant as compared to 102 g of mean of all accessions. The average number of bolls per plant in these genotypes was 122 as against 65.7 of accessions mean. For boll weight large variation was observed ranging from1.7g to 2.9 g with average boll weight of 2.1 g. The number of monopods per plant ranged from 0 (H476-5) to 13 (BH 05 VIII) with mean value of 3.3.

# 1.5 Development of *Gossypium hirsutum* strains with superior fibre strength suitable for rotor spinning

#### JAGMAIL SINGH, S. K. CHOPRA, BABITA CHAUDHARY AND K. ELAYARAJA Indian Agricultural Research Institute, New Delhi-110 012

Cotton is an important commercial crop in India and plays a key role in our economy. India is the only country in the world where all the 4 cultivated species of cotton are under commercial cultivation. The total cotton production of the country has shown tremendous improvement since 2003-04 and recorded an all time high production of 310 lakh bales from an area of 9.53 m hectares during 2007-08. At global level, the estimated total production of cotton during 2007-08 was 25.9 million tonnes of lint from an area of 33.6 m hectares. India occupied first rank in terms of total area under cotton cultivation, but occupied 2<sup>nd</sup> rank (after China) in terms of total production. Until recently breeding programmes aimed at genetic improvement of fibre quality accorded top priority to improving fibre length, followed by fibre fineness and strength to achieve higher spinning counts. A number of varieties of Gossypium hirsutum and Gossypium hirsutum x Gossypium barbadense hybrids combining high yield and superior fibre quality have been released for commercial cultivation in different parts of the country. These cottons were suitable for conventional ring spinning system, which is suitable for spinning very coarse (6s counts) to very fine (120s counts) cottons. However, the modernization of textile industry has lead to adoption of more efficient open-end/rotor spinning system, which requires cotton cultivars with high fibre strength. Consequently the cotton breeding programme have been tailored to meet new challenges. A total of 22 genotypes with superior fibre strength were evaluated in two sets of 11 genotypes each against the local check Pusa 8-6 at IARI, N. Delhi. Set 1 of 11 genotypes comprising P 56-1, P 56-2, P 56-4, P 56-6, P57-6, P 95-27-2 P1, P 95-38-18-2P1, P 4-9211, P 4-9212, P 4515-1 and P 218-1 was evaluated for 3 years from 2005 to 2007. Set 2 comprising P 5-1-P4, P 57-P2, P 61-1-P1, P 70-1-P1, P 70-7-P1, P 386-P1, P 643-3-P4, P 816-2-P1, P 95-3818, P 8668 and P 3192 was evaluated for 2 years from 2006 to 2007. In Set 1, mean fibre strength ranged from 22.5 g/tex in local check Pusa 8-6 to 27.5 g/ tex in P 56-4. Likewise mean 2.5% span length ranged from 27.0 mm in Pusa 8-6 to 28.4 mm in P 56-4 and micronaire ranged from 4.2 in P 56-4 to 4.6 in Pusa 8-6 (LC), P 95-27-2 P1 and P 95-38-18-2 P1. Thus average fibre strength of P 56-4 over 3 year period was highest with fibre strength to length ratio of 0.97, besides desirable micronaire. However with regard to seed cotton yield it showed an average performance. Its mean seed cotton yield was 2024 Kg/ ha against the highest seed cotton yield of 2695 Kg/ ha in P95-38-18-2P1 and 2291 Kg/ha in local check. As many as 4 genotypes (P 56-1, P 56-4, P 56-6 and P 4-9212) showed high fibre strength of 25 g/tex or above. In Set 2 strain P 95-3818 showed highest mean fibre strength of 25.5 g/ tex with 2.5% span length of 28.8 mm and micronaire of 4.3. It also showed fibre strength to length ratio of 0.88 which is also very close to desirable ratio of 1.0. However with regard to seed cotton yield P 95-3818 was an average yielder and showed 2679 Kg/ha against the highest of 3157 Kg/ha in P 70-7-P1 and 2649 Kg/ha in local check. As many as 6 genotypes (P 5-1-P4, P 57-P2, P 70-1-P1, P 643-3-P4, P 95-3818 and P 3792) showed good fibre strength of 24 g/tex or above. Although high fibre strength genotypes were found to show relatively low seed cotton yield as compared to highest yielding genotypes, nonetheless their yield was almost at par with that of local check. The data suggested good scope for combining high yield and superior fibre quality, especially high fibre strength which is suitable for rotor spinning. These genotypes can also be used as a source for high fibre strength and to develop hybrids with superior fibre strength.

### 1.6

### A comparative analysis of genetic distances in cotton hybrids

### I. A. MADRAP, S. L. SAWARGAONKAR, V.K. GITE AND R. RAJMOHAN *Marathwada Agricultural University, Parbhani-431402*

A study has been taken to study the similarity index and suitability of RFLP markers in introgressed hybrids. Two species, *Gossypium aridum* and *Gossypium hirsutum* var. LRA-5166 were crossed. After extracting the DNA in RFLP method nitrocellulose membrane used for southern blotting and biotin for labeling the probe. 15

different primers were used for RAPD analysis. Random primer OPD 11 generated maximum number of polymorphic bands and OPD14 showed 100 % polymorphism, where as primers OPC-2, OPC-4, OPC-6, OPC-11 and OPF1 were non reproducible, RAPD primers OPC-3 produced higher parental bands in its offspring. In RFLP markers, restriction enzymes ECOR-1 produced polymorphic bands. There was 38 percent similarity between two parents and means parents were different from each other. The characters of  $F_1$  were similar to female parent by 63 percent, and for remaining characters it was similar to male parent. The RFLP study of both generation that indicated, alleles of both the parents were present in hybrid. This offers the possibility of finding large number of polymorphism, or DNA sequence variants, which are not subject to environmental influence. Although the choice of parents is often the most important decision in a breeding program, little is known about the importance of parental genetic distance to successful cotton cultivars development. In the present study relatedness between the parent band and its offspring are effectively useful for breeding programme through introgression study.

1.7

## Prediction of $F_2$ performance in *Gossypium arboreum* based on genetic diversity of parental lines at molecular level

#### DHARMINDER PATHAK, JYOTI SINGLA AND KULDEEP SINGH Punjab Agricultural University, Ludhiana-141 004

Choice of suitable parents is a crucial decision in any crop-breeding programme. The efficiency of breeding programme may be enhanced if the breeding potential of F<sub>2</sub> populations could be predicted in advance since studies have shown that high yielding inbred lines are generally obtained from high performing F<sub>2</sub> populations. The association between parental genetic divergence at the molecular level and F<sub>2</sub> performance has not been documented in arboreum cotton. Present study was conducted to estimate genetic diversity among elite arboreum cotton lines using simple sequence repeat (SSR) markers; and to establish relationship between genetic diversity of parental lines and the performance of their F<sub>2</sub> populations. The experimental plant material included 17 parental lines viz., LD210, LD327, LD575, LD694, LD733, LD866, LD902 (Ludhiana), HD457 (Hisar), RG8, RG395 (Sriganganagar), DLSa 1001(Dharwad) PA255, PA606, AH11, AH38 (Parbhani), MDL2643 (Mudhol), KWA147 (Khandwa) and their 52 F<sub>2</sub> populations derived by following line x tester (4x13) mating design. The parents were genotyped by 48 SSR primer pairs belonging to BNL (24), NAU (14) and JESPR (10) series. All the primers showed amplification and produced a total of 76 bands. Average number of bands amplified by each primer was 1.58. Statistical analysis for SSR data was conducted using software programme NTSYS pc version 2.02e. The genetic distance (GD) among the parental lines ranged from 0.03 to 0.56. The highest GD (0.56) was detected between LD694 and MDL2643 while the lowest GD (0.03) was observed between LD 694 and PA606. No relationship between SSR based similarity/differences among the arboreum lines and their geographical origin was observed. Based on SSR markers, no association (r = 0.020) between parental genetic diversity and seed cotton yield of F, populations could be established.

# 1.8 Optimization of shoot tip based *in vitro* regeneration in cotton (*Gossypium* spp.)

### GULZAR S. SANGHERA, M. S GILL, J. S SANDHU AND S. S GOSAL *Punjab Agricultural University, Ludhiana-141004*

In this investigation, a rapid in vitro cotton regeneration system has been optimized to regenerate plants from explants of plant tissues comprising pre-existing shoot apices of aseptically grown seedlings. This system has been found to be useful with different cultivars belonging to *G. arborium* and *G. hirsutum* species. The results revealed that of the three sterilization methods used for production of axenic seedlings in vitro, Bavistin 1.0% + HgCl<sub>2</sub> 0.1% treatment for 6 minutes duration gave the best surface disinfection with minimum contamination of seed (0 to 2 %) and germination as good as (69 to 80%) in different cotton cultivars. The shoot regeneration among different media tested ranged from 50.64 (MS Basal) to 79.87 (half MS + 6% sucrose) percent. Further, age of excision of explants showed a significant effect on shoot tip elongation/regeneration. The elongation/regeneration was significantly higher (76.29%) when shoot tips were excised from 5 days old

seedling than 9 days (68.93%) on half MS medium supplemented with 6% sucrose. The shoot elongation/regeneration among four varieties tested was also significantly different and ranged from 60.55% in LD 210 to 70.84% in LH 2076 which indicate that the regeneration/elongation of shoot tips was genotype-dependent. Rooting efficiency between varieties (58.62 to 61.58%) was not significantly different indicated that rooting efficiency is genotype independent. However, root induction was greatly influenced by media composition as it varied from 53.11 (half MS + 0.2% activated charcoal) to 70.41(half MS + 0.05 mg/l NAA) percent. Root and shoot formation was observed in all genotypes within 4-5 weeks. After plantlet formation, in vitro plantlets were shifted to test tubes containing a little cotton soaked with small amount of water for two weeks and the water from these tubes was changed daily. The hardened plantlets were then transferred to small polythene bags filled with sand soil mixture in the greenhouse and finally transferred to earthen pots in glass house. These plants grew into healthy green plants and reached to maturity. This protocol can be further utilized for genetic transformation of both diploid and tetraploid cotton cultivars using *Agrobacterium* mediated or particle gun bombardment methods.

### 1.9

### Risk assessment of out crossing of BN *Bt* with wild and related species of *Gossypium*

#### VINITA GOTMARE

#### Central Institute for Cotton Research, Nagpur-440 010

Cotton is largely self-pollinated and cross pollination is rare. When it occurs it is mediated by insects, usually honeybees. Even transfer to wild species is unlikely due to genome incompatibility, the relatively isolated distribution of wild species and different breeding systems. Hybrids resulting from artificial crosses between cotton and wild species are generally sterile, unstable and poor fitness, and are difficult to maintain, even under glasshouse conditions. Obtaining fertile hybrids is not sufficient for the successful introgression between commercial cotton cultivars and the wild Gossypium species. There are numerous non -Gossypium Malvaceae species known to occur in nature. Of these most relevant to assessing the risk of Bt gene escape are the closest non-Gossypium species namely Thespesia spp and Cienfugosia spp and Malvaceous species that occur as weeds in cotton fields e.g. Sida spp. And to a lesser extent Malva spp. The closest relatives within the botanical family are Cienfugosia spp (2n = 20, 22) and Thespesia spp (2n + 26). While there are no known studies assessing possibility that Gossypium species can hybridize with any Cienfugosia spp or Thespesia spp, the tremendous evolutionary distance between Cienfugosia spp or Thespesia spp and Gossypium, the difference in chromosome numbers and the profound differences in reproductive architecture undermine any expectations that *Cienfugosia spp x Gossypium* or *Thespesia spp.x Gossypium* hybrids are possible. If there was any possibility of fertile hybrids arising between Bt cottons and weedy Malvaceous species (e.g. Sida spp and Malva spp.), then the environmental consequences would be much greater than for Bt gene flow among Gossypium species, none of which can be characterized as weedy. Experiments were carried out to assess the out crossing of BN Bt cotton with wild and related species of Gossypium. There are significant differences in the size of pollen of cultivated BN Bt and that of wild species which hinders the pollen tube germination. Further the data clearly indicates that artificial pollination of tetraploid BN Bt on wild species does not succeed since most of the wild species maintained under protected condition at CICR. Nagpur are diploid. It is observed that crosses among tetraploid Gossypium species are successful, while crosses between tetraploid and diploid Gossypium species are rare or essentially unknown without human intervention. Only a few crosses are recovered and therefore gene transfer to wild species is unlikely due to incompatibility. Thereby indicating that there are very meager chances of transfer of Bt gene to the the other diploid species of Gossypium and its related species as well. But there are some matters of concern to the environmentalist's *i.e* the introgression of the Bt gene to organic and other non-transgenic cotton cultivars could have significant socio-economic consequences. Seed contamination would be particularly damaging the organic cotton industry, where planting seed is obtained from the previous year's crop. There is real concern that Bt gene would impart a selective advantage to introgressed populations or Bt crop volunteers and increase their colonizing ability. This, in turn, may allow these introgressed populations or crop volunteers to replace their natural and landraces of cottons.

## **1.10** Breeding considerations in the evolution of *Bt* cotton hybrids and beyond

#### J. CHANDR ASEKHAR, N. P. MEHTA, B. S. DAHIYA AND N. P. SARMA Kaveri Seed Company Ltd., Secunderabad-500 009

Despite mounting opposition to GM crops, the adoption and spread of Bt cotton in India is unprecedented as it provided scale neutral solution to an intractable pest problem, boll worm. The techno fix of BT cotton hybrid breeding has several aspects to be weighed. Foremost among these is the choice of female or male Bt in the hybridization process. From amongst several thousand germplasm lines, the choice of Coker 312 for genetic transformation was dictated by its tissue culture response. Using the transformed line as male, several agronomically superior lines were converted into Bt versions for subsequent use in hybrid synthesis. The need for broad spectrum resistance lead to improved Bt version of hybrids with stacked genes (crv 1Ac and Crv 2Ab). As this process of gene pyramiding continues, it is important to assess the role and choice of male and female parents. And with addition of more alien genes by stacking or pyramiding the issue is all the more crucial for technical reasons and from commercial prospect. Breeding Bt cotton hybrids and beyond implies several aspects, aside resistance to bollworm complex alone. With reduced pressure from bollworms, the sap feeders-jassids, aphids, mirids and mealy bugs are now emerging threats. Labour and water scarcity impact the type of hybrids needs to be developed for sustaining cotton cultivation. Adaptability to specific agro ecologies of each zone underscores the need for designer hybrids. Evolution of cotton hybrids in future warrants emphasis on new parameters, eg. Semi compact plant type, determinate vegetative growth, earliness, synchrony in boll development, uniformity in boll weight and endurance to drought as well as lint quality as per demand of textile industry both for domestic market and export.

### BIOTECHNOLOGY

### 1.11 RAPD based diversity analysis of cotton genotypes for cotton leaf curl virus disease

### MINAKSHI, O. P. LUTHRA AND S. S. SIWACH CCS Haryana Agricultural University, Hisar-125 004, India

Genetic diversity of 15 cotton (Gossypium hirsutum L.) genotypes including 3 hybrids was analyzed using 15 RAPD primers. This included 5 resistant, 1 tolerant and 6 susceptible genotypes. Total genomic DNA was isolated following modified CTAB method and subsequently used for RAPD analysis. These primers generated 135 amplification products of which 119 were polymorphic. Primer OPN-02 amplified maximum number (13) of polymorphic bands and Primer OPN-12 amplified minimum number (3) polymorphic bands. Genotype Resistant genotype RS 875 showed maximum amplification i.e. 19 bands and susceptible genotype HS –6 showed minimum number of bands (61). Size of amplified products ranged from 70bp to 800bp. Unique bands for specific genotypes were also produced by 12 primers. The value for similarity coefficient ranges from 40.0% to 87.8%. Statistical analysis was carried out using NTSYS-PC software and clustering was done using the symmetric matrix of similarity coefficients and cluster was obtained based on unweighted pair group method based on arithmetic average. Resistant and susceptible genotypes formed separate clusters with an exception of susceptible H -1098 genotypes and grouped with the resistant RS 875 genotype. The two genotypes HS-6 and HS 182 (susceptible genotypes) were separated from rest of the genotypes and showed maximum divergence than others. These findings suggest the importance of molecular markers for genetic diversity analysis.

## 1.12 Genetic transformation and regeneration in cotton (*Gossypium arboreum*)

### B. N. CHINCHANE, S. B. NANDESHWAR AND L. A. DESHPANDE *Marthwarda Agricultural University, Parbhani-431 401*

Regeneration of cotton *in-vitro* by somatic embryogenesis is the most difficult process. Therefore regeneration by shoot tip and meristem culture was investigated. Shoot tip explants of diploid cotton *Gossypium arboreum cv*. PA-402 was subjected to three media combination with and without phytohormone. The *in vitro* germinated seedlings forms the source of shoot tip explants. In half MS and full MS, growth of shoot tip was direct and without the formation of callus. Majority of the explants showed regeneration of plants. Influence of hormone on shoot foundation was investigated for this, 6 Benzyl amino purine and kinetin combination was evaluated for multiple shoot induction. Shoot tips from 6-7 days old seedling were cultured in Murashige and Skoog (1962) medium. The explants showed induction of multiple shoot buds at the region of cotyledonary node. The mass of multiple shoot bud was sub-cultured in MS medium devoid of hormones. In another 15 days the shoot were differentiated into well-defined shoot axis, which consist of nodes and internodes. This regeneration method was applied in *Agrobacterium* mediated gene transfer. Transformation was done by co-cultivating shoot tip explants in a suspension of overnight grown cultures of *Agrobacterium* containing Cry 1 A (b) gene. After 24 hours of cultivation, explants were screened on Kanamycine medium and then they were transferred to fresh medium.

### 1.13 Molecular characterization of *Bt* and non-*Bt* cotton hybrids of *G. hirsutum spp.* using DNA markers

#### A. A. BHAROSE, RAKESH KUMARMEENA, A.R. GAIKWAD AND D.B. DEOSARKAR Marathwada Agricultural University, Parbhani-431401

The present study was attempted to evaluate molecular characterization among commercial grown cotton hybrids of *G.hirsutum spp.* by using two different molecular markers i.e. ISSR and SSR markers. Total of 8 hybrids of which 4 *Bt* and 4 *Non Bt* were selected for DNA extraction. The extracted DNA was quantified and diluted accordingly to make working sample of 30 ng / ul. The working samples of all the eight hybrids were screened with 8 ISSR and 3 SSR primers. The amplified product was visualized on agarose gel electrophoresis for ISSR marker and Polyachramide Gel Electrophoresis for SSR markers. ISSR primer IS -3 generated maximum number of polymorphic bands i.e. 7 where as IS-9 generated lowest number of polymorphic bands i.e. 2. The ISSR primers produce 67.65 percent average number of polymorphic bands. The ISSR primers distinguish hybrids at 57.4 percent similarity into 3 clusters. SSR primer JESPR-11 generate maximum number of polymorphic bands i.e. 10 where as JESPER-20 generate lowest number polymorphic bands i.e. 5. The average number of polymorphic bands generated by SSR primers were 79.16 percent.

### 1.14 Development of GM cotton and its biosafety guidelines

## G. BALASUBRAMANI, J. AMUDHA, RAJSHRI KORDE, CHANDRASEN LILHARE, K. R. KRANTHI, S. B. SINGH, V. V. SINGH AND B. M. KHADI *Central Institute for Cotton Research, Nagpur-440010*

New technologies and new crop or products will emerge, and with them may come new concerns about health and biosafety. Older concerns may become less relevant or found to have no basis. The fast-paced and everchanging nature of research and product development presents a moving target for biosafety regulators, research managers, scientists and the public. We should study continuously the process of acquiring new information, developing new plants, deepening our understanding of ecological relationships, revising our perceptions of risk and benefit, and adjusting the ways in which we seek to minimize risk and maximize benefit. Although the course is not always smooth, these processes move, and will continue to move, forward in parallel.

### 1.15

## PCR detection of strains of *Myrothecium roridum* - the leaf spot pathogen of cotton

#### P. K. CHAKRABARTY AND R. L. CHAVHAN Central Institute for Cotton Research, Nagpur, 440 010

*Myrothecium* leaf spot disease of cotton (*Gossypium* species), assumed serious proportion in recent years and losses to the extent of 15 percent has been documented. The disease is more prevalent at seedling stages. Cultivars of *G. hirsutum* and *G. harbadense* are more susceptible than *G. arboreum*. Occurrence and onset of disease can be prevented if prevalence of the pathogen in the source is ascertained early in the season. Conventional method of detection is time consuming and has major limitations, as it needs culturing the organism and also requires taxonomic expertise. Molecular detection of pathogen serves to circumvent the shortcomings of conventional methods and can help in rapid and precise detection of the pathogen. In order to develop species specific diagnostic tool. five strains of *M roridum* were isolated from infected cotton leaves collected from different geographical regions. The cultures were purified and deposited in Type Culture Collection of Agharkar Research Institute, Pune. DNA from one of the strains CICRMRI, of *MM roridium* was subjected to PCR amplification of rDNA using conserved primers ITS4 and ITS5. The rDNA fragment of 618 by was cloned, sequenced and identity was confirmed by BLAST search. The multiple alignments of rDNA sequences of *M roridum* with other pathogens were done using web-based software. Large stretches of conserved sequences in the rRNA genes were observed among different fungi. ITSI and ITS2 regions of fungi

showed greater sequence divergence compared to rRNA genes. Based on unique nucleotide sequences in the ITS region of *M. roridum*, a set of speciesspecific primer (pMror) was designed. The primer amplified a specific fragment of 350 by from all strains of *M roridum*, collected from different geographical regions but failed to detect any other pathogens of cotton tested.

### **POSTER PRESENTATIONS**

### 1.16

## Stabilization of environment sensitive genetic male sterile line in upland cotton *Gossypium hirsutum*

### S. LAXMAN

### Acharya N. G. Ranga Agricultural University, Agricultural Research Station, Mudhol-504102

Cotton, known as king of fibres, assumes place of pride in the Indian economy. Exploitation of hybrid vigour is one of the major achievements in plant breeding. In cotton, large number of intra and interspecific hybrids have been released for commercial cultivation. Hybrid seed produced by the conventional method in cotton by hand emasculation and pollination is expensive and seed set per cent is also low. By using male sterility system the cost of hybrid seed production can be reduced significantly. However, the per se performance and heterotic expression of conventional hybrids were better than hybrids based on CMS system. The presence of strong sterile cytoplasm of wild species i.e. G. harknessi and G. aridum in CMS may be a reason for the poor performance of hybrids. Strong sterile cytoplasm has a tendency to reduce heterosis, since in such cases restorers only restore fertility but cannot neutralize completely the adverse effect of strong sterile cytoplasm on heterosis. These negative effects of sterile cytoplasm can be avoided if environment sensitive genetic male sterility system (EGMS) is used for commercial hybrid seed production, because there will not be any strong sterile cytoplasm of wild species in this system. New vistas in hybrid breeding in self pollinated crops have been opened by successful development of two line hybrids in rice by Chinese breeders using EGMS lines. which have proven to be a potential alternative tool for hybrid seed production. In upland cotton (G. hirsutum) also an EGMS line has been identified at Agricultural Research Station, Mudhol which expresses full male sterility during summer conditions (when maximum temperatures are above 33°C and minimum temperatures range from 26°-29 °C) and same line reverts back to full fertility during kharif and rabi seasons (when maximum temperatures are below 33 °C and minimum temperatures range from 16 °C to 25 °C). The month wise acetocarmine test for sterility behaviour showed complete absence of stained pollen grains during summer period. As many as 250 EGMS lines have been isolated and their stability for expression of male sterility confirmed for three years i.e., 2006, 2007 and 2008 summers. This type of EGMS system would be of considerable value particularly in cotton where cost of hybrid seed production by conventional method of hand emasculation and pollination is very high.

### 1.17

## Estimation of combining ability for seed cotton yield and its components in inter and intra varietal crosses of cotton

### Y. R. REDDY, C. V. C. M. REDDY AND K. RAJA REDDY and G. Narsasimha Rao

### Acharya N. G. Ranga Agricultural University, Nandyal-518 050

The success of any plant improvement plan depends largely upon the availability of genetic variation in the heredity material for the preferred plant traits. In any hybridization programme, identification and selection of superior parental lines are required to construct genetically diverse and potentially rewarding hybrids. The analysis of quantitative inheritance was also an equally important objective to gain knowledge regarding the nature and magnitude of gene action, which has an important bearing on the choice of most appropriate and efficient breeding procedures. Thus, keeping in view the importance of combining ability of the parents for various plant characters in cotton, the line x tester analysis was carried out. The estimates of various genetic parameters would provide guidelines to the cotton breeders to launch effective breeding strategies. The gca effects for the different traits revealed TCH-1002 to be a uniformly good combiner for seed cotton yield per

plant. It was also found to be a good combiner for days to 50 per cent flowering, boll weight and ginning percentage. SLV-1 and MCU-7 were however, observed to be good combiners for seed cotton yield. Further, the parents, Suvin and Sujata, were observed to be good combiners for 2.5 per cent span length, while Narasimha was found to be a good combiner for micronaire value. An analysis of the sca effects revealed significant and desirable effects for seed cotton yield per plant, for the hybrid, Narasimha x TCH-1002. The hybrid, Narasimha x Suvin had recorded significant and desirable sca effects. Further, an analysis of the parental gca effects of the potential hybrids identified in respect of seed cotton yield per plant revealed maximum number of hybrids possessed at least one good general combiner.

### 1.18 NDLA-2463, a new high yielding superior quality variety of *arboreum* cotton for Rayalaseema region of Andhra Pradesh

### C. V. C. M. REDDY, Y. R. REDDY, P. R. REDDY AND S. BASHA MOHIDDIN

#### Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Nandyal-518050

NDLA-2463, a high yielding variety of arboreum cotton (*G. arboreum*), has been recently released by State Seeds Sub-Committee for large scale cultivation in Andhra Pradesh state.NDLA-2463 was tested at Regional Agricultural Research Station, Nandyal for a period of three years1999-2000, 2001-2002 and 2002-2003 in the yield trials and it has recorded an average seed cotton yield of 1993 kg/ha as against 1652 kg/ha of the check variety Aravinda. Thus it recorded 21 percent increased yield over the check. This improved selection NDLA-2463 was tried in large scale demonstration plots and minikit trials conducted by Department of Agriculture. On farmers fields, on an average it has recorded (1859 kg/ha) 29 percent increased yield than check variety Aravinda (1446 kg/ha). NDLA-2463 has recorded superior performance for yield and fibre quality in All India Co-Ordinated Cotton Improvement Project trials conducted during 2002-03. In the overall performance of NDLA-2463 in all the trials conducted, it has recorded (2012 kg/ha) 23 percent increased yield of seed cotton over Aravinda. It possesses mean fibre length of 22.0 mm and mean ginning percentage of 36.5 as against 21.3 mm halo-length and 36.2% ginning percentage of Aravinda. This was found to spin 20 s counts. This new variety is medium tall in height and shorter in duration (160 days) and suitable for cultivation in red soils of Rayalaseema region of Andhra Pradesh.

### 1.19

## Promising *desi* cotton (*G. arboreum L.*) germplasm for fibre quality traits and locule retentivity.

### R. A. MEENA, D. MONGA AND GHANSHYAM

#### Central Institute for Cotton Research, Regional Station, Sirsa-125 055

In North Zone cotton being cultivated in about fifteen-lakh hectare area out of which desi cotton (G. arboreum) constitutes around 25% area. The desi cottons are having very high yield potential along with resistance to biotic and abiotic stresses. The yield potential of some desi cotton varieties is noticed up to 40 g/ ha, which is even higher than G. hirsutum in certain cases. However, inferior fiber properties and poor locule retentivity are the major drawbacks in desi cotton. The seed cotton immediately after opening of boll falls down on the ground and as a result several types of impurities combine with lint, which deteriorate the lint quality. Inferior fiber properties are also due to its coarse nature (micronnair around 7-8), short fiber length (around 16-18 mm) and low strength (16-18 g/tex). Screening of available germplasm for these traits is essential to make the improvement in desi cotton. 540 germplasm lines were evaluated for three years during 2001-2002 to 2003-2004 and superior genotypes are identified for each parameter based on their performance. A wide range of variability for each parameter was observed. Eight lines PA 255, CISA 196, CISA 290, CISA 334, CISA 338, CISA 342, 6637 and AC 3088 were observed completely resistant to shattering. The cultivar CISA 290 also showed higher boll number and good yield potential. Five superior genotypes for 2.5 % span length (above 25.6 mm) were CISA 12 (27.5), DLSA 8 (26.8), PA 255 (26.5), 1789 (26.4) and AK 580 (25.6); for fiber fineness CISA 12 (5.0), 1789 (4.9) AK 60-2 (4.8), AKH 607 (4.6), AK 580 (4.6) and 6629 (4.5); for fiber strength AC 3370-1 (24.8), KWAN 3 (24.5), CISA 245 (24.1), 6629 (23.2) AND PA 255 (22.7); for ginning outturn AKH 592 (37.3), DLSA 8 (35.5), AK 580 (35.0), 6571 (35.0) and KWAN 3 (34.5); for lint index AK 580 (4.8), AKH 592 (4.3), 6612 (4.2), 6619 (4.1) and 7038 (4.0) and for yield potential AC 1374 (128.8), DLSA 8 (103.4), KWAN 3 (99.9), 7173 WL NLL (98.6) and 6586 (97.5). The genotypes exhibiting >0.9 strength length ratios were CISA 245 (1.05), KWAN 3 (1.02), 6629 (0.92), 6644 (0.91) and CISA 329 (0.90). In addition to superiority for strength-length ratio some genotypes were also noticed superior for other quality traits such as culture 6629 for fineness, strength and GOT; KWAN 3 for GOT and yield and CISA 245 for fiber strength and GOT.

### 1.20

## Effect of alien cytoplasmic and nuclear genes on seed cotton yield and fibre quality traits in *Gossypium hirsutum* cotton

### O. P. TUTEJA AND S. K. VERMA

### Central Institute for Cotton Research, Regional Station, Sirsa-125055

The alien cytoplasm and nuclear genes exhibited their deleterious effect on yield and related traits, as reported by earlier workers. Our study was oriented to find out the effect of alien cytoplasm in 'alloplasmic x euplasmic' hybrids in first experiment, and the effect of alien cytoplasm as well as of alien nuclear genes in the 'alloplasmic x euplasmic' and 'euplasmic x euplasmic' hybrids respectively, in the second experiment. The hybrids for both the experiments were produced using Line X Tester mating system. Yield and contributing traits exhibited superiority of conventional 'euplasmic x euplasmic' hybrids over CMS based 'alloplasmic x euplasmic' hybrids in both the experiments and over GMS based 'euplasmic x euplasmic' hybrids in second experiment. CMS based 'alloplasmic x euplasmic' hybrids were superior over GMS based 'euplasmic x euplasmic' hybrids in the second experiment for yield and boll weight, however, for fibre quality traits the trend of performance was variable. Alien cytoplasmic and nuclear genes did not exhibit severe deleterious effects for fibre quality related traits, even though a gain was reported in CMS based 'alloplasmic x euplasmic' hybrids for 2.5% span length and uniformity ratio over the 'euplasmic x euplasmic' hybrids in first experiment. In the second experiment, CMS based 'alloplasmic x euplasmic' hybrids expressed their superiority over the GMS based 'euplasmic x euplasmic' hybrids for most of the fibre quality traits. The average performance of conventional euplasmic x euplasmic' hybrids were unambiguously superior over the two type of hybrids for yield and contributing traits and most of the quality traits.

### 1.21

## Comparative studies on stability parameters and sustainability index for selecting stable genotypes in Asiatic cotton (Gossypium arboreum L.)

### S. K. VERMA, O. P. TUTEJA AND D. MONGA

### Central Institute for Cotton Research, Regional Station. Sirsa-125 055

Comparative studies on stability parameters and sustainability index for selecting stable genotypes in Asiatic cotton *(Gossypium arboreum* L.) was carried out according to Eberhart and Russell model with sustainability index model. Stability analysis was carried out on seven *Gossypium arboreum* genotypes for seed cotton yield, seed index, lint index and number of bolls/plant, boll weight. GOT. 2.5% span length. micronaire and bundle strength on three years data *viz.*, 2004, 2005 and 2006. Based on the linear component (bi), non-linear response (S<sup>2</sup>di) and normal mean performance (x), the genotypes LD 861 and CISA 614 were found stable for seed cotton yield. While based on sustainability index and best performance, the only genotype CISA 614 was found to be stable. For other traits like seed index, lint index. GOT. no. of bolls/plant, boll weight and micronaire, the deviation from regression was non significant and on the basis of sustainability index, the variety CISA 614 was found stable having sustainability index more than 80%. For seed index, GOT, micronaire, 2.5% staple length and bundle strength, all the genotypes recorded very high sustainability index, which indicated that these characters are least influenced by the environmental factors. However, the genotype CISA 614 has *high* sustainability index for 2.5% span length. For many characters the results were found in conformity based on Eherhart and Russell model and hence the sustainability index model may be used for selecting the stable genotypes.

## **1.22** Breeding for improvement of yield and fiber quality in upland cotton

### YAGYA DUTT, K S NIRANIA AND P. P. JAIN

### Chaudhary Charan Singh Haryana Agricultural University, Cotton Research Station, Sirsa-125055

The present study was undertaken to develop and identify superior cross combinations on the basis of seed cotton yield and fiber quality. For this purpose, one hundred hybrids were developed during kharif 2003 and evaluated along with check (HHH 223) for yield traits during kharif 2004. On the basis of results, seven lines namely HS6, HS 88, RS 875, HS 253, HS 1000, HS 253 and HS 223M were identified as promising as these were involved as either one or both the parents in the crosses that showed significantly positive heterosis for seed cotton yield. During kharif 2005, fifteen crosses were made by crossing these lines in half-diallel fashion. These 15 hybrids along with commercial check hybrid (HHH 287) were evaluated for yield and fiber quality traits in the kharif 2006. The range of heterosis was -19.77 % to 33.40 % for seed cotton yield, -20.88 % to 34.63 % for lint yield, -16.00 % to 56.00 % for bolls per plant, -12.29 % to 8.57 % for boll weight, -12.8 % to 6.78 % for seed index, -2.62 % to 7.30 % for ginning out turn, -5.19 % to 4.81 % 2.5 % span length and -8.00 % to 12 % for fineness. Hybrid HS 88 x HS 1000 having highest seed cotton yield and high SCA effects along with acceptable level of fiber quality could be further exploited at commercial level after multilocational testing. Whereas, hybrid HS 88 x RS 875, RS 875 x H 223M and H1000 x H 223M were observed as promising as they recorded significantly high heterosis and high SCA effects for seed cotton yield but also having good fiber quality. All the above hybrids showed either resistance or moderately resistance to cotton leaf curl disease (CLCuD). Hybrids HS 88 x H 1000, HS 88 x RS 875, RS 875 x HS 223M and HS1000 x HS 223M were identified as most promising as these hybrids possessed significantly high heterosis in both the years and high SCA effects for yield along with good fiber quality.

### 1.23 Newly developed fine quality *arboreum* (desi) cotton

### V. N. CHINCHANE, L. A. DESHPANDE, D. B. DEOSARKAR and K. S. BAIG *Marathnada Agricultural University, Parbhani-431 402*

The development of Bt cotton represents a technological change in cotton production. This technological break through has the potential to expand the production frontier of cotton and improve producers' welfare. This Bt technology in cotton is known because of it's ability to provide resistance to cotton boll worm. But this technology is mainly suitable for deep heavy soils and requires high input management. Bt cotton is high cost technology and mainly suitable for irrigated condition. It does not provide resistance to sucking pest. The advantages, which Bt cotton possesses, are naturally present in arboreum (desi) cotton. Gossypium arboreum (desi cotton) has inherent ability to resist major pests and diseases and can withstand moisture stress. It provides natural resistance against boll worm. Series of experiments conducted over the years at Cotton Research Station, Marathwada Agricultural University and through Technology Mission on Cotton clearly indicated that if proper management procedures are followed, the desi cotton has comparable yield potential. In spite of high, medium or low boll worm infestation level, the arboreum recorded comparatively low infestation. As regards to sucking pests, arboreums are resistant to moderately resistant. The reduction of pyrethroids and several conventional insecticides on Bt cotton has resulted in the increase of the population of spodoptera, several other bugs such as mirid bug, mealy bug and other non target species. The overall study indicates that the arboreums are either resistant, moderately resistant or disease free for most of the diseases like bacterial blight, alterneria, leaf spot and anthracnose. Desi cotton strains derived from conventional as well as introgression breeding methods are fairly tolerant to abiotic stresses. The desi cottons showed chlorophyll degradation (CSI) less than 25.0 per cent with higher per cent of relative water coefficient (more than 83.0%) as compared to Bt cotton. In agronomical experiments on nutrient management for production of organic cotton under rainfed condition, the quality arboreum genotypes were found better. As regard to the fibre quality parameter, the fibre properties like fibre length, fibre strength, uniformity ratio, fibre elongation and spinning potential of the newly developed desi cotton varieties are comparable to Bt cotton. Economic analysis of various treatment combinations in relation to cost benefit ratio clearly indicate that desi cottons are superior. The efforts of scientists have resulted into evolution of large number of long linted fine quality arboreums like PA-183, PA-255, PA-402, MDL-2463 and DLSA-17.

# 1.24 Evaluation of *Bt* cotton hybrids identified for central zone under rainfed conditions

#### D. S. PHAD, D. B. DEOSARKAR, S. S. BHATADE AND D. H. SARANG Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Sixty one Bt Cotton hybrids identified for Central Zone were evaluated for yield, fibre quality and pest and disease reaction under rainfed condition at Cotton Research Station, Nanded during kharif, 2007 - 08 under TMC MM 1.4 project. Among the Bt hybrids tested, Ajeet 11 BG II ranked first for seed cotton yield (2458 kg/ha) followed by VICH 15 (2276 kg/ha) and were found significantly superior over Bt checks, RCH 2 BG I (2003 Kg/ha) and Bunny Bt (2038 Kg/ha). Fifteen Bt cotton hybrids recorded significantly higher seed cotton yield over superior non-Bt check, NHH 44 (1551 kg/ha). Five hybrids namely MRC 7301 BG II, NCS 954 BG II, NCS 207 BG II, NSPL 999 BG I and NCS 145 BG I showed superior performance for fibre characters namely 2.5 % span length, micronaire value and fibre strength. Incidence of sucking pests was moderate throughout the season. Hybrid, KDCHH 786 BG I was found tolerant to jassids, thrips, and whitefly. A hybrid, Ajeet 11 BG II was found tolerant to jassids, thrips and whitefly while Ajeet 155 BG II and RCH 144 BG I showed less infestation of thrips and jassids. The hybrids, Ajeet 155 BG II (0.47) followed by Ankur Akka BG I (0.57), VBCH 1010 BG I (0.62), VICH 5 BG I (0.74) and Ankur Jay BG I (0.79) recorded lowest infestation of bollworm (percent fruiting body damage). As regards reaction to major diseases, fourteen hybrids exhibited disease free reaction for bacterial blight, whereas eighteen were resistant and twenty-three cotton hybrids were moderately resistant for bacterial blight. As regards alternaria, KDCHH 9821 BG I exhibited resistant reaction, whereas fifty cotton hybrids exhibited moderately resistant reaction .All the sixty one hybrids exhibited disease free reaction for grey mildew due to escape of disease because of late sowing.

### 1.25 Evaluation of *Bt* cotton hybrids under rainfed condition

### V. N. CHINCHANE, K. S. BAIG, P. R. UNCHEGAONKAR, P. S. KADAM, A. R. GAIKWAD

### Marathwada Agricultural University, Parbhani-431 401

Twenty three Bt cotton hybrids were evaluated along with Bt cotton check RCH-2 Bt, Non-Bt cotton check, NHH-44 and local hybrid check, PHH-316 under rainfed condition at Cotton Research Station, Mahboob Baugh Farm, M.A.U., Parbhani during Kharif, 2006-07. These Bt cotton hybrids were evaluated for yield, yield traits, fibre quality as well as reaction to pest and diseases. Among the Bt cotton hybrids tested, Atal BG II ranked first (1066 kg/ha) followed by Ankur Akka BG II (997 kg/ha) and were found significantly superior over Bt cotton check RCH-2 BG I (786 kg/ha)) and Non-Bt cotton check, NHH-44 (679 kg/ha). Twelve Bt cotton hybrids recorded significantly higher seed cotton yield over superior non-Bt cotton check, NHH-44. Bt cotton hybrid Atal BG II, Ankur Akka BG II, Ankur Jai BG I, Dhruv Bt and Sigma Bt showed superior performance for fibre length (above 29.00 mm), fibre strength (above 21 g/tex), ginning outturn (above 36%) and micronaire value. Infestation of all the sucking pests was low to moderate except thrips population, which was recorded above ETL two times once at 60 DAS and another on 75 DAS on all the Bt cotton hybrids. Bt cotton hybrids, Ankur Akka BG II and RCH-2 BG II recorded lowest infestation of jassids, aphids, thrips and whitefly. Mealy bug infestation was also observed low. Natural enemies like coccinellids and chrysopa were observed with optimum population. Incidence of spotted bollworms as well as *Helicoverpa armigera* was very low on all Bt cotton hybrids under test. The hybrids, Navkar-5 Bt (0.64), RCH 923 Bt (0.66), Dhruv (0.68), RCH-2 BG II (0.71) and Ankur Akka BG II (0.72) recorded lowest infestation of bollworms (percent fruiting body damage). All the Bt cotton hybrids as well as checks indicated resistant reaction against alterneria leaf spot and disease free reaction for grey mildew where as seven Bt cotton hybrids recorded disease free reaction for bacterial blight.

### 1.26 Performance of some *Bt* cotton hybrids in south-western districts of Punjab

### PANKAJ RATHORE, J. S. GILL, VIKAS JINDAL, SATNAM SINGH AND MANPREET SINGH

#### Punjab Agricultural University Regional Station, Faridkot-151 203

Fourteen Bt cotton hybrids, RCH134 Bt, RCH317 Bt, RCH308 Bt, RCH314 Bt, MRC6301 Bt, MRC6304 Bt, MRC6025 Bt. MRC6029 Bt. JKCH1947 Bt. Ankur651 Bt. Ankur2534 Bt. NCEH6R Bt. NCS138 Bt and NCS913 Bt along with two non-Bt hybrids, CSHH198 and LHH144, and two non-Bt varieties, F1861 and F846 were evaluated in a randomized complete block design with three replications. Different genotypes were sprayed with the insecticides for the management of bollworms on the basis of ETL (F1861, F846, LHH144, CSHH198: 3 sprays; Ankur651Bt: 2 sprays; NCS913 Bt, RCH308 Bt, RCH134 Bt, MRC6304 Bt, NECH6R Bt: 1 spray). In addition, 3 sprays of insecticides were given to all the genotypes for the management of mealy bug. Genotype, MRC6029 Bt recorded the highest seed cotton yield (3252 kg/ha) which was significantly higher than the best non-Bt check, F1861 (2569 kg/ha). Four genotypes, RCH314 Bt (2749 kg/ha), NCS138 Bt (2311 kg/ha), NECH6R Bt (2268 kg/ha) and JKCH1947 Bt (2200 kg/ha) gave statistically at par seed cotton yield than the best non-Bt check, F1861. MRC 6029 Bt also recorded the significantly higher lint yield (1023 kg/ha) than the best non-Bt check, F1861 (823 kg/ha). The highest ginning outturn (35.1%) was recorded by JKCH1947 Bt. The highest boll weight (5.23 g), bolls/plant (36.2) and seed index (11.6 g) were recorded by MRC6029 Bt, whereas the highest lint index (6.16 g) was recorded by NCS913 Bt. The mean jassid population varied from 0.28 to 0.75 nymphs per plant. The whitefly population was lowest (3.4 adults/plant) on NCS138 Bt and highest (6.92 adults/plant) on MRC6301 Bt. The thrip population varied from 0.41 to 1.56 thrips/plant. Non significant differences between genotypes were observed w.r.t mealy bug incidence. The minimum (0.006 /10cm terminal shoot) mealy bug population was recorded on RCH308 Bt and maximum (2.75 /10cm terminal shoot) on NCS913 Bt. The green boll damage varied from 0.00 to 10.00 per cent. It was minimum on RCH308 Bt and Ankur2534 Bt and maximum on CSHH198. The maximum pink boll larvae were observed in CSHH198 and F846 genotypes.

### 1.27 Development of Asiatic cotton cultivars with high fibre quality

### DHARMINDER PATHAK, M. S. GILL, G. SINGH, N. SHARMA AND H. HASAN

### Punjab Agricultural University, Ludhiana-141 004

One of the two Asiatic cotton species, G. arboreum is grown in North Indian cotton growing states of Punjab, Haryana and Rajasthan. Desi cotton cultivars are high yielding and possess high degree of resistance to dreaded cotton leaf curl disease (CLCuD) and are tolerant to sucking insect pests and drought. Asiatic cottons are characterized by their short stapled and coarse fibre. On the other hand, American cotton cultivars, besides possessing high yield and superior fibre properties, are susceptible to CLCuD and sucking pests. Up to 92 per cent yield losses have been reported in different susceptible genotypes of American cotton due to CLCuD in North India. Moreover, most of the American cotton cultivars grown in the Punjab, Haryana and Rajasthan are not resistant to this devastating disease. Therefore, the development of G. arboreum varieties possessing fibre properties similar to those of American cotton cultivars has become an important research priority. Under the Project Technology Mission on Cotton, we have evaluated large number of genotypes originating from diverse eco-geographical regions for seed cotton yield, fibre traits and other traits of economic importance. Several lines possessing fibre properties matching those of hirsutum cultivars have been identified. Based on the mean performance of the last two years at Ludhiana, six entries were found to possess more than 27 mm 2.5% span length as compared to 26.0 mm of American cotton check (F1861) and 19.1 mm recorded by arboreum cotton check (LD 694). These six long linted genotypes are: RAC 024 (28.2 mm), JLA 1600 (28.0 mm), PA08 (28.0 mm), PAIG8/1 (27.7 mm), PA255 (27.5 mm), and AH1 (27.3 mm). These entries are from Central India and did not produce higher yield under North Indian conditions. However, these are excellent sources of QTL for superior fibre quality characteristics and are being used as donors in our breeding programme for the development of arboreum lines with enhanced fibre properties with high yield and lint percentage. Some of the advanced lines developed at our centre possessing fibre of medium staple length and acceptable vield levels include LD733, LD909, LD 929, LD955 etc. These lines will contribute towards the supply of the medium staple fibre in the event of potential limitation created by widespread occurrence of CLCuD epiphytotics in American cotton in North India.

### 1.28 Comparative performance of *Bt* and non-*Bt* versions of cotton hybrids

### MS GILL, BS GILL, RS SOHU, PARAMJIT SINGH AND INDERPREET DHALIWAL *Punjab Agricultural University, Ludhiana-141004*

To study the impact of Bt cotton technology six Bt cotton hybrids, RCH 134, RCH 317, MRC 6301, MRC 6304, Ankur 651 and Ankur 2534 were compared to their respective non-Bt versions at Ludhiana and Faridkot in the Punjab state. Significant increase in mean seed cotton yield has been observed in the Bt cotton hybrids especially RCH 134 (109.4%), RCH 317 (101.1%), MRC 6304 (86.1%) and MRC 6301 (73.2%). This increase in yield is mainly attributed to increase in number of bolls per plant due to their inbuilt resistance to bollworm complex especially the American bollworm and spotted bollworm. The boll number per plant in RCH 134Bt and RCH 317Bt has been recorded to be more than twice to that of their non-Bt counterparts with slight difference in boll weight which is also on higher side. In case of Ankur 651 and Ankur 2534 hybrids which are very early and short compact, the increase in boll number per plant is small and also the boll weight is on the lower side in case of Bt versions as compared to non-Bt versions. This further affects the ultimate yield potential due to which the percent increase in yield is very low i.e. 7.5% in Ankur 651 and 16.1% in Ankur 2534. Significant reduction in plant height, number of monopods per plant, number of sympods per plant, days to maturity and seed index has been observed in Bt versions as compared to non-Bt versions of all the test hybrids. This shows that the Bt cotton technology became a boom to the cotton growers as it improves the production and productivity of cotton in the Punjab state and the socio-economic status of the Punjab farmers.

### 1.29 GGE biplot analysis of multi-environment trials of *Bt*-cotton hybrids

### B. S. GILL, R. S. SOHU, R. K. GUMBER, INDERPREET DHALIWAL AND P. S. SHERA

#### Punjab Agricultural University, Ludhiana-141004

Multi-environment testing of genotypes over locations and years is common practice in plant breeding. GGE biplot analysis allows two interacting factors viz. genotypes and environments to be visualized simultaneously. The analysis is simple, informative and gives graphical presentation of genotypes and environments. In the present study an attempt has been made to identify Bt-cotton testing environments that are both informative (discriminatory) and representative and also to identify Bt-cotton hybrids with high performance and stability for yield. For this purpose seven cotton hybrids which included four BG-I hybrids (RCH 134, JKCH 1945, Ankur 2226 and NCEH 9), two BG-II hybrids (RCH 134 and MLCH 315) and one non-Bt check, LHH 144 were evaluated under six environments having different locations and years, namely Ludhiana and Faridkot (2006 & 2007), Bathinda (2006) and Abohar (2007). Environment evaluation based on biplot analysis showed that six environments fall into two apparent groups: Faridkot 07 and Abohar 07 formed one group and the remaining environments formed another. The presence of wide obtuse angles between some of the test environments indicated strong crossover G x E interactions i.e. ranking of Bt hybrids changed in some of the environments. The length of environment vectors showed that Ludhiana 06 was most discriminating (informative) and representative among all the environments whereas Bathinda 06 was least discriminating. The analysis suggested that hybrids RCH 134BG-I and RCH 134BG-II were better than check and other Bt hybrids in four environments (Ludhiana 06 & 07, Faridkot 06 and Bathinda 06). The hybrid JKCH 1945BG-I was better at Faridkor 07 and Abohar 07 while Ankur 2226BG-I, NCEH 9BG-I, MLCH 315GB-II and LHH 144 were not high performing in any of the environments.

### 1.30 A comparative study of heterosis in single, double and three way crosses in *Gossypium hirsutum* L.

#### R. K. GUMBER, B. S. GILL AND M. S. GILL

Punjab Agricultural University, Ludhiana-141004

India has become cotton surplus state from cotton importing country. Hybrid cotton occupies about 90 per cent of the total cotton area. Development of hybrids is the quickest breeding method for exploiting the heterosis to improve yield potential of crop plants. Therefore, breeding efforts involving the use of heterosis are needed to realize maximum yield potential. The objective of present study was to estimate the magnitude of heterosis in different types of intra-specific crosses of American cotton viz. single (A x B), double (A x B) x (C x D), and three way (A x B) x (C) crosses. Seventy-nine single, 15 double and 45 three way crosses were evaluated against cultivar LH1556 in randomized complete block design in single row plot of 8 m length using two replications in 2006. Rows were kept apart at 67.5 cm with plant-to-plant spacing of 75 cm for hybrids and 60 cm for cultivar. Increase/decrease in mean performance of different types of hybrids over check LH1556 was calculated for seed cotton yield, boll number, boll weight, seed index, and ginning out turn. The heterosis for vield over check cultivar LH1556 varied from -39 % to 122.7 %. Mean performance and heterosis of three ways cross hybrids was higher than the two-way crosses. Heterois for yield ranged from -56.7 to 126.2%. In contrast to single crosses, a number of three way hybrids showed improvement for yield. Mean performance of double cross hybrids was much less than that of three way cross hybrids. Like single cross hybrids, very few double cross hybrids exhibited positive heterosis for seed cotton yield. Three ways cross hybrids also had better performance and heterosis for bolls per plant as compared to single and double cross hybrids. For boll weight, heterosis ranged from -12.5 to 51.3 % in single crosses, -62.4 to 78.6 % in three way crosses and -25.4 to 42.4 % in double crosses. Single cross hybrids had better ginning out turn than check cultivar LH1556. On the contrary, none of the double and three ways crosses expressed higher ginning out turn than LH 1556. For seed index, most of the single, double and three way cross hybrids had negative heterosis over LH1556. In general, single cross and three way cross hybrids performed better than double cross hybrids.

### 1.31

## Assessment of male sterile lines of *desi* cotton for synchronization and pollination period under varying climatic conditions

### S. K. BURGHATE, B. R. PATIL, A. S. ZAPE, P. A. DESHMUKH AND A. S. BONDE

#### Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-440 004

The research was carried out to evaluate compatibility of females under varying climatic conditions, to increase the efficiency of hybrid cotton seed production and to reduce its production cost by using genetic male sterile lines of *G. arboreum*. Among all three GMS lines, GAK-423 exhibited earliness for flowering and fruiting behavior in September. Boll setting, boll retention and seeds per crossed boll were significantly influenced by period and time of pollination. The stigma receptivity judged on the basis of boll setting percent was maximum at time of pollination from 11.00 a.m. to 01.00 p.m. in September and from 12.00 noon to 02.00 p.m. in October and November and it might be due to varying climatic conditions during these three months. This information may be useful for properly synchronizing males and females and suggested that pollination can be extended up to 02.00 p.m. for getting high seed yield and quality particularly in desi cotton hybrid seed production programme.

### Diallel analysis for quantitative traits in upland cotton

#### S. P. PATIL, B. R. PATIL AND S. K. BURGHATE Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444 004

A set of 56 hybrids and eight parents were evaluated in randomized block design with three replication bat Cotton Research Unit, Dr. P.D.K.V, Akola. The heterosis studies through diallel analysis in upland cotton revealed high amount of mid parent heterosis for seed cotton yield per plant. The data revealed that the number of bolls per plant and boll weight appeared to be the major component of heterosis for yield followed by number of sympodia per plant, seed index etc. Based on the per se performance and percentage of heterosis the'NH-1021 x PH-1009, GJHV-374 x GBHV148, GJHV-374 X AKH-9913, and GJHV-374 x PH-1009 were found best reciprocal crosses while PH-1009 x GJHV-374, PH -1009 x NH-1021, GBHV-148 x GBHV-374 and ADB-320 x GJHV-374 were found best  $F_1$  crosses among 56 hybrids evaluated. Results also indicated that the magnitude of heterosis was high for morphological characters followed by fibre quality characters in both  $F_1$  and reciprocal crosses.

### 1.33 Study on pollen mediated flow of Cry1Ac gene in *Bt* cotton

### V. SANTHY, G. BALASUBRAMANI, ANSHU VISHWANATHAN AND VARSHA DHOSEWAN Central Institute for Cotton Research, Nagpur-440 010

The increasing number of Bt cotton hybrids being developed and released for commercial cultivation demand urgent need to develop protocols for seed production and certification. Determining the distance of gene transfer through pollen is an important requirement under bio safety guidelines for approval of any GM crop as well as in deciding the isolation distances to be maintained for seed purity. A study was conducted at CICR, Nagpur on variety BN Bt (Bikaneri Nerma Bt) carrying the Cry 1 Ac gene. The field was laid out in a circular fashion with BN Bt planted in the central plot of 50 sq.m. size surrounded by male sterile non Bt G. hirustum variety on all sides up to the distance of 30 mts. The bolls set on male sterile borders indicated that pollen of Bt cotton could be dispersed into the environment. Three replications of 10 mg fresh seed sample from bolls set in the non Bt plants on all four directions and at distances of 1 mt, 6 mt, 11 mt, 16 mt, 21 mt, 28 mt each were collected and used to extract total protein. A total of seventy two samples prepared were subjected to ELISA test to study the expression of Cry protein. The OD values obtained were fit to a power curve model: Y = 0.015x + 0.2495 against the standard value for determining protein expression. Based on the protein expression it was observed that the pollen flow was maximum only up to a distance of 1m towards north, east, west sides and 6m towards south direction. No contamination or cross pollination by transgenic pollen grains was observed beyond 6m in any direction. Dispersal frequency decreased as dispersal distance increased. The out crossing frequency for the Cry 1 Ac gene was observed to be about 1% to non-Bt cotton plants. The results indicate that a 6 m buffer zone would serve to limit dispersal of transgenic pollen from small scale field tests.

### 1.34 Performance of different *Bt* cotton hybrids in south-western region of Punjab

### PARAMJIT SINGH, G. S. BUTTAR, R. S. SOHU AND M. S. GILL Punjab Agricultural University, Regional Station, Bathinda-151 001

Twenty-one Bt cotton hybrid of Private sector along with two standard checks viz. RCH 134 Bt and LHH 144 were evaluated in a randomized complete block design with three replications for yield and its component characters. The soil of the experiment site was low in organic carbon; medium in P & K and the pH of the soil was 8.5. The objective of the study was to assess the suitability of Bt cotton hybrids and to identify superior Bt hybrids from private sector, which can gave higher yield in agro-climatic conditions of southwestern region of Punjab. Out of twenty one Bt hybrids tested only four viz. PCH 402 Bt, RCH 308 Bt, NCH 901 Bt and VICH 11 Bt gave significantly higher seed cotton yield than recommended Bt hybrid check RCH 134 Bt where as

most of the Bt hybrids gave higher seed cotton yield as compared to public sector non Bt hybrid check LHH 144. This establishes the superiority of Bt hybrids on non Bt hybrids. The maximum seed cotton yield was exhibited by PCH 402 Bt (3283 Kg/ha) followed by RCH 308 Bt (3245 Kg/ha), NCH 901 (3204 Kg/ha) and VICH 11 Bt (3195 Kg/ha). The maximum number of bolls per plant were gave by RCH 317 Bt (97.26) followed by RCH 308 Bt and PCH 402 Bt (93.26) and PCH 402 Bt (92.53) which were significantly higher than Bt as well as non Bt checks. As far as boll weight was concerned non of the Bt cotton hybrid was able to gave higher boll weight than the non Bt check LHH 144 but Ankur 2226 Bt (4.22g) and RCH 317 Bt (4.09g) gave more boll weight as compare to Bt hybrid check RCH 134 Bt (4.05g). It can be concluded from the study that Bt cotton hybrids have more yield potential than non Bt hybrids and this is due to more number of bolls per plant.

### 1.35 Performance of BG I and BG II cotton hybrids under Rahuri condition

#### J. M. PATIL, P. A. NAVALE AND S.B.KHARBADE Mahatma Phule Krishi Vidyapeeth Rahuri-413 722

A total of about 42 Bt hybrids involving BG I and BG II events were evaluated for yield performance, fibre quality and reactions to different pests during summer 2007-08. These Bt hybrids include 25 intra-hirsutum, 8 inter-specific (G. hirsutum x G. barbdense) hybrids with BG I (Cry 1 Ac) and remaining 9 with BG II event (Cry 1 Ac + 2Ab). The sowing of the trial was done separately for BGI and BGII events along with appropriate checks. The experiment was conducted following appropriate design along with all recommended packages to raise the normal crop. Observations were recorded on seed cotton yield, no.of bolls, plant height, sympodial branches /plant, fibre quality parameters viz., staple length, tenacity, elongation, micronaire and uniformity ratio. Among the hybrids of intra-hirsutum group (BG I) seed cotton yield varied between 13 to 37 g / ha, whereas in inter-specific H x B hybrids (BGI) it was 10 to 33.5 q/ ha. However in H \*H BG II event yield varied between 13 to 26.5 g/ha. Yield differences were distinct in BG I and BG II events. The high yield in H x H and H x B, BGI event appears to be due to high number of sympodial branches, high boll number and high boll weight. For fibre quality parameters, the staple length in H x H BG I ranged between 25.8 - 32.7 mm with a mean of 29.46 mm, whereas in hybrids (H x H) with BG II event it varied between 25.1 - 31.9 mm with a mean of 28.62 mm However, the tenacity of fibre appears to be low in both the events with a mean of 23.17 and 22.79, respectively in BG I and BG II events. The length and tenacity of H x B hybrids in BG I hybrids appears good i.e. 31.33 mm and 24.9 g/tex respectively. In case of pest reaction, the BG I hybrids recorded sucking pest complex below economic threshold level (ETL) except aphids. Likewise for BG II hybrid with the exception thrips all other sucking pest remained below ETL. The sucking pest population was high on Bt events as compared to non Bt events. In spite the presence of Bt toxin in BG I / BGII events, locule damage was observed to the tune of 7.3 % indicating the activity of pink boll worm in BG I /BG II hybrids and needs attention in future breeding programme.

### 1.36

### Boll setting using hand emasculation and pollination techniques in *Gossypium arboreum* L.

#### D. P. PUNIA AND R. S. SANGWAN CCS Haryana Agricultural University, Hisar-125 004

In desi cotton *(G. arboreum)* crossed boll setting is a big problem by hand emasculation and pollination. Main reasons are small flower and pedicel size in arboreum cotton besides climatic conditions and skill of person engaged in and emasculation and pollination. Optimum boll setting period in north India is from 25 July to 20<sup>th</sup> September. In general it is observed that early boll setting has an advantage over late boll setting. Many times late boll opening period coincides with low day and night temperature. In the present study efforts were made to find out the percentage of crossed boll setting in *desi* cotton and optimum period for better setting of bolls and to find out the climatic conditions that affect the boll setting. In the present investigation the crossing programme was to started from August 21, 2008 and continued up to September 12, 2008. Flower buds were emasculated in the evening hours between 3.00 to 5.00 p.m. and on the next morning emasculated buds were hand pollinated between 9-00 to 12-00 noon. On each day (21.8.2008 to 12.9.2008) the number of emasculated buds was counted (2672) and at the time of picking number of crossed bolls were picked and counted (367).

Thus percent boll setting was calculated and it ranged from 5.1 to 42.7 % and over all bolls setting percentage was 13.7.

### 1.37 Genetic divergence in cotton *(Gossypium hirusutum L.)*

### RAJ BAHADUR, S. S. SIWACH AND R. S. SANGWAN CCS Haryana Agricultural University, Hisar-125 004

Genetic divergence was studied for ten yield traits in 108 diverse genotypes of cotton. Based on D<sup>2</sup> values, genotypes were grouped into nine clusters. The intra-cluster distance ranged from 0.00 to 3.88 whereas, intercluster distance varied from 3.44 - 6.86. The inter-cluster distance was maximum between cluster I and VII, whereas closest proximity was observed between cluster II and V. The clustering pattern indicated that geographical diversity did not necessary represent genetic diversity. Hence, promising genotypes from clusters having large inter cluster distances offer better opportunity to provide enough genetic variation for getting high yielding and desirable segregants in cotton.

### 1.38 DUS testing of *Bt* cotton hybrids approved for south zone states–a trial run

### K. RATHINAVEL, S. MANICKAM AND N. GOPALAKRISHNAN

#### Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Due to the enactment of Protection of Plant Varieties and Farmers Rights Act, 2001, plant breeders, public funded institutions, farmer and group of farmers have got legitimacy to protect their novel creative plant varieties/hybrids due to their intellect, which is otherwise not entitled under Indian patent law. This act envisages the confirmation of criteria of novelty, distinctiveness, uniformity and stability of new plant variety / hybrid before the confirmation of registration. For the purpose of comparison of commercially approved Bt. cotton hybrids for south zone states and absolute determination of their distinctiveness a DUS trial was laid out involving 53 Bt.hybrids (intra-hirsutum) and 3 Bt.hybrids (inter-specific) as per the National test guidelines of tetraploid cotton. Observations on thirty morphological traits were recorded during the ontogeny of crop. With the observation being recorded in a randomly selected ten plants, as per the National test guidelines of tetraploid cotton. The state of expressions for hypocotyl pigmentation in all 56 varieties was present, for leaf colour, 4 had light green and 52 others had green. For traits such as leaf gossypol glands, nectariness, petiole pigmentation and stem pigmentation, all 56 hybrids expressed the state present. Similarly, all the 56 hybrids were grouped into one state for bract type (normal); boll bearing habit (solitary); boll colour, (green) and boll opening (semi-open). The results suggested narrow genetic base and posing hardship in establishing distinctiveness among the hybrids. However, a fair amount of variability was noticed as regards plant height (semi dwarf (60-90cm) tall (>150 cm)), petal colour (cream - yellow), pollen colour (cream, yellow, deep yellow) and boll weights (medium (4.1-5.0 g; very large (>6.0 g) are concerned. This study provides ample opportunity for identification of newer heritable morphological traits for the determination of distinctiveness of plant varieties/hybrids, especially among transgenic Bt. cotton hybrids.

### 1.39

## Identification of genotypes suitable for mechanical harvesting in upland cotton *Gossypium hirsutum* L.

#### JAGMAIL SINGH, S. K. CHOPRA, BABITA CHAUDHARY AND M. K. SHARMA Indian Agricultural Research Institute, New Delhi-110 012

In *G. arboreum* varieties burs do not possess enough holding force to keep seed cotton sticking in the burs. Although it is easy to pick such a cotton but requires more frequent pickings to avoid falling of seed cotton on the ground. Most varieties belonging to *G. herbaceum* are very difficult to pick because of the position of the burs after opening. Bolls are smaller and locks after opening are positioned such that each lock has to be

picked separately. Although varietal differences do exist, nonetheless most varieties belonging to G. arboreum and G. herbaceum are not suitable for machine picking. In G. hirsutum cottons on the other hand the bolls open relatively widely and can hold locks for a longer period of time without letting the seed cotton fall on the ground. Early and synchronous maturity, compact plant type, medium plant height, wide boll opening, flared kapas attachment to the locule, shedding of leaves at the time of harvesting, etc. are some of the traits which need to be considered for developing such varieties / genotypes. Furthermore, defoliants may need to be used before harvesting to facilitate leaf shedding and better and relatively more synchronous opening of bolls. Genotype P 1752 recorded highest seed cotton yield (3210 Kg/ha) among the 10 test genotypes. In comparison, the local check Pusa 8-6 showed 2811 Kg/ha seed cotton in 100 cm x 10 cm spacing and 2871 Kg/ha in 100 cm x 30 cm spacing. Genotypes P 1001 and H 1300 both with 3048 Kg/ha vield ranked 2<sup>nd</sup> after P 1752. Both these genotypes also showed significantly higher yield as compared to local check. The lowest yield of 1508 kg/ha was recorded in variety RS 875, which is a variety with compact plant type and was released for Rajasthan. Other genotypes like H 1098-1, RS 810, F 2036, CSH 3036 and CSH 3118 also gave significantly higher seed cotton yield as compared to local check Pusa 8-6. Besides highest seed cotton yield, P 1752 also showed highest lint yield (1098 Kg/ha) amongst all the genotypes evaluated. This was followed by H 1300 (1056 Kg/ha) and P 1001 (1044 Kg/ha). In comparison local check Pusa 8-6 showed lint yield of 964 Kg/ha in 100cm x 10cm spacing and 989 Kg/ha in 100cm x 30cm in spacing. There was not much variation in ginning outturn (GOT) among the genotypes which ranged from 33.0% in CSH 3036 to 34.8% in RS 810. Likewise boll weight ranged from 3.5g in RS 810 to 4.9g in Pusa 8-6, while seed index varied from 7.4g in RS 810 to 9.1g in Pusa 8-6. The lowest plant height of 86 cm was observed in RS 875 which was found to be most compact variety. On the other hand CSH 3118 and P 1001 were the tallest genotypes with plant height of 158 cm and 157 cm, respectively. Highest quantity harvested during 1st picking at 120 DAP was 56.3% in RS 875. This was followed by P 1752 with 45.5% harvesting. Lowest 1st picking harvest was 29.5% in CSH 3036. The highest quantity harvested during 2<sup>nd</sup> harvest at 135 DAP was 28.5% in Pusa 8-6 (100cm x 30cm spacing) and 27.5% in CSH 3036. Variety RS 875 showed lowest second picking harvest (9.0%). There was not much variation among the genotypes with regard to the percentage of seed cotton harvested during 3<sup>rd</sup> picking at 150 DAP. It ranged from 28.2% in CSH 3118 to 32.4% in RS 875. During 4th harvest at 165 DAP the lowest seed cotton harvested was 2.3% in RS 875 and highest was 17.0% in PIL 8. On the basis of total seed cotton harvested in first 3 pickings at 150 DAP, variety RS 875 ranked 1st with 97.7% harvest completed. This was followed by 96% harvesting in P 1752. The range for the remaining genotypes varied from 83% in PIL 8 to 94.2% in local check Pusa 8-6 in 100cm x 30cm spacing. The 2.5% span length varied from 24.8mm in RS 810 to 28.7mm in CSH 3118. Most of the genotypes showed good fibre uniformity and elongation. Highest fibre strength of 22.9g/tex. was observed in P 1001 and the lowest was 17.9g/tex in RS 810. Micronaire value varied from 4.6 to 5.0. The highest yielding genotype P 1752 also showed relatively better fibre quality as compared to other genotypes like H 1300 and RS 875. Amongst the ten genotypes evaluated in this study, the genotypes P 1752, H 1300 and P 1001 gave highest seed cotton and lint yield, respectively with 96%, 88.4% and 87% harvest completed at 150 DAP. Nonetheless, variety RS 875 was the most compact and early in maturity with 97.7 % harvesting at 150 DAP and 0.80 as the Bartlett rate index. But its seed cotton yield at 1508 Kg/ha was lowest among all the genotypes and was more than 50 % lower as compared to that of highest seed cotton yielding genotypes like P 1752 and H 1300. Thus genotypes P 1752 and H 1300, besides high seed cotton yield, were found to be quite synchronous and early in maturity. These genotypes also showed flared kapas attachment, wide locule opening and average height. Thus these genotypes were found to possess several traits necessary to meet requirements and suitability considerations for machine picking.

### 1.40 Genetic variation for composition of cotton seed meal

### M. K. SANGHA, D SHARMA, A. K. ATWAL AND DHARMINDER PATHAK Punjab Agricultural University, Ludhiana-141004

Besides lint, cotton is also an important source of oil and proteinaceous meal. The present study was undertaken to assess the genetic variation among some diploid and tetraploid cotton genotypes for the composition of cotton seed meal. The experimental plant material included nine genotypes each of *Gossypium arboreum* (LD 327, LD 491, LD 694, LD 733, LD 784, LD 805, LD 861, LD 866 and LD 900) and *G. hirsutum* (F 1861, F 1946, F 2009, F 2022, F 2032, F 2036, LH 1556, LH 1961 and LH 1968). The mean values for meal protein, crude fibre, and free gossypol content in *G. arboreum* ranged from 45.0 – 54.8 g/100g, 9.8 – 12.8 g/100g, and 0.12 - 0.49 %, respectively. Similarly, among *G. hirsutum* entries evaluated, the range

for these characters was observed to be 43.2 - 54.5 g/100g, 10.1 - 12.5 g/100g, and 0.48 - 0.67 %, respectively. Mineral composition of meal among *G. arboreum* genotypes ranged from 50.00-68.75 ppm (Zn), 36.25-147.25 ppm (Fe), 12.0-15.0 ppm (Cu), 1.56-1.98 % (K), 0.10-0.18 % (Na), 0.20-0.41 % (Ca), 1.04-1.34 % (P) and 0.30 - 0.45 % (Mg). Similarly among *G. hirsutum* genotypes, the mean values of various minerals ranged from 63.75-70.5 ppm (Zn), 120.5-153.25 ppm (Fe), 11.75-13.70 ppm (Cu), 1.41-1.96 % (K), 0.14-0.87 % (Na), 0.54-0.68 % (Ca), 1.03-1.16 % (P) and 0.51 - 0.68 % (Mg). The mean values of American cotton and desi cotton genotypes were statistically at par for meal protein content, crude fibre content, and mineral composition (except Na, Ca, and Mg). *G. arboreum* seed cake contained significantly less mean free gossypol than that of *G. hirsutum* in the present investigation. Cotton genotypes with desirable meal characteristics may be involved in the breeding programmes.

### 1.41 Cytomorphological studies in apomictic cotton lines

### SANGITA U. FATAK AND U. G. KULKARNI

### Department of Agricultural Botany, Marathwada Agriculture University, Parbhani-431 402

The present investigation was carried out at Department of Agricultural Botany, Marathwada Agriculture University, Parbhani to study of chromosomal behavior of Metaphase-I in somatic cells. Trispecies derivatives developed in segregating population of hybridization between *Gossypium* species viz., *G. hirsutum*, *G. arboreum* and *G. barbadense*. In apomictic cotton lines somatic cells showed exact chromosome number and behavior of chromosome at Metaphase-I. In somatic cells at metaphase , mean chromosome number was 40.20,42.85,47.30,and44.15 in apomictic lines viz., IS-244/4/1, IS-244/4/2, IS-181/7/1 and IS-376/4/1/5/19, respectively. While chromosome configuration at Metaphase-I was 8.5I+9.65II+1.95III+1.62IV in IS-244/4/1, 10I+10.15II+2.25III+1.55IV in IS-244/4/2, 11.40I+ 12.50II+ 1.70III+ 1.45IV in IS181/7/1 and 10.10I+10.20II +2.25III+1.85IV in IS-376/4/1/5/19, respectively. More number of bivalents than univalents, trivalents and quadrivalents were observed. At Anaphase-I irregular separation of chromosome was observed, which form diads and triads. Morphological characters were reduced in plant height, leaves floral parts, pollen fertility, number of seeds per boll and 100 seed weight than checks, it is due to haploid nature of apomictic plants and variation in chromosome number within line lead to develop aneuploid plant. The pollen fertility 68.77, 5.83, 72.68 and 80.61 per cent in lines IS-244/4/1, IS-244/4/2, IS-181/7/1 and IS-376/4/1/5/19, respectively might be helpful for pollination and to fix heterosis in cotton.

### 1.42

### Stability parameters for $G \ge E$ interaction of seed cotton yield in *Bt* cotton (BG-II)

### P. N. PATEL, J. C. PATEL AND D. H. PATEL

### Vikram Seeds Limited, Ahmedabad

Two promising genotypes viz., VICH-301 (BG-II) and VICH-303 (BG-II) were evaluated for stability of seed cotton yield along with RCH-2 (BG-II) as Bt check and G.cot Hy-12 as non-Bt check at Surat, Talod, Junagadh, Anand (Guj.) and Jalgaon (M.S.). The trial was laid out in R.B.D. replicated thrice during Kharif, 2008. Bt cotton hybrids VICH-303 (BG-II) recorded maximum seed cotton yield (3404 kg/ha) followed by VICH-301 (BG-II) (3232 kg/ha) as against 2531 and 2260 kg/ha of RCH-2 and G.cot Hy-12 check, respectively. The most promising hybrid, VICH-303 (BG-II) also stood first in seed cotton yield at all locations except Anand and Surat. The pooled analysis of variance showed that genotypes as well as environmental differed significantly. The significant G x E interactions indicated that the yield expression of genotype varied with environments. Mean squares for pooled deviation were highly significant, which indicated that part of the variability attributable to G x E interaction was non predictable in nature. The hybrid VICH-303 (BG-II) appeared to be the most stable genotype as it showed high mean, unit regression and non significant deviation from regression. The remaining hybrids showed significant non-linear components indicating unstable and unpredictable behavior.

### 1.43 Evaluation of interspecific cotton derivatives for yield and biotic stress

### S. S. BHATADE, D. B. DEOSARKAR AND A. R. GAIKWAD

Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Screening against pests and diseases were done in 21 genotypes derived from interspecific crosses. At Cotton Research Station, Nanded during 2006-07. The genotypes LAS-10 (2383 kg/ha), DWR a 05-02 (2278 kg/ha) and DWR a 05-01 (2222 kg/ha) had recorded significantly superior seed cotton yield over the checks NH-545 (1380 kg/ha) and NH-615 (Local Check 1639 kg/ha). However, the genotypes L-799 (2028 kg/ha) and IS-376-4-9-68-2 (2011 kg/ha) were significantly superior over the check NH-545. The highest GOT was recorded by the genotypes GISV – 206 (40.72 %) followed by GISV-33 (40.41%). Genotypes LAS-10 and DWR-H-05-03 exhibited multiple disease resistance for bacterial blight, alternaria and grey mildew diseases. In all, four genotypes were disease free and four were found resistant to bacterial blight. Whereas, three genotypes were found resistant to alternaria and seventeen were showed disease free reaction to grey mildew. As regards screening against pests, significantly lowest jassid incidence was recorded by LAS-10 (2.5) followed by RHRAC-33 (2.70) over check NH-545 (3.90). For aphid infestation, seven genotypes exhibited significantly lowest infestation over check NH-545 (10.90), amongst which genotype H-1098-1 (6.90) exhibited lowest aphid infestation followed by LAS -10 (7.20), L-799 (7.30), IS-376-4-1-9-68-2 (8.00), RHRAC-33 (8.50), IS-376-4-1-30-12 (8.75) and L-798 (9.30). For thrips and whitefly infestation only two genotypes viz., LAS-10 and RHRAC-33 could show significantly lowest incidence over check NH-545. Thus genotypes LAS-10 and RHRAS-33 exhibited multiple sucking pest resistance to all the pest complex. In the bollworm infestation evaluation, only one genotype (RHRAC-33, exhibited significantly lowest infestation of bollworm to fruiting bodies 6.85% whereas nine genotypes could show significantly lowest bollworm infestation to locule.

### 1.44

## Evaluation of inter-specific derivatives developed at CRS, Nanded for yield, yield contributing characters and fibre properties

### S. S. BHATADE, D. B. DEOSARKAR AND A. R. GAIKWAD

Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Six promising genotypes developed at Cotton Research Station, Nanded having resistance to sucking pest were evaluated for seed cotton, yield, yield contributing characters and fibre properties. Genotype IS-376-9-68-2 exhibited highest seed cotton yield (1643.97 kg/ha) and staple length of 26.40 mm with 36.50% ginning outturn. The genotype IS-376-4-1-30-12 (26.40 mm) and IS-376-4-1-2-29 (25.02 mm) exhibited superior mean staple length over check NH-545 (24.14 mm). Important contribution of Cotton Research Station, Nanded is development of introgressed strain (IS-376-4-1-14-21), which is registered at NBPGR-New Delhi with INGR-NO. 04106 Dt. 23 December, 2004. An Important characteristic of this strain is resistant to sucking pest complex.

### 1.45

## Identification of sources of resistance against biotic and abiotic stresses and fibre properties in interspecific derivatives of cotton

### S. S. BHATADE, D. B. DEOSARKAR AND A. R. GAIKWAD

Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Screening of seventy four segregating population derived form interspecific crosses were done at Cotton Research Station, Nanded for yield, fibre properties, biotic and abiotic stresses during the year 2006-07. Fourty three single plant selections were made on the basis of good plant type having more no. of bolls and sympodial branches, seed cotton yield, boll weight, ginning outturn, fibre length and tolerance to various biotic and abiotic stresses at field level. The segregating population of the cross Abhadita x Surat – 4 exhibited highest seed cotton yield (68.16 g/plant) with high GOT (39.15%) followed by the genotypes TCHH-101104 (62.12 g/plant) seed cotton yield with 37.55% ginning outturn. The highest fibre length was observed in entry

TCHH-35102 (30.5 mm) followed by the cross LK-861 x H-96 (29.5 mm). The wide variation for boll weight was observed in populations viz., NISC-37 and IGMA-12 (3.15 to 4.20 g/boll).

### 1.46

## Evaluation of tetraploid cotton genotypes for ginning outturn and fibre quality

### A. R. GAIKWAD, D. B. DEOSARKAR AND S. S. BHATADE

Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Evaluation of twenty three tetraploid genotypes with two checks were carried out at Cotton Research Station , Nanded during 2007-08. The genotypes depicted significant differences for seed cotton yield and ranged from 522 to 1459 kg/ha. Two strains namely NH-630 (1459 kg/ha) and TCHH-58111 (1391 kg/ha) recorded significantly highest seed cotton yield over local check NH-545 (1070 kg/ha). The percentage in seed cotton yield over the check was to the tune of 36 to 30 percent respectively. High yielding strains namely NH-630 (560 kg/ha) and TCHH-58111 (479 kg/ha) recorded superior performance for lint yield. A range of 30.29 to 39.40 % was observed for ginning outturn. NH-545 recorded the highest ginning outturn (39.40 %) followed by NH-630 (38.40%) and NH-615 (38.20%). Mean halo length of different strains ranged from 22 to 30 mm. The strains NH-615, CCHL-S-4, GSHV-154 andNH-630 recorded superior halo length (29 to 30 mm) as against the check NH-545 (2.6 mm). The strains TCHH-58112 and TCHH-5199 (28.5 mm) and P-21-15 (28 mm) also showed good fibre length.

### 1.47

### Cotton ideotype breeding in the *Bt era:* an exercise in varieties and hybrids

### RAJESH S. PATIL, GURURAJ, YASHWANTH KUMAR K. J, B. R. PATIL, S. S. PATIL AND B. M. KHADI

University of Agricultural Science, Dharwad-580 007

A rethink on the cotton ideotype is now necessary as there is enough preliminary evidence showing increased productivity under dense planting of compact genotypes and hybrids. The present paper deals with the characterization of the cotton plant and its morphological behaviour under varying spatial accomodation. A simple but effective methodology adopted to categorise the plant type has been outlined. The initial study characterized 32 genotypes into two classes i.e., compact and robust types based on the height and diameter of the plant. The productivity of these genotypes was assessed under three population densities and it was seen that compact types out yielded the robust types. The increase in yield of compacts over increasing densities of planting was higher than in the robusts pointing towards the better adaptability of the compact plant type to closer spacings. In the backdrop of the current cotton scenario where hybrids predominate, the need to extend the ideotype concept to hybrids was felt. In a further refinement of the categorization methodology a set of 33 experimental hybrids were characterized into four plant types, one robust and three compact classes. Ten hybrids were robust and the rest were in the three compact classes. An almost equal number of hybrids out of the 33 fell into two yield categories, high and low. Only one hybrid (TCH-1705 x RCR-4) was super compact and notably, a high yielder. The lone Bt hybrid check was a compact but had the lowest yield. It can be concluded that a denser population, even of hybrids, than the one adopted in this single environment study could increase the productivity as evidenced by the previous multi-environment experiment. The study also proves that compact hybrids can be successful. And with the new public domain Bt event now available, the cost involved in the increased seed rate for denser plantings of compact Bt hybrids' seed would also come down. Good compact hybrids can be converted into Bt versions making cotton cultivation remunerative. The dynamics of the heterosis phenomenon for yield contributing traits need to be studied specifically in the compact plant type background. With the advantage of reduced height coupled with synchronous maturity in the compact ideotype, mechanization of cotton cultivation can become a reality in India.

### 1.48 Quality paramezters of *Bt* cotton

#### CHITRANAYAK AND D. N. MAKWANA Central Institute of Research on Cotton Technology, Mumbai-400 019

Bt Cotton is the first genetically modified crop which guards it from the bollworm infestation. In India, Bt cotton cultivation was introduced during 2002 and 2005 in south and north regions respectively. It took nearly six to seven years in introducing and permitting the Bt cotton cultivation in India on the commercial level at larger scale. During this period the cotton researchers and breeders have been conducting several tests and producing data on agronomy, environmental and biosafety. The trials conducted on the ecology aspects of Bt cotton prior to its commercialization actually established the superior performance shown by rise in production, productivity as well as reduction in pesticides requirement. Every year AICCIP-Fibre Testing section of CIRCOT, Mumbai conducts the testing of quality parameters of Bt as well as other cotton samples received from the cotton samples received are measured by using the High Volume Instrument (HVI) operated in the ICC mode. All the fibre quality data have been simultaneously compared with the standard CIRCOT fibre quality norms for the release of the varieties.

### 1.49

## Identification of suitable *Bt* cotton hybrids under rainfed condition of Marathwada region

### D. S. PHAD, S. S. BHATADE AND D. B. DEOSARKAR

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

In order to identify suitable Bt cotton hybrids for Marathwada region, study was carried out to asses the yield performance of approved Bt cotton hybrids. Yield potential of approved Bt cotton hybrids under rainfed condition was assessed at Cotton Research Station, Nanded during Kharif season of 2007 - 08 and 2008 - 09 with an objective to identify suitable Bt cotton hybrids for Marathwada region. Pooled data revealed that Bt cotton hybrids viz; MRC 7301 BG II (2094.83 Kg/ha) and Ajeet 11 BG II (1927.58 Kg/ha) recorded highest seed cotton yield with significant superiority over checks, Ankur 651 BG I and NHH 44 (Non Bt). These hybrids also depicted superior fibre quality. Considering agro-climatic conditions of Marathwada region, Bt cotton hybrids viz; MRC 7301 BG II, Ajeet 11 BG II, NCS 145 BG I (Bunny BG I), NCS 954 BG I, NCS 207 BG II, MRC 6301 BG I, RCH 144 BG I, RCH 386 BG I, SP 504 BG I and NCS 929 BG I will prove helpful to farmers to get the maximum yield.

### 1.50

## To judge efficacy of *Bt* biozyme on *Bt* cotton with special reference to yield and yield contributing characters under rainfed condition

### LEKHARAM JATAV, H. C. SINGHAL AND P. P. SHASTRY Main Cotton Research Centre, B.M. College of Agriculture, Khandwa-450 001

Field experiment was conducted with an object to find out to judge efficacy of Bt Biozyme on Bt cotton with special reference to yield and yield contributing characters under rainfed condition during 2007-08 and 2008-09 at Main Cotton Research Centre, Khandwa (M.P.).The result clearly indicated that incorporation of Bt Biozyme granules in soil at the rate of 8 kg/ acre 25 DAS followed by two sprays of Bt Biozyme liquid formulation (40 & 70 DAS) has a positive and significant impact on the growth and yield of Bt cotton hybrids.

### 1.51 Analysis of adaptability and stability of *Gossypium hirsutum* L. genotypes in rainfed vertisols

### K. VENKATA SIVA REDDY, S. RATNA KUMARI, A. SUBBARAMI REDDY AND M. GOPINATH Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam, Guntur-522 034

Cotton is the first most important fibre crop in Andhra Pradesh. It is grown mostly as rainfed crop in vertisols. The crop is sown usually sown from June to August as a rainfed crop. There is a need for identifying suitable high yielding genotypes adaptable to vertisols. In view of this eight genotypes were evaluated for their performance in rainfed vertisols for three years. The uniqueness of the rainfed environment which varies with year to year was taken as advantage and Additive Main Effect and Multiplicative Interaction (AMMI) analysis was used to understand the complex genotype x environment (GE) interactions. The most desirable genotypes for selection of both stability and high seed cotton yield were genotype 801, followed by genotypes L 770 and L 818.

### 1.52

### G x E interaction in introgressed under abiotic stress

### K. G. PATEL, RITA. B. PATEL, MADHU .I. PATEL, V. KUMAR, G. S. PATEL AND J. S. PATEL

### Navsari Agricultural University, Main Cotton Research Station, Surat-395 007

Stability analysis was carried out using introgressed materials of tetraploid as well as diploid cotton to study the genotypes x locations interaction for seed cotton yield and its component traits for their evaluation in rainfed condition. The variance due to genotypes, locations and genotypes x locations were significant for all the characters. Both the linear and non linear components were found significant. Simultaneous consideration of all the parameters of stability revealed that the genotypes SRIS-10 were found stable for seed cotton yield. For ginning percentage, SRIS-2 found stable, for lint index, SRIS-2, SRIS-3 and SRIS-10 were found stable.

### 1.53 Cotton seed production *vis-a-vis* requirement in Harvana

### **D. S. NEHRA**

### CCS Haryana Agricultural University, Hisar-125 004

Cotton is a cash crop of Haryana and uptil no comodity has been able to replace cotton in kharif season. During 2006-07, 4.78.lakh hectare area was under cultivation with productivity of 569 kg/ha. An effective maintenance of nucleus and breeder seed production programme was undertaken at Haryana Agricultural University, Hisar. During 2006-07 the seed production was taken up taking into consideration of indents for varieties HS 6, H 1098, H 1117, H 1226, H 974, HD 123 and HD 324. The University is able to meet the demands of the government agencies but not that of private seed companies.

### 1.54

## Identification of suitable *Bt* cotton hybrids for Punjab conditions to get maximum yields

### R. S SOHU, P. S. SEKHON, R. S SARLACH, P. S. SHERA AND INDERPREET DHALIWAL

### Punjab Agricultural University, Ludhiana-141004

Eight Bt cotton hybrids (RCH 308, RCH 314, MRC 6025, MRC 6029, NCS 138, NCS 913, JKCH 1947 and NECH 6) were evaluated along with the check Bt hybrid RCH 134 in the breeding trial (protected) as well as in entomological trial (under unprotected condition) at Ludhiana centre on light sandy loam soils. Among these

RCH 314 recorded the highest seed cotton yield (3620 kg/ha) followed by MRC 6029 (3497 kg/ha) and RCH 134 (3429 kg/ha) under protected conditions. The early maturing short compact hybrid MRC 6025 gave the lowest mean seed cotton yield of 1541 kg/ha. JKCH 1947 and NCS 913 also recorded comparatively lower yields 2645 kg/ha and 2659 kg/ha, respectively. Similarly under unprotected conditions, though all the Bt hybrids gave comparatively less yield than under protected conditions but NCS 913 and JKCH 1947 gave significantly lower yields 1858 kg/ha and 1767 kg/ha, respectively as compared to the yield levels under protected conditions. The early maturing short compact hybrids (NCS 913, MRC 6025 and JKCH 1947) recorded high incidence of boll rot and para wilt. NCS 913 recorded good boll weight (3.8g) and very good fibre properties but it has the highest percentage of boll rot (26.6%) and para wilt (40.3%). It is suggested that breeders should develop the Bt hybrids, which belong to medium maturity group (165-185 days) having 2-3 monopods per plant and 140-155cm-plant height especially for light soils.

### 1.55

## Developing enhanced cotton lines as good indicators of agronomic base for producing superior transgenics in *hirsutums*

#### T. R. LOKNATHAN, V. V. SINGH AND PRAFULLA RAUT Central Institute for Cotton Research, Nagpur-440 010

There has been a great surge in the development of superior cotton varieties and hybrids in *G* .*hirsutums* catering to all three cotton growing zones. Some of the best hybrids went into diverse conversion programmes mostly by the concerted efforts of Private sector and whole series of Bt hybrids both Bollgard I and Bollgard II They became popular and widespread more so in irrigated areas. The hybrids bore a restricted genetic base though they gave marked increase in yield levels against conventional genotypes. In order to better the existing agronomic base an ambitious programme on Genetic enhancement in cotton was mooted wherein new and unadapted germplasm was included as donors to improve yield, fibre quality and resistance to biotic and abiotic stresses. Also there has been a shift in yield and other components already existing in elite well adapted cultivars. Some of the superior enhanced populations developed through backcross breeding and incorporation for e.g. PKV 081 has increased in boll wt upto 3.8 g and yield levels above 2000 kg/ha and also in case of LRA -5166 there has been improvement in sucking pest resistance. It appears we have to shift to better improved potential agronomic bases to sustain higher yield levels even under rainfed situations. This could be a new beginning to the existing transgenic conversion programme covering only the prevalent popular hirsutum hybrids.

### 1.56

## Development and promotion of medium and long linted *G. arboriums* under rainfed situations

#### T. R. LOKNATHAN, S. K. VERMA, V. V. SINGH, PRAFULLA RAUT AND PRANJALI DESHMUKH Central Institute for Cotton Research, Nagpur-440 010

In fact transgenic development in diploids is yet to make headway since it is yet to enter large scale trials. However, there has been a tremendous improvement in desi cottons for medium and long linted characteristics. It has touched 28 mm length and above with strength of more than 24 g /tex and above. This includes both introgressed material and improvement of pure *arboreums* per se. A couple of cultivars holds a promising value of 3.8 micronnaire with long staple and high strength. The *arboreums* have touched yield levels upto 2200 kg/ha under rainfed situation. With resistance to wide array of pests and diseases and drought tolerance they can hold great promise under dryland or drought conditions. We can exercise the option of combining Bt and drought tolerant genes and bringing those genes under diverse diploid elite material possessing enhanced fibre quality traits, better fibre length, fibre strength and micronnaire . Diploid transgenic breeding would be more instrumental if promotion of enhanced diploids gains momentum. Also this could be alternative to transgenic hybrids making rapid strides in high inputzones.

### BIOTECHNOLOGY

### 1.57 Plant regeneration and shoot tip proliferation in different cultivars of cotton

### B. N. CHINCHANE, S. B. NANDESHWAR, AND V. N. CHINCHANE Marathwada Agricultural University, Parbhani-431 402

Regeneration from different cells and tissues is most important aspect for efficient transformation procedure. Present experiments were conducted to optimize the conditions for plant regeneration and shoot tip proliferation in four cultivars PA-183, PA-402, PA-255 and PH-348 of cotton. Embryogenic calli were initiated from hypocotyls and cotyledonary node explants on MS based callus induction media containing sucrose and maltose as carbon sources and auxins like NAA or 2,4-D and cytokinin like kinetin, zeatin or TDZ. The callus induction frequency varied from 29.5 to 82.1 % depending upon the genotypes, explants and constituents of medium. Plants were regenerated on MS based medium containing 0.1-0.3 mg/l zeatin, 1-1.6% sucrose or maltose or MS + 3-6mg/l zip, 0.1 mg/l NAA and sucrose or maltose from 6-9 days old calli Maximum shoot regeneration frequency was observed in PH-348 (4.1%) followed by PA-255 (3.6%), PA-402 (2.9%) and PA-183 (2.2%). For shoot tip proliferation, shoot tips of different genotypes were cultured on medium containing different concentrations of auxin, cytokinin and gibberellin. Highest frequency of shoot tip proliferation was obtained in cultivars PA-255 (71.2%) followed by PH-348 (64.00%), PA-402 (56.87%) and PA-183(43.9%).

### 1.58

### Study of micro propagation in cotton

### B. N. CHINCHANE, S. B. NANDESHWAR AND L. A. DESHPANDE Marathwada Agricultural University, Parbhani-431 402

Improvement in cotton was made only by utilizing conventional breeding methods like, selection, hybridization, polyploidy, mutation, etc., Tissue culture techniques have shown a way to overcome the species barriers and to develop cotton genotypes with character transformed from wild species. It can also be helpful in commercial multiplication of varieties to maintain the genetic purity, for collection and storage of germplasm and genetic transformation. The success of this technique depends upon response of different genotypes to micropropogation at various levels of growth regulators for multiple shoot and root induction. The response of any growth hormone depends greatly upon the indigenous levels of these growth regulator in the explants used for initiation of growth culture. The present investigations were carried out to study response of different cultivar of cotton for micro propagation through shoot tip culture at different levels of growth regulators using cultivars, PA - 402 and PA 255 (Gossypium arboreum). Shoot tip explants from both of the cultivars were inoculated in MS media supplemented with different concentration of BAP (Benzyl Amino Purine) 0.5, 1.0 and 2.0 mg/l. Multiple shoot induction was observed in both these cultivars but differences were observed for various parameters studied for shoot initiation and proliferation. In PA - 255, initiation of multiple shoot was observed in 26.81 days while PA – 402 required 28.56 days. Similarly, numbers of shoots and shoot length were more in PA – 255 than PA -402. Less numbers of days were required for root induction in PA -255 (25) as compared to PA - 402 (27) at different concentration of NAA. This shows that the former variety gave more positive response than the latter for micropropogation at the same concentration of growth regulators. Both cultivars showed great difference in response to shoot initiation, number of multiple shoots and number of shoot. It is thus important to have a separate protocol with optimum concentrations of growth regulators for each genotype as per their response to micropropogation.

### 1.59

## Molecular characterization of cotton (Gossypium sp.) cultivars using PCR-based molecular markers

#### A. A. BHAROSE, A.L.TAMBE, D.B. DEOSARKAR, GAIKWAD A.R. AND F.S.PATIL Marathwada Agricultural University, Parbhani-431401

The presented study attempted to evaluate genetic diversity among G. arboreum and G. hirsutum and also within cultivars of some species. Two markers system was used to assess genetic diversity. It included 8 ISSR and 4 SSR or Microsatellite primers. Dendrogram obtained by ISSR marker showed similarity coefficient values in the range of 0.298 to 0.854 between G. hisrsutum and G. arboreum and SSR markers showed similarity coefficient value in the range of 0.181 to 0.818 between G. hirsutum and G. arboreum. Two cotton hybrids PHH-316 and NHH-44 among the cultivars showed highest similarity with their female parents PH-93 and BN-1, respectively. In the ISSR marker analysis BN-1 and NHH-44 showed highest similarity of 85.4 percent and cultivars belonging to two different species *i.e.* G. arboreum and G. hirsutum showed least similarity of 29.8 percent. In SSR markers analysis, PA-405 and PA-08 showed highest similarity of 81.8 percent and cultivars belonged to two different species showed least similarity of 18.3 percent. The dendrogram generated by both ISSR and SSR markers showed two clusters of the cultivars, which belonged to two different species. ISSR and Microsatellite or SSR marker method effectively classify the cultivars belonging to two different species of genus Gossypium. Grouping results from cluster analysis based on NTSYS-pc showed that the cultivars chosen had narrow genetic variation to a considerable extent. The cultivars with distinct DNA profiles provided useful information for selection of parents to develop new cotton hybrids. ISSR primer IS-5 generated maximum number of amplicons *i.e.* fourteen and IS-3 primer showed highest polymorphism *i.e.* 80 percent. ISSR primer IS-12 generated minimum number of polymorphic bands (four) and showed only 50 percent polymorphism. SSR primer JESPR-14 generated maximum number of polymorphic bands *i.e.* eight and showed highest 72.72 percent polymorphism. SSR primer JESPR-24 generated least polymorphic bands and showed least 50 percent polymorphisms.

### 1.60

## Genetic diversity in *intra*-specific *desi* cotton (*G. arboreum*) through DNA marker

### D. B. DEOSARKAR, V. K. GUPTA AND A. R. GAIKWAD

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

In the present investigation random amplified polymorphism DNA (RAPD) markers were used to study the DNA polymorphism and molecular diversity of 20 genotypes. A total of 9 RAPD primers were used for amplification of genotypic DNA of 20 genotypes, using these RAPD primers yielded 71 fragments that could be scored of which 59 were polymorphic. Percentage polymorphism ranged from 33.33% to 100% across all genotypes with an average of 83.33%. The dendrogram was obtained from UPGMA method of cluster analysis using dice similarity matrix through NT-SYS PC software. The genotypes were broadly clustered in four groups viz., group I, II, III and IV. Group-I have genotypes belonging to crosses and their parents, remaining having different lines. Cluster A, form a subcluster 'a' of crosses and their parents was comparable at similarity coefficient 0.89. Another subcluster 'b' of MDL 2582 and ZC (AKA-7) were similar at the coefficient value of 0.82. Both subcluster 'a' and 'b' were similar at 0.70. In the second main cluster 'b' sub cluster a (PA 402, CINA-343, GAM-115, GAM-141) was similar at 0.86. The main cluster A and B showed similarity coefficient 0.70 i.e. they are 30% genetically diverse. The first genetic diverse group comprises of cross H1, H2, H3, PA-255, G COT-19, AH-65, PA-405, PAIG-8/1. Less genetic diversity was recorded by cross H2, PA-405 (0.5%) and PA-255, AH-65 and MDL 2582 (12%) whereas, cross H2 were diverse from their female parent (PA-405) by 5% while cross H1 10% diverse from their female parent PAIG-8/1 and cross H3 were 5% diverse from their female parent PA-255. Four primers (OPA-6, OPC-7, OPD-7, OPD-11) with higher value of market index (MI) were found to be best suited for fingerprinting of cotton germplasm. The combination of any two of these four primers are sufficient to allow differentiation of all 20 genotypes under study. Present investigation on genetic diversity analysis in desi cotton germplasm reconfirmed that RAPD technique is useful in area of genetic diversity analysis. As the need to protect proprietary germplasm is likely to increase in the future.

### 1.61 Variation in ä-endotoxin expression of *Bacillus thuringiensis* var *kurstaki* with nitrogen fertility and planting dates

### MANPREET KAUR AND A. K. DHAWAN

#### Punjab Agricultural University, Ludhiana-141 004

Nitrogen is widely considered as one of the major essential nutrients for plant growth and nitrogen is essential for C flow and protein synthesis of higher plants. Deficiency of N interfere with protein synthesis as it is the constiuent of proteins, purines, pyrimidines and many other coenzymes. Earlier study on Bollgard RCH 134 indicates that increase in nitrogen doses enhanced the expression of Cry1Ac. An experiment was carried out to study the effect of nitrogen doses and planting dates on different plant parts viz. leaves, squares and bolls of Bollgard II MRC 7031 genotype. Crop was sown during different sowing dates viz. 15th April, 1st May and 15th May with different nitrogen doses viz. recommended (150 kg/ha), 1.5 times recommended (220 kg/ha), 2.0 times recommended (300 kg/ha) and control (no fertilizer dose) under each sowing date in RBD design having 10×8 m<sup>2</sup> plot size with three replications at Entomological Farm, Punjab Agriculture University, Ludhiana. The expression of Cry1Ac and Cry2Ab was estimated by using separates kits of ENVIROLIGIX 500 Riverside industrial parkway port land marine U.S.A (Amar Immunodiagnostic Hyderabad) as per protocol under IRM Laboratory, Punjab Agricultural University, Ludhiana. The results of above studies revealed that in different sowing dates, the expression of Cry1Ac was maximum in late sown crop at 200 kg/ha  $(4.44\mu g/g)$  in leaves,  $(4.30 \ \mu g/g)$  in squares and  $(4.17 \ \mu g/g)$  in bolls. Similarly, when the expression of Cry2Ab was observed during different sowing dates, again the expression was maximum in late sown crop at 300kg/ha  $(19.41 \ \mu g \ /g)$  in leaves,  $(21.14 \ \mu g \ /g)$  in squares,  $(20.91 \ \mu g \ /g)$  in bolls. But the variable trend of expression of both toxins was observed at 220 kg/ha and 300 kg/ha. The expression was significantly low at other two sowing dates. Expression of Cry1Ac was maximum in leaves followed by squares and bolls while that of Cry2Ab was maximum in squares followed by bolls and leaves. The expression of Cry2Ab was 3 to 6 times more than Cry1Ac. Bt endotoxin levels in cotton planted during early April were 14 per cent lower than planted in early May, presumably due to remobilization of the leaf N to support the larger developing boll load in the early April planted cotton. Nitrogen level enhanced the expression of toxin and was more in late sown crop than in early sown crop. They also observed that additional nitrogen 27.22 kg/ha elevated the Bt endotoxin expression 12 per cent relative to treatments that only received 18.14 kg/ha nitrogen

### 1.62

### Development of cotton transgenic's with Antisense *rep* gene for resistance against leaf curl virus

### J. AMUDHA, G. BALASUBRAMANI, S. RENUKA AND V. G. MALATHI Central Institute of Cotton Research, Nagpur-440 010

Cotton is an important source of fiber, feed and edible oil. India is the world's second largest cotton producer. Most important constraint in cotton production is susceptibility of this crop to insect and pests. Cotton leaf Curl Virus Disease (CLCUD) is one of the major threats' for cotton production and has emerged as serious disease of cotton in North India. Gemini viruses can cause significant yield losses and they accumulate in the plant cell nuclei where they replicate and develop disease. The monopartite begomovirus causing cotton leaf curl disease has DNA A and DNA â. DNA A codes for AV 1 (Coat Protein), AV 2 (Movement Protein), AC 1 and AC 4 (Replicase initiation protein), AC 2 (Transcription Activator Protein), AC 3 (Replicase Enhancer protein). The presence of DNA â enhances the development of the disease. Genetic engineering plays a major role in improving the crop by introducing genes of our interest. Antisense RNA is actually a part of complex natural pathways for gene regulation by homology dependent gene silencing mechanisms where sense transcripts are able to silence gene expression. The antisense RNA pairs with the complimentary target mRNA and would inhibit the expression of homologous genes by degrading the target mRNA and prevents translation. Cotton transgenics resistant to leaf curl disease (CLCuD) using Antisense *rep* (Replicase protein) gene was

developed via Agrobacterium-mediated and pollen tube pathway transformation. A binary vector carrying the Antisense rep gene along with the *npt* II (neomycin phosphotransferase) gene driven by CaMV-35S promoter and Nos terminator was used for transformation in three genetypes HS6, H777 and F846. The presence of the *rep* and *npt 11* genes in the transgenic plants were verified by PCR and integration of T-DNA into the plant genome was confirmed by specific gene primers. PCR amplification of the *rep* and *npt 11* gene using specific primers was carried out to check the presence of the transgenes, the *rep* specific primer (5'-3') ATG CCA CGT GAT TTA AAA ACA and GTG GGG AGA GTT TCA GAT CG and *npt 11* specific primer GAG GCT AATTCG GCT ATG ACT G and ATC GGG AGA GGC GAT ACC GTA. T1 plants were raised in the pot and they were tested for the presence of Antisense *rep* gene. Antisense based resistance transgenic plant with the rep gene will arrest the replication of the invading viral genome by targeting the complementary mRNA produced by the plant. Cotton transgenics obtained in the present study pave the way to develop virus resistance in a recalcitrant system like cotton.

### 1.63

### PCR based detection of *Bt* cotton

### V. PRATHAP REDDY, I. N. BHEEMALINGESWARA REDDY, A. RAVI CHARAN Y. VENKATESWARLU, S. SIVARAMAKRISHNAN

#### Acharya N. G. Ranga Agricultural University, Hyderabad-500030

Cotton crop requires an intensive use of pesticides to control the various types of pests that cause extensive damage. Over the past 40 years, many pests have also developed resistance to pesticides. The only successful approach to engineering crops for insect tolerance has been the addition of Bt toxin, a family of toxins originally derived from soil bacteria (Bacillus thuringiensis). The bacterial gene cry 1A(c) introduced genetically into the cotton, protects the plants from bollworm (A. lepidoptora), a major pest of cotton. The worm feeding on the leaves of Bt cotton plant becomes lethargic and is killed, thereby causing less/ no damage to the plant. With the growing demand for Bt cotton seeds and the high price fixed compared to non Bt cotton it is very likely that there could be contamination of Bt seeds. The spurious and unapproved GM planting material has contributed to crop failures and commercial losses. To ensure effective and genuine GM cultivation, a methodology is needed to detect and identify the trait of interest and concurrently evaluate the structural and functional stability of the transgene insert. There are many methods to detect Bt cotton like dip stick, ELISA and PCR. A polymerase chain reaction (PCR) approach has been developed for detection of cry 1 A(c) gene in cotton. Eight cry gene specific primers were designed from the sequences available in NCBI data base. Of the primers designed ABT-1 primer could differentiate Bt cotton from non-Bt showing amplification of 1.2 Kb band in Bt cotton and no amplification in non-Bt. Seven Bt cotton samples brought from different farmers fields of A.P were tested with these primers and the 1.2 Kb fragment could be seen in all Bt cotton hybrids. We also carried out Southern blot analysis of the different Bt cotton hybrids using the 1.2 kb DNA fragment as the probe.

### 1.64

### A biolistic approach for DNA delivery into embryonic axes of cotton (Gossypium hirsutum L.) cultivars

### A. B. DONGRE, MAMTA RAUT, LALIT KHARVIKAR, NAMRATA JATAP, KSHANADA MESHRAM

Central Institute for Cotton Research, Nagpur-440010

A simple, reliable, efficient, and much less laborious protocol for cotton transformation is described. Bt toxin gene, cry I A(c) under the control of CaMV 35S promoter and the npt-II gene as selectable marker is used for

transformation of cotton c.v. NH 545. The embryonic axes explants were bombarded at various parameters of pressure and distance and an incubation period at 28°C for 2 days after bombardment was provided on MS medium supplemented with BAP (3 mg/l). Selection for transformed embryonic axes was conducted on MS medium containing 100-mg/l kanamycin supplemented with BAP alone as well as paired with kinetin and NAA after 15 days. A maximum regeneration frequency of 25.92% was achieved on selection medium (100 mg/l kanamycin) when explants were bombarded with 900 psi at 6 and/or 9 cm distance and co-cultured on MS medium supplemented with BAP (1.6 mg/l) and Kinetin (0.4 mg/l) but no NAA. The presence of transgene was detected by polymerase chain reaction (PCR) analysis. Overall 2.67 % of the 112 plantlets, those survived selection, were shown to be transformed. Three transgene integrated cotton plantlets were recovered from 432 bombarded explants. Hence, the transformation frequency achieved through this method of transformation was 0.69%.

### 1.65

### Genetic purity testing of parents and hybrids revealed by molecular markers

### A. B. DONGRE, MAMTA RAUT, MANOJ BHANDARKAR

#### Central Institute for Cotton Research, Nagpur-440010

Three Hybrids Savitha, Surva, Shruthi along with their parents T 7 (Female) X M 12 (Male), T13 (Female) X M 12 (Male), 70E (Female) X RSP 4 (Male) respectively were analyzed for the development of markers, identification of Hybrids and ascertaining genetic purity using PCR based DNA Markers, 40 RAPD primers were used for the identification of F1 hybrids and their parents. Out of 40 primers used for Surva only four primers viz. OPA 5, OPA 15, OPB 2 and OPA 8 were showed distinct characteristics for identification of Hybrids and parents. Unique bands such as 450 bp band of OPA 5, 1100 bp and 600 bp band of OPA 15, 1100 and 400 bp band of OPB 2. 2kb and 550 bp band of OPA 8 were found to be specific for hybrid and female but absent in male. For Savitha, 750 bp band of OPA 11 is specific for hybrid and female but absent in male. OPA 5, OPA 13, OPB 1, OPB 2, OPB 14, OPA 9 were found to be polymorphic primers for Shruthi. 450 bp band of OPA 5, 500 bp band of OPB 1, 1100 bp and 400 bp band of OPB 2, 2 kb band of OPA 9 is only present in Male and hybrid but absent in Female. OPA 13 was found to be the perfect marker of Shruthi in which 500 bp band present in Hybrid and Female but absent in Male. 900 bp and 2000 bp band present in Male and Hybrid but absent in Female. Similarly, OPB 14 was found to the perfect marker in which 800 bp band found only in Hybrid and Female but absent in Male while 250 bp band is specific for Male and Hybrid but absent in Female. This proves the hybridity of Shruthi. 12 ISSR primers were used for the identification of F1 hybrids and their parents. IS 1, IS 2, IS 3, IS 4, IS 10 were found to be polymorphic. IS 10 is found to be the perfect marker in Surva in which 700 bp band is present in Male and Hybrid but absent in Female while 1200 bp band is only present in Hybrid and Female. 800 bp band of IS 3, 900 bp and 1700 bp band of IS 2, 1500 bp band of IS 4, 1900 bp band of IS 10 is specific for only Hybrid and Female but absent in Male. For Shruthi 700 bp band of IS 1, 1800 bp band of IS 3 and 1500 bp band of IS 4 is specific only for Male and Hybrid but absent in Female. IS 2 is found to be the perfect marker for Shruthi. 700 bp and 600 bp band is present only in Male and Hybrid while 1800 bp band present only in Hybrid and Female. Molecular finger print of the hybrid and parents serve as a document to protect from infringement of the parental line and checking spurious seeds in the market.

### **1.66** Molecular characterization of tetraploid cotton (*G. hirsutum*) by using PCR based RAPD and ISSR markers

### MAMTA RAUT, A. B. DONGRE, PUNIT MOHAN, KRISHNA MUNNE, NAMRATA JATAP, KSHANADA MESHRAM

#### Central Institute for Cotton Research, Nagpur-440 010

Twenty-four selected working germplasm of G. hirsutum (four of Boll weight group, two of Boll weight exotic cultivars group, seven of Ginning percentage group, two of Ginning percentage exotic cultivars group, four of Mean hallow length group and five of okra leaf structure group) were analyzed for genetic diversity, phylogenetic relationship and Molecular identity using PCR based Randomly amplified Polymorphic DNA (RAPD) and Inter Simple Sequence Repeat (ISSR) markers. Twenty selected RAPD primers were used which generated total 166 amplification products, among which 71 were found to be polymorphic with an average of 8.3 bands per primer. This resulted in 46.50% polymorphism whereas nineteen selected ISSR primers were used which generated total 198 amplification products, among which 83 were found to be polymorphic with an average of 10.42 bands per primer. This resulted in 42.55% polymorphism. The Similarity Coefficient of dendrogram calculated by RAPD and ISSR markers were found to be 0.86-0.96 and 0.82-0.97 respectively. The UPGMA clustering pattern using RAPD Markers showed GP-EC-13780 (France) emerged out to be the most distinct and GP-2557 (Coimbatore) emerged out to be the most distinct in ISSR with bootstrap support of 100%. The average genetic similarity values among the G. hirsutum by Jaccard's Similarity Coefficient were ranges between 0.58-0.78 in RAPD and 0.13-0.87 in ISSR. PCA plot supported to the dendrogram values gave clear information regarding all accessions spreaded out on all three axis in both RAPD and ISSR. Based on the clustering pattern and genetic relationship obtained from the present study, cotton germplasm which were less close genetically or which showed low similarity Coefficient or with distinct DNA profiles may be utilized in cotton breeding for development of promising germplasm or hybrids and for the selection of parents.

### 1.67 Development of insect resistance transgenic diploid cotton

### S. B. NANDESHWAR, VIDHI BHATNAGAR, MITHILA MESHRAM, P. K. CHAKRABARTY AND KESHAV KRANTHI

#### Central Institute for Cotton Research, Nagpur-440 010

Cotton is an important source of fiber, cattle feed and edible oil. Lint is the most economically important product which provides a source of high quality fiber for the textile industry. The genus Gossypium contains about 52 diverse species, out of which four are under commercial cultivation i.e G.hirsutum, G.arboreum, G.barbadense and G.herbeceum. With the introduction of Bt technology, the productivity of cotton specially G.hirsutum has enhanced to 560 kg lint/ha during 2007. Diploid cottons G.arboreum are cultivated on 20% of the area and the cultivars belonging to this cotton species are comparable with that of G. hirsutum cultivars owning to their high yielding potentiality, drought tolerance and long fibre. The present study aimed to develop transgenic diploid cottons by incorporating insect resistance gene (Cry I Ac, Cry I Aa3 and Cry I F) by mediating Agrobacterium. For genetic transformation of diploid cotton G.arboreum, promising cvs RG 8 (short staple), PA 255 and PA 402 (long staple) were used. The seven days old shoot tips of in-vitro germinated seedlings of these cultivars were excised and inoculated for 30 minutes with log phase culture of Agrobacterium tumifeciens strain EHA 105 carrying the binary vector pBin Bt for transformation. The vector was obtained from NRCPB, New Delhi. The plasmid harbored the Cry I Ac gene and neomycin phosphotransferase (nptII) gene, each driven by CaMV 35 s promoter. The shoot tip explants were cocultivated for 3-4 days on MS medium supplemented with 100 mg/L myo-inositol, 10 mg/L thiamine, 30 mg/L glucose and 30 mg/L acetosyringone. After co-cultivation, the explants were incubated on MS medium containing 50 mg/L kanamycin to select putative transformants. The explants were then transferred to regeneration medium consisting of MS Basal salts supplemented with kinetin (0.1 mg/L), myo-inositol (100 mg/L), thiamine (10 mg/L) and glucose (30 mg/L) or benzyl adenine, BA (2 mg/L) and kinetin (1 mg/L) to induce either single or multiple putative transformant shoots, respectively. The elongated shoots regenerating directly from shoot tip explants and those differentiated from multiple shoot mass, after their separation, were

transferred to a rooting medium- liquid MS supplemented with 0.05 to 0.1 mg/L NAA and 15 g/L glucose . The rooted plants were acclimatized in liquid MS without harmone followed by their transfer to plastic pots containing soilrite Mix-TC and grown under control temperature and relative humidity condition. The plants were allowed to mature and were confirmed as transgenic for Cry I Ac gene using PCR, ELISA and Southern blot analysis.

### 1.68 Molecular mapping and marker assisted selection (MAS) for fibre quality traits in cotton

#### VIJAY N. WAGHMARE Central Institute for Cotton Research, Nagpur-440 010

Cotton, (Gossypium sp.) the world's leading natural fibre crop, has long been a focus of genetic, systematic and breeding research. Cotton has a wide gene pool, genetic variability largely present in about 45 diploid (2n=2x=26), five allotetraploid (2n=4x=52) species, land races, germplasm collection and obsolete cultivars. *Gossypium* genome is very complex and has immense genetic potential. Molecular markers are widely being employed in cotton genome mapping to unfold genome structure, evolution, identification of introgression and marker assisted breeding programmes. Several genetic linkage maps of DNA markers using  $F_2$ , DH and backcross populations have been published. A detailed genetic map provide an opportunity for mapping quantitative trait loci (QTLs) and identification of DNA markers associated with traits of economic importance. DNA markers assisted selection (MAS) facilitate breakage of unfavourable linkages and early detection of targeted genes. The closely linked markers also help in identification of recombinants with desirable targeted traits from unstructured population and gene pyramiding. In cotton, MAS has successfully been used for improvement of fibre quality traits. This paper discussed intricacy of fibre quality traits in relation to marker assisted selection and genome-mapping efforts in cotton improvement.

### 1.69

## Genetic diversity analysis of maintainer and restorer lines in upland cotton (Gossypium hirsutum L.)

### DEEPAK R. SAPKAL, SATISH R. SUTAR, PRAJWAL B. THAKRE, B. R. PATIL AND VIJAY N. WAGHMARE

### Central Institute for Cotton Research, Nagpur 440 010

A study was conducted to analyze the genetic diversity amongst 91 cotton genotypes (50 maintainer (B lines), 41 restorer (R lines) using SSR and RAPD markers. The maintainer and restorer genotypes used in the study were developed through conversion and diversification in different genotypic backgrounds. Three wild species viz., G. aridum (D4), G. thurberi (D1) and G. anomalum (B1) were also included to assess the relationship with cultivated genotypes of G. hirsutum (AD1). A total of 53 markers (30 SSR and 23 RAPD primers) were selectively sampled for screening of 94 cotton genotypes of which 26 SSR and 17 RAPD primers produced well resolved bands. A total of 120 amplicons (66.66%) showed polymorphism. SSR markers detected average polymorphism of 72.5% while RAPD markers detected 62% polymorphism. The size of each amplified fragment ranged from 280 to 2300 bp in case of RAPD and 100 to 700 bp by SSR markers. Similarity coefficient values within and between B and R lines ranged from 0.72-0.98, 0.73-0.97 and 0.69-0.98 for RAPD and 0.65-0.95, 0.61-0.98 and 0.53-0.93 for SSR markers. UPGMA cluster analysis independently for SSR and RAPD markers and combined SSR + RAPD data showed correspondence to the large extent in relation to pattern of clustering of B and R lines and it was consistent with the pedigree of the genotypes. RAPD and SSR matrices showed significant positive product moment correlation (r = 0.93 and 0.92, respectively) with the RAPD+SSR combined data matrix. The results indicate that a great deal of genetic diversity is available in studied B and R lines and that SSR and RAPD markers could contribute to the wise use of this diversity for development of productive cotton hybrids and thus in the improvement of cotton productivity and quality.

### **1.70** Comparative assessment of microsatellite and RAPD markers and their efficiency in DNA fingerprinting of upland cotton (*G. hirsutum* L.)

### SATISH R. SUTAR, PRAJWAL B. THAKRE, DEEPAK R. SAPKAL, B. R. PATIL AND VIJAY N. WAGHMARE

### Central Institute for Cotton Research, Nagpur 440 010

This study employs statistical approach to compare the potential of microsatellite (SSR) and RAPD markers in DNA fingerprinting. Twenty four SSR and seventeen RAPD primers were screened across 91 upland cotton genotypes (50 maintainer and 41 restorer lines). Polymorphism information content (PIC), resolving power (Rp) and marker index (MI) were computed and compared for the ability of primers to discriminate among the genotypes. Only polymorphic amplicons of microsatellite and RAPD primers were considered to detect efficiency of markers. PIC values ranged from 0.02 to 0.46 for microsatellite primers and from 0.04 to 0.49 for RAPD primers. Rp and MI values ranged from 0.06 to 1.91 and 0.02 to 1.42 respectively for microsatellites while it ranged from 0.04 to 2.52 and 0.04 to 1.59 for RAPD primers. No significant linear relationship was observed between PIC and the number of genotypes identified ( $r^2=0.10, 0.01$ ) by SSR and RAPD markers. MI of the primers showed excellent linear relationship with number of genotypes identified ( $r^2 = 0.70$  and 0.68) by SSR and RAPD primers than Rp ( $r^2 = 0.65$ , 0.55). Five selected microsatellite primers (BNL-3255, CIR-179, CIR-246, CIR-370 and CIR-411) based on high MI values produced 18 amplicons and discriminate 75 genotypes while five RAPD primers (OPB-01, OPC-09, OPB-07, OPB-03, and OPC-04) based on high MI values produced 22 amplicons and discriminate 83 genotypes. The combine use of five SSR+RAPD primers (BNL-3255, CIR-246 OPB-01, OPC-09 and OPB-03) produced 26 amplicons and discriminated 85 of 91 genotypes, however 24 SSR or 17 RAPD or 24 SSR+ 17 RAPD primers polymorphic data could discriminate 89, 90 and 90 genotypes, respectively. The study indicates that microsatellite / RAPD markers or in combination distinguish almost all genotypes. Average polymorphism produced by SSRs (78.87%) was higher than the RAPD primers (65.95%). Genotype discrimination capacity of SSR markers based on PIC, Rp and MI values were significantly higher than RAPD markers although polymorphic amplicons generated by RAPD primers (3.64 per primer) were higher than the SSR (2.33 per primer). Selection of informative primers based on MI values proved efficient in DNA fingerprinting of upland cotton.

### **CROP PRODUCTION**

### **ORAL PRESENTATIONS**

### 2.1

## Performance of *Bt* cotton based double cropping system in black cotton soils under irrigated conditions

#### E. NARAYANA, D. APARNA, A. SUBBARAMI REDDY AND CH. MALLIKARJUNA RAO Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam farm, Guntur-522 034

A field experiment was conducted during *kharif* and *rabi* seasons of 2007-08 at Regional Agricultural Research Station, Lam to study the production potential and economics of cotton based double cropping system under irrigated conditions.Cotton was cultivated under rainfed whereas the subsequent second crop was taken up with irrigations. Cotton–watermelon + methi sequence gave significantly highest cotton equivalent yield (88.5 q ha<sup>-1</sup>), net monetary returns (Rs 1,05,750) and production use efficiency (30.0 kg ha<sup>-1</sup> day<sup>-1</sup>) followed by cotton – cucumber double cropping system which recorded 71.3 q ha<sup>-1</sup>, with a net return of Rs 91,800. However, the highest BCR of 2.8 was recorded in cotton – sesamum followed by cotton – cucumber (2.41), where sesamum and cucumber being a short duration crops with low cost of cultivation attributed for higher BCR.

### 2.2

## Seed and fibre development of Bunny Bt cotton grown under elevated $CO_2$ atmosphere

#### S. E. S. A. KHADER, N. GOPALAKRISHNAN AND A.H. PRAKASH Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Bunny Bt and non Bt cotton was grown under elevated  $CO_2$  atmosphere of  $650 \pm 50$  ppm maintained in open top chambers to study the seed and fibre development process. Seed development was at slower pace during the initial stages of boll development up to 20 days after anthesis. Plants grown under elevated  $CO_2$  atmosphere accumulated more dry matter and maximum weight was attained by  $40^{th}$  day with 1.70 g per boll compared to 1.58 g per boll in ambient grown control plants. Significant differences were not discernible between Bt and non-Bt version in terms of accumulation of dry matter in the seed. Fibre development also followed the same trend to that of seed development up to 20 days after anthesis in both Bt and non-Bt bunny cotton. By  $40^{th}$  day maximum fibre weight was attained. Plants grown under elevated  $CO_2$  atmosphere were characterized with significantly more fibre of 1.31 per boll compared to 1.04 per boll in control plants. The fibre quality was also superior in fibre taken from plants grown under elevated  $CO_2$  atmosphere in terms of staple length, strength and maturity ratio thereby increasing the fibre quality index.

### 2.3

## Drip fertigation of major, secondary and micronutrients for enhancing the productivity of ELS *Bt* cotton

#### P. NALAYINI, S. PAUL RAJ AND K. SANKARANARAYANAN Central Institute for Cotton Research, Regional Station, Coimbatore -641003

A study in this direction at the Central Institute for Cotton Research, Regional Station, Coimbatore. An' experiment was conducted during 2006-07 and 2007-08 cropping season (August – February) in factorial RBD with three water conservation techniques viz., drip, drip + poly mulch and conventional irrigation along with six fertilization practices to find out the efficient water conservation method and to standardize the optimum

fertilization technique for ELS Bt cotton, RCHB 708. The results revealed that the ELS Bt cotton responded significantly to poly mulch + drip and drip method. Among the water conservation techniques, poly mulch + drip recorded significantly higher seed cotton yield (6732 kg/ha) followed by drip system without poly mulch (5033 kg/ha) as against the lowest seed cotton yield of 4096kg/ha under conventional method. The enhancement in seed cotton yield was 22.8% due to drip and 64.4% due to drip + poly mulching Among the fertilization techniques, application of 100 % of recommended NPK (120: 60: 60 kg/ha, N and K in four equal splits) with either foliar spraying of 0.15 % boron as solubor (twice) during flowering to boll development stages or magnesium sulphate @ 50 kg/ha as drip fertigation were on par with application of either 100 % of recommended NPK with 50kg each of zinc sulphate, magnesium sulphate and foliar spraying of boran 0.15 % as solubor or 75 % of all the above combination. The zero tilled rotation maize, raised after the harvest of cotton also benefited by the drip + poly mulching with 86.6 % higher yield than conventional method.

### 2.4 Drought tolerance studies in cotton genotypes

### D. V. PATIL, D. B. DEOSARKAR AND A. R. GAIKWAD

#### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

A field experiment was conducted under rainfed and irrigated condition at Cotton Research Station, Nanded during 2007-08 to study drought tolerance in twenty cotton genotypes on the basis of various stress indices for yield and yield attributes under irrigated and rainfed conditions. The mean data on performance of different genotypes showed considerable genotypic variation in drought tolerance indices for yield and yield components. The data revealed that the genotypes KH-138, NH-615, PH-1009, Sahana , CSH-7106 recorded highest yield under both irrigated and rainfed condition. Similarly, these genotypes showed high degree of indices for Dry Matter Stability Index (DMSI) , Leaf Area Stability Index (LASI) and yield Stability Index (YSI), with least (< 1.00) Drought Susceptibility Index (S) and also percent reduction in yield under rainfed was to the lower side, indicating their drought tolerance nature. These genotypes may prove useful in breeding programme aimed at drought tolerance. The other genotypes *viz*, GSHV-99/291, HAG-811, GSHV-991 and ARB-815 performed poor in respect of drought tolerance indices and seem to be susceptible for moisture stress.

### 2.5

### Effect of seasonal variation on the seed cotton yield of *Bt* cotton under semiarid condition of northwestern India

### S. K. JALOTA AND G. S. BUTTAR

### Punjab Agriculture University, Ludhiana-141 004

Cotton cultivation in semi arid region of Indian Puniab widely provides livelihood security to millions of marginal and small farmers. But the farmers consider it most risky crop as its yield varies with the season and prices fluctuate in the market. Temporally, its production has increased from 176 lakh bales in 1996-97 and an all time record of 315 lakh bales during 2007-08. This record production became possible only due to the good weather and introduction of Bt cotton hybrids. Due to global warming in future, temperature is likely to increase and may influence the seed cotton yield. Till now information about the effect of temperature on the Bt cotton yield in this region is lacking to generate such information. CropSyst model was used rather than field experimentation as the later is not feasible due to difficulty in controlling /creating variability in weather parameters. The model was customized using the data of crop, soil and weather for an experiment conducted on Bt cotton hybrid RCH 134 during 2005 at Punjab Agriculture University, Regional Station, Bathinda and simulations were made for 15 years 1991-2005. From the simulated results, relationship between temperature and duration of total crop growth period as well as of phenophases (sowing to flowering, flowering to boll formation and boll formation and maturity) and subsequently between duration of phenophases and cotton seed yields were developed. The results indicated that by the increase in temperature from 28 to 32 °C cotton seed vield decreased from 4700to 2300 kg ha<sup>-1</sup> following linear relation with high coefficient of determination (0.97) and the reduction was more during sowing to flowering stage than others. Regarding water relationships, real crop water productivity was more (10.2 kg mm<sup>-1</sup>) than apparent (8.8 kg ha mm)
### 2.6 Root anatomy and ABA profiles in certain cotton genotypes differing in drought tolerance

### P. S. ARJUNKUMAR, H. VIJAYARAGHAVAN AND R. RAVIKESAVAN Tamil Nadu Agricultural University, Coimbatore-641 003

A cross section of 28 cotton genotypes were screened for drought tolerant characteristics based on physiological and biochemical parameters under controlled glass house conditions. The study indicated that the genotypes, JKC 701, JKC 779, AS 2 and MCU 13 showed high level of drought tolerance when compared to Surabhi which was the most susceptible one. Further, these genotypes were subjected to root anatomy and the leaf samples were analysed for ABA profiles in order to find out any relationship of these parameters with respect to drought tolerance nature. The cotton root system develops as a taproot system where the primary root develops into a large taproot which produces smaller, lateral roots and the tissue of cotton root can be categorized into three tissue systems (dermal, ground and vascular). The dermal tissue system consists of only the epidermis. The ground tissue system is composed of the cortex (which includes the endodermis), and the vascular tissue system includes the xylem, phloem and pericycle. In the present study the root anatomy sections of JKC 701 and Surabhi were taken. The size of the ground tissue (i.e. cortex) was minimal in control irrespective of both the genotypes. On the other hand, these cortex tissues were getting enlarged in the case of water stress. The enlargement was noticed maximum in the case of JKC 701 when compared to Surabhi. Hence, it is seen that the enlargement of cortical cells is associated with drought tolerance nature and the relative roles of endodermis and cortex under drought condition require further investigation.Similarly, ABA quantification was done at boll development stage indicated that the tolerant genotype JKC701 recorded a significantly higher accumulation than the susceptible genotype Surabhi. This indicates that ABA accumulation at boll development stage could be used as a factor for drought tolerance.

### 2.7

## Studies on intercropping of Bt-cotton with kharif crops under rainfed conditions

### S. S. HALLIKERI, Y. R. ALADAKATTI, R. A. NANDAGAVI, SHIVAMURTHY, D. B. M. KHADI AND S. S. PATIL

### University of Agricultural Science, Agricultural Research Station, Dharwad Farm, Dharwad-580 007

An experiment was conducted on medium deep black soil to study the performance of Bt-cotton and evaluate the economics on intercropping with different kharif crops under rainfed conditions at Agricultural Research Station, Dharwad, Karnataka. Bt-cotton was intercropped with kharif crops like green gram, soybean, groundnut, coriander, red gram, and beans. Results indicated that there was a beneficial effect of intercropping with green gram, beans or coriander on the growth, productivity and economic advantage over sole cotton. Intercrops like soybean, groundnut, and red gram had a suppression effect on cotton by reducing the accumulation of total dry matter production, number of bolls production per plant, yield per plant and yield per hectare. Hence it can be concluded that Bt-cotton can be better intercropped with green gram (1: 1) in normal planting or in paired row plating with either 3 rows of beans or coriander or 2 rows of green gram between paired row can able to produce on par yield of sole cotton along with intercrop yield for highest gross returns, net returns and B: C ratio. These intercropping systems not only contributed additional yield but also acts as cover crops for moisture conservation and supporting cotton in the later phases for growth and production. WUE can be increased with coriander (1:3) or (1:2) or beans (1:3) or green gram (1:1). Further, fibre quality parameters were altered due to intercropping. Significantly finer fibre, higher tenacity value and elongation fiber percentage were obtained when cotton was intercropped with red gram (normal planting) (4.2) as compared to sole cotton and other intercropping systems under rainfed conditions.

### 2.8 Effect of six different environments on fibre quality of cotton (*Gossypium hirsutum* L.)

### S. K. CHOPRA, JAGMAIL SINGH, RAKESHWAR VERMA AND BABITA CHAUDHARY Indian Agricultural Research Institute, New Delhi-110 012

A field experiment was conduced at research farm of Indian Agricultural Research Institute, N. Delhi during 2007-08 crop season to study the effect of 6 different environments on important fibre quality parameters of G. hirsutum cotton. Crop was planted in split plot design with 3 replications. Six dates of sowing, i.e. February 23, March 19, April 13, May 8, June 2 and June 28, 2007 constituted 6 environments and formed main-plot treatments. Four varieties namely H-1117, P 56-4, P 1752 and RS 2013 formed the sub plot treatments. Fibre quality parameters were evaluated using fully automatic High Volume Instrument (HVI). Significant differences were observed due environments as well as varieties for 2.5% span length, uniformity ratio, fibre strength, elongation%, reflectance, colour and short fibre index. The 2.5% span length did not show many changes due to environments in case of variety H-1117. The remaining three varieties showed higher 2.5% span length when planted on June 2 as compared to other dates. Likewise the uniformity ratio also showed similar changes due to different environments. Showing better uniformity in planting done May 8 as in case of 2.5% span length. Varieties H-1117, P 56-4 and P-1752 showed highest uniformity when planted on May 8. H-1117, which did not show change in fibre length, was found to have highest uniformity all through showing only minor variation. In case of fibre strength the effect due changing environments was quite prominent, especially in high fibre strength strain P 56-4. Fibre strength in general was better when planting was done in the normal period. P 56-4 showed relatively low fibre strength during February to April sowings. Nonetheless, fibre strength was better in April planting in comparison to February and March plantings. It showed high fibre strength in May plantings. These changes were relatively more prominent in P 56-4, which is a strain with high fibre strength. P 56-4 showed strength varying from 22.5 g/tex to 26.7 g/tex in comparison to 20.5 g/tex to 21.0 g/tex in H-1117. The elongation percentage showed consistent increase during different dates of sowing starting February. Early three sowings showed relatively lower values as compared to last 3 sowings which fell in the normal sowing period. Amongst all the 4 varieties, P 56-4 showed highest elongation. H 1117 and P 1752 showed decrease in elongation in late sowing of June 28.

### **POSTER PRESENTATIONS**

### 2.9

## Performance of organic cotton under protected and unprotected conditions of insects

### G. S. BUTTAR, RISHI KUMAR AND S. L. JAT Punjab Agricultural University, Regional Station, Bathinda-151 001

An experiment was conducted at regional station, PAU, Bathinda during 2005-06 & 2006-07 to study the performance of organic cotton under protected and unprotected conditions. The cultivation of cotton was done under recommended fertilizer applications (N-150kg/ha & P2O5- 30 kg/ha), only FYM (10 tonne/ha) and control (no application) conditions both under protected (need based sprays) as well as unprotected (no spray) conditions. The total yield was significantly higher in recommended fertilizer conditions (18.14 q/ha) compared to FYM (16.51 q/ha) and control (15.86 q/ha). The yield attributing characters like plant height, number of monopods/ plant, number of sympods/ plant and number of bolls/plant were non-significant in all the treatments. In case of protected conditions the average yield of all treatments (20.67 q/ ha) as well as the number of bolls/ plant (43.0) was significantly higher as compared to the unprotected conditions. Average populations of jassid (1.60/ 3 leaves), whitefly (1.44/ 3 leaves) and thrips (1.35/ 3 leaves) was less in protected conditions as compared to the unprotected conditions where it was 1.86, 2.13 and 1.81 per 3 leaves, respectively. However, the populations of natural enemies (spider, *Chrysoperla carnea* and *Coccinella septumpunctata*) were high in unprotected conditions (maximum in recommended fertilizer applications treatment) as compared to protected conditions.

### 2.10

## Studies on amelioration of water stress in cotton through use of osmoprotectants and chemicals

### S. RATNA KUMARI, K. HEMA AND E. NARAYANA

### Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam, Guntur-522 034

A field investigation was carried out during 2005-06 and 2007-08 at Regional Agricultural Research Station, Lam farm, Guntur in black cotton soils with 9 treatments and three replications to know the affect of foliar application osmoprotectants and chemicals at at 75 and 85 days after sowing to ameliorate the moisture stress under rainfed conditions. The foliar application of Calcium Chloride @ 0.25%+ Potassium Nitrate @ 0.5% recorded significantly higher number of sympodia and this is on par with Thiourea @ 500ppm, Diothiotol @20 ppm and Potassium Nitrate @ 1.0%. Significantly higher number of bolls were recorded in Calcium Chloride @ 0.25%+ Potassium Nitrate @ 0.5% followed by and Potassium Nitrate @ 1.0%, Thiourea @ 500ppm and Diothiotol @20 ppm. The higher boll weight was also recorded by Calcium Chloride @ 0.25%+ Potassium Nitrate @ 0.5% followed by Thiourea @ 500ppm, Potassium Nitrate @ 1.0% and Diothiotol @20 ppm. The treatment Calcium Chloride @ 0.25%+ Potassium Nitrate @ 0.5% followed by Thiourea @ 500ppm, Potassium Nitrate @ 1.0% and Diothiotol @20 ppm. The treatment Calcium Chloride @ 0.25%+ Potassium Nitrate @ 0.5% recorded significantly higher yield (1671 Kg/ha) followed by Thiourea @ 500ppm (1588 Kg/ha), Potassium Nitrate @ 1.0% (1585 Kg/ha) and Diothitol @ 20 ppm (1537 Kh/ha) and the seed cotton yield improvement in these treatments can be attributed to the higher number of sympodia, bolls per plant and boll weight.

### 2.11 Studies on soil plant narrations in intercropped *kharif* legumes with *Bt* cotton under rainfed conditions

#### E. NARAYANA, D. APARNA, A. SUBBARAMI REDDY AND CH. MALLIKARJUNA RAO Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam, Guntur-522 034

A field experiment was conducted during kharif season of 2007 at Regional Agricultural Research Station, Lam to study the soil plant narrations in intercropping of Bt. Cotton with kharif legumes under rainfed conditions. Cotton intercropped with green gram recorded significantly higher kapas yield of 3.58 t/ha followed by sole Bt. Cotton. The highest cotton equivalent yield (3580 kg ha<sup>-1</sup>), net returns (Rs 46,760) and BCR (2.46) was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram. The lowest kapas yield was recorded in cotton intercropped with green gram in 4:1 ratio, where cotton population has been reduced by 20% under replacement series. However, Bt. Cotton planted under normal sowing as well as paired row planting recorded no significant difference in seed cotton yields.

### 2.12

## Agronomic management for *Bt* cotton (Bunny) under rainfed conditions in Adilabad

### M. SREE REKHA, T. PRADEEP AND K. SUKUMAR Acharya N. G. Ranga Agricultural University, Agricultural Research Station, Adilabad

A field trial was conducted for two seasons during 2006-07 and 2007-08 with an objective to find out response of hybrid Bunny Bt to three different nitrogen levels (120,150 and 180 kg N/ ha) and scheduling of nitrogen in five equal splits at 25 days interval viz., 15-40-65-90-115 days after sowing (DAS), 20-45-70-95-100 DAS and 25-50-75-100-125 DAS under rainfed conditions at Agricultural Research Station, Adilabad. Soil of the experimental site was low in nitrogen (134.2 kg ha<sup>-1</sup>), high in phosphorus status (49.0 kg ha<sup>-1</sup>) and potassium with 347.2 kg ha<sup>-1</sup>. Scheduling of nitrogen from 20 or 25 days after sowing gave significantly higher boll number (36.9 and 37.8) and seed cotton yield (4020 kg ha<sup>-1</sup> and 3931 kg ha<sup>-1</sup>) than scheduling nitrogen from 15 DAS with boll number 34.2 and seed cotton yield of 3357 kg ha<sup>-1</sup>. Number of monopodia and sympodia and per plant, boll weight were not influenced by nitrogen scheduling. Nitrogen application influenced only seed cotton yield. Application of Nitrogen at 180 kgha<sup>-1</sup> recorded significantly higher seed cotton yield (3939 kg ha<sup>-1</sup>) over 150 kg N ha<sup>-1</sup> with (3595 kg ha<sup>-1</sup>) but was on par with 120 kg N ha<sup>-1</sup> with seed cotton yield of (3774 kg ha<sup>-1</sup>) indicating that the Bt hybrid Bunny would give its potential yield with recommend dose of nitrogen. Boll number, boll weight and sympodia per plant were not influenced by nitrogen levels. No significant interaction among the different variables for any treatment combination was observed.

### 2.13 Effect of magnesium, zinc and boron on yield of rainfed *Bt* cotton

### M. SREE REKHA AND T. PRADEEP

### Acharya N. G. Ranga Agricultural University, Agricultural Research Station, Adilabad

Response of Bt cotton hybrid Bunny to magnesium, zinc and boron (soil application@ 50,50,10 kg/ha and foliar spray @ 1%, 0.2% and 0.15% at 45, 60, 90 DAS respectively) were tried for two seasons during 2006-07 and 2007-08 at Agricultural Research Station, Adilabad under rainfed conditions. Soil of the experimental site was moderately alkaline with pH 8.3, medium in organic carbon (0.53%), medium in Zn (0.77ppm), low in nitrogen (134.2 kg/ha), high in phosphorus (49.0 kg/ha) and potassium with 347.2kg/ha. Application of nutrients (Mg, Zn, and B) either basally or foliar spray along with RDF@120:60:60 NPK /ha did not influence seed cotton yield, number of sympodia and monopodia per plant and boll weight. However, number of bolls per plant was significantly higher with 1%  $MgSo_4$  spray (40) and 0.15% boron spray (40) over control (32) where only NPK was applied. Though seed cotton yield was statistically not significant, numerically the mean yields ranged from 30-33 q/ha with maximum yield of 3541 kg/ha obtained with soil applied zinc compared to 2920 kg/ha recorded in control plot.

### 2.14 Assessment of suitability of *Bt* cotton hybrids under rainfed ecosystem

### K. SANKARANARAYANAN, P. NALAYINI, C. S. PRAHARAJ, K. K. BANDYOPADHYAY AND N. GOPALAKRISHNAN

#### Central Institute for Cotton Research, Regional Station, Coimbatore 641003

Three Bt transgenic hybrids (RCH 2 Bt, RCH 20 Bt, RCHB 708 Bt) along with their non-Bt counterparts and a variety (LRA 5166) as a control were taken in a replicated field trial during the winter rain-fed season (Aug.-February) of 2006-07 & 2007-08 at new area farm of Central Institute for Cotton Research, Coimbatore. Sucking pest and predators' population were similar in all the cultivars where as non Bt hybrids and control LRA 5166 recorded significantly higher population of bollworms. The total quantity of rainfall received during the cropping period were 447 and 438.2mm out of which 254 and 275.9 mm were calculated as effective portion respectively for the year of 2006-07 & 2007-08. The crop evapotransiration has been worked out as 338.6 and 351.5mm and crop experienced deficit moisture stress during the early crop growth period and also later period of crop growth. Under the deficit moisture condition, the pooled mean data revealed that Bt hybrids (1819 Kg) produced significantly higher seed cotton yield than non-Bt hybrid (1210 Kg) on per hectare basis while the check variety (LRA 5166) performed in between these two (1630 Kg). Bt gene protected early formed bolls (90 DAS) from boll worm complex and these attained maturity but in case of non Bt some of early formed bolls were lost by boll worms and later formed bolls did not attain maturity because of insufficient soil moisture availability at this stage. Amongst the hybrids, RCHB 708 Bt performed better over others by producing 2117 Kg per ha which is 32, 10.5 and 23 per cent higher than respectively with RCH 2 Bt, RCH 20 Bt and LRA 5166. The results of higher performance of Bt hybrids over its non-Bt counterparts under low moisture condition indicated the suitability of Bt hybrids for rainfed cultivation

### 2.15

### Optimization of water and NPK in extra long staple *Bt* cotton through dripfertigation in semiarid irrigated southern zone

### C. S. PRAHARAJ, K. SANKARANARAYANAN, K. K. BANDYOPADHYAY AND N. GOPALAKRISHNAN

#### Central Institute for Cotton Research, Regional Station, Coimbatore 641003

A field experiment was undertaken to optimize of water and nutrients through drip-fertigation without deterioration in fibre quality in an ELS Bt cotton (hxb hybrid RCH 708 Bt) on a black clay loam at Coimbatore under irrigated condition during 2007-08. The soil was alkaline (pH of 8.63) low in soil available N and organic carbon, medium in P, high in K, but non-saline (EC: 0.67 dsm<sup>-1</sup>). The results revealed that irrigation at 0.8 ETc (crop evapotranspiration) registered significantly higher seed cotton yield in RCHB 708 Bt (3369 kg/ha) over that in 0.6 ETc (2794 kg/ha), thereby making 0.8 ETc, the optimum level for drip irrigation; this was also superior over furrow irrigation at 0.6 IW/CPE level. Higher yield under drip over furrow irrigation was attributed to higher bolls per plant at 120 days after planting (DAP) and greater single plant yield at 150 DAP and above all, higher profile moisture storage maintained in the 0-60 cm soil. Evidently, crop water use (CWU) progressively increased from 0.6 ETc (39.5 cm) to 1.0 ETc (59 cm) and 0.6 IW/CPE ratio (64 cm). Consequently, highest water use efficiency (WUE) was also observed in 0.8 ETc (68.3 kg/ha-cm) followed by 1.0 ETc (56) and 0.6 IW/CPE (49.9), thereby indicating the highest productive efficiency per unit water use at 0.8 ETc (on par with 0.6 ETc). Based on consumptive use of water, around 1464 litres of water was used per kg of seed cotton under 0.8 ETc drip (1412 litres in 0.6 ETc) in comparison to 2004 litres/kg of seed cotton in furrow irrigation at 0.6 IW/CPE ratio. Therefore, with economy in CWU and without sacrificing on yield, scheduling drip at 0.8 ETc was found optimum. With regards to NPK supply, fertigation through drip @ 90:45:45 kg NPK/ha (RDF) was optimum as it led to significantly higher seed cotton yield (3345 kg/ha) over that in 75 % RDF (3006 kg/ha) and soil application of RDF (3063 kg/ha). However, NPK levels did not influence on CWU (53-54 cm) or WUE (57-65 kg/ha-cm). Difference in yield or other parameters were not significant in interaction of NPK supply versus drip. It may be concluded that drip-irrigation at 0.8 ETc and recommended NPK (N & K in 6 splits through drip, P as basal) in RCHB 708 Bt were optimum under the existing condition.

### 2.16 Studies on effect of nitrogen level and irrigation regimes on biochemical constituents at various phonological stages in cotton cv. RCH 2 *Bt*

### A. H. PRAKASH, K. K. BANDYOPADHYAY, N. GOPALAKRISHNAN AND ANDERSON A. KUMAR

Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

An experiment was conducted to study the biochemical changes in response to four nitrogen levels and four irrigations under mixed red and black Vertic ustropept at the Central Institute for Cotton Research, Coimbatore, during 2006-08 in cotton cv. RCH 2 Bt. Among the irrigation regimes 0.6 and 0.7 IW/CPE was on par at varying levels of nitrogen. The plant response to nitrogen was observed till flowering (75 DAS) only. Application of nitrogen @ 90 kgN ha<sup>-1</sup> showed higher accumulation of reducing sugars in root during the early seedling growth. This was reflected in better root growth, seedling vigour and establishment. Total soluble amino acid and phenols also followed a similar trend. With the onset of flowering the solutes started to decline. Proline showed no significant variation with N application. The total chlorophyll content (1.493 mg<sup>-1</sup>g FW) due to application of 90 kgN ha<sup>-1</sup> was significantly higher than all other treatments. The enzyme Nitrate Reductase- which is an indicator of plant health showed maximum activity of 0.84 units/mg of protein at 90 kgN ha<sup>-1</sup>. The cumulative effect of better seedling establishment, seedling vigour and enhanced biochemical activity with N application was reflected in better productivity over the control plants.

### 2.17

## Effect of elevated carbon dioxide atmosphere on nitrate reductase and photosynthetic activity in *Bt* cotton hybrids

#### N. GOPALAKRISHNAN, S. E. S. A. KHADER AND A. H. PRAKASH Central Institute for cotton Research, Regional Station, Coimbatore-641 003

Key metabolic activities like the Nitrate reductase and photosynthetic activities were studied in Bt cotton hybrids under elevated  $CO_2$  atmosphere maintained at  $650 \pm 50$  ppm in open top chambers. Nitrate reductase activity in Bt and non Bt counterparts responded significantly to elevated  $CO_2$  atmosphere. However, the response was more in Bt cotton with activity of 3.44 - 3.93 u mol  $NO_2$  g<sup>-1</sup> h<sup>-1</sup> compared to 3.31 - 3.56 u mol  $NO_2$  g<sup>-1</sup> h<sup>-1</sup> in non Bt irrespective of the hybrids studied. Among the hybrids, Bunny and Mallika recorded higher activities of the enzyme. The activity of the enzyme increased significantly from 2.11 - 2.92 u mol  $NO_2$ g<sup>-1</sup> h<sup>-1</sup> on  $30^{th}$  day after sowing to 3.31 - 3.93 u mol  $NO_2$  g<sup>-1</sup> h<sup>-1</sup> on  $60^{th}$  day after sowing irrespective of the atmosphere in which the hybrids were grown. Photosynthetic activity also followed the same trend with more activity on 60 th day. Among the hybrids Bunny and Mallika both Bt and non Bt had better efficiency and responded well to elevated  $CO_2$  atmosphere. However, Bt hybrids recorded higher photosynthetic rate of 21.1 to 24.3 u mol  $CO_2$  m<sup>-1</sup> s<sup>-1</sup> compared to 18.4 to 23.3 u mol  $CO_2$  m<sup>-1</sup> s<sup>-1</sup>. The study indicated that Bt cotton could respond favourably to elevated  $CO_2$  atmosphere by increasing their key metabolic functions in terms of enzyme activity and photosynthetic rate.

## 2.18 Effect of water logging on yield and yield parameters in *Bt* cotton

### S. E. S. A. KHADER, N. GOPALAKRISHNAN AND A. H. PRAKASH Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Four cotton Bt hybrids namely Bunny, RCH-2, RCH-20 and Mallika were raised in large cement pots with 20 kg of soil. Sixty days after sowing, water logging was imposed continuously for 5, 10, and 20 days and withdrawn later to maintain a normal condition. At harvest, morphological and yield attributes were not affected significantly in plants that were subjected to 5 days of water logging. However, water logging for more than 5 days brought about a significant decrease in plant height, sympodia and leaf number. The influence of water logging on these morphological characters was finally reflected on yield parameters. Yield

reduction ranged between 22 to 68 % depending upon Bt cotton and the duration of water logging. 10 days of water logging brought about a minimum reduction of yield by 22 % in Bunny hybrid while RCH 20 suffered a loss of 45 % for the same 10 days of water logging. However, water logging for 20 days affected the yield drastically ranging between 61 to 68 %. The minimum loss of 61 % was recorded in Mallika and RCH 20 and Bunny while RCH 2 suffered a loss of 68 % In general, Bunny and Mallika were comparatively better found to be high yielding and were able to withstand water logging.

### 2.19 Changes in metabolic activity due to water logging in *Bt* cotton

### N. GOPALAKRISHNAN, S.E.S.A. KHADER AND A. H. PRAKASH

Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Changes in chlorophyll content, nitrate reductase activity, photosynthetic rate and lenticel formation due to water logging were studied in Bt versions of Bunny, RCH-2, RCH-20 and Mallika. Irrespective of the Bt hybrids, chlorophyll content of the leaves started declining 8 days after water logging. As water logging continued, loss of chlorophyll from the tissue was upto 22% by 20 th day irrespective of the Bt cotton. Similarly, nitrate reductase activity started declining from the tissue at a faster rate after 12<sup>th</sup> day of water logging treatment irrespective of the hybrids. Among the hybrids Bunny and Mallika cotton showed higher activity. Photosynthetic activity followed the same trend to that nitrate reductase activity with bunny cotton photosynthesizing at a higher rate. Decrease in photosynthetic rate was at a faster rate after 8<sup>th</sup> day irrespective of the Bt hybrids. Water logging for 20 days drastically reduced the photosynthetic rate from 19.5 to 4.4 u mol  $CO_2$  at the end of 20 days of water logging. Lenticel formation, a mechanism by which cotton plants are able to tide over the water logged condition showed differential response among the hybrids. Lenticels started appearing from 4<sup>th</sup> day in Bunny and Mallika and by 10<sup>th</sup> day the entire circumference was covered by the lenticl and hence these two Bt hybrids appear to be tolerant to waterlogging situation.

### 2.20

## Assessing trade-off between *Bt* cotton production and global warming potential using info crop-an indigenous generic simulation model

### K. K. BANDYOPADHYAY, A. H. PRAKASH, K. SHANKARANARAYANAN, B. DHARAJOTHI AND N. GOPALAKRISHNAN

### Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Simulation models can serve as a useful tool in taking critical decisions with respect to optimization of input use for sustainable cotton production and assessing the associated environmental impacts like global warming potential.A field experiment was conducted during 2006-2008 to study the effect of irrigation and N interaction on crop yield and input use efficiency in a Bt cotton hybrid (RCH2 Bt) and to validate an indigenous generic simulation model "INFOCROP" in a mixed red and black calcareous clay loam soil (Vertic Ustropept) of Periyanaickan Palayam series at the Central Institute for Cotton Research, Regional Station, Coimbatore. The validation of the model showed that the root mean square error between the observed and simulated yield of RCH2 Bt cotton hybrid was 284.1, which corresponds to 13.7% of the mean observed seed cotton yield. The index of agreement (D index) between the observed and simulated seed cotton yield was 0.67. There was significant reduction in water use efficiency of cotton and significant increase in global warming potential and carbon efficiency (g CO<sub>2</sub> equivalent green house gas emission/ kg seed cotton yield) with the increase in the level of irrigation. The partial factor productivity of nitrogen decreased significantly with the increase in irrigation and N levels. There was a trade-off between the cotton production and global warming potential estimated by the model. This calls for efficient use of water to reduce the global warming potential. Thus RCH2Bt cotton hybrid can be grown under protective irrigation and 60 kg N ha<sup>-1</sup> to achieve higher water and nitrogen use efficiency with minimum global warming potential but without significant yield reduction under winter irrigated situation in the Southern zone of the country.

### 2.21 Yield attributing characters of rainfed *Bt* cotton as influenced by different moisture conservation techniques with precision farming

### RACHANA DESHMUKH, SHILPA BABAR, JAGVIR SINGH AND P.R. BHARAMBE Central Institute for Cotton Research, Nagpur-440010

Release of Bt cotton on commercial scale in 2002 in India, now it has occupied around 80% area out of 9.1 m ha and production has been increased to 310 lakh Bales in 2007-08. Still there is an opportunities to enhance cotton production with the proper management of fertilizer and soil moisture conservation techniques for Bt with precision farming in rainfed cotton growing regions having more than 90% under rainfed. Keeping in view, a field experiment was conducted with three moisture conservation techniques being MI- opening of furrows in alternate rows, M2- cotton intercropped with legumes viz, green gram and M3 - mulching with green manure viz; sunhemp with six fertilizer treatments viz; FI- RDF (N:P: K: 112:56:45), F2- RDF 75% inorganic + 25% FYM, F3 - RDF 75% inorganic + 25% vermicompost, F4 - RDF 50% inorganic + 50% FYM, F5 - RDF 50% inorganic + 50% vermicompost and F6 - RDF + micronutrients (viz; Fe + B each @ 10 kg/ha) at Central Institute for Cotton Research, Nagpur for 2 years i.e. 2007-08 and 200809. Field trial on Bt cv NCS 145 was conducted in split plot design with 3 replications. Soil of experimental site was medium deep, pH 8.2, low to medium in available N and P, high in available K and low in organic C (0.36%).

Yield attributing characters in Bt cotton are the important yield contributing factors as its growth period has been reduced as compared to their non-Bt counterpart. Results of 2 years on yield attributing characters of Bt cotton indicate that 11-14 % higher dry matter accumulation in intercropping system such as cotton + green gram (1:1) was recorded over alternate furrows system (sole cotton), this may helps in increasing fruiting parts which reflects simultaneously, in higher bolls. Because of Bt, the period of growth was reduced to 20- 25 days earliness and accumulates less biomass as compared to its non-Bt hybrid, it clearly showed the termination of further fruiting parts in Bt. On an average of 2-3 monopodia per plant were recorded in all the treatments. Higher sympodia (average of 23 numbers per plant) were recorded in intercropping system (average of 40 bolls per plant) followed by green manuring plots (average of 36 bolls/ plant) were recorded as compared to alternate furrow system (average of 33 bolls per plant). Different fertilizer levels superimposed over soil moisture conservation practices, the combined application of organic and inorganic fertilizer (F4: 50% inorganic + 50% organic as FYM) was found superior as compared to pure inorganic fertilizer or75 % inorganic + 25% organic manure, with respect to bolls and seed cotto yield.

### 2.22

## Farmers participatory evaluation of transgenic *Bt* cotton in Nagpur district of Maharashtra through institute village linkage programme

#### A. S. TAYADE AND M. K. MESHRAM Central Institute for Cotton Research, Nagpur 440 010

The area under cotton cultivation in Maharashtra is declining due to non-remunerative returns, high labour cost, excessive and indiscriminate use of pesticides, development of insecticidal resistance in major pests like bollworms and poor productivity. Analysis of problem-cause relationship through farmer participatory approach revealed that low productivity of cotton was mainly because of non availability of quality seed of cotton hybrids matching the micro-farming situations of farmers. For technology assessment and refinement (TAR) of rainfed cotton based production system, the villages Telgaon and Tishti of Nagpur, Maharashtra (India) were selected under Institute Village Linkage Programme (IVLP) of ICAR. The on farm trials on Bt cotton were conducted for three consecutive years during (2002 to 2005) involving farmers with their resources. The result of farmer's participatory evaluation of cotton hybrids and varieties revealed that there was 20 to 26 per cent improvement in seed cotton yield due to introduction of Bt cotton hybrids in the villages. Further it was observed that MECH 184 Bt recorded highest seed cotton yield of 998 kg / ha and was found significantly superior over local hybrids. Moreover the findings of the present experiments have revealed that Bt cotton hybrid MECH 184 recorded the highest net returns of 14537.50 Rs/ha and it has concomitantly gave higher b:c ratio of 1.31 and which was significantly better than other Bt cotton hybrids during the season 2002-03. Thus farmer's participatory approach was found effective in reaching the technology to the resource poor farmers and has increased the acceptance of recommended cotton hybrids and varieties.

### 2.23 Effect of different levels of irrigation and fertilizers through drip on productivity of *Bt* cotton

### M. S. BHATTOO, DEV RAJ, K. S. NIRANIA AND P. P. JAIN CCS Haryana Agricultural University, Cotton Research Station, Sirsa-125 055

A field experiment was conducted to find out optimum irrigation schedule and nutrient requirement with drip for Bt cotton at Cotton Research Station, CCS HAU, Sirsa in the year 2007. The experiment was conducted in split plot design having four irrigation levels ( $I_1$ -0.6 Etc,  $I_2$ -0.8 Etc.  $I_3$ -1.0 Etc and  $I_4$ -irrigation in furrows) in main plot and four fertilizer levels ( $F_1$ -75% RDF,  $F_2$ -100% RDF  $F_3$ -125% RDF and  $F_4$ -100% RDF through soil) in sub plots. The irrigation was given through drip on the basis of Etc and N & K was applied through drip in 6 splits while P was applied as basal dose. The boll weight was lower in furrow irrigation as compared to drip-irrigation at 1.0-Etc and 0.8 Etc. The total number of bolls also increased with increasing levels of irrigation and fertilizer and highest (58.60) was found at  $I_3 \ge F_3$  level. The seed cotton yield per plant and per hectare followed the similar trends. The highest seed cotton yield (3222.22 kg ha<sup>-1</sup>) and lowest (2148.14 kg ha<sup>-1</sup>) were observed at  $I_3 \ge F_3$  and  $I_1 \ge F_1$  levels. About 17% higher seed cotton yield, and 25% saving of irrigation water obtained under 1.0 Etc irrigation levels as compared to furrow irrigation. The consumptive use of water was highest in furrow irrigation (600.53mm) and lowest (448.25mm) with drip irrigation 0.6 Etc level. Water use efficiency was highest (5.50 kg ha<sup>-1</sup> mm<sup>-1</sup>) in 1.0 Etc irrigation level and lowest (4.12 kg ha<sup>-1</sup> mm<sup>-1</sup>) in furrow irrigation.

### 2.24 Effect of split dose of nitrogen and potassium on productivity of *Bt* cotton

### M. S. BHATTOO, DEV RAJ, K. S. NIRANIA AND P. P. JAIN

CCS Haryana Agricultural University, Cotton Research Station, Sirsa-125 055

A field experiment was conducted of CRS, Sirsa to study the effect of split application of Nitrogen alone and in combination of potassium on the productivity of BT-cotton. The nine treatments comprising different timing of fertilizer applications of split dose viz. T1-50-50 at basal and 45 days T2-50-25-25 at basal, 45 and 75, T330-40-30 at basal, 45 and 75, T4-50-25-25 at basal, 30 and 45.T5-50-25-25 at basal 30-60, T6-50-25-25 at basal 40 and 60, T7-50-25-25 at basal, 45 and 75, T8-25-25-25-25 at basal, 30, 45 and 75 days were applied in factorial randomized block design with three replications. Entire dose phosphorus was applied as basal through SSP, while N and K was applied in above split dose through urea and MOP. The number of bolls and yield was attached by the timing of fertilizer applications; however, effect of split dose of NK over N was in consistent. The seed cotton yield varied from 2166 kg ha-1 to2742 kg ha-1 and highest yield was obtained where four split of NK and N was applied at T8 timing followed by T5 and T9 timing of fertilizer application. The N uptake varied from 79.31 kg ha-1 to 121.27 kg ha-1, P uptake varied from 12.64 to 25.46 kg ha-1 and K uptake varied from 71.58 kg ha-1 to 116.68 kg ha-1 under different treatment combinations.

### 2.25 Physiological efficiency of *Bt* and non *Bt* cotton genotypes to different dates of sowing

### PROMILA KUMARI, DEV RAJ AND B. S. CHHABRA CCS Haryana Agricultural University Hisar-125004

Two Bt. cotton genotypes; RCH-134 (BG-1) and MRC-6301 (BG-1) along with their non Bt counterparts and local check hybrid (HHH 223) were sown on two different dates (at 15 days interval) for evaluating their physiological efficiency. Sampling was done at 50, 80, 110 and 140 DAS for various physiological parameters. Plant height and leaf area increased with increasing sampling period in all the genotypes and at

both the dates of sowing. Higher plant height was recorded in non Bt cotton genotypes as compared to Bt genotypes whereas higher leaf area was recorded in Bt than in non Bt. Genotypes. DMI (Dry matter index), CGR (Crop growth rate), RGR (Relative growth rate) and Plant Biomass increased with increase in crop age. Higher plant biomass, DMI, RGR and CGR was recorded in Bt genotypes than their corresponding non Bt. and local check hybrid genotypes. Water use efficiency (WUE) was more in Bt. than in all other genotypes under test. No consistent pattern was recorded for net assimilation rate (NAR) with the increase in crop age in all the genotypes and for both the dates of sowing. The boll weight and number of opened bolls per plant was higher in Bt. genotypes as compared to all other genotypes. Significantly higher seed cotton yield (3211 kg/ha) was recorded in Bt. RCH 134. Overall the performance of Bt cotton genotypes was better than non Bt. cotton genotypes. CGR and DMI of 2<sup>nd</sup> and 4<sup>th</sup> stage exhibited highly positive correlation with seed cotton yield and WUE determined at maturity. Thus, Bt cotton genotypes have shown its superiority for seed cotton yield because of having efficiency for some physiological parameters.

### 2.26

## Physiological efficiency in Bt cotton hybrids under normal and delayed sowing

#### D. V. PATIL, D. B. DEOSARKAR AND A. R. GAIKWAD Marathwada Agricultural University, Cotton Research Station, Nanded-431604

Physiological efficiency in Bt cotton hybrids under normal and delayed sowing condition was studied at Cotton Research Station, Nanded during 2006-07 and 2007-08. The data over two years indicated that the seed cotton yield recorded under normal sowing date (1381 kg/ha) was significantly higher over delayed sowing date (1058 kg/ha). The sowing time invariably influenced plant height, number of sympodia, number of bolls, yield per plant, seed index, ginning out turn and number of monopodia per plant. The genotype Bunny Bt followed by RCH-2 Bt were found significantly superior over rest of the genotypes for all the parameters studied. On the basis of these observations it is concluded that for higher yield the cultivars should have higher values for leaf area index, biomass, absolute growth rate, relative growth rate, net assimilation rate and crop growth rate.

### 2.27

## Effect of osmoprotectants on amelioration of water stress in cotton genotype NH-615

### D. V. PATIL, D. B. DEOSARKAR AND A. R. GAIKWAD

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

Effect of osmoprotectants on amelioration of water stress in G hirsutum cotton, NH-615 was studied at cotton Research Station, Nanded under rainfed situation during Kharif 2005-06, 2006-07 and 2007-08. The studies indicated that the foliar spray of CaCl<sub>2</sub> 0.25 % + KNO<sub>3</sub> 0.50% recorded significantly highest seed cotton yield (1455 kg/ha) followed by KNO<sub>3</sub> 1.00% (1439 kg/ha) and Glycine 0.3% (1434 kg/ha) as against unsprayed control (1187 kg/ha). The plant height at harvest, bolls per plant, boll wt (g), biomass and harvest index increased significantly due to different treatments over unsprayed control in general. However in particular KNO<sub>3</sub>, CaCl<sub>2</sub> and Glycine recorded highest value. The foliar spray of CaCl<sub>2</sub> (0.25%), KNO<sub>3</sub> (0.50%) recorded significantly higher chlorophyll content (3.13 mg/g) followed by KNO<sub>3</sub> 1.00 % (2.96 mg/g) and Glycine 0.3% (2.92 mg/g) over unsprayed control (2.32 mg/g). Therefore, these osmoprotectants were found useful for amelioration of water stress under dry land cultivation of cotton.

### 2.28 Effect of precision application of irrigation and fertilizers though drip on productivity and water use efficiency of *Bt* cotton

### V. S. SHINDE, D. N. GOKHALE, G. L. SAWARGAONKAR AND G. R. HANWATE Marathwada Agricultural University, Parbhani-431 402

Field study was conducted during kharif 2007 on the precise application of irrigation and fertilizer through drip to Bt cotton at Instructional Farms, Department of Agronomy, College of Agriculture, Parbhani. The experiment was laid in split plot design replicated thrice. The main plot comprises four irrigation treatment viz., I<sub>1</sub>- Irrigation at 0.6 Etc, I<sub>2</sub>- Irrigation at 0.8 Etc, I<sub>3</sub>- Irrigation at 1.0 Etc and I<sub>4</sub>- Irrigation in furrow at 0.6 IW/CPE, whereas sub plot comprises four fertilizer level viz., F<sub>1</sub>-75% RDF. F<sub>2</sub>-100% RDF, F<sub>2</sub>-125% RDF and F4-100 % RDF in 3 split through soil application. N and K fertilizers are applied through drip in six splits with 10 to 15 days interval where as P was soil applied through SSP at sowing. Irrigation was given on the basis of crop evapo-transpiration by using the formula,  $Etc = Eo \times Kc Kp$  where Eo = Pan evaporation of two days, Kc = Crop factor of the month, Kp = Pan factor 0.7 results indicated that irrigating Bt cotton through drip at 0.8 Etc (3278 kg/ha) and 1.0 Etc (3290 kg/ha) Were at par and recorded significantly higher seed cotton yield as compared to scheduling of irrigation at 0.6 Etc and furrow irrigation and 0.6 IW/CPE ratio. Application of 100% RDF and 125% RDF through drip in six splits were at par with each other in recording seed cotton yield and proved significantly superior over all other fertilizer schedules. Highest Consumptive use was observed in 13 i.e. schedule of irrigation at 1.0 Etc which is follow by I2 i.e. irrigation scheduling at 0.8 Etc. Fertilizer use efficiency were higher with 1.0 Etc and 0.8 Etc. whereas lowest values were noted in I1 (i.e. Irrigation scheduling at 0.6 Etc). Highest net monitory returns (Rs 43262 ha-1) was recorded by scheduling of irrigation at 1.0 Etc which was at par with scheduling of irrigation at 0.8 Etc (Rs 43028 ha-1) and both these treatments were found significantly superior over other treatments. As regard to fertilizer doses, application of 100% RDF and 125% RDF were at par and recorded significantly highest net monitory returns as compared to how fertilizer levels

### 2.29

## Synchronizing nutrient supply with crop demand to improve its use efficiency and yield and yield of *Bt* cotton

### D. N. GOKHALE, V. S. SHINDE, G. L. SAWARGAOKAR AND J. D. GAIKWAD *Marathwada Agricultural University, Parbhani-431 402*

The field study was conducted during kharif of 2007-08 at Research farm, Department of Agronomy, College of Agriculture, Marathwada Agricultural University, Parbhani on Vertisols in factorial design with three replications. Factor one comprises of sever levels wiz S1- two splits of nutrients at 10 and 45 DAS, S2-3splits (1/2, 1/4, 1/4,) at 10, 45 and 75 DAS S3-3 splits 10, 30 and 45 DAS, S4-3 splits at 10, 30 and 60 DAS, S5-3 splits at 10, 45 and 60 DAS, S6-3 splits at 75 DAS, S7-4 splits at 10, 30, 45 and 60 DAS and S8-4 splits at 10, 30-45 and 75 DAS. Factor two consists of two levels wiz of split application of N (P & K applied basally) and split application of NK (P applied basally) was the rainfall received from Hune to September was 838.10 mm as against 936.7 mm of normal rainfall of Parbhani. The results indicated that four splits of nutrients at 10, 30, 45 and 60 DAS recorded significantly higher seed cotton yield as compared to all other nutrient application timings, however it was at par with three splits of nutrients at 10, 30 and 45 DAS. As regards to splitting of nutrients, split application of nitrogen recorded significantly higher seed cotton yield (2533 kg /ha) over split application of both nitrogen and potash. However, the lowest seed cotton yield was recorded with two-split application of nutrients at 10 and 45 DAS. The increase in yield with three or four splits of nitrogen before 60 DAS was attributed because of increase in growth and yield attributes viz. no. of sympodia, number of bolls/plant, boll weight and seed cotton weight g/plant. The highest gross monetary returns was recorded in treatment s7 (i.e. 4 splits of nutrients at 10,30,45 and 60 DAS and S3 i.e. (3splits of nutrients at 10,30 and 45 DAS) which were at par with each other and proved significantly superior over rest of split application of nutrients. Similarly, highest net returns and B: C ratio was recorded in S7 (4 splits as 10,30,45 and 60 DAS0 and S3 (i.e. 3 splits at 10,30 and 45 DAS) as compared to rest of the treatments. The lowest gross returns, net returns and B: C Ratio was recorded in two-split application of nutrients at 10, and 45 DAS.

# 2.30 Performance of *Bt* cotton under different *in-situ* soil moisture conservation techniques and integrated nutrient management

### V. S. SHINDE, D. N. GOKHALE, G. L. SAWARGAONKAR AND K. K. ZADE Marathwada Agricultural University, Parbhani-431 402

The field experiment was conducted during the kharif 2007-08 at Instructional Farm, Department of Agronomy, Marathwada Agricultural University, Parbhani on effect of INM and in - situ rain water conservation in rainfed Bt. Cotton in split plot design. Three soil moisture conservation techniques viz., S, – opening of furrow in alternate row, S2 – intercropping system i.e. cotton + soybean intercropping and S<sub>2</sub>– straw mulching after last inter-culture were allotted in main plots, whereas sub plot comprises six integrated nutrient management practices viz. 100% RDF (80:40:40 kg/ha), RDF based on soil testing out of which 75%through inorganic + 25% through FYM / Vermicompost, soil test based PDF out of which 50 % through inorganic + 50 % through FYM/ Vermicompost and soil test based RDF + micronutrient (Zn, Fe & B). The results indicated that opening of furrow in alternate row (2759 kg/ha) recorded significantly higher seed cotton yield as compared to straw mulching in cotton (2421 kg/ha) and cotton + soybean intercropping (2036 kg/ha) treatments. The increase in yield with opening of furrow in alternate row might be attributed to increased moisture availability to the cotton crop. However, cotton + soybean intercropping system recorded significantly higher seed cotton equivalent yield (3291 kg/ha) as compared to straw mulching and opening of furrow in alternate row. As regards to integrated nutrient management, application of 100% soil test based RDF (100:50:30 kg NPK/~) +micronutrient Zn, Fe, B based on soil test and application of RDF with soil testing of which 75% was through inorganic + 25% through vermicompost were at par with each other and recorded significantly higher seed cotton and seed cotton equivalent yield as compared to rest of the INM treatments. Similarly, cotton + soybean-intercropping system recorded significantly higher net returns and benefit: cost ratio as compared to rest of the moisture conservation techniques. Application of RDF along with micronutrients based on soil testing recorded significantly higher net returns and benefit: cost ratio as compared to all other INM treatments.

### 2.31

## Studies on intercropping of *kharif* legumes with *Bt* cotton under rainfed condition

### V. K. KHARGKHARATE, D. B. DEOSARKAR, A. D. PANDAGALE AND V. B. AWASARMAL

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

A study was conducted in kharif 2007-08 at Cotton Research Station; Nanded to find out Bt cotton based intercropping system for sustainable cotton production. The experiment was laid out in randomized block design with eight treatments and was replicated thrice. Different intercropping treatments reduced various plant growth characters (plant height, number of monopodia and sympodia), yield attributing characters (weight per boll, number of picked bolls per plant and seed cotton yield per plant) and seed cotton yield per hectare over sole cotton treatments. Among the intercropping treatments, Cotton + Green gram (1:1) recorded highest plant growth and yield attributing characters as well as seed cotton yield (2759 Kg/ha). Cotton + Green gram under paired row treatment recorded highest cotton equivalent yield (3223 Kg/ha). However highest gross and net monetary returns were obtained from Cotton + Soybean (1:1) intercropping system (Rs. 86,046/-per hectare and Rs. 41,691/- per hectare respectively). Maximum B:C ratio to the tune of 1.94 was received from Cotton + Green gram under paired row treatment recorded by Cotton + Soybean (1.93).

### 2.32

### Response of *Bt* cotton hybrid under varied plant densities and fertilizer levels

### A. D. PANDAGALE, D. B. DEOSARKAR, V. K. KHARGKHARATE AND V. B. AWASARMAL Marathwada Agricultural University, Cotton Research Station, Nanded-431604

A field experiment was conducted during kharif 2006-07 and 2007-08 at Cotton Research Station, Nanded to study the response of Bt cotton hybrid (RCH-2) to various plant densities and fertilizer levels. The experiment was designed in split plot design with three plant densities and three fertilizer levels and was replicated thrice. Pooled results of two years indicate that plant density of 18,518 plants / ha (90 cm x 60 cm spacing) gave the highest seed cotton yield. It was significantly superior over plant density of 12,345 plants / ha (90 cm x 90 cm spacing) and at par with plant density 24,691 plants / ha (90 cm x 45 cm spacing). Among the fertilizer levels 125 % RDF produced significantly higher seed cotton yield than 100 % RDF (100:50:50 Kg NPK / ha) and 75 % RDF. The combination of plant density 18,518 plants / ha (90 cm x 60 cm) and fertilizer level 125 % RDF (i.e. 125 : 62.5 Kg NPK / ha) recorded highest seed cotton yield.

### 2.33

### Intensification of cotton based cropping systems for maximizing the use of natural resources under irrigated condition

### V. K. KHARGKHARATE, D. B. DEOSARKAR, A. D. PANDAGALE AND V. B. AWASARMAL Marathwada Agricultural University, Cotton Research Station, Nanded-431604

A field trial was conducted during 2007-08 at Cotton Research Station, Nanded with a view to find out suitable Bt cotton based crop diversification for maximizing the efficiency of production system under irrigated condition. The experiment was designed in randomized block design with four replications. Among various crop sequences, highest seed cotton equivalent yield, gross monetary returns, net monetary returns (Rs. 56,776/- per hectare) were recorded in Bt cotton – Groundnut followed by Bt Cotton summer Sunflower (Rs. 47,931/- per hectare). These sequences also recorded highest benefit cost ratio and therefore appear to be proved more promising.

### 2.34

## Studies on different sources and levels of sulphur on yield and nutrient availability in rainfed *Bt* cotton in vertisols

#### M. S. DESHMUKH, D. S. KIDE, W. N. NARKHEDE AND M. P. YADAV Marathwada Agricultural University, Parbhani-431402

A field experiment was conducted on rainfed Bt. Cotton to study effect of different sources and levels of sulphur on growth and yield on experimental farm, Department of Soil Science and Agricultural Chemistry, Marathwada Agricultural University, Parbhani during 2006 - 2007. The experimental soil was vertisol with low in available sulphur status. The experiment was laid down in Randomized block design (RBD) with seven treatments viz.  $T_1$  - RDF (80:40:40 kg NPK ha<sup>-1</sup>),  $T_2$  - RDF + 20 kg S ha<sup>-1</sup> through Gypsum,  $T_3$  - RDF + 40 kg S ha <sup>-1</sup> through Gypsum, T<sub>4</sub>- RDF + 60 kg S ha <sup>-1</sup> through Gypsum, T<sub>5</sub> - RDF + 20 kg S ha <sup>-1</sup> through sulphur bentonite, T6 - RDF + 40 kg S ha<sup>-1</sup> through sulphur bentonite. T7 - RDF + 60 kg S ha<sup>-1</sup> through sulphur bentonite. The sulphur was applied either through gypsum or sulphur bentonite pastilles as per treatment specified before 15 days of sowing. The results obtained from effect of different sources and levels of sulphur on yield of cotton showed that seed cotton yield, dry matter yield was influenced by different levels of sulphur indicated a significant yield improvement over control at 40 and 60 kg S ha-1 for both the sources. Among the sources both gypsum and Sulphur Bentonite pastilles found to be statistically at par with their respective levels although numerically and consistently higher yields were obtained with Sulphur Bentonite pastilles. The residual availability of N, P, K and S was significantly higher in S applied plots over control. Highest values were recorded with  $T_7$  (60 kg S ha<sup>-1</sup> through bentonite) and the available N, P, K and S were ranged from 234.29, 19.48, 425.68 kg ha<sup>-1</sup> and 14.79 mg kg<sup>-1</sup> respectively and these values were significantly higher over

control as well as initial values. Residual effect of sources and levels of sulphur applied to cotton showed synergistic effect on the availability of N, P and K content in soil after harvest of cotton.

### 2.35 Response of Bt cotton hybrid RCH-134 to varied nutrient and spacing levels

### PARMINDER KAUR, M. S. GILL, G. S. BUTTAR AND MANINDER KAUR Punjab Agricultural University, Ludhiana-141 004

A field experiment was conducted on sandy loam soils at Punjab Agricultural University, Ludhiana during the kharif seasons of 2006-07 and 2007-08 to find out optimum nutrient and spacing level for Bt cotton hybrid RCH-134. The treatments comprised three spacings i.e. 67.5 x 75 cm, 100 x 60 cm and 100 x 75 cm in the main plot and three nutrient levels i.e. 75 percent of recommended dose of fertilizer (RDF) (112.5 : 22.5 : 22.5 NPK kg/ha), RDF (150 : 30 : 30 NPK kg/ha) and 125 percent of RDF (187.5 : 37.5 : 37.5 NPK kg/ha) in the sub plots. The treatments were replicated four times in a split plot design. The results revealed that the closer spacing of 67.5 x 75 cm produced the significantly higher seed cotton yield of 3045 kg/ha as compared to wider spacings of 100 x 60 cm and 100 x 75 cm which recorded seed cotton yield of 2681 and 2652 kg/ha, respectively during 2007-08. During 2006-07, different spacings failed to affect the seed cotton yield significantly highest seed cotton yield during both the years. However numerically highest seed cotton yield was recorded at 125 % of recommended dose of fertilizer i.e. 187.5: 37.5: 37.5 NPK kg/ha ( 2842 and 2260 kg/ha) respectively as compared to 75 percent RDF and recommended dose of fertilizers.

### 2.36 Multilocation evaluation of *Bt* cotton hybrids in relation to different soil types

### PARMINDER KAUR, R. S. SOHU, G. S. BUTTAR, B. S. GILL AND R. K. GUMBER *Punjab Agricultural University, Ludhiana-141004*

Six Bt cotton hybrids (RCH 134, RCH 317, MRC 6301, MRC 6304, Ankur 651 and Ankur 2534) were evaluated at four locations viz., Ludhiana, Bathinda, Abohar and Faridkot) in the Punjab state. All the six Bt hybrids have different plant type. RCH 134 gave the highest mean seed cotton yield over the locations as it has robust plant type and performs well on both heavy and light soils. RCH 134 recorded the highest mean plant height of 146cm and has bushy plant type. Similarly RCH 317, MRC 6301 and MRC 6304 have more than 120cm plant height with 2-3 monopods per plant, 25-27 sympods per plant and belong to medium maturity group. All the test hybrids have good boll size, seed index and lint index. Ankur 651 and Ankur 2534 having plant height of 91cm and 95cm, respectively; number of monopods per plant (1.7 and 1.8) with a maturity period of 135-145 days, performed poorly on light soils as they gave significantly lower seed cotton yields at Ludhiana and Abohar locations which are having sandy loam soils. Further due to heavy boll load these early maturing short compact hybrids it is desired that the hybrids should have 2-3 monopods per plant with an average plant height of 140-150cm and they should belong to medium maturity group (165-180 days) which can respond favorably to all types of soil.

### 2.37

## Effect of Ethrel on seed cotton yield and yield contributing parameters in *Bt* cotton

### R. S. SARLACH, R. S. SOHU AND M. S. GILL Punjab Agricultural University, Ludhiana-141004

A field experiment was laid out at the experimental area of Punjab Agricultural University, Ludhiana in a randomized complete block design with 7 treatments and 3 replications to study the effect of different concentrations (500, 650, 800 ppm) of ethrel through foliar application on seed cotton yield and its components of Bt hybrids – RCH-134 and MRC-6301. The data on seed cotton yield, plant height, boll number per plant, boll opening percentage, of Bt hybrids – RCH-134 and MRC-6301 weight, ginning out turn

(GOT), and seed index were recorded.No significant differences for seed cotton yield, plant height, GOT, seed index, and boll weight were observed among the treatments. However, the treatments recorded, numerically, higher seed cotton yield than that of the control. Maximum increase of 12.5% and 15.5% in seed cotton yield was observed in RCH-134 and MRC-6301, respectively, on the application of ethrel @ 800 ppm 145 days after sowing (DAS). Significantly higher number of bolls per plant were recorded in the treatments 800 ppm at 145 DAS (68); 800ppm at 130 DAS (59); and 650ppm at 145DAS (64) in RCH-134 Bt. Similarly in MRC-6301, the maximum number of bolls (67) were observed in treatment 800 ppm 145 DAS, followed by 650 ppm 145DAS (51) and 800 ppm 130DAS (50). Significant increase in boll opening percentage was also observed in both the hybrids with maximum boll opening percentage of 80 and 76% in RCH134 and MRC6301, respectively, with the foliar application of ethrel @ 800 ppm 145 DAS treatment. Among the various treatments, ethrel @ 800 ppm after 145 days of sowing produced better results in both the hybrids.

### 2.38

## Studies on the performance of *Bt* cotton hybrids and biovita for improving productivity

#### KULVIR SINGH, RUPINDER SINGH AND KULDEEP SINGH Punjab Agricultural University, Regional Station, Faridkot-151 203

A field experiment was conducted at PAU-Regional Station, Faridkot during Kharif 2007-08 to evaluate the performance of Bt cotton hybrids and Biovita for improving productivity. The experiment was conducted in randomized block design (RBD) having four replications comprising treatment combinations of four Bt cotton hybrids namely RCH-308, RCH-314, RCH-134 and NCS-138, each evaluated in two supplement treatments i.e Biovita and Control. The soil of the experimental field was alluvial with sandy loam texture, normal (pH 8.3, E.C 1.02 m mhos/cm), low in organic carbon (0.21 %), medium in available phosphorus (16.3 kg P<sub>2</sub>O<sub>2</sub>/ha) but high in available potassium (315 kg K<sub>2</sub>O/ha). Among the four tested hybrids, NCS-138 recorded significantly least seed cotton vield of 1612 kg /ha. The other Bt hybrids namely RCH-308, RCH-314 and RCH-134 were at par with each other having seed cotton yield of 2513, 2431 and 2225 kg/ha, respectively. Significantly highest sympods (36.8) and bolls per plant (47.9) were recorded in RCH-308 whereas significantly highest boll weight (4.38 g) was observed in RCH-134. Monopods per plant and plant stand were not affected among tested Bt cotton hybrids. The application of Biovita granules @ 20kg/ha could not improve seed cotton yield or either of the yield contributing characters to any significant level. Only, plant height was significantly improved with application of Biovita (137.9 cm) as compared to control treatment (128.0 cm). The seed cotton yield in Biovita treated and control treatment was 2262 and 2129 kg/ha, respectively. Hence, farmers should not get lured by such products and instead opt only for recommended fertilizers.

### 2.39

### Nutrient management of Bt cotton in Punjab

### PREETI SHARMA AND M. S. BRAR

### Punjab Agricultural University, Ludhiana-141004

Cotton is predominantly grown in southwestern districts of Punjab. Soils of these areas are low to medium in available nitrogen and low to high in both available phosphorus and potassium. For both Bt as well as non-Bt hybrids, 150 kg nitrogen and 30 kg phosphorus is recommended. In addition to this, application of 4 foliar sprays of potassium nitrate starting from flower initiation has been recommended. Several postulations are being expressed regarding an altered nutritional requirement of Bt cotton. The purpose of the present study was to explore the possibilities to modify the fertilizer recommendations for Bt cotton grown in Punjab. The results of large number of experiments conducted at farmer's fields showed that it is not possible to alter the dose of nitrogen and phosphorus. However soil application of potassium at the rate of 60 kg K<sub>2</sub>O ha<sup>-1</sup> on soils testing low and medium in available potassium is beneficial with a benefit to cost ratio of 5:1and no response to soil application was observed on soils testing high in available potassium. The foliar application of potassium nitrate increased the yield of seed cotton irrespective of the soil status and soil applied potassic fertilizer dose, with a benefit cost (BC) ratio of about 10.5: 1.0. The seed cotton yield increased due to beneficial effect of these treatments on the number of sympodial branches and weight of bolls.

### 2.40 Agronomic evaluation of *Bt* cotton hybrid under varied crop geometry and NPK levels

### P. L. NEHRA AND S. P. GODARA

Rajasthan Agricultural University, Agricultural Research Station, Sriganganagar-335 001

The study was carried out with the objective to determine the optimum plant spacing and fertilizer levels for Bt cotton hybrid. A field experiment was conducted during kharif 2006 and 2007 at ARS, Sriganganagar. The soil of the experimental field was sandy loam, alkaline in reaction (pH 8.1), low in total nitrogen, and medium in available phosphorus and high in available potassium. The experiment was laid out in a factorial RBD. The treatment combination consisting of three plant spacing (108 x 45 cm, 108 x 60 cm & 67.5 x 60 cm) and three fertilizer levels (75%, 100% & 125% of RDF kg/ha) with check (RS - 2013). Phosphorus and Potash were applied as basal dose through DAP and MOP, respectively. Nitrogen was applied through urea, 1/3 as basal, 1/3 at first irrigation and 1/3 at square initiation. Other agronomic practices were followed as per recommendation.

The two years pooled data showed that the highest seed cotton yield was recorded under wider spacing of 108 x 60 cm over narrow spacing. Application of 100% R.D.F (150 kg N, 40 kg  $P_2O_5$  & 20 kg  $K_2O$ /ha) seems to be the optimum dose for this hybrid (3052 kg/ha) which was significantly superior to 75% R.D.F (2747kg/ha) and remained statistically at par with 125% RDF (3067 kg/ha). When compared hirsutum Bt hybrid RCH-134 v/s hirsutum Variety RS- 2013, it gave 46.08 per cent higher seed cotton yield with higher FUE and water productivity (g/m<sup>3</sup>). The maximum FUE and water productivity (g/m<sup>3</sup>) was recorded in the spacing of 108 x 60 cm & lowest in 67.5 x 60 cm. As regards fertilizer level, the maximum FUE and water productivity (g/m<sup>3</sup>) was noticed in 75% RDF and 125% RDF respectively.It was concluded that the Bt cotton hybrid (RCH –34 Bt) is superior over hirsutum variety (RS –2013) and it should be planted at 108 x 60 cm spacing with 100% RDF (150: 40 :20 kg NPK per hectare) in Canal irrigated area of north-west Rajasthan.

### 2.41

## Effect of moisture conservation and nutrient management for improvement in productivity and fiber quality of cotton

### P. L. NEHRA AND S. P. GODARA

Rajasthan Agricultural University, Agricultural Research Station, Sriganganagar-335 001

The study was carried out with the objective to determipe yield optimization by moisture conservation and integrated nutrient management for Bt cotton hybrid. The results showed that the treatment green manuring of Dhaincha gave significantly higher seed cotton yield over inter cropping of short duration legumes like moong but it was statistically at par with opening of alternate furrows during last inter culture. The yield increase under this treatment might be due to conservation of soil moisture and weed suppression through mulching which is helpful to increase the seed cotton yield and as well as yield attributes and the yield decrease under inter cropping of short duration legumes like moong was due to competition of moong with cotton. As regards nutrient management treatments, RDF+ Zn gave significantly higher seed cotton yield over RDF and rest of the INM treatments.The Bt cotton hybrid (RCH -134 Bt) should be green manured with Dhaincha was recommended dose of fertilizer (RDF) plus application of Zn in Canal irrigated area of north-west Rajasthan.

### 2.42

## Synchronizing N and K supply with *Bt* cotton crop demand to enhance water and nutrient use efficiency

### P. L. NEHRA AND S. P. GODARA

### Rajasthan Agricultural<sup>-</sup> University, Agricultural Research Station, Sriganganagar-335 001

The study was carried out with the objective to synchronize nutrient supply with crop demand under irrigated condition for *Bt* cotton hybrid. The data indicated that the significantly higher seed cotton yield was recorded under the treatment  $T_3$  (three splits, 30:40:30 at 45&75 DAS) closely followed by  $T_8$  (four splits, 25:25:25:25)

at 30, 45 & 60 DAS) & T9 (four splits, 25:25:25 at 30, 45 & 75 DAS) over T, (two splits, 50:50 at 45 DAS) but the split application of potash, did not show any significant effect on seed cotton yield of *hirsutum* cotton. The Bt cotton hybrid (RCH -134 Bt) gave highest seed cotton yield under three split application of nitrogen (30:40:30 at basal, 45 & 75 DAS, respectively) while split application of potash, did not show any significant effect on seed cotton yield in Canal irrigated area of north-west Rajasthan.

# 2.43 Evaluation of *Bt* cotton hybrids under different plant geometry and fertilizer levels

### K. KALAICHELVI

### Tamil Nadu Agricultural University, Coimbatore-641 003

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during winter irrigated and summer irrigated season of 2005-2006 to study the effect of plant spacing and fertilizer levels on yield of Bt cotton hybrids in the western zone of Tamil Nadu. The experiment was laid out in split plot design with three replications. Bt hybrids viz., MECH 184 (H<sub>1</sub>), MECH 162 (H<sub>2</sub>) and RCH 2 (H<sub>3</sub>) and plant spacing of 90 x 45 cm (S<sub>1</sub>), 90x60 cm (S<sub>2</sub>) and 120x60 cm (S<sub>3</sub>) as main plot treatments while sub plot consisted of three different fertilizer levels of 120:60:60 kg NPK ha<sup>-1</sup> (F<sub>1</sub>), 160:80:80 kg NPK ha<sup>-1</sup> (F<sub>2</sub>) and 200:100:100 (F<sub>3</sub>) kg NPK ha<sup>-1</sup>. The results revealed that MECH 162 and RCH 2 Bt hybrids adopted at a plant spacing of 90x60 cm applied with fertilizer level of 160:80:80 kg NPK ha<sup>-1</sup> had recorded significantly higher sympodia, boll setting percentage and boll number and seed cotton yield. But there was significant influence only between two factors studied, Bt hybrids and plant spacing. RCH 2 and MECH 162 Bt hybrids had recorded significantly higher seed cotton yield at plant spacing of 90x60cm over other combinations in both the years of study. MECH 184 Bt hybrid recorded significantly higher seed cotton yield only at closer plant spacing of 90x45 cm in 2005.

### 2.44

### Agronomic evaluation of Bt and non-Bt hybrids cottons in Tamil Nadu

### **K. RAJENDRAN**

### Tamil Nadu Agricultural University, Coimbatore-641 003

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during 2001 to evaluate the programme on three Bt cotton hybrids. The hybrids evaluated were MECH 184, MECH 162 and MCH 12 as well as their non Bt counterparts along with a check NHH 44. During the crop period 551.4 mm of rainfall was received in 19 rainy day. The detailed field observation on seed cotton yield, ginning percentage, lint yield, and duration, number of bolls, boll weight, seed and lint indices were recorded. The fibre properties were analyzed using High Volume Instrument. Among the hybrids evaluated MECH 162 recorded the highest seed cotton yield of 2459 kg ha<sup>-1</sup>, MECH 184 registered 2065 kg ha<sup>-1</sup> and MECH 12 recorded 1863 kg ha<sup>-1</sup>. In general Bt versions recorded higher kapas yield than their corresponding non Bt versions. MECH 162 Bt registered 105.2 per cent higher seed cotton yield than MECH 162 non Bt while it was 55.4 percent and 9.3 percent in the case of MECH 184 and MECH 12 respectively. The Bt entries also recorded higher number of bolls per plant, ginning outturn and lint index than their non Bts while non Bts recorded higher boll weight. The Bt versions were earlier than their non Bt counterparts. The higher number of bolls in Bt entries could be attributed to the lower square drop in Bt versions due to inherent genetic resistance to boll worms. The highest yielding hybrid MECH 162 Bt also recorded significantly higher number of bolls and ginning outturn with a bolls weight of 5.4 gram. Boll maturity was exceptionally synchronous in MECH 184 and all the bolls in most of the plants could be collected in one picking. The bursting of MECH 184 was also very good and deserves for testing using mechanical pickers.

### 2.45 Response of *Bt* hybrid (NCS 145 *Bt*) to different levels of spacing and fertilizer in Tamil Nadu

### **K. RAJENDRAN**

### Tamil Nadu Agricultural University, Coimbatore-641 003

A field experiment was conducted on Bt cotton (NCS 145 Bt) to study the response for different levels of spacing and fertilizer in black cotton soil at Tamil Nadu Agricultural University, Coimbatore during winter irrigated season (August – February) 2005 – 06. The result indicated that Bunny Bt recorded significantly higher seed cotton yield (31.5 q/ha) under closer row spacing (90 x 45 cm), which was significantly superior over wider plant spacing (90 x 60 cm and 90 x 90 cm) within the row. Seed cotton yield was not increased substantially on further increase in application of N, P and K levels from the 120 : 60 : 60 kg NPK / ha to cotton hybrids and it was statistically non-significant. Bolls per unit area decreased due to wider spacing of 90 x 90 cm. Seed index was significantly increased under closer spacing as compared to wider plant spacing in intra row. However, there was no significant effect on percentage of ginning outturn of Bunny Bt cotton by manipulation of intra row plant spacing. Among the different levels of fertilizers studied 150 : 80 kg NPK / ha was found to be optimum for achieving higher seed cotton yield of Bunny Bt in black cotton soils of Tamil Nadu under winter irrigated condition.

### 2.46

## Foliar nutrition to reduce the boll shedding and square drain in cotton cv. *Gossypium hirsutum*

### R. AMUTHA, T. SIVAKUMAR AND C. R. ANANTHAKUMAR

Tamil Nadu Agricultural University, Agricultural College and Research Institute, Madurai 625 104

A field experiment was conducted to find out the effect of plant growth regulating chemicals on growth and yield of cotton cv. KC 2 under rainfed vertisol conditions at the experimental farm of RRS, TNAU, Aruppukottai during 2007. The treatments included i) Salicylic acid 100 ppm, ii) DAP (2%) plus KCl (1%), iii) 19:19:19 (2%) plus multi K (2%), iv) TNAU formulation (Salicylic acid, MgSO<sub>4</sub>, KNO<sub>3</sub>, Zn, B, urea and planofix v) control. The crops were sprayed with chemicals twice, first on flowering and second at boll formation stage. The results revealed that the foliar spray of chemicals exhibited significant influence on all the growth parameters. Among the treatments the foliar spray of TNAU formulation proved to be the best treatment with the highest mean values in respect of height (107.3), Number of sympodial branches (14.6), Number of bolls per plant (24.7), Boll weight per plant (3.7 gm), Seed cotton yield (811.5 Kg/ha). The per cent increase over control is 19.

### 2.47

## Agronomic practices for late planted *Bt*-cotton (*Gossypium hisutum L*) under irrigation

### SATYANARAYAN RAO, VISHWANATH AND B. T. PUJAR University of Agricultural Sciences, Regional Agricultural Research Station, Raichur-584 102

A field experiment was conducted at Regional Agricultural Research Station Farm, Raichur on medium black soil during 2006-07 to study the response of late sown Bt cotton to plant spacings, fertilizer levels and NAA applications under irrigation. There were 18 treatment combinations comprising of three spacings (90 x 30 cm, 90 x 45 cm and 90 x 60 cm) in main plots, two fertilizer levels (100 and 150 per cent RDF) in sub plots and three levels of NAA applications @ 10 ppm (control, two sprays at flower commencement and full blooming stages and three sprays at squaring, flower commencement and full blooming stages) in sub-sub plots. Treatments were replicated thrice in split-split plot design. Bunny Bt hybrid was sown on 25-09-06. Among spacings, significantly higher seed cotton yield was recorded with 90 x 30 cm spacing (2479 kg/ ha) and it was on par with the 90 x 45 cm spacing (2343 kg/ha). Application of 150 per cent RDF recorded significantly

higher seed cotton yield (2420 kg/ ha) as compared to 100 per cent RDF (2195 kg/ha). Significantly higher seed cotton yield (2488 kg/ha') was recorded with three sprays of NAA as compared to two sprays of NAA (2297 kg/ha) and control (2139 kg/ha). Economic analysis indicated that 90 x 30 cm spacing recorded significantly higher net returns (Rs.38, 603/ha) but was on par with 90 x 45 cm spacing (Rs. 36,661/ha). Net returns increased significantly with increase in the levels of fertilizer from 100 per cent RDF (Rs. 34,617 /ha) to 150 per cent RDF (Rs. 37,227 /ha). Net returns recorded with three sprays of NAA were maximum (Rs. 39,813/ha) and significantly higher over two sprays of NAA (Rs. 36,022/ha) and control (Rs. 31,932/ha) treatment.

### 2.48

## Morpho-physiological basis of yield difference in *Bt* and non *Bt* cotton hybrids at two dates of sowing

### B. C. PATIL, K. N. PAWAR AND PRAKASH KOLER

University of Agricultural Science, Agricultural Research Station, Dharwad-580 007

A field experiment was conducted at Agricultural Research Station Dharwad (UAS Dharwad) during 2005-06 and 2006-07 to know the difference in physiological parameters, yield and yield components in four Bt cotton hybrids along with their non Bt counter parts. The intrahirsutum hybrid DHH-11 was the non Bt check. The results revealed that 20 days delay in sowing of hybrid cotton resulted in 31.1% reduction in seed cotton yield. Among the hybrids, Bt hybrids yielded 20.0% more yield than their non Bt counter parts. Among the genotypes, NHH-44 Bt recorded maximum yield (2217/kg/ha) as compared to other genotypes and DHH-11 the least yield (1566/kg/ha).In general the number of bolls were 16.7% more in Bt cotton hybrids than their non Bt counter parts. Bt hybrids recorded 10.0% more boll weight than non Bt hybrids. Bt cotton hybrids flowered seven days early than their non Bt counter parts. In general the rate of photosynthesis was 14.13 percent more in Bt hybrids than non Bt counter parts.

### 2.49

### Studies on root growth of *Bt* cotton hybrids under rainfed condition

### P. D. BHALERAO, B. R. PATIL AND G. S. GAIKWAD Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola-444 104

Fifty four Bt cotton hybrids of different seed companies and two non Bt hybrids were sown on dated 2<sup>nd</sup> July 2007 at 90x60cm spacing in RBD with two replications to know the root growth of various Bt cotton hybrids under rainfed condition. After last picking irrigation was applied in alternate rows by opening furrows. Randomly one plant of each genotype was selected for root study. Soil near the plant was removed with big size fork manually, to remove the plant from soil. Due care has been taken that there should not be damage to the roots. Root portion was washed with clean water. After that root length, lateral spread of root, plant height and dry matter were recorded. There was vast difference (24 cm to 100cm)in root length of Bt cotton hybrids. Maximum root length (100cm) was observed with VICH -15 Bt hybrid followed by MRC-7326 BG II (98cm) and Bio 111 (95cm). Minimum root length was found with Ajeet 11 BG II (28cm). Four hybrids Viz: Dhoom BG-II NCS-207, NCS-145 and MRC-7351 BG II showed root length less than 40cm. It was seen that 63 per cent Bt cotton hybrids showed shallow, 31.5 per cent medium and 5.5 per cent deep root system under rainfed condition.

Out of 56 cotton hybrids 34 Bt cotton hybrids were classified in shallow rooted group (less than 60 cm), 17 medium rooted (61-90 cm) and 03 hybrids in deep rooted group (more than 90 cm). The non Bt cotton hybrids (H-8and PKVHy-2) were showed medium root length.

### 2.50 Effect of weather parameters and plant geometry on sucking pest dynamics in *Bt* and non-*Bt* cotton

### SOM PAL SINGH, B. S. SEKHON AND G. S. BAINS Punjab Agricultural University, Ludhiana-141 004

A field experiment was conducted at PAU, Regional Research Station, Bathinda (Latitude 30'17'N; Longitude 74° 58'E and altitude of 211 uses msl l) during the kharif season of 2004-05. The experiment comprised of RCH-134 Bt and non-Bt hybrids of cotton sown under three plant geometry i.e 67.5x75cm, 67.5x90cm and 67.5x105cm. The experiment was laid out in randomized block design and replicated thrice. The population of three sucking pests i.e. whitefly, jassid and thrips was observed at weekly interval. The maximum population (3.27 adults/ 3 leaves) of whitefly was reported in mid September. A mean temperature of 30.2°C, morning humidity 70 per cent and evening humidity of 37 per cent was reported during peak population of whitefly. The weather remained dry during 15 days before the date of observation of peak population. The mean maximum population of whitefly was found in the spacing 67.5x105cm in Bt cotton and 67.5x75cm in the non-Bt cotton. The jassid population was found to be maximum in the I51 and 2nd week of the August in Bt and non-Bt cotton respectively. The corresponding weather variables were mean temperature of 27°C and relative humidity above 85 per cent with two rainy days. The plant geometry of 67.5x75 cm was more favorable for the multiplication of jassid possibly due to the microclimate'modification in the dense crop canopy. The jassid population was more in the Bt cotton than in the non- Bt version of the same cultivar. Besides this the peak population of the thrips was maximum (6.03thrips/3 leaves) in the end of the September in Bt cotton with corresponding mean temperature of 28.4°C coupled with morning and evening relative humidity of 87 and 60 per cent respectively. However, in non-Bt cotton the peak population was in the end of July. The mean temperature during this time was 30.3°C with a morning and evening RH of 66 and 45 per cent and no rainfall. The maximum thrip population was in plant geometry of 67.5x 105cm both in the Bt and non -Bt cotton.

### 2.51 Effect of plant spacing and fertilizer levels on insect pests in *Bt* cotton hybrids

### K. KALAICHELVI

### Tamil Nadu Agricultural University, Coimbatore-641 003

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, during winter irrigated and summer irrigated season of 2005-2006 to study the effect of plant spacing and fertilizer levels on pest infestation in Bt cotton hybrids. The experiment was laid out in split plot design with three replications. Bt hybrids viz., MECH 184 (H<sub>1</sub>), MECH 162 (H<sub>2</sub>) and RCH 2 (H<sub>3</sub>) and plant spacings of 90x45 cm (S<sub>1</sub>), 90x60 cm (S<sub>2</sub>) and 120x60 cm (S<sub>3</sub>) as main plot treatments while sub plot consisted of three different fertilizer levels of 120:60:60 kg NPK ha<sup>-1</sup> (F<sub>1</sub>), 160:80:80 kg NPK ha<sup>-1</sup> (F<sub>2</sub>) and 200:100:100 (F<sub>3</sub>) kg NPK ha<sup>-1</sup>. No pesticide was applied for the first experiment as there was no infestation of bollworms above the ETL level. The sucking pest population exceeded the ETL thrice but the rains washed off. Dimethoate was sprayed twice at 45 and 90 DAS @ 1.0 1 ha<sup>-1</sup> to manage sucking pests (Jassids and aphids) in 2006. The results revealed that RCH 2 Bt hybrid recorded lower aphid and jassid infestation. Closer plant spacing of 90x45 cm was observed with more population of aphids and hoppers. Fertilizer applied at the rate of 200:100:100 kg NPK ha<sup>-1</sup> enhanced the sucking pest population. Bt hybrids had recorded zero damage due to American and Spotted bollworms and pink bollworm at negligible level during the study. Stem weevil infestation occurred during 2006 alone and the Bt hybrid MECH 184 was found to be susceptible to stem weevil.

### 2.52 Physiological efficiency of Bt cotton hybrids in relation to growth and yield contributing characters

### A. N. GITTE, D. B. DEOSARKAR, D. V. PATIL AND A. R. GAIKWAD

Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experiment was conducted at Cotton Research Scheme, Parbhani to study the Physiological efficiency in different phases in relation to growth yield and yield contributing characters. Bunny Bt and RCH-2 Bt with their non Bt versions including NHH-44 as a check were sown in split plot design during year 2008-09. Significant differences were recorded in respect of seed cotton yield, plant height, number of bolls per plant, boll weight and biological yield under normal sown condition (1069.5 kg/ha) as well as late sown condition (663.24 kg/ha). Similarly the normal date of sowing was found significantly superior in respect of plant height, number of bolls/ plant, biological yield and harvest index. In case of genotypes, Bunny Bt recorded (1358.30 kg/ha) significantly more seed cotton yield than rest of the genotypes followed by Bunny Non Bt (1114.70 Kg/ha), RCH-2 Bt (789.15 Kg/ha) and RCH-2 Non Bt (575.40 Kg/ha).

### 2.53

### Screening of cotton genotypes for water stress tolerance

### A. N. GITTE, D. B. DEOSARKAR, D.V. PATIL AND A. R. GAIKWAD

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

Drought tolerance study in twenty cotton genotypes on the basis of various stress indices and yield attributes at Cotton Research Scheme, Parbhani was carried out under rainfed condition during the year 2008-09. A separate set under irrigation condition was also sown to work out different moisture stress indices for various parameters. In all twenty genotypes, leaf area index, relative water content, plant height, biological yield per plant, harvest index, dry matter stress index (DMSI), yield stability index (YSI) were carried out. Among the genotypes CPD-817 (1.39), WDHH-411 (1.25) and GSHV-01/27 (1.14) recorded significantly higher leaf area index at 140 DAS. Highest relative water content was observed in NH-630 (84.45 %). The genotypes GTHV-02/45 (1452.45 Kg/ha), NH-630 (1195.79 Kg/ha) recorded significantly highest seed cotton yield. When compared with irrigated situation, genotypes NH-615 (9.72 %) and GSHV-01/27 (9.96 %) recorded least reduction in yield. Regarding yield stability index (YSI), NH-615 (90.28) showed highest YSI followed by GSHV-01/27 (90.04); CPD-824 (87.92); LRA-5166 (86.87) and GSHV-152 (85.42).

### 2.54

### Root study in cotton genotypes for drought tolerance

### A. N. GITTE, D. B. DEOSARKAR, D. V. PATIL AND A. R. GAIKWAD

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experiment was conducted at Cotton Research Scheme, M.A.U., Parbhani to study drought tolerance in cotton genotypes on the basis of root system development. Total thirteen genotypes were studied under Randomized Block Design with two replications during year 2008-09. Significant genotypic differences were observed, the genotype NHH-225 recorded the highest radical length (15.95 cm) followed by PH-1031 (14.05 cm), Bunny Bt (13.25 cm) and PA-528 (13.18 cm). The genotypes showed significant differences in root length as 30 DAS. The genotype NHH-615 (Ch.) recorded the highest root length (31.05 cm) followed by PA-08 (31.00 cm) and PH-1031 (29.50 cm). Root length at 140 DAS differ significantly among the genotypes. The genotype PA-08 recorded the highest root length (127.50 cm) followed by PA-532 (111.50 cm) and NHH-44 Bt (108.00 cm). Significant differences were observed in radicle plumule length ratio on 10 <sup>th</sup> day of germination and root shoot length ratio at 30 and 140 DAS. The genotype PA-528 recorded the highest radicle plumule length ratio (1.64) followed by NHH-225 (1.53), PA-532 & PA-402 (1.42). At 30 DAS, the root shoot length ratio was highest in NH-615 (2.35) followed by NH-630 (2.05) and NHH-44 Bt (1.93). At 140 DAS, the highest root shoot length ratio was observed in NHH-206 (1.63) followed by NHH-225 (1.59) and NH-615

(1.57) Significant differences were observed in dry matter of radicle on 10 <sup>th</sup> day of germination, dry matter of root at 30 and 140 DAS. The highest radicle dry matter was recorded in PA-08 and NHH-44 Bt (0.012 g) followed by NHH-206 and PH-1031 (0.011g) . At 30 DAS, the root dry matter was recorded in Bunny Bt (0.043g) followed by PA-532 and PH-1031 (0.034g) . At 140 DAS, the highest root dry matter was produced in PH-1009 (70.05g) followed by PA-08 (29.85) and PA-528 (25.25g). The genotypes differed significantly in length of plumule and shoot length at 140 DAS, whereas shoot length differences at 30 DAS were non significant. The genotype Bunny Bt recorded the highest length of plumule (12.54 cm) on 10<sup>th</sup> day of germination followed by NHH-206 (11.38 cm) and NHH-44 (11.00 cm). The genotype PA-08 recorded highest length of shoot (107.00 cm) followed by PH-402 (104.50 cm) PA-532 (99.50 cm).

### 2.55 Testing of cotton genotypes for drought tolerance under natural conditions

### D. B. DEOSARKAR, A. N. GITTE, D. V. PATIL AND A. R. GAIKWAD

Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experiment was conducted at Cotton Research Scheme, Parbhani to screen sixteen cotton genotypes for drought tolerance during the year 2008-09. Observations were recorded on phenological characters, seed cotton yield and ancillary data and water status studies. The genotypes exhibited significant differences in plant height, highest by PIAG-29 (130.85 cm) followed by PA-402 (128.75 cm), PA-528 (124.25 cm) and PA-532 (123.00 cm). The genotype PA-528 maintained the highest leaf area index (LAI) throughout growth period followed by NHH-225. The genotypes NHH-44 and Bunny Bt recorded the highest leaf water potential (LWP) (-22.00 bar) followed by NHH-225 (23.00 bar). The genotype Bunny Bt recorded the highest relative leaf water content (RWC) (85.28%) followed by NHH-44 Bt (84.25%) and NHH-206 (81.55%). The genotypes differed significantly in respect of yield per plant, biological yield per plant, number of bolls per plant, boll weight (g) and harvest index (HI). Overall the genotype Bunny Bt showed earliness, high relative water content, leaf water potential, number of bolls per plant, harvest index and yield per plant which indicates its tolerance to drought.

### 2.56 Effect of etheral defoliant on cotton variety NH-615 (Anusaya)

### D. B. DEOSARKAR, A. R. GAIKWAD AND S. G. PATIL

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experient was undertaken at Cotton Research Station, Nanded with an objective to study the effect of etheral on defoliation of leaves of NH-615 (Anusaya) a straight variety useful for machine picking. The sprays of defoliants was taken at 120 DAS, 135 DAS and 150 DAS at 3000 ppm, 4000 ppm, 5000 ppm and 6000 ppm concentrations.At 120 DAS higher seed cotton vield was obtained from control as compare to defoliant sprays. However, above 90 percent seed cotton recovery was obtained in all the treatments. In the II<sup>nd</sup> picking percent recovery of seed cotton yield was drastically reduced (2 to 6 %) in the different treatments. Whereas, percent recovery of seed cotton yield was constant in control. There is no variation for seed cotton yield in defoliant sprays. Spraying of defoliant at 135 DAS has shown its effect at 150 DAS. In this treatment there is no variation for seed cotton yield by application of different concentrations of defoliants. Nearly 50 % recovery of seed cotton yield was obtained by all the treatments. In this treatment total seed cotton yield was increased as compared to 120 DAS treatments. When spraying of defoliant was done at 150 DAS, its effect was shown at 165 DAS. There is no variation in yield and percent recovery by the different treatments. In 6000 ppm etheral treatment drying of leaves start from 3<sup>rd</sup> day of spraying and complete plot was dried in 6-7 days after spray but leaves remains attached to plant till 158-160 DAS i.e. very low defoliation of dry leaves was observed. In 5000 ppm etheral treatment drying of leaves start from 3-4<sup>th</sup> day of spraying. Complete plot was dried in 7-8 days after spray but leaves remains attached to plant till 161-162 DAS i.e. low defoliation of dry leaves was observed. In 4000 ppm etheral treatment drying of leaves start from 4-5th day of spraying. Complete plot was dried in 8-10 days but defoliation was low. In 3000ppm etheral treatment drying of leaves start from 8-10<sup>th</sup> day of spraying and complete plot was dried in 10-12 days but defoliation was in average. By application of different concentration of defoliant (3000, 4000, 5000 and 6000 ppm) there was no variation in seed cotton yield but percent recovery was faster in these treatments as compared to control.

### 2.57 Intensification of *Bt* cotton based cropping systems for maximizing the use of natural resources under irrigated conditions

### P. S. SOLUNKE, J. G. THOKALE AND U. S. BARVE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was carried out during kharif-rabi season of 2007-08 on clayey soil under irrigated condition to identify the most remunerative Bt cotton based cropping sequence for maximizing production efficiency of cropping system under technology mission on cotton project at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth., Rahuri (M.S.). Results revealed that the among various cropping sequences, Bt cotton – Gram cropping sequence ranked first in respect of cotton equivalent yield and benefit cost ratio (63.71 q ha<sup>-1</sup> and 3.40) and this was followed by Bt cotton – Okra (62.59 q ha<sup>-1</sup> and 3.01), Bt cotton – Wheat (49.74 q ha<sup>-1</sup> and 2.53), Bt cotton – fodder Maize (44.53q ha<sup>-1</sup> and 2.56) and Bt cotton – Sunflower (39.82 q ha<sup>-1</sup> and 2.20) cropping sequence, respectively. However, sole Bt cotton was recorded lowest B:C ratio (2.11).

### 2.58

### Studies on nutrient management and plant geometry for Bt cotton hybrid

#### P. S. SOLUNKE, J. G. THOKALE AND U. S. BARVE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was conducted at Cotton Improvement Project Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during summer season of 2008-09. The experiment laid out in split split plot design with three replications. The treatments consisted of two cotton hybrids (Bt RCH-2 & Non Bt RCH-2) in main plot, two spacings (90 x 90 cm & 90 x 115 cm) in sub plot and three fertilizer levels (100:50:50, 125:62.5:62.5 & 150:75:75 kg NPK ha<sup>-1</sup>) in sub-sub plot. The experiment results revealed that the Bt cototn hybrid RCH-2 recorded significantly maximum seed cotton yield, net monetary returns and benefit cost ratio (32.31 q ha<sup>-1</sup>, Rs. 53117 ha<sup>-1</sup> and 2.31, respectively ) as compared to Non Bt cotton hybrid RCH-2 (30.21 q ha<sup>-1</sup>, Rs. 47556 ha<sup>-1</sup> and 2.19, respectively )). Non significant results observed in between 90 x 90 cm and 90 x 115 cm spacings in respect of productivity and economics. Among the fertilizer levels, 150 % RDF (33.08 q ha<sup>-1</sup>, Rs. 53188 ha<sup>-1</sup> and 2.24, respectively ) and 125 % RDF (31.33 q ha<sup>-1</sup>, Rs. 50541 ha<sup>-1</sup> and 2.25, respectively ) being at par recorded significantly maximum seed cotton yield, monetary returns and benefit cost ratio over 100 % RDF (29.38 q ha<sup>-1</sup>, Rs. 45532 ha<sup>-1</sup> and 2.15, respectively ).

### 2.59

## Influence of foliar feeding of different micronutrients on yield and economics of hybrid cotton

### P. S. SOLUNKE, J. G. THOKALE AND U. S. BARVE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

Influence of foliar feeding of different micronutrients on yield and economics of hybrid cotton was studied during 2008-09 at Cotton Improvement Project Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). The experiment laid out in randomised block design with five replications and seven treatments. The treatments consisted of control,  $ZnSO_4$  (0.5%),  $ZnSO_4$  (1%),  $FeSO_4$  (0.5%),  $FeSO_4$  (1%),  $ZnSO_4$  (0.5%) +  $FeSO_4$  (0.5%) and spraying of Urea 2% at flowering and DAP 2% at boll development stage. The results indicated that the treatment consisted spraying of of Urea 2% at flowering and DAP 2% at boll development stage registered maximum seed cotton yield (24.63 q ha-1), net monetary returns (Rs. 31758 ha-1) and benefit cost ratio (1.80) as compared to control treatment (18.80 q ha-1, Rs. 15821 ha-1 and 1.41, respectively) closely followed by spraying of  $ZnSO_4$  (0.5%) +  $FeSO_4$  (0.5%) at square formation, flowering and boll development stage.

### 2.60 Influence of organic manures and bio pesticides on cotton production under summer irrigated condition

### P. S. SOLUNKE, J. G. THOKALE AND U. S. BARVE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was conducted during summer season of 2008-09 at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) to study the effect of organic manures and bio pesticides on cotton productiuon under summer irrigated condition. The experiment was laid out in split plot design with three replications. The treatments consisted of two plant protection measures i.e. recommended plant protection measures and plant protection with biopesticides in main plot and nine levels of organic manures in sub plot. The data of experiment indicated that the seed cotton yield due to plant protection measures were found not significant. The treatment RDF (100:50:50 kg NPK ha<sup>-1</sup>) registered significantly maximum seed cotton yield (27.71 q ha<sup>-1</sup>) as compared to rest of the organic manurial treatments closely followed by treatments FYM @ 10 t ha<sup>-1</sup> (24.44 q ha<sup>-1</sup>) and FYM @ 5 t ha<sup>-1</sup> + VC @ 1.25 t ha<sup>-1</sup> (24.00 q ha<sup>-1</sup>).

### 2.61

### Integrated nutrient management in cotton under summer irrigated condition

### U. S. BARVE, J. G. THOKALE AND P. S. SOLUNKE

Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was conducted at Cotton Improvement Project Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during summer season of 2008-09 to study the effect of integrated nutrient management on seed cotton yield and benefit cost ratio. The experiment laid out in randomised block design with three replications and eight treatments. The experiment results revealed that the treatment HW at 20, 40 and 60 DAS registered significantly maximum seed cotton yield (28.72 q ha<sup>-1</sup>) over other treatments. However, treatment Pendimethalin 1.00 kg a.i. ha<sup>-1</sup> pre emergence application + HW at 30 and 60 DAS (25.96 q ha<sup>-1</sup>) and treatment Fluchloralin (*a*) 1.00 kg a.i. pre emergence application + HW at 30 and 60 DAS (25.25 q ha<sup>-1</sup>) was found at par with treatment HW at 20, 40 and 60 DAS. Unweeded control treatment recorded significantly lowest seed cotton yield (6.74 q ha<sup>-1</sup>).

### 2.62

## Effect of different fertilizer doses and green manuring treatments on growth and yield of rainfed *Bt* cotton

### A. N. DOLI, M. G. UMATE, G. L. SAWARGAONKAR, M. G. PATIL Marathwada Agricultural University, Parbhani-431 402

A study was conducted during the *kharif* season 2008-09 at Instructional Farm, Department of Agronomy, Marathwada Agricultural University, Parbhani to study the effect of different fertilizer doses and green manuring treatments on growth and yield of rainfed Bt cotton in split plot design. The results of the study revealed that application of 120:60:60 and 100:50:50 kg NPK/ha were on par with each other and recorded significantly higher seed cotton yield as compared to application of 80:40:40 kg NPK/ha. Similarly, application of 10 t FYM/ha was at par with Cotton + sunhemp and cotton + cowpea green manuring treatments and all of these recorded significantly higher seed cotton yield as compared to green manuring of cotton with dhaincha/ glyricidia.

### 2.63 Studies on effect of different doses of fertilizers and spacings on yield of *Bt* cotton

### S. U. PAWAR, A. N. GITTE AND G. L. SAWARGAONKAR Marathwada Agricultural University, Parbhani–431402

Field trial was conducted to find out the effect of different doses of fertilizer and spacings on yield of Bt cotton during 2008-2009 at the Farm of Cotton Research Scheme, Marathwada Agricultural University, Parbhani (M.S.). The experiment was laid out in split plot design with six different spacings in main plot and five fertilizer levels in sub plot. Results indicated that, maximum seed cotton yield was recorded at 180 cm x 30 cm spacing (3046 kg/ha) and it was at par with 90 cm x 60 cm spacing (2774 kg/ha). However, it was further at par with 150 cm x 45 cm spacing (2671 kg/ha). Among the different fertilizer levels, application of 200 : 100 : 100 and 175 : 87.5 : 87.5 NPK kg/ha were at par and recorded significantly higher seed cotton yield as compared to application of lower fertilizer levels.

## 2.64 Assessing physiological efficiency in *Bt* and non *Bt* cotton hybrids

### K. N. PAWAR, B. C. PATIL, B. M. KHADI, S. A. ASHTAPUTRE AND RAJESH PATIL University of Agricultural Sciences, Agricultural Research Station, Dharwad Farm, Dharwad-580 007

A field experiment was conducted under rainfed condition at Agriculture Research Station, Dharwad to compare the morpho physiological characters and yield potential of different Bt and non-Bt cotton hybrids. The experiment consisted of four Bt hybrids and their non Bt counter parts and one check hybrid laid out in a randomized block design with three replication. Among the Bt hybrids NHH-44 Bt produced significantly higher seed cotton yield (2818 kg/ha) followed by MRC 6322 (2713 kg/ha). Where as in case non Bt highest yield was recorded in NHH-44 (2422 kg/ha) followed by Bunny (2321 kg/ha). This was mainly attributed to its close association with number of bolls per plant, boll weight, Total dry matter, Leaf area index and more harvest index. In general the rate of photosynthesis, relative water content, NRA and chlorophyll content was recorded more in Bt as compared to non Bt cotton hybrids.

### 2.65

## Effect of planting geometry and nutrient levels on yield and economics of *Bt* cotton under irrigated conditions of Tunga Bhadra project area

### M. A. BASAVANNEPPA, Y.R. ALADAKATTI D. P. BIRADAR, AND J. M. NIDAGUNDI

### University of Agricultural Sciences, Agricultural Research Station, Siruguppa-583 121

Tunga Bhadra Project area (TBP) is one of the major irrigated cotton belts in Karnataka having its quantum share in cotton production. In recent years, the productivity of cotton was on declining trend and growing of cotton was almost uneconomical. But after the introduction of Bt cotton since last 3-4 years in TBP area, the yield levels of cotton are on increasing trend. In the absence of research results on plant population and nutrients for Bt cotton in the irrigated tract of TBP, the recommended dose of fertilizers for Non-Bt cotton is being advocated and followed in most of the areas. Hence, the present investigation was initiated to find out optimum planting geometry and nutrient levels for Bt cotton under irrigated conditions, at Agricultural Research Station, Siruguppa, during 2006-07, 2007-08 and 2008-09. The experiment was laid out in a split plot design with three replications in deep black soils and consisted of nine treatment combinations with planting geometry as main plots viz.,  $S_1$ : 90 x 90 cm,  $S_2$ :90 x 60cm and  $S_3$ :90 x 45 cm, and sub plots representing three levels of NPK, which equals to 75, 100 and 125 percent of recommended dose of fertilizers for Non-Bt (RDF: 120:60:60 NPK kg /ha). The hybrid used in experiment was Bunny Bt (NCH 145 BG I). Except for the nutrient doses and planting geometry all other cultivation practices remained same in all the treatments blocks. Pooled data on seed cotton yield revealed that planting geometry of 90 cm x 45 cm resulted in significantly highest seed cotton yield (2243 kg/ha), net returns (Rs.32,551/ha) and B:C ratio (2.20) as compared to planting

geometry of 90 cm x 90 cm (1867 kg/ha) and 90 cm x 60 cm (2121 kg/ha). The percent yield advantage in planting geometry of 90 cm x 45 cm, varied from 6 to 20 percent over 90 cm x 60cm and 90 cm x 90 cm respectively. Further, for every increment in the RDF levels from 75 to 125 percent there was a significant improvement in the seed cotton yield from 1912 kg/ha to 2182 kg/ha and net returns of Rs 24,237/ha to Rs. 28,666/ha with B: C ratio of 2.01 to 2.15. However, the interaction effects were turned out to be statistically non significant. Based on the pooled results of three year experimentation, it is concluded that a planting geometry of 90 cm x 45 cm with a nutrient levels of 120: 60: 60 NPK kg/ha found optimum for Bt cotton (Intra hirsutum) under irrigated conditions of TBP area.

### 2.66 Response of *Bt* cotton to foliar nutrition under irrigated conditions

#### M. A. BASAVANNEPPA, Y. R. ALADAKATTI, D. P. BIRADAR AND J. M. NIDAGUNDI University of Agricultural Sciences, Agricultural Research Station, Siruguppa-583 121

Soil application of fertilisers of major nutrients to Bt cotton is a common practice observed in Tunga Bhadra project area. Due to synchronized flowering, retention of most of the first formed bolls and reduced crop duration to an extent of one or two weeks, there is a scope to increase the productivity of Bt cotton with foliar nutrition coupled with soil application of the fertilisers under irrigated conditions. In view of it, the present investigation was carried out to study the response of Bt cotton to foliar nutrition of both major and micronutrients under irrigated conditions at Agricultural Research Station, Siruguppa (Karnataka), during 2008-09. The experiment was laid out in a Randomized Block Design with three replications in deep black soils. There were nine treatments of foliar sprays viz.,  $T_1$ : Control,  $T_2$ : 0.1 % Boron,  $T_3$ : 0.5 % ZnSO<sub>4</sub>,  $T_4$ : 1.0 % MnSO<sub>4</sub>,  $T_5$ : 1.0 % MgSO<sub>4</sub>,  $T_6$ : 1.0 % MgSO<sub>4</sub> + 0.5 % ZnSO<sub>4</sub>,  $T_7$ : 5 % FeSO<sub>4</sub>,  $T_8$ : 0.5 % FeSO<sub>4</sub> + 0.5 % ZnSO<sub>4</sub> and T<sub>0</sub>: 2 % Urea at flowering and 2 % DAP at boll development stage. The micronutrients were twice foliar spraved, each at flowering and boll development stages. Recommended fertilizer dose of 120:60:60 NPK kg/ha with FYM @ 10 t/ha was applied commonly to all the treatments. The hybrid used in experiment was Bunny Bt (NCH 145 BG II) with a spacing of 90 cm x 60 cm and all other cultivation practices remained same for all the treatments. The results revealed that foliar spray of micronutrients had significant effect on the yield parameters and seed cotton yield. Foliar application of 1.0 % MgSO<sub>4</sub> at flowering and boll development stage in addition to the soil applied recommended dose of fertilisers (RDF) resulted in higher seed cotton yield (2066 kg/ha), closely followed by the foliar spray of 0.5 % FeSO<sub>4</sub> + 0.5 % ZnSO<sub>4</sub> (1990 kg/ha) and both were significantly higher as compared to the yield obtained with soil application of RDF with out foliar spray of MgSO4 (1627 kg/ha). The higher seed cotton yield was due to more seed cotton yield per plant (139.60 g/pl) due to foliar nutrition. Significantly higher net returns and B:C ratio were obtained with foliar spray of 1 % MgSO<sub>4</sub> at flowering and boll development stages (Rs. 33,105 /ha and 2.61) and it was closely followed by foliar spray of 0.5 %  $FeSO_4 + 0.5$  %  $ZnSO_4$  (Rs.30, 979 /ha and 2.49 ). Based on the one year results it is inferred that foliar nutrition of either 1% MgSO<sub>4</sub> or combined sprays 0.5 % FeSO<sub>4</sub> + 0.5 % ZnSO<sub>4</sub> at flowering and boll development stages in addition to recommended dose of fertilizers to Bt cotton increase the seed cotton yield and monetary returns under irrigated conditions of Tunga Bhadra Project area.

### 2.67

## Studies on soil plant narrations in intercropped *kharif* legumes with *Bt* cotton under rainfed condition under Rahuri condition

### J. G. THOKALE AND P. S. SOLUNKE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was carried out during kharif season of 2007-08 on clayey soil under technology mission on cotton project at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth., Rahuri (M.S.) to find out the best profitable Bt cotton based intercropping system under rainfed condition. Experiment results revealed that among intercropping of various legumes with Bt cotton, intercropping of Bt cotton + Soy bean (1:1) recorded significantly more seed cotton yield (17.83 q ha<sup>-1</sup>) closely followed by intercropping of Bt cotton + Green gram (1:1) i.e.(16.93 q ha<sup>-1</sup>) as compared to sole Bt cotton (15.25 q ha<sup>-1</sup>). All the intercropping treatments were at par with each other in respect of seed cotton yield. Treatment consisting intercropping of Bt cotton + Green gram (1:1) was recorded maximum cotton equivalent yield i.e. CEY (21.37 q ha<sup>-1</sup>), gross monetary returns (Rs. 23,151 ha<sup>-1</sup>) and B:C ratio (1:1.89) closely followed by treatments of Bt cotton + Soy bean (1:1), Bt cotton + Cluster bean (1:1), Bt cotton + Cowpea in paired row and Bt cotton + Black gram (1:1) intercropping, respectively as compared to sole Bt cotton.

## 2.68 Performance of *Bt* cotton hybrids under rainfed situation

### A. V. KOLHE, V. U. SONALKAR, B. R. PATIL AND S. A. BHONGLE Dr. Panjabrao Deshmukh Krishi Vidyapeeeth, Akola-444 104

Ninety seven Bt Cotton hybrids were evaluated along with two Bt and three Non Bt check hybrids against bollworms under unprotected condition at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) India during Kharif 2008-09. The results revealed that, all the Bt cotton hybrids evaluated, except, Encounter Bt were significantly superior over Non Bt checks ( i.e. NHH-44, PKV Hy -2 and PKV Rajat ) in checking the bollworm damage at harvest. Open boll and loculi damage due to Bollworm complex in Non Bt hybrids was in the range of 36.67 to 60.00 and 13.56 to 34.15 %, respectively. Such damage in Bt cotton hybrids was in the range of 0.00 to 6.67 and 0.00 to 5.38 %, respectively. Highest seed cotton yield (1750 kg/ha )was obtained in TCHH 9 Bt and being on par with MRC-7347 BG II, MRC-6301 Bt,TCHH-4 Bt, SP-503 Bt, MRC-7301 BG II and NECH-14 Bt.

### 2.69

## Response of *Bt* cotton hybrids to varying nutrient levels under irrigated conditions

### MANINDER KAUR, PARMINDER KAUR AND M. S. GILL

Punjab Agricultural University, Ludhiana-141 004

A field experiment was conducted at Punjab Agricultural. University, Ludhiana during the *kharif* season of 2006-07 to evaluate the response of Bt cotton hybrids RCH 134 and MRC 6304 to various nutrient levels under irrigated conditions. The experiment was conducted separately on the two hybrids sown at a spacing of 67.5 x 75 cm in a randomized block design. Six levels of N, P20<sub>5</sub>, K20 and ZnSO4 kg/ha as (F,=150-0-0-0, F2=150-30-0-0, F<sub>3</sub>=150-30-30-15, F4=200-40-40-20, F5=250-50-50-25 and F6=75-90-9025) were tested and each level was replicated four times. The results revealed that the seed cotton yield was not significantly affected by different nutrient levels in both the hybrids. However, seed cotton yield of RCH 134 increased numerically with increase in nutrient level up to F<sub>5</sub> with maximum seed cotton yield (2337 kg/ha) at F5 nutrient level and the yield decreased in F6 nutrient level in which N application was decreased to 75 kg/ha, P<sub>2</sub>0<sub>5</sub> and K<sub>2</sub>0 was increased to 90 kg/ha each whereas ZnSO4 remained 25 kg/ha. In MRC 6304, maximum seed cotton yield of 1615 kg/ha was obtained at F<sub>2</sub> nutrient level i.e. 150-30-0-0 of N, P<sub>2</sub>0<sub>5</sub>, K20 and ZnSO4 kg/ha which were 16.5 and 13.9 percent higher than F, i.e. application of nitrogen alone.

### 2.70 Evaluation of cotton genotypes suitable for machine picking

### D. B. DEOSARKAR, A. R. GAIKWAD AND S. G. PATIL

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experiment to evaluate twenty cotton genotypes suitable for machine picking was conducted at Cotton Research Station, Nanded during 2008-09. Spacing of 100x10 cm was maintained for the cotton genotypes with local variety check (NH-452) at 100x10 cm and 100x30 cm. Bt hybrid check (Bunny Bt) was space planted at 100 x 60 cm. Observations on seed cotton yield and percent recovery of seed cotton of different genotypes was recorded at 135 DAS, 150 DAS and 165 DAS. Highest plant was height was recorded by GJHV-358 (94.53 cm) while lowest plant height was recorded in GSHV-01/1358 (62.60 cm). The maximum number of monopodia per plant was ranging form 0.53 to 2.13. The minimum number of monopodia per plant was reported in genotype CCH-724 and KH-139 (0.53). While, maximum number of monopodia per plant was

observed in GJHV-358. The maximum and minimum number of sympodia per plant was recorded in genotype CCH 281 (16.93) and CCH-724 (13.13) respectively. Width of plant was ranging from 47.87 to 76.60 cm. Plant width was maximum in TCH-1608 (76.60 cm) followed by GJHV-358 (76.20 cm). While, lowest was 47.87 cm in CCH-724. The height of I<sup>st</sup> sympodia was ranging from 11.47 to 19.20 cm. The lowest height of I<sup>st</sup> sympodia was recorded in local check NH-452 in 100 x 10 cm (11.47cm) while it was maximum in genotype SCSBC-1001 (19.20 cm). The height of I<sup>st</sup> boll was ranging form 10.87 to 18.27 cm. The lowest height of I<sup>st</sup> boll was recorded in NH-452 (100 X 30 cm) 10.87cm. While, maximum height of I<sup>st</sup> boll was reported in L-788 and BS-177 (18.27 cm). Maximum number of bolls per plant was recorded in Bunny Bt (19.07) followed by NH-615 (17.40), NH-635 (15.60) while, lowest was in GSHV-97/59 (7.13). Weight of boll was ranging from 2.42 to 3.08 gm per boll. Maximum boll weight was recorded in genotypes GJHV-358 (3.08 gm) followed by local check NH-452 (100 x 10 cm) 3.05 gm. While, minimum boll weight was observed in GSHV-97/59 (2.42gm). All the genotypes possess acute type of monopodia except genotype RACH-11 which posses right angle monopodia.

The genotype BS-177 having medium type of kapas attachment to boll while, other genotypes have flared type of attachment. Straight type of locule opening was observed in genotype NH-635 while, in other genotypes wide type of locule opening was recorded. High leaf shedding was observed in genotype Bunny Bt and KH-139 while, average leaf shedding was observed in other genotypes. At 135 DAS maximum seed cotton yield was recorded by check Bunny Bt (848.18 kg/ha) followed by CCH-281 (552.11 kg / ha) Table 3. While, at 150 DAS NH-615 (759.77 kg/ha) followed by GSHV-01/1358 genotype have recorded highest yield (421.59 kg/ha). At 165 DAS NH-635 have recorded highest vield (488.31 kg/ha) followed by check NH-452 (100 x 10 cm) 361.12 kg/ha. Over all total maximum yield upto 165 DAS yield was recorded in NH-615 (1266.43 kg/ha) followed by check Bunny Bt (1211.39 kg/ha) and NH-635 (1084.20 kg/ha). In the final seed cotton yield, the genotype NH-615 (1350 kg/ha) has recorded higher seed cotton yield over check Bunny Bt (1250 kg/ha).Percent recovery of seed cotton was observed maximum in bunny bt (67.85 %) followed by cch 281 (49.96 %) at 135 das table 3. at 150 das maximum recovery of seed cotton yield was found in nh-615 (56.28 %) followed by gshv-01/1358 (45.33 %). at 165 das maximum percent recovery of seed cotton yield was recorded in nh-635 (41.74 %) followed by local check nh-452 (100x30cm) 40.26 %. overall higher percent recovery of seed cotton yield up to 165 das was recorded in bunny bt, gshv-01/1356 and cch 281 (96 %). The higher fibre length and ginning out turn was recorded by the entries L-761 (29 mm fibre length and 38 % GOT) and NH-615 (28 mm fibre length and 38% GOT)as compare to local check NH-452.

### 2.71

## Development of compact plant type with synchronous flowering in G. hirsutum for machine picking

### D. B. DEOSARKAR, A. R. GAIKWAD AND S. G. PATIL

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

Evaluation of twenty-five cotton genotypes was done for compact plant type with synchronous flowering at Cotton Research Station, Nanded. Experiment was laid in Randomized Block Design with three replications during 2008-09. Among the genotypes the highest plant height was recorded by PH-1060 (129.90 cm) and lowest by local check NH-452 (100 x 30 cm) 80.20cm . The maximum number of sympodia per plant was recorded in genotype PH-1060 (21.40) followed by NH-632 (19.20), NH-637 (19.00) and minimum was recorded in genotype PH-1057 (15.00). The maximum height of Ist boll was recorded in genotype NH-650 (20.00 cm) while, minimum was recorded in local check NH-452 (100 x10 cm) (11.20 cm). Maximum number of bolls per plant was recorded in Bunny Bt (27.10) followed by PH-1055 (16.20), NH-637 (16.00). Maximum boll weight was observed in NH-650 and PH-2065 (3.37gm). Genotypes PH-518.5-1, NH-640, NH-637 and NH-631 have right angle monopodia while, other genotypes have recorded acute type monopodia. Among all genotypes studied NH-630, NH-633 and NH-634 have medium type of kapas attachment to the boll while, remaining genotypes have flared type. Straight type of locule opening was observed in PH-2065, NH-637, PH-418-1 while, other genotypes possess wide type. High leaf shedding was recorded in genotypes PH-1053, NH-647, NH-637, PH-1055 and Bunny Bt while, average leaf shedding was observed in other genotypes. Picking of seed cotton was done on 135, 150 and 165 DAS. AT 135 DAS .In final yield the highest seed cotton yield was recorded by check Bunny Bt (1200 kg/ha). Whereas, NH-627 (1190 kg/ha) and NH-637 (1050 kg/ha) have recorded significantly higher seed cotton yield over check NH-452 at spacing (100 x 10 cm) 920 kg/ ha. Percent recovery of seed cotton yield was observed maximum in check Bunny Bt (65.85 %), PH-1057 (38.96 %) and PH-1055 (36.86%) at 135 DAS. At 150 DAS percent recovery of seed cotton was observed maximum in NH-637 (48.37 %) followed by NH-637 (43.87 %). While, at 150 DAS maximum

percent recovery of seed cotton was recorded in NH-647 (52.26 %). Overall percent recovery of seed cotton up to 165 DAS was recorded maximum by NH-637 (97.87 %), PH-1053 (97.42 %) and NH-647 (97.38 %). Among the genotype studied higher fibre length and GOT was recorded by entries PH-1056 (28 mm fibre length and 39 % GOT), PH-519-1 (29 mm fibre length and 38 % GOT) and PH-418-1 (28 mm fibre length and 38 % GOT). The highest GOT by entry NH-649 (40 %).

### 2.72

## Economics of Bt cotton as influenced by different fertilizer doses and green manuring

### G. L. SAWARGAONKAR, A. N. DOLI, AND S. U. PAWAR Marathwada Agricultural University, Parbhani-431 403

A field experiment was conducted during the kharif season 2008-09 at Instructional Farm, Department of Agronomy, Marathwada Agricultural University, Parbhani on yield and economics of rainfed Bt cotton in split plot design. Application of 120:60:60 and 100:50:50 kg NPK/ha were at par with each other and recorded significantly higher seed cotton yield over application of 80:40:40 kg NPK/ha. Profound effect of different fertilizer levels and green manuring treatments were observed on yield and economics of Bt. Cotton (Table 1). Application of 120:60:60 and 100:50:50 kg NPK/ha were at par with each other and recorded significantly higher seed cotton yield, GMR, NMR and B:C ratio over application of 80:40:40 kg NPK/ha. Similar results were reported by Halemani, 2004. As regards to green manuring and FYM treatments, application of 10 t FYM/ha, green manuring of cotton with sunhemp and cowpea were at par and all of them recorded significantly higher seed cotton yield, GMR and NMR as compared to green manuring of cotton with dhaincha/ glyricidia.

### 2.73

### Bale and balance: integrating transgenic technology and agronomics- a review

### C. S. PRAHARAJ, K. SANKARANARAYANAN P. THUKKAIYANNAN AND N. GOPALAKRISHNAN

### Central Institute For Cotton Research, Regional Station, Coimbatore 641003

The development of transgenic crops is one of the most significant advances in crop production technology of the past fifty years. Current Bt crops are based on highly specific insecticidal *cry* proteins of *Bacillus thuringiensis* (Bt) - a soil bacterium having a remarkable safety record in many agro-ecosystems involving many important crops including cotton (*Gossypium* species). Of late, concern has been raised about the transfer of Bt genes to wild relatives and neighbouring crops, impact of Bt on non-target organisms, effects on crop yield and the possibility of insect pest populations developing resistance (& evolution of emerging pests), role of approved *versus* unapproved Bt and more importantly, the safety issue in growing Bt cotton on food chain. Therefore, strategic alliance between bale (refers to cotton, 1 bale=170 kg) and balance (agro-ecological balance and sustainability) for integrating the transgenic technology and improved agronomics over a time scale plays vital for sustainability of Bt Cotton Technology (BCT). An attempt is made to review BCT and agronomics conjunctively to have valid integration deriving maximum advantages of BCT with respect to yield, pesticide use, input cost and revenue generation at various levels (Agronomics).

Trials conducted worldwide report a remarkable yield advantage (20-39%) & widespread adoption of BCT (adding Indian subcontinent regardless of gender/farm size) and were mostly associated with reduced insecticidal applications (& operational costs up to two-thirds). As a result, retention of squares and young bolls is higher in Bt (than in non-Bt) and is shown to maintain its yield even under delayed sowing through shorter fruiting cycle (due to higher earlier fruit retention), allowing time to support growth of the same number of bolls as earlier sowings. Thus, varying planting dates for Bt in different production regions may offer opportunities for growers to help optimize yield, fiber quality and reduce risks associated with poor crop stand when seed are sown too early. Besides, BCT proves its worth by reducing crop costs for the resource-poor conditions (e.g. rainfed central India). Positive role of higher nutrient, FYM and INM (integrated nutrient management) on BCT also cannot be ignored as use of these had favorable effects on soil available-N, nutrient balance and increased crop performance. Therefore, BCT has been suitable for the Indian farmer despite small farm holdings and thus, the area under Bt cotton is projected to increase rapidly in the coming years.

Beneath the soil surface also, Bt cotton probably stimulates microbial activity following addition of cotton tissue *per se*, that increase soil enzyme activities (urease, invertase and cellulose etc) by masking any negative

effect of the Bt toxin (?-endotoxins) on microbial & enzyme activities. A higher boll GA3 and zeatin content, that may increase boll N metabolism intensity, is also responsible for the enhanced boll development of Bt hybrids without any adverse effects on soil system due to similar rhizospheric functional diversity of microbial communities (of Bt vs. non-Bt). Evidence also suggests Bt toxin may not be the direct factor for decrease of the numbers of functional bacteria (N-fixing ones) as other factors may be involved. There is also a significant spatial and temporal variation in these 'benefits', and much depends upon where production is taking place and on the season (threats). Yet, adoption of an innovation like Bt cotton seems to pay only in an agro-ecosystem with a sufficient level of intensification. Moreover, it is untenable to project high yields for all GM crops in all developing countries in all the seasons under poor cropping management. In addition, most studies generate economic benefits of BCT (reported up to 63 %) under a typical pest density situation, not under a pest free situation per se - sometimes a normal phenomenon worldwide. Similarly, many situations show the impact of uncertainty in the variables (prices and yield) that influence the profitability of Bt cotton and alternative crop protection methods. Bt cotton cultivars have a more intense leaf N metabolism than their parents during reproductive development that may lead to excessive vegetative growth requiring cultural interferences. Study also shows that transgenic cotton plants can compensate for even the removal of 100% of the initial squares for 1-2 weeks under ambient/elevated CO<sub>2</sub>. Yet, the damage inflicted by bollworm on cotton is predicted to be more serious (irrespective of Bt and non Bt) under elevated CO2 conditions because of individual compensatory feeding on host plants caused by N deficiency. Although biological model simulations shows rapid resistance buildup in pest populations appears unlikely under maintenance of minimum non-Bt refuge areas, yet integrating BCT with agronomics remains vital for sustainability.

### 2.74

### Identification of innovative Bt cotton based cropping systems

### E. NARAYANA, D. APARNA AND A. SUBBARAMI REDDY

Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam, Guntur-522 034

On introduction of Bt. Cotton and by virtue of its resistance to boll worms and attaining maturity earlier than non Bt. hybrids, there is a scope to change the cropping systems both in rainfed as well as irrigated conditions to make the system scientifically sound, economically viable, practically feasible, ecologically desirable and socially acceptable by utilizing all the natural resources to its maximum extent. In view of this, the project has been initiated in the year 2007 under TMC MMI 2.2 project with 12 centers across the country to find out the suitable intercrops based on location specific for rainfed areas and also the most remunerative second crop after Bt. cotton for irrigated areas so as to enhance the land use efficiency for achieving higher production efficiency of the system as a whole. The zone wise salient findings during the year 2007 - 08 are as follows. In north zone normal planting is better in alluvial soils while paired row planting performed well in sandy loam soils of north zone. No intercrop system was found to be beneficial as compared to sole cotton in north zone even under irrigated condition. Transplanted Bt. cotton performed well by recording 4 - 7% more seed cotton yield than that of direct sown cotton. Bt. Cotton followed by wheat was found to be the most prominent double cropping system with higher production efficiency of the system as a whole. In central zone Bt. Cotton under normal planting performed better than that of paired row planting in black cotton soils. Cotton + Soybean, Cotton + Blackgram, Cotton + Cowpea, Cotton + Radish, Cotton + Spinach in 1:1 ratio, Cotton + Redgram in 6:2 ratio, Cotton + Marygold in 8:2 ratio and Cotton + Greengram, Cotton + Cowpea under paired row planting in 1:3 ratio were found to be ideal for Maharastra state whereas Cotton + Soybean, Cotton + Greengram, Cotton + Blackgram in 1:2 ratio were found to be promising for Madhya Pradesh in central zone. Fodder jowar, fodder maize, wheat and sesamum for Gujarath whereas Groundnut, greengram, sunflower, gram, wheat and okra for Maharastra; and wheat, okra, onion and cowpea for Madhya Pradesh were found to be more beneficial after Bt. Cotton under double cropping system in black cotton soils of central zone. In south zone Normal planting is better than that of paired row planting in south zone by recording 6-8% more seed cotton yield. Cotton component yield under Cotton + Greengram (1:1) intercropping system has surpassed the yield levels of sole cotton in black cotton soils. 30% yield reduction under Cotton + Redgram (4:1) was observed by reducing 20% of cotton population. However, the system as a whole is as good as sole crop and helps in sustainability. Bt. Cotton followed by vegetable crops like cucumber, Ridgegourd, tomato, coriander, watermelon recorded higher production while sesamum and maize were found to be more promising after Bt. Cotton under double cropping system in black cotton soils.

### 2.75

# Morphological characteristics of Bt cotton and available soil moisture as influenced by integrated nutrient management and moisture conservation practices

### SHILPA BABAR, RACHANA DESHMUKH, JAGVIR SINGH, AND P. R. BHARAMBE Central Institute for Cotton Research, Nagpur-440 010

To study the effect integrated rain water and nutrient management on available soil moisture and morphological characteristics of Bt cotton, the field study was conducted at Central Institute for Cotton Research, farm, Nagpur during 2007-08 and 2008-09. The three treatment of moisture conservation M1: alternate furrows, M2: Mung as intercrop and M3: Dhaincha as green manure mulch in main plot and integrated nutrient management viz. F1 - N: P2O5:K2O:112:56:45 (fertilizer dose adjusted based on soil test) RDF, F2 - F1 as 75 % N inorganic + 25 % N as FYM, F3 -F1 as 75 % N inorganic + 25 % N as vermicompost, F4 - F1 as 50 % N inorganic + 50 % N as FYM, F5 - F1 as 50% Ninorganic + 50 N as vermicompost, F6- F1+ limiting micronutrients ( B & Fe @ 10 kg/ha). The experiment was laid out in split plot design with three replications. Significantly higher dry matter yield was recorded in mulching treatment with Dhaincha (1242 kg/ha) which was at par with intercropping (1142 kg/ha). Similar results were recorded in case of number of burst bolls per plant. Among integrated nutrient management treatment F4 as 50%N as IN + 50% N as FYM recorded higher DMY (1222 kg/ha) followed by F2 (75 % N as IN + 25 % N as FYM and F6 (RDF + micronutrient). Highest number of burst bolls was recorded in the INM treatment F2 (38.24) closely followed by F4 (37.27). Data regarding DMY at 120 DAS and 150 DAS was statistically non significant. Available moisture content was higher in the treatment mung was grown as an intercrop with cotton at 90 and 120 DAS and at 150 DAS it was higher in the treatment in which dhaincha was used as green mulch. Among integrated nutrient management treatments, the available moisture was highest in the treatment F4 receiving 50% N as IN+ 50% N as FYM followed by F3 at 90 DAS. However, at 120 DAS and 150 DAS the treatment F3 and F2 showed higher soil moisture contents at surface soil. No difference was observed in soil moisture contents at lower depth (20-40 cm).

### 2.76

## Nutrient requirement of soybean *Bt* hybrid cotton rotation in participatory mode

### A. RAVINDER RAJU, G. MAJUMDAR, M. K. MESHRAM AND SONIYA THAKARE Central Institute for Cotton Research, Nagpur-440 010

A field experiment was conducted to find out onfarm remedy for red leaf of Bt hybrid cotton, response and input use efficiency of the Soybean-Bt hybrid cotton system during 2008-09. The field experiment consists of 4 fertilizer levels in main plots viz., 75, 100, 125 and 150% recommended dose of fertilizer (RDF) for N bt and Bt hybrid cotton bunny NCS 145 and 7 sub plots such as Control, Zn SO<sub>4</sub> 25 kg ha<sup>-1</sup> year<sup>-3</sup>, Mg SO<sub>4</sub> 25 kg ha<sup>-1</sup> year<sup>3</sup>, Borax 10 kg ha<sup>-1</sup> year<sup>3</sup>, All Zn SO<sub>4</sub>, Mg SO<sub>4</sub>, Borax, S 20 ha<sup>-1</sup> year<sup>-2</sup> applied as split annual applications and foliar spray of 2% Urea / DAP + Mg SO<sub>4</sub> 1% and sub sub plots were 75 and 100% RDF for soybean crop in sequence for estimating residual fertility in shallow and medium deep soils. Similarly, participatory trials were also conducted in two villages of Ralegaon Tehsil, Yeotmal district, each with 24 farmers in medium soils and shallow, sloppy soils to verify the major, secondary and micronutrients response. The results found that farmers fertilizer application in soybean-bt hybrid cotton system was 8-22% N, 9-28% or 100% K<sub>2</sub>O and 22-44% P<sub>2</sub>O<sub>5</sub> was deficient, occasionally exceeding 28% of RDP with DAP fertiliser. The farmers are taking soybean as residual crop. The average soybean yields were 1500 and 2000 kg ha-1 without and with fertilizers with 250 kg ha<sup>-1</sup> response for rhizobium and PSB inoculants broth 0.5% of seed rate. Bt cotton yields were 1200-2000 kgha<sup>-1</sup> depending upon the fertiliser application and management. The seed cotton yields improved linearly up to 1.5 times RDF reaching 1500 and 2000 kg ha<sup>-1</sup> respectively in shallow and medium deep soils at economic level. In station trials seed cotton yields significantly improved with 1.5 times recommended dose of fertilizers. The red leaves were significantly brought down 25% by Mg SO<sub>4</sub> soil application @ 20 kg ha<sup>-1</sup>. The participatory trials also confirmed similar results but the shallow soils with imbalanced fertilization more vulnerable with 30% red leaves reducing yields by 5q ha<sup>-1</sup>. The normal red leaves were 13 per plant only which

were not significantly reducing the seed cotton yields if compensated by producing more green leaves with sufficient soil moisture or nutrients. Mg application, rain water conservation delayed red leaf appearance by late October/ November. The plant analysis found no deficiency of N, P, K, Mg in red leaves. The red leaves photosynthesis was reduced by 1/5<sup>th</sup> compared to healthy leaves. In participatory mode N fertilizer application was significantly correlated with seed cotton yield whereas P and K application was found non significant response for Bt hybrid cotton yield.

### 2.77

## Improving the profitability and resource use efficiency through relay and intercropping in *Bt* hybrid cotton

### A. RAVINDER RAJU, G. MAJUMDAR, SONIYA THAKARE AND J. R. KATORE Central Institute for Cotton Research, Nagpur-440 010

Bt hybrid cotton was relay planted with green leafy vegetables, winter oil seeds, pulses and cereal grain crops in medium to deep black soils with 40% less than normal rain during the year 2008-09. Bt hybrid cotton was paired row planted at 67.5 x 45 cm. The skip row was used for rain water harvesting in monsoon and planted with different relay crops at 45 x 10-22.5 cm in end of September. The time tested relay crops like rabi sorghum, bengal gram, safflower, sunflower, linseed, lentil, peas were grown but could not produce economic yields. The most successful relay cropping was Bt hybrid cotton relay cropped with hybrid castor followed by sunflower planted at 45 x 22.5 cm in end of September. Both castor and sunflower were ready to harvest by January which produced the 3 q ha<sup>-1</sup> castor beans. Bt hybrid cotton based innovative intercropping systems were evaluated during 2007-09 found a confirmation of the feasibility and profitability of Bt hybrid cotton intercropped with legumes like green leafy vegetables, cow pea, radish and cluster bean. The mean seed cotton yields were 1.6, 1.9, 1.79, 1.73 t ha<sup>-1</sup>, net profits were 20, 000; 37, 000; 42, 000; 43, 000 and benefit cost ratio were1.97, 2.95, 4.43 and 5.57 with Bt hybrid cotton alone and inter copped with cowpea, radish and cluster bean respectively.

2.78

### Identification of innovative Bt hybrid cotton based cropping system

## RAVINDER RAJU, A. P. R. BHARAMBE, G. MAJUMDAR, SONIYA THAKARE AND J. R. KATORE

Central Institute for Cotton Research, Nagpur-440 010

Two field experiments were conducted with 12 intercropping systems in shallow and medium deep soils during 2008-09 at Central Institute for Cotton Research, Nagpur. An innovative design for both bullock drawn / tractor plantable paired row for Bt hybrid cotton (67.5 x 45 cm) was designed for planting intercrops and rain water harvesting was developed. The seed cotton yields were not significantly influenced by the addition of cropping systems, however, cotton equivalent yields (CEY) were lowest in spinach + sesamum due to poor grain filling of oil seed crop. Cotton equivalent yields (4396 kg ha<sup>-1</sup>) and net returns (Rs. 98, 425 ha<sup>-1</sup>) were maximum in Bt hybrid cotton intercropped with maize + tomato followed by Bt hybrid cotton intercropped with sweet corn (baby corn) +cow pea (2805 kg ha<sup>-1</sup>, Rs. 65, 117 ha<sup>-1</sup>) and Bt hybrid cotton intercropped with sweet corn (baby corn) +cow pea (2805 kg ha<sup>-1</sup>, Rs. 45, 412 ha<sup>-1</sup>) in shallow soils. Similarly in medium deep soils highest cotton equivalent yields (CEE) 2933 kg ha<sup>-1</sup>, net returns Rs. 61, 870 ha<sup>-1</sup> were with cotton +maize (green cobs) intercropping followed by marigold intercropping (2850 kg ha<sup>-1</sup> Rs. 53, 223 ha<sup>-1</sup>) and spinach intercropping followed by relay cropping of green peas (2507 kg ha<sup>-1</sup> Rs. 52, 675 ha<sup>-1</sup>).

### 2.79

### Meeting the challenge of climate change for food, fibre and fresh water through rain water harvesting and recycling

### A. RAVINDER RAJU, G. MAJUMDAR, SONIYA THAKARE AND J. R. KATORE Central Institute for Cotton Research, Nagpur-440 010

Climate change can bring severe disturbances in monsoon behavior risking the needs of food, fibre and fresh water for human needs as experienced during 2009. Everything can be imported except water for drinking and agriculture needs. Climate change offers the challenge of abnormal behavior of monsoon with severe summers as we are experiencing. Every drought needs to do advance planning of saving rain water. Rain water harvesting was validated in big farm ponds of variable sizes in different soil types were dugged with open well and irrigation system and the economics was calculated. The medium deep black soil were poor in permeability for recharge of ground water render impossible the tube wells. The runoff started only after 30-50 mm of initial rains. In mid july with 80 mm day <sup>-1</sup> rainfall 10-15% of annual rainfall capacity designed farm ponds got first fill subsequent 2-3 fills depend upon the distribution. The initial seepage losses lateral were very high ranging from 10-15% day <sup>-1</sup> of storage reaching a saturation point with predominant losses. Lining of the sides with HDPE sheet or cement mortar is one alternative. Recharging the underground storage aquifers through well or tube well directly from water harvesting ponds needs to evaluated in vertisols with top clay as impermeable layer. Overall the water available for winter irrigations at the end of September and October were 88 and 65% of pond capacity water is available for supplemental irrigations for Bt hybrid cotton with a crop response of 7.5 g ha <sup>-1</sup> for two irrigations at critical stages of seedlings/ flowering as observed in participatory mode. Terminal seedling droughts of August can overcome by supplemental irrigations from farm ponds of 10 hectare catchment with a breakeven of 12 years. Large farm ponds at community level can solve the problem of july seedling drought besides recharging the drinking water wells for summer shortages. The water must have multiple uses of high value crops/ short season fisheries/ duckery or recreation inorder to justify above 1000 M<sup>3</sup>. A discharge of 2.5-5 M<sup>3</sup> hr<sup>-1</sup> with 50 - 150 M<sup>3</sup> day<sup>-1</sup> was available from a recharged well for drinking water in June and May months respectively with 700 mm rainfall which was sufficient for 50 farm families during 2009 summer.

### 2.80

## Effect of *Bt* cotton on soil microbial population under shallow and medium deep vertisols

### K. VELMOUROUGANE Central Institute for Cotton Research, Nagpur-440010

Although a number of studies have been carried out to assess the long term consequences of Bt toxins on soil processes, examples of such studies on cotton are scarce in India. Hence, the present study is taken up to assess whether Transgenic Cotton has any effects on microbial communities and related processes in vertisol under rainfed condition. Two field experiments one each in shallow and medium deep soil have been taken up to assess the impact of Bt cotton on rhizospheric soil microbial community. Three Bt cotton types (Bunny, Ankur and Ajeet) were used in the study along with their counterpart (Non-Bt cotton) with three replications. Observations on general and physiological groups of microbes formed the major activity and the microbial analysis were made at periodic interval from sowing, flowering, boll formation and harvest to study the impact of stages of cotton crop on microbial population. Standard microbiological procedures have been used to enumerate the microbial population from rhizosphere soil. From the study, it was found that there are no much population changes between Bt and Non-Bt cotton in all the stages. However, the flowering stage recoded maximum population compared to other crop stages. The population dynamics found to increase with flowering and go on decline towards harvest. Medium deep soil recorded higher population count as compared to shallow soil. In cotton types, Bunny cotton recorded slightly higher microbial population as compared to BG-II cotton (Ajeet). The general increase of microbial population during flowering may be due to increase in root exudation guantitatively and gualitatively apart from higher moisture availability during that period. The similar trend was observed in crop stage and soil types with physiological groups of microbes in Bt and Non-Bt cotton. Studies are in underway to determine the differences in soil biological properties i.e. soil microbial biomass, basal respiration, soil enzyme activities, nutrient dynamics between Bt and Non Bt cotton in relation to microbial population in vertisols. The detailed results of the microbial population differences between Bt and Non Bt cotton will be discussed in the paper.

### 2.81

## Effect of defoliants and their levels on *Bt* cotton leaf shedding as a pre requisite to mechanical picking

### G. MAJUMDAR, P.S. MAHALE, J. R. KATORE, A.R. RAJU AND A. B. PANCHBUDDHE Central Institute for Cotton Research, Nagpur-440 010

Application of defoliants/harvest-aids is an inevitable operation for efficient and trash free picking of cotton by mechanical harvester. Mechanical picking of cotton with spindle type pickers must necessarily be done on cotton plants completely stopped of leaves in order to ensure that the leaves do not find their way into the harvested cotton. The wet leaves cause discoloration and the dried leaves add to the trash content of seed cotton and the consequently down grade of the cottons. Therefore, the mechanical picking has to be preceded by chemical defoliation of cotton plants, Bunny Bt cotton under rainfed condition sown on 24th June 2008 and spraying of defoliants was on 6<sup>th</sup> December 2008. The experiment was laid out in split plot design having four defoliants i.e. Dropp, Dropp + Roundup, Etheral and Etheral + Roundup in main plot and three concentrations i.e. 3000ppm, 5000pm, 7000pm in sub plot treatments. To check the effect of defoliants on leaf shedding of the cotton plant, 25 numbers of leave has been marked in each net plot. After marking of 25 leaves defoliants has been sprayed according to treatments and consequently leaves were counted two times at 7<sup>th</sup> and 14<sup>th</sup> days after spraying. Finally after the duration of 14 days how much number of leaves has been left was counted and on that basis percentage of defoliated leaves has been calculated. The mean per cent of leaves at 7th day of spraying was 45.80 and at 14th day of spraying was 75.31. The effect of different defoliants on leaf drop was found significant at 7th, 14th days after spraving. At 7th days after spraving maximum leaf drop was recorded after spraying of alone Etheral (56.94 %) which was statistically at par with the combination of Etheral + Roundup (49.88 %). This might be due to the effect of Etheral in combination. Dropp alone and in combination with Roundup shows less leaf drop at initial 7th days as compare to Etheral. At 14th days after spraying also same effect of defoliants was observed. Ethereal alone shows maximum per cent of leaf drop than other defoliants. It is concluded from this that Etheral was best for leaf drop which dropped the leaves 78.67 per cent. Different concentration of defoliants use was found non significant. Comparatively at 14<sup>th</sup> days after spraying highest defoliation was observed at 7000 ppm.

### 2.82 Effect of spacing on plant characteristics amenable to mechanical picking of *Bt* cotton

### G. MAJUMDAR, J. R. KATORE, P. S. MAHALE, A. R. RAJU AND A. B. PANCHBUDDHE Central Institute for Cotton Research, Nagpur-440 010

Cotton plant canopy play important role in mechanical picking of cotton and for modulating that spacing is important. Maintenance of triangular canopy of plant, height of lowermost boll, height and length of monopodial and sympodial branches, are plant characteristics influencing amenability for mechanical picking and can be manipulated by adjusting. In order to study the effect of closer spacing on plant characters suitable for mechanical picking, the experiment was laid out with recommended spacing (90 x 60 cm) and two closer spacing(90 x 30 and 90 x 20 cm). Plant height was maximum in wider spacing 90 x 60 cm (100.94 cm) followed by 90 x 20 cm (100.40 cm) and 90 x 30 cm (94.13 cm). Along row and across the row width of plant was maximum in wider spacing of 90 x 60 cm. due to this wider spacing recorded maximum number of monopodial branches i.e. 3.47. Closely spacing plants showed less number of monopodia and maintained triangular canopy, which is amenable for mechanical picking. Sympodial branches were found more in wider spacing. Height of 1<sup>st</sup> monopodia and sympodia were found maximum in wider spacing but height of lowermost bolls was less. Length of monopodia was more in wider spacing of 90 x 60 cm this may due to the

additional space available for its growth as compared to other two closer spacings. Total number of bolls was maximum in the wider spacing of 90 x 60 cm followed by 90 x 30 cm; this might be due to the maximum number of sympodia present in this wider spacing. Close bolls were also found more in wider spacing than closer spacing. Size of open bolls was found maximum in spacing 90 x 30 cm. Yield per mater and per hectare was found maximum in the closer spacing of 90 x 20 cm i.e. 228.69 g per meter and 2286 kg ha<sup>-1</sup>, followed by 90 x 30 cm i.e. 194.22 g per meter and 1942 kg ha<sup>-1</sup> whereas, wider spacing of 90 x 60 cm recorded less yield i.e. 104.83 g per meter and 1048 kg ha<sup>-1</sup>. Though the per plant yield in closer spacing got reduced, the total yield realized per hectare was more with the closer spacing of 90x20 cm due to more number of plants per unit length of the row. It is concluded that the closer spacing had an effect on compactness of the plants which is more desirable from the point of mechanical picking.

### 2.83

## Fertiliser use efficiency and yield of rainfed *Bt* cotton as influenced by different N sources and soil moisture conservation techniques

### JAGVIR SINGH, SHILPA BABAR, RACHANA DESHMUKH, AND P. R. BHARAMBE Central Institute for Cotton Research, Nagpur-440 010

The productivity of rainfed cotton and consequently nutrient requirement mostly depends upon the amount and distribution of rainfall, moisture reduce holding capacity of soils and its native fertility. To conserve surface run-off water and soil erosion (field studies on different moisture conservation techniques and different N sources were conducted with Bunny Bt hybrid cotton (NCS-145), under rainfed conditions for 2 years, 2007-08 and 2008-09, at Central Institute for Cotton Research, Nagpur. Three moisture conservation techniques were used i.e. opening of furrows in alternate row (M1), green gram intercropped with cotton (M2) and sunhemp as green mulch (M3) in main plot and six different N sources fertiliser viz. F1: 100% RDF on soil test based fertilizer (STBF), F2: 75%N through inorganic + 25%N as FYM, F3: 75%N through inorganic + 25% N as Vermicompost, F4: 50%N through inorganic +50%N as FYM, F5: 50 % N through inorganic + 50% N as Vermicompost, F6: F1+ Fe and B @ 10 kg/ha in sub plots with three replications in split plot design. Total rainfall was 569 mm during the crop seasion which was 59 % deficit to normal rainfall.

The intercropping system as cotton + greengram produced higher yield of seed cotton with an addition of an average of 2.0 q /ha economic yield of greengram. Significant increase in CEY with the intercropping system (1860 kg/ha) was observed over the other two techniques, mulching of sunhemp in cotton (1540 kg/ha) and opening of alternate furrows in cotton (1592 kg/ha) because of an addition yield of greengram, increase in moisture availability in surface soil and control of weeds during the growth period of intercrop in Bt cotton in. With respect to different N sources, the data on CEY was statistically non significant at any source of N fertilisers. However higher yield was recorded in the treatment 75%N through inorganic + 25%N as FYM (1695kg/ha) and with the addition of micronutrients i.e. Fe & B (1694 kg/ha) as compared to other N fertilizers in 2008-09 only. Highest FUE was observed in intercropping system as compared to other moisture conservation techniques. Effect of different N sources fertilizer on FUE was non significant. Higher values of soil available N P K at surface soil were recorded in intercropping system followed by mulching system.

### 2.84

## **On-Farm** evaluation of integrated production technologies on *Bt*-cotton achieving higher returns to cotton growers

### P.R. BHARAMBE, O.S.RAKHONDE, JAGVIR SINGH, M.V.VENUGOPALAN Central Institute for Cotton Research, Nagpur-440 010

Productivity of cotton under rainfed is very low as compared to irrigated cotton, especially in central part of India. The farmers of Viderbha region are not getting adequate income from the cotton. In order to improve the income of the cotton farmers, cotton on 60 acres area of 30 farmers selected in Babhulgaon Tahasil of Yeotmal district was grown with the improved production technologies developed by CICR, Nagpur during 2008-09 under NAIP on: "A Value Chain for Cotton Fibre, Seed and Stalks: An Innovation for Higher Economic Returns to Farmers and Allied Stake holders". The income of the farmers of study area achieved in 2008-09 with the adaptation of improved production technologies was compared to that of 2007 assumed as control. Cotton is the main crop of both groups of the farmers in kharif season. Area occupied by the cotton ranged from 49.52% to 65.8% in Adopters while it was 62.88% in control. Due to the adoption of the integrated

cotton production technology package an additional yield of 6.53 q ha<sup>-1</sup> was obtained over farmers existing practice. FYM application improved the yield of rainfed cotton at both the spacing (75 x 75 and 75 x 60 cm), but its effect was more pronounced at closer (75 x 60 cm) spacing. The mean improvement with FYM application over recommended NPK alone was 20%. Under rainfed conditions, 75 x 60 cm (closer) spacing was superior to 75 x 75 cm spacing providing 18.6% more yield. Adjacent plots with farmer's management formed the control checks. From on farm trials around 359 q of seed cotton yield was produced in 60 acre with the additional income of Rs.12, 000 /- from cotton stalk to the farmers and supplied to CIRCOT under NAIP programme.

### 2.85

### Ergonomically designed cotton picking bags for rural farm women

#### SUNITA CHAUHAN, A.R. RAJU, G. MAJUMDAR, M. K. MESHRAM Central Institute for Cotton Research, Krishi Vigyan Kendra, Nagpur-440010

Cotton picking is one of the most labour consuming operation in cotton cultivation. After the introduction of Bt cotton in India, the requirement for the human labour for cotton picking increased many folds. In India, picking is generally attended by women and the operations of picking and transport of cotton is making drudgery in cotton picking. To overcome the drudgery of cotton picking, human friendly and ergonomically designed cotton picking bags (MAU, Parbhani and CCS, HAU) were evaluated for its suitability in cotton farming. A preliminary trial of ergonomically designed picking bags of CCS, HAU and MAU Parbhani were tested in Hingna and Nagpur tahsil, Nagpur District with local cotton picking method as control. Observation on picking, carrying capacity, ease, comfort, safety, loading and unloading etc. were documented to compare the efficiency of different cotton picking bags. From the study it was inferred that the cotton picking bags and local farm practiced. The picking rate was more in HAU designed bag (5-7Kg) and lesser heart rate (? HR 11.3 beatsm<sup>-1</sup>) of picking farm women was also observed as compared to MAU (? HR 23.3 beatsm<sup>-1</sup>).

### 2.86

## Evaluation of agronomic requirements of *Bt* cotton hybrid under different spacing and fertility levels in rainfed conditions

### S. K. KHAMPARIA, A. UPADHAYA, M. S. SHAH AND R. I. SISODIA Main Cotton Research Centre, RVSKVV, Khandwa-450 001

A trial was conducted at Khandwa (M.P.) for two consecutive seasons of 2007-08 and 2008-09 under AICCIP to evaluate the agronomic requirements of Bt cotton hybrid (RCH-2) under rainfed conditions. The treatments consisted of three plant spacing (90x45,90x60,90x90 cm) in main plot and three fertility levels (90:45:30,120:60:40 and 150:75:50: kg NPK/ha) in sub plot with three replications in split plot design. The results revealed that closer inter plant spacing of 90x45 cm recorded highest average seed cotton yield of 2080 kg/ha which was found to be significantly superior over 90x90 cm during both the years. A reverse trend was observed for number of bolls/plant and boll weight. 25% higher dose of fertilizer (150:75:50 NPK kg/ha) recorded consistent increase in seed cotton yield over 75 % RDF (90:45:30: NPK kg/ha) during both the years but remained at par with RDF (120:60:40 50 NPK kg/ha). On an average the increase in seed cotton yield by RDF was to the tune of 338 kg/ha over 75% RDF but 25% increase in RDF recorded 107kg/ha over RDF. The yield attributing characters also showed an ascending trend with the increase in the dose of fertilizers. It can be concluded that plant spacing of 90x45cm and RDF of 120:60:40 kg NPK/ ha would be quite feasible for Bt hybrid under rainfed conditions of Nimar tract of Madhya Pradesh.
### 2.87 Integrated nutrient management for sustainable production of cotton

### V. C. RAJ, R. R. PARMAR, J. G. PATEL, C. M. SUTARIYA AND V. KUMAR Navsari Agricultural University, Main cotton Research Station, Surat-395007

A field experiment was conducted during *Kharif* seasons of three consecutive years (2004-05 to 2006-07) at Main Cotton Research Station. Surat (Gujarat) on clayey soil having pH 7.20 with organic carbon content 0.50%, available  $P_2O_5$  28.6 kg ha<sup>-1</sup> and K<sub>2</sub>O- 415 kgha<sup>-1</sup> to study the effect of integrated nutrient management on cotton G-Cot. Hy-12. Total eight treatments (T<sub>1</sub>-100% RND through urea, T<sub>2</sub>-75% RND through urea, T<sub>2</sub>-50% RDN through urea,  $T_4$ - 75% through RDN through urea + 10 t FYM ha<sup>-1</sup>,  $T_5$ - 75% RDN through urea + 25% N through oil seed cake,  $T_6$  - 50%RDN through urea + 20 t FYM ha<sup>-1</sup>,  $T_7$  -50 % RDN through urea + 25 % N through oil seed cake and  $T_8$  - 50% through RDN through urea + 10 t FYM ha<sup>-1</sup> + 25% N through oil seed cake) were tested in randomized block design with four replications. The pooled data revealed significant effect of different treatments on growth and yield attributes as well as seed cotton yield and organic carbon content of soil. Treatment  $T_{s}$  (50% through RDN through urea + 10 t FYM ha<sup>-1</sup> + 25% N through oil seed cake) recorded the highest sympodial branches plant<sup>-1</sup> (24) dry matter accumulation plant<sup>-1</sup> (1239g) number of bolls plant<sup>-1</sup> (30) and boll weight (4.16 g) and seed cotton yield (2234 kgha<sup>-1</sup>) being at par with  $T_5$  and  $T_4$  treatments in case of growth and yield attributes and with treatments  $T_4$  and  $T_7$  in case of seed cotton yield. The highest organic carbon content was noticed under T<sub>6</sub> and T<sub>8</sub> treatments while available P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O content remained unaffected by different treatments. It is advisable to fertilize G.Cot.Hy-12 cotton with either 75% RDN (180 kg N through urea) + 25% through Castor cake (175kg) or 50 % RDN (120kg N through urea) + 25% N through Castor cake  $(175 \text{kg}) + 10 \text{ t FYM ha}^{-1}$  to obtain higher seed cotton yield with sustained soil health.

### 2.88

# Response of *Bt* cotton to soil and foliar application of nutrients on yield and nutrient concentration

### J. S. BRAR, C. B. SINGH AND B. S. SIDHU

### Punjab Agricultural University, Regional Research Station, Bhatinda-151 601

The field experiments were conducted with Bt cotton at two locations on sandy loam soils classified as Typic Ustochrept to study the nutrient requirement of Bt hybrid In south -western region of Punjab. The treatments consisted of recommended doze of nutrients along with additional nutrients applied as soil and foliar application. The soils were grouped with respect to available potassium and observed that cotton responded to soil application of potassium (60kg  $K_2O/ha$ ) on soil testing medium in available potassium and little response to soil application was observed on soils testing high in available potassium. The foliar application of potassic fertilizer. It was also observed that the depth wise content of water soluble -K and boiling  $HNO_3(non - exchangeable -K)$  of soil was less at one location to another location but had higher content of ammonium acetate extractable K. The plant leaf analysis indicated an average N,P and K content varying from 0.5 to 1.32,0.21 to0.45% and 0.84 to 1.43% respectively, under different treatments.

### 2.89

# Response of cotton to the application of boron on soils varying in calcium carbonate content

#### M. P. S. KHURANA, J. S. BRAR AND U. S. SADANA Punjab Agricultural University, Ludhiana-141 004

Modern agriculture based on high crop yields, intensive cropping, improved crop varieties have caused depletion of soil fertility, more so that of micronutrients. Next to zinc, deficiency of boron is wide spread in India . Its deficiency is found in nearly 30% soils of the country which are highly calcareous, leached and

sandy in nature. According to various sources, about 5-10 percent soils are deficient in available boron in Punjab. Three field experiments on Bt cotton (RCH-134) were conducted, one at farmers field at Moga (Site -1) and two (Sites -2 and Site -3) at the farm of Punjab Agricultural University, Bhatinda to study the response of boron applied through borax (Na, B, O, 10H,O) on soils differing in available boron content and content of calcium carbonate. All the soils were alkaline, course textured and low in organic matter but the available boron content were 0.46 mg kgsoil<sup>-1</sup> at site 1 and 0.54 and 0.56 mg kg<sup>-1</sup> soil at site-2 and site-3 respectively. Considering 0.5 mg kg soil as a critical deficiency limit for available boron, the soil at Site 1 was deficient where as soils at sites 2 and 3 were adequate in available boron content. The calcium carbonate content of the soils differed considerably being 0.5 % at site-1, 8.25 and 10.3 % at site-2 and site-3 respectively. The treatment consisted of soil application of four levels of B (0, 0.75, 1.0 and 1.25 kg ha<sup>-1</sup>). The response in term of seed cotton yield at site 1 was not observed to the application of boron even though the available content of boron in the soil was below the critical limit. This may be attributed to low calcareousness of the soil as this much amount has caused no influence on B availability and input of boron through irrigation water. How ever, there was significant response in term of seed cotton yield to applied boron at application rate of 1 kg/ha at site 2 and 3 respectively even though the soils were adequate in available boron because of presence of high amount of calcium carbonate in these soils. The results revealed that calcium carbonate was the dominant factor controlling the availability of the soils. Therefore, there is need to find critical limit of available B in these types of soils. The second reason may be due to additional supply of B through irrigation. Therefore input of B from this source is to be considered before formulating the response doze.

### 2.90

## Agronomic requirements of *Bt* cotton hybrid under different spacing and fertility levels under rainfed conditions

#### M.S. SHAH AND R.I. SISODIA

#### Main Cotton Research Centre, RVSKVL, Khandwa-450 001

A trial was conducted at Khandwa (M.P.) for two consecutive seasons of 2007-08 and 2008-09 under AICCIP to determine the agronomic requirements of Bt cotton hybrid (RCH-2) under rainfed conditions. The treatments consisted of three plant spacing (90x45,90x60,90x90 cm) in main plot and three fertility levels (90:45:30,120:60:40 and 150:75:50: kg NPK/ha) in sub plot with three replications in split plot design. The results revealed that closer inter plant spacing of 90x45 cm recorded highest average seed cotton yield of 2080 kg/ha which was found to be significantly superior over 90x90 cm during both the years. A reverse trend was observed for number of bolls/plant and boll weight. 25% higher dose of fertilizer (150:75:50 NPK kg/ha) recorded consistent increase in seed cotton yield over 75 % RDF (90:45:30: NPK kg/ha) during both the years but remained at par with RDF (120:60:40 50 NPK kg/ha). On an average the increase in seed cotton yield by RDF was to the tune of 338 kg/ha over 75% RDF and 25% increase in RDF recorded 107kg/ha over RDF. The yield attributing characters also showed an ascending trend with the increase in the dose of fertilizers. It can be concluded that plant spacing of 90x45cm and RDF of 90:45:30 kg NPK/ ha would be appropriate for Bt hybrid under rainfed conditions of *Nimar* tract of Madhya Pradesh.

# 2.91 Interactive effects of genotypes and environment on yield and fibre quality in upland cotton *G. hirsutum* (L.)

### A. D. PATEL, U. G. PATEL AND V. KUMAR

Navsari Agricultural University, Main Cotton Research Station, Surat-395 007

In 8 x 8 half diallel, 8 parents, 28  $F_1$ 's were studied with two checks *viz.*, G.Cot.Hyb 8 and G. Cot. Hyb 10 of *G. hirsutum* (L.) at three locations for genotype-environment effect for fibre quality.Genotype-environment (linear) and deviation linearity were significant for traits under study. The magnitude of G x E (linear) was larger than non linear. The fibre quality trait, 2.5 per cent span length indicated the lack of possibility to predict the performance of genotype across the environments. Fibre uniformity ratio and fibre elongation responded consistently over environment due to their insignificant G x E interaction. The hybrids under study were suitable for poor environments for fibre quality parameters due to below average responsiveness. Considering stability parameters, a parental line GSHV 97/13 and GISV 197 were observed stable for favourable and unfavorable environment, respectively, whereas, among the crosses, SD 3 x GISV 197 and GSHV 97/13 x GISV 197 were superior in all environments. Hence, they should be recommended for commercial cultivation after sufficient testing over environments for wider adaptability.

### 2.92

# Studies on soil plant narrations in intercropped *kharif* legumes with *Bt* cotton under rainfed condition

#### P. S. SOLUNKE AND J. G. THOKALE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

A field experiment was carried out during *kharif* season of 2007-08 on clayey soil under technology mission on cotton project at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth., Rahuri (M.S.) to find out the best profitable Bt cotton based intercropping system under rainfed condition. Experiment results revealed that among intercropping of various legumes with Bt cotton, intercropping of Bt cotton + Soy bean (1:1) recorded significantly more seed cotton yield (17.83 q ha<sup>-1</sup>) closely followed by intercropping of Bt cotton + Green gram (1:1) i.e.(16.93 q ha<sup>-1</sup>) as compared to sole Bt cotton (15.25 q ha<sup>-1</sup>). All the intercropping of Bt cotton + Green gram (1:1) was recorded maximum cotton equivalent yield i.e. CEY (21.37 q ha<sup>-1</sup>), gross monetary returns (Rs. 23,151 ha<sup>-1</sup>) and B:C ratio (1:1.89) closely followed by treatments of Bt cotton + Soy bean (1:1), Bt cotton + Cluster bean (1:1), Bt cotton + Cowpea in paired row and Bt cotton + Black gram (1:1) intercropping, respectively as compared to sole Bt cotton.

### 2.93

## Response of *Bt* cotton (*Gossypium hirsutum* L.) for integrated rain water and nutrient management

### E. NARAYANA, D. APARNA, MRIDULA GEORGE and CH. MALLIKARJUNA RAO

### Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam Farm, Guntur-522 034

A field experiment was conducted during *kharif* season of 2007-08 at Regional Agricultural Research Station, Lam to study the effect of integrated rain water and nutrient management for improvement in productivity and fiber quality of Bt. cotton. Opening of an alternate furrow at last interculture  $(S_1)$  recorded the highest seed

cotton yield with increased number of sympodia, bolls / plant, BCR (3.42) and higher seed index (11.7 g). Application of RDF based on soil test values plus two sprays of 2%  $KNO_3$  each at flowering and boll development stage recorded the highest seed cotton yield (4550 kg ha<sup>-1</sup>) which was closely followed by 75% in organic and 25% organic in the form of well decomposed FYM (4490 kg ha<sup>-1</sup>). CUW increased by raising sunhemp as green manuring crop in 1:2 ratio which attributed for higher GOT (34.9%) but oil content was declined by 1%. No quality parameter has been influenced by any of the treatments under rainfed condition.

### 2.94

# Performance of cotton varieties (*Gossypium arboreum* L.) under different spacings and nitrogen levels in black cotton soils of coastal Andhra Pradesh

E. NARAYANA, D. APARNA CH. MALLIKARJUNA RAO and MRIDULA GEORGE

Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam Farm Guntur-522 034

A field experiment was conducted at Regional Agricultural Research Station, LamFarm, Guntur under rainfed condition during *kharif* 2007 with an objective to find out the optimum spacing and nitrogen level for pre released cotton variety *viz.*, GAM 93 with check entry Aravinda. Closer row spacing of 90 x 60 cm with 120 kg N ha<sup>-1</sup> was found to be optimum for both the varieties. Further increase to 150 kg N ha<sup>-1</sup> or decrease to 90 kg N ha<sup>-1</sup> of the fertilizer levels declined economic returns. Quality of the fiber was not influenced by either spacing or fertilizer application under rainfed condition in black cotton soils. 105 x 60cm spacing and N levels up to 120 kg N ha<sup>-1</sup> recorded significantly higher seed index. Lint Index and GOT (%) showed declining trend with increase in N doses.

### **CROP PROTECTION**

### **ORAL PRESENTATIONS**

### 3.1

# Impact of *Bt*-cotton in different management modules under rainfed agroecosystem

#### G. M. V. PRASADA RAO, N. V. V. S. D. PRASAD, A. D. G. GRACE AND M. GOPINATH Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station Lam, Guntur-522 034

A field trial was laid out at institute farm, Regional Agricultural Research Station (ANGRAU), Lam, Guntur, Andhra Pradesh, to find out the impact of Bt technology (Bt cotton containing Cry1Ac) on bollworms incidence and yield over its non-Bt counter part (NBt-cotton) during 2006-07 and 2007-08 crop seasons under different management modules viz., Integrated Pest Management module, Insecticide Spray module and Check module (no intervention). By adopting the Bt technology, on an average, percent reduction in square damage due to *Helicoverpa armigera* ranged from 78.8 to 89.3. Similarly, percent reduction in open locule damage due to *Pectinophora gossypiella* ranged from 91.0 to 94.3 in different modules, highest reduction was observed in check module. Maximum advantage was observed in realization of higher kapas yield per ha. Due to Bt technology, additional kapas of 795 kgs / ha was realized in check module, followed by 472 kgs / ha in IPM module in comparison with non-Bt counterparts. Hence, it is evident that Bt technology has been successful in reducing the damage due to bollworms and realizing more kapas yield per ha.

### 3.2

# Bio-ecological studies on solenopsis mealy bug, *Phenacoccus solenopsis* Tinsley (Hemiptera : Psuedococcidae) on cotton

#### RISHI KUMAR, VIJANDER PAL, RAHUL CHAUHAN AND SARWAN LAL JAT Central Institute for Cotton Research, Regional Station, Sirsa, 125055

The biology of the *Solenopsis* mealy bug, *Phenacoccus solenopsis* Tinsley was studied under poly house conditions on potted cotton plants during 2008-09 at Central Institute for Cotton Research, Regional station, Sirsa. The female laid eggs in covered ovisac under its body. The number of ovisac varied on an averge from 2-4 per female. The mealy bug was found as a prolific breeder with mean reproductive potential based on crawler production per female in a range from 289 to 517 on cotton. The numbers of nymphal stages recorded were 3 both in female and male (two nymphal instars and a cocoon). Both 1<sup>st</sup> and 2<sup>nd</sup> instar mealy bug lacked mealy wax secretion. The first instar mealy bug / crawlers lacked permanent feeding site because of high motility. The total nymphal duration in case of male and female was 13-15 days and 14-19 days respectively. In the last instar female nymph the appearance of mealy wax scale covering entire body was observed but in male secretion of cocoon (puparia) was observed leading to emergence of short lived winged males with two long waxy caudal filaments at the posterior whose longevity were 4-6, 4-8 and 3-6 days respectively. The longevity of males and females was 1-1.8 days and 13-16 days, respectively. The correlation between the mealy bug populations with abiotic factors and its vertical and horizontal rate of dispersal was also studied in cotton.

# **3.3** Exploitation of induced resistance in cotton pest management.

### S. KRANTHI, K. R. KRANTHI, V. NAGRARE, S. KADU AND N. N. ZADE Central Institute for Cotton Research, Nagpur-440 010

Host plant resistance is governed by constitutive resistance in cotton. Mechanisms of constitutive resistance have been elucidated and their influence on the major insect pests has been well documented especially before the introduction of Bt. In the pre-Bt era, breeding for insect tolerant cotton involved the use of resistant sources. Limited success was obtained due to several reasons one of which is that the expression of constitutive factors is multigene controlled. Resistant or tolerant sources although resistant or tolerant in the field often failed the screening test under lab conditions. Bioassays with constitutive factors have revealed that the cotton bollworm, Helicoverpa armigera has a high level of tolerance to them. Gossypol is regarded as the most effective allelochemical against the bollworms. High expression levels seen in the leaves and fruiting parts are often insufficient to exercise adequate control of the pest. Induced resistance in cotton and mechanisms governing it has been well elucidated in crop plants, including cotton although intensive research in this area is barely a decade old. With the introduction and large scale cultivation of Bt cotton the bollworms have been restrained while sucking pests continue to damage Bt cotton. In addition we have a new spectrum of emerging pests like the mealy and mirid bugs and thrips that damage Bt cotton whose loss estimates are seen to vary year after year. Jassids that caused 13-25% avoidable losses on conventional cotton continue to damage Bt cotton. In fact management of the emerging sucking pests is a great challenge to realize the full yield potential of Bt cotton.

The herbivore induced resistance pathway has demonstrated that several products, often as breakdown end products of linolenic acid through the lipoxygenase pathway have been documented. These end products are often volatile in nature, are released into the environment and essentially benefit both the emitter and the receiver. Taking the example of one end product, methyl jasmonate this is a volatile released from the nectaries of the cotton plant. It serves to attract the natural enemies of the pest to the crop thereby aiding in its defense. For the induced resistance pathway to work, an inducer is essential. The inducer may be a chemical elicitor or prior herbivore damage, preferably damage by chewing insect.

The concept of constitutive resistance factors for direct use as sprays in pest management was never exploited as it was uneconomical and subject to breakdown before being ingested by lepidopterans. With the advent of Bt cotton, bollworm incidence and damage are low. The concept of exploitation of induced resistance was therefore formulated so as to have eco-friendly cost effective management strategies for sucking pests. We chose to test methyl jasmonate the commercial analogue of which is available in jasmine perfume. Different methods of application were tested and it was found that this synthetic analogue was most effective as a spray. Its efficacy against sucking pests. bollworms, and coccinellids was tested as topical, or by releasing test insects on treated surface under controlled conditions. That its use steps up host plant resistance by inducing Lipoxygenace enzyme of the induction pathway has been demonstrated. This paper suggests the use of induced resistance factors that are eco-friendly and that can be employed for crop protection especially against sucking insect pests on Bt cotton. It also explores for alternate sources of the products of the induced resistance pathway that are simpler to use. Like all other analogues, development of resistance in the target insect pest is a perceivable problem and its use is governed by precautions that govern the use of botanicals as sprays.

### 3.4 Management of bacterial blight of cotton through bio agent

### H. J. KAPADIYA, R. P. LAKHTARIA, B. A. KUNADIA AND M. D. KHANPARA Junagadh Agricultural University, Regional Cotton Research Station, Junagadh-362 001

Cotton is an important cash crop in Saurashtra region next to groundnut. Among the diseases bacterial blight is the major disease in Gujarat. Ten treatments with three frequent sprays on 30, 60 and 90 days after sowing (DAS) was carried out for management of bacterial blight disease. Observations were recorded from randomly selected five plants of each treatment in terms of 0 - 4 grade and worked out Percent Disease Intensity (PDI). The yield of seed cotton was recorded from net plot area. Pooled data from 3 years revealed that, seed treatment with Pseudomonas fluorecens  $Pf_1$  @ 10 g/Kg seed + soil application @ 2.5 Kg/ha; followed by seed treated with Pseudomonas fluorecens  $Pf_2$  (CHAO) @ 10 g/kg seed + soil application @ 2.5 kg/ha at the time of

sowing; seed treated with  $Pf_2$  @ 10 g/kg seed + foliar spray @ 0.2 % and seed treated with  $Pf_1$  @ 10 g/kg seed + foliar spray @ 0.2 % on 30, 60 and 90 DAS were found significantly superior in reducing the bacterial leaf blight disease of cotton as compared to control and other treatments

### 3.5 Effectiveness of IPM packages in *Bt* cotton in Marathwada region

#### **B. B. BHOSLE, B. V. BHEDE, D. D. PATAIT AND N. R. PATANGE** *Marathwada Agricultural University, Parbhani-431 402*

An experiment was conducted to develop IPM package in cotton during 2007-08 at Sunegaon Tq. Loha Dist. Nanded. Bunny Bt variety was sown at 90 x90 cm<sup>2</sup> on 1 acre plot each for IPM and Non-IPM treatments. The observations on sucking pests, bollworm damage and natural enemies were recorded and economics of IPM and Non-IPM calculated. In Bt IPM condition mean sucking pests incidence viz; aphids, jassids, thrips, & whiteflies were 7.46, 1.23, 10.2 & 2.25 per plant respectively, compared to non-IPM i.e.11.66, 2.26, 17.18 and 4.82 per plant, respectively. However, percent fruiting bodies damage by bollworms was 1.35 and 2.37 percent for both the conditions respectively. The mean pink bollworm larvae recorded per 100 bolls were 8 in IPM plot and 14 in non-IPM plot with 2.81 and 4.76 percent locule damage respectively for both the conditions. The mean population of natural enemies viz; ladybird beetle, Chrysopa, Syrphid fly and Predatory spiders were 4.72, 1.04, 0.65 and 0.73 for Bt-IPM respectively & for Bt non-IPM it was 3.12, 0.61, 0.46 and 0.60 respectively. The cost-benefit ratio recorded for IPM and non-IPM condition was 1: 1.52 and 1:1.01 respectively.

# **3.6** Incidence and severity of diseases on *Bt*-cotton hybrids in the Punjab

### DALJEET SINGH AND J. S. BRAR

### Punjab Agricultural University, Regional Station, Faridkot-151 203

Cotton is the first successful trend setting example of commercialization of Bt transgenic technology in the country. Since 2006, Bt cotton hybrids namely RCH 134, RCH 308, RCH 314, RCH 317, MRC 6301 and MRC 6304 have been recommended for general cultivation in the Puniab. These hybrids were attacked by diseases and other physiological disorders like parawilt and tirak alike non-Bt cotton varieties and hybrids. As far as diseases like cotton leaf curl, bacterial blight, fungal foliar leaf spots are concerned, there was no difference in the symptoms and their control in Bt and non-Bt American cotton hybrids/cultivars. A survey was conducted during 2006-07 and 2007-08 in cotton growing areas of the state, to record the disease incidence and severity on Bt transgenic cotton hybrids. In 2006, CLCuD was found in traces to 45 % with grade 3 severity, 15% with grade 3 severity; and 2% with grade 3 severity on hybrids RCH 134 Bt, Ankur 2534, and MRC 6301 Bt, respectively in the areas of Bathinda, Faridkot, Muktsar, Ferozepur and Mansa district. However bacterial blight and fungal foliar leaf spots were found in traces to severity grade 2 in different villages of these districts. Para wilt was found in traces to 5% on RCH 134 Bt in the villages of Faridkot district. During 2007, CLCuD incidence was 22% (grade 3 severity), 19% (grade 3 severity), 45 to 60% (grade 3 severity), 10% (grade 3 severity) and 25 to 50% (grade 3 severity) in hybrids RCH 134 Bt and RCH 314 Bt in the areas of Bathinda, Mansa, Faridkot, Muktsar and Ferozepur districts respectively. Bacterial blight and fungal foliar leaf spots were found with grade2 severity in these hybrids in all the villages of Bathinda, Mansa, Faridkot, Muktsar and Ferozepur districts. The incidence of parawilt varied from 4 to 40% in hybrid RCH 134 Bt at farmer's fields in Faridkot district. Emerging disease such as CLCuD, bacterial blight, fungal foliar leaf spots and para wilt on Bt transgenic cotton to be monitored. Appropriate management strategies for sustainable use of Bt transgenic technology in the state, need to be developed.

### 3.7 Effect of different chemicals applied by seed or stem smearing techniques on sucking pest of *Bt* cotton

### S.M.THAKARE, BHARTI DHOBLE AND A. S.THAKARE

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola 444 104

Evaluation of the effect of stem smearing and seed treatments against sucking pests on Bt cotton, revealed stem application to be superior over seed treatments. Stem application of monocrotophos @ 1:4 dilution, thiomethoxam @ 1:20 dilution and acetamiprid @ 1:20 dilution at 15 and 30 days after emergence were found to be better treatments in reducing the aphid population to the tune of 18.40 to 21.53 numbers per leaf. Among the seed treatments imidacloprid @ 10 g kg<sup>-1</sup> seed was found comparatively better over other seed treatments in recording lower population of aphids. However the most effective treatment was thiomethoxam (ST) @ 4 g kg<sup>-1</sup> seed and monocrotophos (SS) @ 1:4 dilution at 15, 30 and 45 DAE as stem smearing against jassids, followed by thiomethoxam (ST) @ 4 g kg<sup>-1</sup> seed and monocrotophos (SS) @ 1:4 dilution at 15, 30 and 45 DAE. Stem application of imidacloprid and acetamiprid @ 1:20 dilution thrice at 15, 30 and 45 DAE proved next effective against jassids recording only 0.76 number of jassids per leaf.

Stem application of monocrotophos @ 1:4 dilution at 15, 30 and 45 DAE was most effective, followed by the stem application of imidacloprid @ 1:20 dilution and twice application of imidacloprid @ 1:20 dilution and monocrotophos @ 1:4 dilution at 15 and 30 DAE against thrips. For the management of whiteflies on cotton, stem application of monocrotophos @ 1:20 dilution at 15, 30 and 45 DAE emerged as most effective and recorded lowest (0.49 /leaf) population, followed by the stem application of imidacloprid at 15, 30 and 45 DAE and seed treatment of thiomethoxam @ 4 g kg<sup>-1</sup> seed.

### 3.8

# Population dynamics of mirid bug, (*Creontiades biseratense* Distant) (Hemiptera: Miridae) on *Bt* cotton

#### M. BHEEMANNA, A. C. HOSAMANI, S. G. HANCHINAL, B. V. PATIL AND SHARANABASAPPA University of Agricultural Sciences, Regional Agricultural Research Station, Raichur-584 101

India ranks first with respect to area under cotton, it stands third in total production after China and USA and the productivity is low on account of biotic constraints. For management of bollworms Bt-cotton was introduced, that led to reduction in number of sprays. However, minor pests become gained importance as Cry genes had no effect on sucking pests. Among the sucking pest complex, mirid bug Creontiades biseratense (Distant) was a minor pest of cotton and occurs during reproductive stage of the crop. Both nymphs and adults of mirid bug suck the sap from squares and small bolls, leading premature drop. In view of the above reasons the present investigation was undertaken on Bt cotton. Seasonal incidence of the mirid bug, C. biseratense was studied during 2006-08 at Regional Agricultural Research Station, Raichur. Observations on mirid bug population was recorded at weekly intervals from 10 randomly selected plants and number of bugs was recorded on ten squares from each plant under unprotected condition on NCS-145 Bt. Weather data viz., maximum and minimum temperature (°C), morning and evening relative humidity (%), rainfall (mm) and number of rainy days were recorded from meteorological laboratory located at research station. Incidence of mirid bug was recorded from second week of October to second week of February. However, there was a steep increase in the population of mirid bug from last week of October to December third week, recording a maximum population of 11.60 bugs/ 10 squares/ plant. Its population starts declining from fourth week of December to second week of January. From third week of January onwards the pest population starts declining and were extremely scare in the month of March. The population of mirid bug, C.biseratense showed a negative association with maximum temperature (r = -0.39), minimum temperature (r = -0.36) and positive relationship with morning relative humidity (r = 0.34), evening relative humidity (r = 0.19), and rainfall (r = 0.14). 0.39). However, the influences of all weather parameters were found to be non-significant.

### **POSTER PRESENTATIONS**

### **3.9** Effect of age of transgenic *Bt* cotton on survival of *Helicoverpa armigera* (Hubner)

#### H. BASAVARAJA, B. S. CHHILLAR AND RAM SINGH CCS Haryana Agricultural University, Hisar 125004

Studies on the effect of transgenic Bt cotton on survival of *Helicoverpa armigera* (Hubner) at different crop ages were carried out in the Department of Entomology, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India, during 2006. Eleven genotypes including five Bt (Ankur 2534 Bt, Ankur 651 Bt, RCH 134 Bt, RCH 317 Bt and MRC 6304 Bt) and their corresponding non-Bt hybrids with one local hybrid HHH-223 were studied, recommended package of practices was adopted. The survival of first instar larvae of *H.armigera* was observed on top leaves, middle leaves, squares and bolls for five days at an interval of 60, 90, 100, 120 and 140 days of crop age at 28± 1°C in BOD incubator. Significant adverse effect of Bt was observed at 60, 90 and 100 days of crop age in top leaves, middle leaves, squares and bolls. The minimum per cent survival of larvae in transgenic Bt hybrid was observed at 60 days of crop age in top leaves (16.67-20.00 %), middle leaves (13.33-20.00 %), squares (26.67-36.67 %) and bolls (30.00-36.67 %). Similar trend followed at 90 and 100 days of crop age. The effect of Bt at 120 and 140 days of crop age was non-significant from non-Bt and local hybrid HHH-223 with respect to larval survival.

### 3.10 Disease scenario in *Bt* cotton in Andhra Pradesh

### S. L. BHATTIPROLU AND G. BINDU MADHAVI

Acharya N. G. Ranga Agricultural University, Regional Agricultural Research Station, Lam, Guntur-522 034

Cultivation of Bt cotton since its approval in March 2003 led to quick replacement of non-Bt cotton. Further dual gene Bt cotton cultivation is also attracting farmers and area under dual gene Bt cotton is picking up. Under these circumstances an analysis was made to verify the disease scenario in Bt cotton. There is no difference in the occurrence of diseases between Bt and non Bt cottons. Leaf spots caused by Alternaria, Cercospora, Helminthosporium and bacterial blight In recent times grey mildew is gaining a major status. However, the disease occurs at similar intensity on Bt as well as non Bt cottons. In fact, area under non Bt is negligible in farmers' fields. Hence observation on non Bt cotton are limited to cotton plots at RARS, Lam, Guntur.

In Andhra Pradesh Tobacco Streak Virus (TSV) on cotton has been occurring since 2005-2006 and disease incidence has increased from traces in 2005-2006 to 5.0 to 30% during 2008-2009 in Bt cotton on farmers' fields i.e., from 0.2 to 3.4 in 2007-2008 to 2 to 13% in 2008-2009 on non-Bt cotton at Regional Agricultural Research Station, Lam, Guntur. Presence of TSV was confirmed by ELISA. Despite keeping cotton fields weed free, presence of asymptomatic weed hosts, especially Parthenium along the roadsides and vacant lands increased TSV incidence in farmers' fields. Destruction of weed/wild hosts in the vicinity of cotton fields, seed treatment with imidacloprid and timely sprays with systemic insecticides against vector thrips at correct dosage soon after the appearance of the disease helps to reduce TSV infection in Bt cotton.

### 3.11

# Heritability estimates for infestation by mealy bug in *G.hirsutum* genotypes and cytotypes

#### S. L. AHUJA, RITU BALA, D.MONGA, RISHI KUMAR AND BHAJAN LAL Central Institute for Cotton Research, Regional station, Sirsa-12505

To study heritability estimates for the mealy bug infestation in *G.hirsutum* and cytotypes six trials were conducted in randomized block design during Kharif, 2007 crop season. In each trial in the month of August

(peak period for mealy bug infestation) number of mealy bug infested plants was counted for each genotype in each replication and percentage of infested plants were calculated. The trial number 1, 2 and 3 included 12 genotypes of *G.hirsutum* in spacings of 100x10 cm, 100x20 cm and 100x30 cm respectively , the 4<sup>th</sup> trial included 40 genotypes of BrO2a trial of AICCIP whereas the 5<sup>th</sup> trial involved 23 genotypes /selections of *G.hirsutum* of this station. In the 6<sup>th</sup> trial 42 cytoplasmic diverse material developed at this station with cytoplasmic back ground of *G.barbdense, G.tommentosum, G.herknessii, G.longikalyx* and *G. arboreum* were sown. Heritability estimates were;14.3, 15.0, 4.9, 6.2 and 7.7 percent in trials ;1, 2, 3, 4 and 5 respectively indicating that the trait has very low transmission index from one generation to other irrespective of density of plant population. Relatively high heritability was observed for cytoplasmic diverse material (44.5%). This observation indicated that within a genotype the mealy bug infestation has low transmission index and high influence by the environment and between genotype it has high transmission index and is less influenced by the environment.

### 3.12

# Impact analysis of IRM strategies on *Bt* cotton in the irrigated tracts of Tamil Nadu

#### B. DHARA JOTHI, N. GOPALAKRISHNAN, T. SURULIVELU AND T. R. MANJULA Central Institute for Cotton Research, Regional Station, Coimbatore-641003

Insecticide Resistance Management strategies (IRM) were implemented on Bt cotton in the irrigated tracts of Salem district of Tamilnadu during 2006-08. Impact analysis of the study indicated that an effective adoption of the strategies by the project village farmers resulted in effective management of the pests and increased yield and profitability. The average sucking pests incidence (jassids, aphids, thrips and whiteflies), natural enemy population (Coccinellids, spiders and Chrysopa) and boll damage on Bt cotton were 0.51, 0.16 and 1.14% in IRM villages against 2.93/leaf and 0.16/plant and 3.80%, respectively in the control villages. The impact analysis of the project activities indicated that the implementation of IRM strategies in the project villages resulted in reduction in number of insecticidal sprays, quantity of insecticides used and reduction in plant protection cost from 3.26 to 1.44, 903.66 to 388.99 g a.i /ha and Rs.2,638 to Rs.1387/ha respectively. An average increase in yield by 27.13% over non IRM villages with net profit of Rs.41, 318/ha against Rs.26, 248/ha and higher cost benefit ratio of 1:3.54 against 1:2.12 against non IRM villages could be noticed. The success of IRM strategies is further discussed.

### 3.13 Relative incidence of pest complex on different *Bt* and non *Bt* hybrids

#### B. DHARA JOTHI, N. GOPALAKRISHNAN, K. NATARAJAN AND T. R. MANJULA Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Comparative incidence of pest complex and natural enemies on nine different Bt and NBt hybrids were recorded under field conditions, during 2006-08 at CICR, Regional Station, Coimbatore. During the study period, jassid population was significantly high on RCHB708 Bt and NBt and MRC 6918 Bt and NBt no significant difference was recorded in the aphid population among the Bt and NBt hybrids during 2006-07, however RCH20Bt, NBt, RCH 2 NBt recorded significantly high population during 2007-08. Population level of whitefly, coccinellid, spider and percentage of boll and locule damage did not exhibit any significant difference. Incidence of *Pectinophora gossypiella* (PBW) was significantly lower on Bt (0-12.95%) than NBt hybrids (0-29.3%). Among the Bt hybrids ACH-11 and 33 recorded maximum percentage of incidence and larval population. During 2007-08 leaf miner larvae/leaf and total number of mines/leaf were significantly high in RCH 20 NBt (1.96 larvae/leaf and 2.65mines/leaf) and Mallika Bt (1.79larvae/leaf and 2.11mines/leaf) respectively. Overall, a corresponding increasing trend was recorded in the mean population of sucking pests, natural enemies and PBW incidence on Bt and NBt hybrids.

### 3.14 Relative occurrence of leafhopper and assessment of yield loss due to sucking pests in the popular hybrids of *Bt* cotton grown in south India

### T. SURULI VELU, B. DHARA JOTHI AND T. R. MANJULA

Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Seven popular hybrids of Bt cotton (Cry1Ac) were assessed for their reaction to leafhopper, *Amrasca biguttulla bigutiulla* Ishida in Coimbatore during 2006-07 and 2007-08, winter cotton seasons (August to February). The results revealed that MECH 184 Bt was the least preferred by the leafhopper, 3.1 leafhopper /plant (3 leaves) followed by Bunny Bt, (4.57) and RCH 2 Bt (5.40). These three hybrids recorded significantly low population in both the seasons while RCH 20 Bt (5.73) and Mallika Bt (5.80) recorded significantly low population in one of the two seasons. On the other hand, the ELS cotton hybrids viz., RCHB 708 Bt and MRC 6918 Bt were found to be highly susceptible to the leaf hopper and harboured significantly higher population in both the seasons, the mean population being 9.3 and 10.8/plant respectively.

Assessment of yield loss due to sucking pests revealed that the lowest yield loss was seen in MECH 184 Bt (4.22%) while the rest of the hybrids recorded higher reduction in yield ranging from 9.01 to 12.18 percent. The lower yield loss in MECH 184 Bt may be due to the low infestation of leafhopper because of the densely hairy nature of the plant (stem, leaves and fruiting parts) which was not seen in the other hybrids. Yield loss in rest of the other hybrids was as follows: MRC 6918 Bt (9.01%), RCH 2 Bt (9.14%), Bunny Bt (10.34%), Mallika Bt (10.92%), RCH 20 Bt (11.31%) and RCHB708 Bt (12.18%).

### 3.15

# Effect of entomopathogenic nematode-bacteria complex on different stages of *Spodoptera litura* on cotton

### J. GULSAR BANU AND B. DHARA JOTHI

Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Experiments were conducted to determine the effect of three entomopathogenic nematode – bacteria complexes viz., *Heterorhabditis indica* + *Photorhabdus liuminescens, Steinernema glaseri* + *Xenorhabdus poinarii* and *Steinernema siamkayai* + *Xenorhabdus* sp. against different stages of *Spodoptera litura* at different initial inoculum levels. All three entomopathogenic nematode – bacteria complexes were found to be virulent against larval and pupal stages of *S.litura*. In general insect mortality was found to be increase with increase in initial inoculum. Cent mortality of larval stages was recorded at an initial inoculum of 40 IJ / larva. Though 1 three entomopathogenic nematode – bacterial complexes were equally virulent in causing insect mortality, *H.indica* + *P.luminescens* caused quicker mortality within 36 – 48 HAI. Multiplication of *H.indica* was found to increase in initial inoculum of 40 IJ / pupa. These results clearly indicated high degree of infectivity and pathogenicity of entomopathogenic nematode – bacterial complexes to *S.litura*.

# **3.16 Plant parasitic nematodes associated with** *Bt* **cotton**

### J. GULSAR BANU

#### Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

A survey on plant parasitic nematodes associated with Bt cotton was carried out for two years. A total of 10 genera of nematodes were recorded from the rhizosphere of Bt cotton. Out of them seven were plant parasitic, three were fungal and bacterial feeding nematodes. Among plant parasitic nematodes, Reniform nematode, *Rotylenchulus reniformis* recorded the highest absolute frequency of 83 per cent followed by *Hoplolaimus indicus (24), Tylenchus* sp. (21), *Rotylenchus sp(21)., Criconemoides sp.* (12), *Tylenchorhynchus sp. (*7) and *Xiphinema sp.* (8). Among seven genera of plant parasitic nematodes, *Rotylenchulus reniformis* alone was recorded from the roots. Based on community analysis, *R.reniformis* was identified as key pest of Bt cotton. It was observed that *R.reniformis* entered the roots of Bt cotton (Bunny Bt), completes its life cycle and

multiplies well. Histopathological changes due to nematode infection in Bt and non Bt (Bunny) were found to be similar.

### 3.17

# Impact of IRM strategies on productivity, economic viability, equitability and sustainability of *Bt* cotton

### A. S. TAYADE, R. R. GUPTA, S. M. WASNIK, S. S. PATIL, GULBIR SINGH, U. V. GALKATE, S. N. CHAUHAN, P. B. DEULKAR, R. M. KUBDE AND K.R.KRANTHI,

#### Central Institute for Cotton Research, Nagpur-440 010

IRM strategies in Bt cotton were assessed in six tehsils of Nagpur district in farmers participatory mode during kharif season(s) of 2006-07 and 2007-08 to study the impact of IRM strategies on productivity and economic viability of Bt cotton in Nagpur district. The IRM strategies were implemented on 2332 and 1320 cotton grower's fields covering 3262 and 174.12 ha area in 111 and 60 villages of Nagpur district during 2006-07 and 2007-08, respectively. The results of the investigations revealed that there was 12 per cent improvement in productivity of Bt cotton over non IRM practices. Moreover, IRM strategies reduced the numbers of insecticidal sprays in Bt cotton from 3.42 to 1.57. The IRM strategies were found economically viable as well as effective in enhancing gross returns, net returns and B: C ratio of the cotton growers in Nagpur district. The gross return was observed to be more (Rs 31103/ha) in IRM cotton fields as compared to conventional pest management (Rs. 27726/ha). Congruently, the net return was also found to be more (Rs 11209 /ha) where IRM strategies were adopted, whereas it was less (Rs 6148/ha) in case of non adoption of IRM strategies. The C: B ratio was observed to 1:1.57 where IRM strategies were adopted whereas it was 1:1.21 in case of non adoption of IRM strategies. In general, IRM strategies were found highly sustainable as indicated by 93.68 per cent mean sustainability index and this was the primary reason that most cotton growers have shown keen interest in adoption of IRM strategies on their field. The mean equitability of IRM technology is the next important step to enhance productivity and it is the only way to improve the sustainable cotton production. The per cent equitability of IRM technologies was found to be 12.22 per cent while the value was 13.40 percent for non adoption of IRM technologies. It clearly indicates that the IRM technologies were socially equitable and adopted by poor farmers also. This is basically because of fact that the IRM does not involve use of costly insecticides. The low cost sustainable IRM strategies have created greater impact on a wide strata of farming community.

### 3.18

# Managing potential of fungal antagonists against root-knot nematode as affected by in organic fertilizers in cotton

#### K. K. VERMA AND S. N. NANDAL CCS Harayana Agricultural University, Hisar-125004

Root-knot nematode, *Meloidogyne incognita* is a serious pest of cotton in Haryana. Impact of two antagonistic fungi, *Trichoderma viride* and *Gliocladium virens* has proved better in preliminary studies against root-knot nematode in some crops including cotton. The present study was undertaken to see the effect of nitrogen (N), phosphorus (P) and zinc (Zn) fertilizers at recommended doses on these fungal antagonists against root-knot nematode in cotton. These fungi were incorporated in pots having NPZn fertilizers individually or in combination with appropriate controls. The results indicated that *T.viride* managed *M.incognita* at 50 kg P/ha (66.0 galls) followed by 100 kg N/ha (70.0 galls) as compared to no fertilizer or no bio-control fungi (130.0 galls). The growth of cotton plant was also highest in these treatments. Similarly, *G. virens* also showed minimum number of galls at 50 kg P and 100 kg N/ha as compared to other treatments including zinc and no fungi. The number of egg masses was minimum in *T.viride* at 50 kg P/ha followed by 100 kg N/ha while highest number of egg masses was recorded in no fertilizer treatment without fungal antagonists. Similar trend was observed in respect of final soil population of root-knot nematode indicating thereby that P and N at recommended doses enhance the potential of fungal antagonists against *M.incognita* in cotton.

### 3.19 Studies on abiotic factors influencing incidence of major sucking insect-pests on genetically modified (*Bt*) cotton cultivars

### DEEPIKA KALKAL, K. K. DAHIYA AND ROSHAN LAL CCS Haryana Agricultural University, Hisar-125004

Studies on population dynamics of sucking pests on Bt cotton and influence of weather parameters on their incidence were carried out at CCS Haryana Agricultural University, Hisar during kharif 2006. Two Bt genotypes viz., RCH-134 Bt and RCH-317 Bt and their corresponding non-Bt genotypes, one hybrid (HHH-223) and one variety (H-1226) were evaluated. The experiments were laid out under three sets of conditions viz., unsprayed, sprayed for sucking pests and sprayed for sucking and bollworm pests control conditions. Two major sucking pests i.e. leafhopper, *Amrasca biguttula biguttula* (Ishida) and whitefly, *Bemisia tabaci* Genn were recorded from 22<sup>nd</sup> std. week to 41<sup>st</sup> std. week. The results indicated that no significant difference was recorded in sucking pest (cotton leafhopper and whitefly) populations among Bt and non-Bt genotypes. Among the weather parameters, temperature and mean RH showed a positive correlation with leafhopper. Effect of rainfall was favorable for the activity of both whitefly and leafhopper.

### 3.20

# Mealy bug (*Phenacoccus solenopsis* Tinsley) and its survival in cotton ecosystem in Haryana

### R. K. SAINI, PALA RAM, S. S. SHARMA AND H. R. ROHILLA

CCS Haryana Agricultural University, Hisar-125 004

In Haryana, mealy bug, *Phenacoccus solenopsis* (Pseudococcidae: Homoptera) was first recorded in 2006 in Dabwali area of Sirsa District, adjoining Punjab and emerged as a serious pest on cotton in subsequent years. The pest sucks plant sap and its high populations result in stunted plant growth and drying of attacked parts. *P.solenopsis* is differentiated from other mealy bug species by the following characters: presence of two black longitudinal stripes having three prominent dorsomedial spots on abdomen; two black spots anteriorly with sickle shaped line originating from each spot; wax along mid dorsal line up-raised; 9-segmented plumose antennae, and a well developed ovisac ventrally. The body of fully grown female is creamish or light gray in colour but covered with white mealy powder. The pest has both sexual and asexual reproduction.

Monthly surveys of the cotton growing belt of the state in 2007 and 2008 during the active crop season as well as off-season showed that the pest survived on more than 28 species of plants, including some crops like cotton, okra, egg plant, sesame, guar and guava, and some ornamental plants. The most preferred hosts included *Gossypium spp., Parthenium hysterophorus, Trianthema portulacastrum, Xanthium strumarium, Tribulus terrestris, Abutilon indicum, Conyza canadensis, Achyranthes aspara, Chenopodium spp., Hibiscus rosasinensis, Withania somnifera, etc. From July to December, the pest survived on cotton, <i>T. partulacastrum, P. hysterophorus, T. terrestris, A. indicum, C. canadensis, Physalis minima, A. aspara, Chenopodium spp., Helianthus annus, Azadirachta indica, W. somnifera, Datura metel, Peristrophe peniculata and several other unidentified host plants. In January – February, it passed wintered in/on stacks of cotton sticks, <i>C. canadensis, A. aspara, P. hysterophorus and A. indicum.* During March-April, it developed on *W. sominifera*, sprouts from cotton stubbles and *H.rosasinensis*. During May-June, it thrived on early sown cotton, *P.hysterophorus, H.rosasinensis*, etc. During winter the pest population declined drastically but it could survive in low numbers on plants growing under trees and shrubs where adverse effect of low temperature on its host plants was less pronounced.

Sampling and rearing of mealy bug on cotton during August, 2008 and onwards yielded a nymphal parasitoid, *Aenasius* sp. which has been recently named as *Aenasius bambawalei* Hayat (Encyrtidae : Hymenoptera), which caused 5-90% parasitization of this pest in different areas. This parasitoid also parasitized mealy bugs present on other host plants, indicating its great potential for exploitation in biological control.

### 3.21 Integrated control of *Rhizoctonia* root rot of cotton

#### MAHALAXMI KUMARI, INDRA HOODA AND S. S. KARWASRA CCS Haryana Agricultural University, Hisar-125 004.

*Trichoderma viride* was used in integration with reduced doses of bavistin and emisan for controlling root rot of cotton caused by *Rhizoctonia solani* under screen house conditions. Seed treatment with individual fungicide and soil treatment with *T. viride* significantly increased seed germination of cotton in comparison to inoculated control. Integration of antagonist with fungicides further improved germination and it was maximum in *T. viride* + bavistin treatment (76%) followed by *T. viride* + emisan treatment (72%). In all the treatments disease was significantly reduced. Soil treatment with *T. viride* gave 57% disease control which was better than seed treatment with emisan where only 47% disease control was obtained. Bavistin was more effective than the antagonist and emisan and gave 64% disease control. On integration with half the recommended dosess of bavistin and emisan. The disease control efficacy of *T. viride* was increased by 79 and 72% respectively. On integration with half the recommended doses of kavistia and emusan.

### 3.22

# Efficacy of different talc based formulations of *Trichoderma viride* in controlling root rot of cotton caused by *Rhizoctonia solani*

#### MAHALAXMI KUMARI, INDRA HOODA AND S. S. KARWASRA CCS Haryana Agricultural University, Hisar-125 004

Three talc based formulations of Trichoderma viride viz., powder formulation-1 (bajra grain + 0.5% glucose + talc powder + CMC), powder formulation -2 (jaggery + yeast extract + talc powder + CMC) and pellet formulation (bajra grain + 0.5% glucose + talc powder + CMC) were tested for their efficacy under screen house and compared with their respective fresh cultures in controlling root rot of cotton caused by *R. solani* as seed and soil treatments. Fresh cultures of T. viride were more effective than its formulated products both as seed and soil treatments. Maximum disease control was obtained with fresh culture of *T. viride* grown on jaggery + yeast extract medium. It was 80% with fresh culture and only 47% with powder formulation -2 and 37% with powder formulation-1. As soil treatment, pellet formulation was best among all the formulations and gave disease control was 77%. Pellet formulation probably helps in better survival of *Trichoderma* in soil. All formulations were suitable for commercial exploitation.

### 3.23

# Effect of methanolic leaf extract and fractions of *Datura metel* on biological traits of spotted bollworm of cotton

### NEEL J. LIYANAGE, R. CHAUHAN AND RAM SINGH CCS Haryana Agricultural University, Hisar-125004

Methanol extracts of Datura leaves at 2.5, 5.0, 7.5 and 10.0 per cent concentrations and its fractions in hexane, chloroform and acetone at 0.5, 1.0, 1.5 and 2.0 per cent were evaluated against spotted bollworm *Earias vittella* (Fabricius). Contact toxicity of extract/fractions as evaluated by dry film technique indicated 10 per cent methanol extract and 2 per cent hexane and chloroform fraction as most effective treatments. The larval mortality after 4 and 8 h exposures to dry film of these treatments ranged from 53.34 to 66.67 and 76.67 to 86.67 percent respectively. Larval survival on treated food was minimum (43.34%) in 10 per cent methanol extract and maximum (76.67%) in 0.5 per cent acetone fraction. Biological traits of *E. vittella* viz. larval period, pupation, adult emergence and fecundity were adversely affected on account of larval feeding on food treated with extract/fractions for 48 h. Methanol extract (7.5-10.0%) and hexane (2%) also manifested significant deleterious effects on various consumption-utilization indices of larvae. Methanol extract 10.0 per cent and chloroform 2.0 per cent also caused strong larval feeding deterrence of 64.24 and 48.28 per cent, respectively.

### 3.24 Effect of methanolic leaf extract and fractions of *Datura metel* on oviposition behavior of spotted bollworm of cotton

### NEEL J. LIYANAGE, R. CHAUHAN AND RAM SINGH CCS Haryana Agricultural University, Hisar-125004

A study was carried out under laboratory conditions to test methanol extract of *Datura metel* leaves and its fractions (acetone, hexane and chloroform) on oviposition behaviour and hatchability of eggs of spotted bollworm *Earias vittella* of cotton. Addition of extract (2.5, 5.0, 7.5 and 10.0%) and fractions (0.5, 1.0, 1.5 and 2.0%) in sugar solution diet offered to adults caused significant reduction in the number of eggs laid and their subsequent hatching. Minimum number of eggs (76.67) was laid in the treatment of hexane fraction (2%) whereas hatching of eggs was lowest (32.78%) in 10% methanol extract. Number of eggs laid under choice conditions varied from 25.34 (10% methanol extract) to 58.34 eggs (0.5% acetone fraction) on the treated substrate, whereas on untreated substrate, it ranged from 40.34 (10% methanol extract) to 67.67 eggs (0.5% acetone fraction. Under no-choice condition also methanol extract 10% treatment received minimum number (34.34) of eggs. Eggs directly treated with methanol extract (10%) and hexane fraction (2%) manifested 30.83 to 34.17% egg hatchability compared to 74.17 to 83.34% hatching in acetone and water as control respectively.

### 3.25

# Development of bacterial leaf blight in relation to weather parameters and correlation co-efficient

### R. P. LAKHTARIA, H.J. KAPADIA AND M. D. KHANPARA

Junagadh Agricultural University, Regional Cotton Research Station, Junagadh-362 001

Cotton or 'white gold' is a premier cash crop of *kharif* season and one of the prominent eco-industrial crops of India generating sizeable employment. The average productivity of cotton in India is lowest among the cotton growing nations of the world. Bacterial blight of cotton caused by *Xanthomonas axonopodis pv malvacearum* (Smith)/ Dye.is a major disease prevalent throughout the cotton growing areas of the Gujarat. A study was conducted in *kharif 2007-08* at Regional Research Station, JAU, Junagadh. The result indicated that the bacterial blight disease appeared in the first week of September (36<sup>th</sup> std. week) and progressed upto 5<sup>th</sup> week of October (44<sup>th</sup> std. week) in the range of 0.4 to 10.2 per cent and declined thereafter (8.6-3.0%) and ceased by second week (5<sup>th</sup> std. week) of December. Maximum temperature and rainfall both were positively correlated with bacterial leaf blight disease development. Other weather factors viz. relative humidity (morning) demonstrated significant negative correlate as did relative humidity (evening). Rainy days were found negatively correlated to disease.

### 3.26

# Performance of *Bt* cotton entries in relation to pink bollworm (*Pectinophora* gossypiella) in $F_1$ and $F_2$ generations under unprotected condition

### N. K. BHUTE, B. B. BHOSLE, A. V. PAWAR, A. G. BADGUJAR AND S. J. CHAVAN

### Marathwada Agricultural University, Parbhani-431402

A field experiment was conducted during kharif 2005, at the experimental farm of the Department of Genetics and Plant Breeding, Marathwada Agricultural University, Parbhani (Maharashtra).  $F_1$  and  $F_2$  hybrids of 23 Bt and 5 non-Bt hybrids were grown in a randomized block design with two replications. The data recorded on larval population of pink bollworm per boll in Bt and non Bt cotton hybrids revealed that among  $F_1$  hybrids larval population of pink bollworm observed in Bt cotton hybrids ranged from 0.00 to 0.36 larvae/boll and in non Bt cotton hybrids it ranged from 0.20 to 0.60 larvae/boll. However pink bollworm larvae were not

observed in the green bolls collected from 4225 Bt, 4256 Bt, 4253 Bt, 4258 Bt, 4233 Bt, 4234 Bt, 4247 Bt, 4254 Bt, MECH-162 Bt and Proagro-144 Bt, which were found significantly superior over rest of the hybrids except 4220 Bt (0.02 /boll), MECH-6301 Bt (0.04 /boll), 4248 Bt (0.06/boll) and 4237 Bt (0.10 /boll), which were at par with each other. Maximum larval population was recorded in PHH-316 NBt (0.6/boll) which was followed by MECH-184 NBt (0.48/boll), Bunny-NBt (0.40/boll) and NHH-44 NBt (0.36/boll).

Among  $F_2$  hybrids, larval population of pink bollworm observed in Bt hybrids ranged from 0.05 to 0.42/boll and in non Bt hybrids it ranged from 0.38 to 0.68 larvae/boll. Minimum population (0.05/boll) was recorded in Proagro-144 Bt which was found significantly superior over rest of the hybrids except MECH-162-Bt (0.06/boll), 4254Bt (0.10/boll), 4258Bt (0.18/boll), 4248 Bt (0.18/boll) and 4220 Bt (0.20/boll), which were at par with each other. Maximum population was recorded in PHH-316 NBt (0.68/boll) which was at par with MECH-184 Bt (0.52/boll) and Bunny NBt (0.44/boll). Thus  $F_2$  Bt cotton express Bt protein in segregated pattern in which bollworm attack was more as compared to  $F_1$ .

### 3.27

# Impact of IRM based IPM strategies in cotton in Hingoli district of Maharashtra

#### D. S. SURYAWANSHI, B. V. BHEDE AND D. D. PATAIT Department of Entomology, Marathwada Agricultural University, Parbhani-431 402

During 2006-07, IRM based IPM field trials were conducted on 1743 farmers' fields in 15 intensive cotton growing villages of Hingoli district of Maharashtra (India). Villages were selected based on their crop history, pesticide use pattern on cotton and convenience for supervision and implementing IRM based IPM strategies. Data on incidence of sucking pests bollworm damage, population of natural enemies number of insecticide sprays used in IRM and non-IRM fields were recorded. Yield parameters and economics of IRM and non-IRM farmers were studied and impact of IRM strategies on yield and economics has been worked out. The data on incidence of aphids, jassids, thrips and whiteflies revealed that the population of these sucking pests was less in IRM fields than non-IRM. The incidence of bollworm in IRM fields (4.20%) was significantly less than non-IRM fields (8.72%). The population of chrysopids and coccinellids was higher in IRM fields (1.58 and 2.42 / plant) as compared to non-IRM (0.90 and 1.28/plant). The yield of seed cotton was significantly higher in IRM fields (18.06q/ha) than non-IRM (16.07 q/ha). Due to adoption of IRM strategies, IRM farmers could reduce 56.35 % of insecticide sprays and 63.86 % spray cost. IRM farmers gained Rs. 6330.50 additional profit per hectare due to IRM. In all, IRM strategies proved most effective and remunerative to cotton growers of Hingoli district.

### 3.28

## Performance of *Bt* cotton entries in relation to American bollworm (*Helicoverpa armigera*) in $F_1$ and $F_2$ generations under unprotected condition

### A. V. PAWAR<sup>,</sup> N. K. BHUTE, B. B. BHOSLE AND A. G. BADGUJAR Marathwada Agricultural University, Parbhani-431402

The present investigations were carried out during kharif 2006, at the experimental farm of the Department of Genetics and Plant Breeding, Marathwada Agricultural University, Parbhani (Maharashtra) to study the performance of Bt cotton entries in relation to *Helicovarpa armigera* in  $F_1$  and  $F_2$  generation.

As regards the larval population of *Helicoverpa armigera*, among  $F_2$  hybrids minimum larval population was recorded on 5358 Bt (0.22 larvae/plant) which was at par with 5315 Bt (0.23 larvae / plant) and 5356 Bt (0.25 /plant) and found superior over rest of hybrids. among  $F_1$  hybrids minimum larval population (0.06/plant) was recorded on 5358 Bt which was found significantly superior over rest of hybrids except 5315 Bt (0.08/plant) , MECH-184-12 Bt (0.09/plant), 4247-8 Bt (0.09/plant), 4258-16 Bt (0.10/plant) which were at par with each other. In respect of green fruiting bodies damage due to *Helicoverpa armigera*, among the  $F_2$  hybrids minimum damage was observed in 5358 Bt (2.42%) which was at par with 5356 Bt (2.55%) and found superior over rest of hybrids. Among  $F_1$  hybrids minimum damage was recorded in 5358 Bt (1.68%) followed by 5356 Bt (1.86%), 4247-8 Bt (1.87%) and MECH- 184-12 Bt (1.88%) which were at par with each other. As regard

yield of seed cotton, among  $F_2$  hybrids highest yield was recorded in 5315 Bt (18.32 q/ha) followed by 5326 Bt (17.86 q/ha) and 5315 Bt (17.31 q/ha) which were at par with each other and these hybrids were found superior over rest of the hybrids. Among  $F_1$  hybrids highest yield was observed in 5358 Bt (19.16 q/ha) followed by Bunny Bt (18.19 q/ha), 5326 Bt (18.70 q/ha), 5352 Bt (18.32 q/ha), 4239-16 Bt (18.33 q/ha) and 4254-16 Bt (17.96 q/ha) which were at par with each other and these hybrids found significantly superior over rest of the hybrids. Hence, from this investigation, it is concluded that  $F_2$  is segregating generation and shows poor performance in relation to *Helicoverpa armigera* as compared to  $F_1$  generation.

## 3.29 Evaluation of *Bt* cotton hybrids for reaction to foliar diseases

### P. K. DHOKE AND D. B. DEOSARKAR

Cotton Research Station, Nanded, Marathwada Agricultural University, Parbhani-431 402

Total of thirty seven Bt cotton hybrids were evaluated for their reaction against foliar diseases, viz. Alternaria, Bacterial blight and Grey mildew, under AICCIP project during 2007-2008 season at Cotton Research Station, Nanded. The study revealed that twelve genotypes were found moderately resistant, thirteen genotypes were moderately susceptible and one genotype was found susceptible for Alternaria disease. As regards reaction to bacterial blight, three genotypes were found resistant, five moderately resistant and two genotypes were disease free. For grey mildew disease, ten genotypes were found resistant, nine moderately resistant, three moderately susceptible, three susceptible and on disease free reaction. Considering reaction to multiple diseases three hybrids namely Bt1009, Bt1015, Bt1042, were found free from bacterial blight and grey mildew. Thirteen were found resistant to bacterial blight and grey mildew.

### 3.30

## Evaluation of bio-pesticide against mealy bugs, *Phenacoccus solenopsis* (Tinsley) on cotton

### S. B. KHARBADE, P. A. NAVALE, S. S. MEHETRE AND A. G. CHANDELE *Mahatma Phule Krishi Vidypaeeth, Rahuri-413 722*

A field experiment was conducted to study the efficacy of biopesticides against cotton mealy bug, *Phenacoccus solenopsis* at Cotton Improvement Project, MPKV, Rahuri during 2006-074 on cotton cultivar NHH-44 in a randomized block design with seven treatments. The biopesticides viz.; *Verticillum lecani@* 2000 gm/ha, *Metarrhizium anisopliae @* 2000 gm/ha, *Beauveria bassiana @* 2000 gm/ha, EM solution III *@* 2000 ml/ha and Neem oil *@* 2000 ml/ha. Three sprays of insecticides were given at an interval of 10-15 days. The observations on number of mealy bugs/ 5 cm shoot tip length/plant were recorded on 1, 3, 5, 7 and 10 days after each spray. The treatment with *Metarhizium anisoplae @* 2000 gm/ha was observed to be most effective by recording minimum of 87.46 mealy bugs/ 5 cm shoot tip length/plant resulting in to reduction of mealy bugs over untreated control. This treatment was statistically on par with the treatments of Neem oil 2000 ml/ha and Dashparni

@ 10 % in which average of 108.73 and 110. 33 mealy bugs/ 5 cm shoot tip length/ plant, were noticed, respectively. This was followed by the treatments with EM solution III @ 2000 ml/ha, *Verticillum lecani* @ 2000 gm/ha and *Beauveria bassiana* @ 2000 gm/ha in which 118.00, 124.33 and 127.00 mealy bugs/5 cm shoot tip length/ plant were observed, respectively. The higher seed cotton yield of 1521 kg/ha was obtained in a treatment with *M.anisopliae* @ 2000 gm/ha. The untreated control recorded maximum of 322.06 mealy bugs/5 cm shoot tip length/plant with lower seed cotton yield of 913 kg/ha. Therefore, these biopesticidees can be incorporated in the development of ecofriendly Integrated Pest Management modules for cotton mealy bug.

# **3.31** Efficiency of bio-pesticide against major pests on cotton

### S. B. KHARBADE, P. A. NAVALE AND S. S. MEHETRE Mahatma Pule Krishi Vidypaeeth, Rahuri-413 722

Field experiment on efficacy of biopesticides against sucking pests and bollworms on cotton was conducted at Cotton Improvement Project, MPKV, Rahuri during 2006-07. The experiment was conducted on cultivar NHH-44 in a randomized block design with three replications. The observations on infestation of sucking pests/ 3 leaves and incidence of bollworms on square, green boll, open boll and locule were recorded after each spray. Three sprays of pesticides based on ETL were given at an interval of 10-15 days. The treatment with Dashparni @ 14 % was observed to be most effective against sucking pests and bollworms by recording lower number of 14.25, 8.92, 9.53 and 6.92 aphids, jassids, thrips and whiteflies/ 3 leaves, respectively, whereas, square, green boll, open boll and locule damage of 12.14, 14.98, 7.96 and 17.49 per cent was observed, respectively. This treatment was statistically at par with the treatments of NSK 5%, Metarhizium anisoplae (a) 2000 gm/ha and EM soluation III @ 2000 ml/ha. The treatment with NSK 5% recorded aphids, jassids, thrips and whiteffies of 14.89, 9.17, 10.21 and 7.52/3 leaves, respectively with square, green boll, open boll and locule damage of 12.89, 16.11, 18.69 and 17.13 per cent, respectively. The treatment of Metarhizium anisopliae @ 2000 gm/ha recorded 15.68, 9.59, 10.85 and 7.81 aphids, jassids, thrips and whiteflies/ 3 leaves, respectively with 13.13, 15.89, 18.51 and 16.93 per cent square, green boll, open boll and locule damage, respectively. The treatment with EM Solution III @ 2000 ml/ha also found effective in which aphids, jassids, thrips and whiteflies of 16.21,10.73, 12.19 and 9.32/3 leaves, respectively with square, green boll, open boll and locule damage of 15.67, 18.14, 19.33 and 18.79 per cent, respectively. No phytotoxic effect of these pesticides on cotton crop at the evaluated doses was recorded.

### 3.32 Evaluation of IPM module in *Bt* cotton

### P. R. ZANWAR, D. B. DEOSARKAR, L. T. SHELKE, S. J. CHAVAN AND G. A. YADAV Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

The IPM module was evaluated during 2007-2008 in Bt Bunny at Cotton Research Station, Nanded on one acre. Components of IPM module were clean up campaign and ploughing of land in March/April, sowing of border rows of maize + cowpea + castor and one row of *Sataria*, ETL based spraying of insecticides against sucking pests, spraying of 5% NSKE at 105 DAS and mechanical collection of larvae and infested plant parts in the month of September. Two sprays of acetamiprid 20 SP @ 2 g and fipronil 5 SC @ 10 ml in 10 litres of water were given against sucking pests. Population of aphids, jassids, thrips, whiteflies and mealy bugs were 7.60, 2.11, 7.14, 2.07 and 2.88 / plant respectively. The predominant natural enemies observed were lady bird beetles and chrysopa with 0.35 and 0.31 population / plant respectively. The square damage was 3.15 per cent. The seed cotton yield was recorded 1483 kg/ha with net profit of Rs.20,553.75. The cost benefit ratio obtained was 1:2.70.

### 3.33

# Population dynamics of key pests on *Bt*-cotton as influenced by meteorological parameters in Punjab

#### A. K. DHAWAN, ANAND ANEJA, JASBIR SINGH AND SARIKA SAINI Punjab Agricultural University, Ludhiana-141 004

Cotton (*Gossypium* spp) occupies an enviable place amongst the commercial crop of India. However, the cotton productivity in the country with 502 kg lint/ha is far less than other countries. Besides other causes, the foremost reason for the low productivity is the attack of insect pests. The present study was planned to observe the severity of insect-pest in the fields of South-Western districts of Punjab i.e. Muktsar, Faridkot and Ferozepur in relation to the weather parameters. The infested fields were selected from 190 villages selected

under Insect-Pest Resistance Management Project in all districts and mean number of whitefly, jassid and tobacco caterpillar was worked out for the every meteorological week (From 30th to 38th week). The numbers of whitefly and jassid were counted from three fully developed leaves from top and tobacco caterpillar count was taken from whole cotton plant. Correlation coefficients were calculated between numbers of whitefly, jassid, tobacco caterpillar and meteorological parameters. Step wise regression analysis was conducted between pests and meteorological parameters. Very low incidence of jassid and tobacco caterpillar was found from 30<sup>th</sup> to 38<sup>th</sup> meteorological week in all the districts. The average number of jassid and tobacco caterpillar found was 0.9 and 0.4 (Muktsar), 1.1 and 0.5 (Ferozepur) and 1.8 and 0.8 (Faridkot), respectively. The highest number of whitefly (7.3, 1.9 and 2.9) was found in 35<sup>th</sup> meteorological week in Muktsar, Ferozepur and Faridkot districts, respectively. Population dynamics of the tobacco caterpillar whitefly and Jassids was negatively correlated with maximum, minimum and mean temperature in all the districts. In the Ferozepur district a positive correlation was found of whitefly and Jassids with the maximum, minimum and mean temperature. Population dynamics of jassid, and whitefly was negatively correlated with the morning relative humidity, evening relative humidity and mean relative humidity in all the districts. Rainfall had a negative impact on the population dynamics of jassid and whitefly where a negative correlation was found in all the districts a positive correlation was found with population dynamics of tobacco caterpillar in all the districts.

### 3.34

# Influence of various bollgard cotton hybrids on the incidence of insect-pests in Punjab

#### A. K. DHAWAN AND KAMALDEEP SINGH Punjab Agricultural University, Ludhiana-141 004

Field trials were carried out in Puniab to evaluate these Bt cotton hybrids against insect pests of cotton such as bollworm complex, jassids, whitefly, thrips, tobacco caterpillar and natural enemies. On the basis of the data obtained on sucking pests, RCH 308 Bt and RCH 134 Bt registered significantly the lowest population of 0.59 and 0.71 jassid nymphs per three leaves but remain more or less statistically at par with MRC 6301, NCS 138, MRC 6304 and MRC 6029 Bt hybrids. The highest population of jassid nymphs (1.38 nymphs) was observed on JK 1947 Bt hybrid. The white fly population was also lowest in RCH 308 Bt hybrid with 2.05 adults/3 leaves and was significantly superior to the other hybrids tested. The higher population of white fly adults was observed in case of JK 1947 Bt hybrid. Similarly, the thrips population / 3 leaves was also lowest in case of RCH 308 Bt hybrid with 3.11 thrips. On the other hybrids, the population of thrips/ 3leaves varied from 3.27 to 10.34 thrips which remained statistically at par with each other. Similarly the incidence of new pest, mealy bug, per plant was also lowest in RCH 308 Bt hybrid with 0.12 adults but remained at par statistically with RCH 134 Bt, which registered 0.22 adults of mealy bug per plant. Mealy bug population was higher in case of RCH 317, JK 1947, MRC 6301, NCS 138, NCS 913 and NCEH-6 Bt hybrid with 0.61, 0.48, 0.25, 0.45, 0.46 and 0.70 adults per plant, respectively. In case of leaf eating pests, the population of tobacco caterpillar was lowest (0.05 larva/plant) in RCH 308 Bt numerically, but remained at par with all other hybrids tested with values ranging from 0.11 to 0.26 larval populations per plant. RCH 308 Bt hybrid also registered lowest population of grey weevil adult per plant with value of 0.48 per plant but also remained at par statistically with RCH 314 Bt hybrid having 0.60 adults / plant. In other Bt hybrids, the grey weevil population varied from 0.68 to 1.07 adults / plant, being highest in JK 1947 Bt hybrid. There was no population of cotton bollworm complex observed in all the hybrids tested. Similary in case of natural enemies complex (spiders, green lace wing, lady bird beetles) per plant, the highest number of natural enemies were observed in RCH 308, RCH 314, RCH 134, MRC 6301, MRC 6304, MRC 6029, Ankur 2534 and NCS 913 with values ranging from 0.42 to 0.59 adults per plant. The lowest population of 0.23 predator per plant was observed in JK 1947 Bt. From the above results obtained, it was clear that RCH 308 Bt hybrid harbor lowest number of sucking, leaf eating insect-pests and can be adopted in IPM based programmes in Punjab.

### 3.35

## Evaluation of castor as a trap crop in relation to major insect pests in cotton agro ecosystem in Punjab

#### A. K. DHAWAN, BHARATHI MOHINDRU AND KAMALDEEP SINGH Punjab Agricultural University, Ludhiana-141 004

Castor, Ricinus communis L., one of the industrially important oilseed crop, is cultivated in various parts of the world. India ranks as one of the top countries in the world in respect of castor area (7.5 lakh ha), castor seed production (9.1 lakh tonne) and castor yield (1216 kg ha<sup>-1</sup>). Intercropping lowers yield risks because of (a) lower disease and insect pest incidence and (b) greater potential for yield compensation. Trap cropping is the planting of a trap crop to protect the main cash crop from a certain pest or several pests attack. The trap crop can be from the same or different family group, than that of the main crop, as long as it is more attractive to the pest, such as castor around cotton as border row and cowpea in cotton as intercrop for the control of bollworm. It is a well known fact that castor is a good trap crop for Spodoptera litura Fab., Helicoverpa armigera Hubner, jassids, Amrasca bigutulla Ishida and whitefly Bemisia tabaci Gennadius. An attempt was made to grow castor as a trap crop in cotton agro-ecosystem for the better management of cotton pests. Field trials were conducted during 2007-2008 crop season to study the effect of castor as a trap crop in cotton agro-ecosystem in relation to major insect pests of cotton in Punjab. The treatments were 5 rows of Bt cotton, 10 rows of Bt cotton, 15 rows of Bt cotton interspersed each with 1 row of castor, respectively, sole crop of Bt cotton and castor. The experiment was laid in randomized block design and the treatments were replicated thrice. Weekly observations of jassid nymphs and whitefly adults per three leaves, egg masses/ eggs and larvae of Tobacco caterpillar and American bollworm respectively were recorded on cotton with castor, cotton without castor and only castor on whole plant basis. On the basis of pooled analysis in Punjab, the treatment wherein 10 rows of Bt cotton interspersed with 1 row of castor registered low incidence of jassids (0.76 nymphs/3 leaves), whitefly (2.78 adults/ 3 leaves) and tobacco caterpillar (6.84 larvae/plant). The sole crop of castor recorded high population of whitefly (6.43 adults/ 3 leaves) and tobacco caterpillar (28.83 larvae/plant). No egg or larval population of American bollworm was observed through out the cotton-castor season.

### 3.36

# Laboratory evaluation of the effectiveness of bollgard II cotton hybrids against tobacco caterpillar *Spodoptera litura fab* (Lepidoptera : Noctuidae)

#### A. K. DHAWAN, KAMALDEEP SINGH AND BHARATHI MOHINDRU Punjab Agricultural University, Ludhiana-141 004

The combination of cry2Ab and cry1Ac gene in Bollgard II (BG II) cotton has been permitted for commercial use in USA and in India. BG II provides superior control of lepidopteran pest especially cotton bollworm complex and S. litura, and is expected to have positive implication for resistance management. Keeping in view of the activity of BG II against S. litura, the present investigation was carried out to see the effectiveness of the five hybrids against S. litura in the laboratory. Five hybrids of BG cotton having cry1Ac and cry2Ab genes (Tulsi 4 BG II, Ankur Jassi BG II, MRC 7031 BG II, MRC 7017 BG II, RCH 134 BG II) and one hybrid of non-Bt cotton (MRC 7031), were grown at Entomological Research Farm, Department of Entomology. The newly hatched larvae of F2 generations (2 days old) were used for the bioassay study. Terminal leaves of Bt cotton hybrids viz Tulsi 4 BG II, Ankur Jassi BG II, MRC 7031 BG II, MRC 7017 BG II, RCH 134 BG II and MRC 7031 (Non Bt) were collected from field at 120 days after sowing (DAS) and brought to the laboratory, cleaned with muslin cloth and placed in the petri dishes (10cm diameter) containing solidified agar-agar (for maintaining the moisture). Leaves, bolls and squares at 120 DAS of different cultivars were put in the petri dishes individually and S. litura neonates were released. The petri dishes were kept at  $25 + 2^{\circ}C$  in the laboratory. There were three replications in each treatment with 10 larvae in each treatment. The mortality data were recoded daily. The moribund larvae were also counted as dead. S. litura larvae on leaves, squares and green bolls, RCH 134 recorded the highest 80.00, 90.00 and 83.33 per cent larval mortality followed by Tulsi 4 BGII hybrid that recorded 71.11, 88.89 and 83.33 per cent mortality, respectively. Hybrids, having cry2Ab and cry1Ac gene, fit well fitted into the various IPM programmes for the management of S. litura.

### 3.37 Feeding preference and potential of *Coccinella septumpunctata* L on mealy bug *Phenacoccus solenopsis* Tinsley and aphid *Aphis gossypii* Glover

#### P. S. SHERA, A. K. DHAWAN AND ANAND ANEJA Punjab Agricultural University, Ludhiana-141 004

The present investigation on feeding preference and potential of predator ladybird beetle (*coccinella septumpunctata L.*) adults on mealy bug (*Phenacoccus solenopsis* Tinsley) and aphid (*Aphis gossypii* Glover) was conducted under laboratory conditions at Punjab Agricultural University, Ludhiana under free and no choice tests. Aphids were more preferred (56 %) as compared to mealy bugs (44 %) when both were exposed together to adult of *C. septumpunctata* in free choice test. In no choice test, when aphids and mealy bugs were fed individually to *C. Septumpunctata*, the predation of mealy bugs was 80 per cent after 24 hours; however it increased to 84.7 per cent after 96 hours. The overall consumption of mealy bugs varied from  $24.0 \pm 0.77$  to  $25.40 \pm 0.98$  per day. The mean number of aphids consumed by the predator varied  $26.00 \pm 0.81$  to  $28.00 \pm 0.71$  per day and the per cent predation was 88.7 per cent after 24 hours and it increased to 93.3 per cent after 96 hours. Preliminary studies, thus suggested *C. septumpunctata* could play a vital role as predator of mealy bugs as well as aphids and contribute to their natural control. Conserving the coccinellid species by avoiding indiscriminate use of insecticides against these pests' especially mealy bugs is important.

### 3.38 Seasonal abundance of non-target pests on *Bt* cotton in northern India

#### NAVEEN AGGARWAL AND A. K. DHAWAN Punjab Agricultural University, Ludhiana-141 004

The widespread planting of crops genetically modified to produce Bacillus thuringeinsis Berliner (Bt) toxins for pest control may affect non-target arthropods. Susceptibility of different insect species to Bt protein varies, which may affect pest populations in the field. Aphids, Aphis gossypi (Glover); Thrips, Thrips tabaci (Lindemann.); Mites (Tetranychus spp), Mealybug, Phenacoccus solenopsis (Tinsley) and Spodoptera litura (Fabricius) are important secondary insect pests in cotton fields in northern India. The seasonal dynamics of their mixed populations on a transgenic variety expressing the insecticidal Bt protein CrylAc were compared to seasonal dynamics on similar but nontransgenic varieties from 2005 to 2007. No significant differences were detected between population densities of these pests on normal cotton and transgenic cotton. However, the population of thrips and mites was slightly higher on transgenic cotton in the last two years due to a reduced number of insecticide sprays against lepidopterous pests compared with the number of sprays in the normal cotton. Results also showed that tobacco caterpillar larvae had low susceptibility to Bt cotton. There was no significant difference in larval population densities in conventional and Bt cotton fields. However, the larval populations of the insect on conventional plants treated with chemical insecticides for control of target pest were significantly lower than that in Bt cotton fields. It has also been observed that the total number of insecticide applications on transgenic cotton is much less than the conventional cotton, but in the last two years the number of insecticide applications is drastically increasing because additional applications were required against mealy bugs. These results indicated that the thrips, mites, mealy bugs and tobacco caterpillar have the potential to emerge as pests on Bt cotton.

### 3.39

# Population dynamics of sucking insect pests vis-à-vis weather parameters in Bt cotton

### P. S. SHERA, VIKAS JINDAL, NAVEEN AGGARWAL AND JAI SINGH Punjab Agricultural University, Ludhiana-141 004

Bt cotton provides effective management of bollworms but it is not effective against sucking pests which are still posing a great threat to cultivation of Bt cotton. Therefore, present study was an endeavour to know the seasonal abundance and the role of various abiotic factors in population build up of sucking pests on Bt cotton.

The incidence of sucking pests was recorded on Bt cotton hybrid RCH 134 (BGI) at weekly interval (standard weeks) through out the cropping season under unsprayed conditions at two locations in Punjab viz. Cotton Research Farm, Department of Plant Breeding & Genetics, Punjab Agricultural University, Ludhiana and Regional Station, Faridkot during 2007.

Jassid and whitefly were key pests and populations of aphid and thrips were almost negligible throughout the cropping season at Ludhiana. The population of aphid, jassid, whitefly and thrip ranged from 0.0 to 1.4, 0.2 to 7.8, 0.0 to 14.8 and 0.0 to 0.8 per three leaves. The peak population of jassid nymphs (6.3 to 7.8/3 leaves) was recorded in 26<sup>th</sup>, 27<sup>th</sup> and 29<sup>th</sup> standard meteorological weeks (SMW). The population of whitefly adults remained below economic threshold level throughout the cropping season and was maximum during 29<sup>th</sup> SMW (14.8/3 leaves) with significant positive correlation with minimum and mean temperature. At Faridkot, the population of jassid, thrip, whitefly and mealy bug varied from 0.08 to 2.8, 0.0 to 13.4, 2.7 to 8.2 per 3 leaves and 0.0 to 4.8 per 10 cm central shoot, respectively. The peak jassid population was observed during 28<sup>th</sup> to 30<sup>th</sup> SMW (2.6 to 2.8/3 leaves). The population build up was positively and significantly correlated with minimum and mean temperature. Thrip population was maximum (13.4/3 leaves) during 27<sup>th</sup> SMW with positive significant correlation with temperature. Whitefly population remained below ETL level and its peak incidence was observed in the month of September. Mealy bug population started appearing during 30<sup>th</sup> SMW and was highest (4.8/10 cm central shoot) during 40<sup>th</sup> SMW. The population build up of mealy bug was negatively correlated with temperature.

### **3.40 Management of foliar diseases in** *Bt* **cotton through agro-chemicals**

### DALJEET SINGH, C. MOHAN AND H. S. REWAL

#### Punjab Agricultural University, Regional Station, Faridkot-151 203

Cotton is the most important fiber crop and is primarily used in textile industries. The production potential of the crop has not been fully exploited due to several biotic and abiotic factors. The crop suffers from many fungal diseases, of which foliar diseases take a heavy toll. Among the foliar diseases bacterial blight caused by Xanthomonas axonopodis pv. malvacearum and fungal foliar leaf spots caused by Alternaria macrospora, Myrothecium rordium and Cercospora gossypina respectively, are important. In present study, different agrochemicals were evaluated against these foliar diseases, in order to manage these problems. For this purpose the experiments were conducted at PAU, Regional Station, Faridkot for two years 2006-07 and 2007-08 under natural epiphytotic conditions. Recommended package of practices were followed to raise the crop. Six chemicals i.e;  $T_1$ : Propineb (@ 0.2%),  $T_2$ : Propineb (@ 0.3%),  $T_3$ : Propineb (@ 0.4%),  $T_4$ : Copper oxychloride (@ 0.25%), T<sub>5</sub>: Indofil M-45 and T<sub>6</sub>: (Blitox (@ 0.25%) plus Streptocycline sulphate (@ 15 ppm) were sprayed thrice at an interval of 15 days starting from the initial appearance of the disease. Untreated plot was maintained as control. Final observations on the severity were made 10 days after last spray of fungicides adopting 0-4 disease scoring scale. Per cent disease incidence was calculated using Wheeler's formula and finally percent disease control was calculated. All the six treatments were significantly effective in controlling the incidence of foliar diseases over control. The pooled data for two seasons indicated that copper oxychloride plus Streptocycline sulphate treatment reduced 6.1; 7.8; 5.6; and 4.6 per cent disease incidence of bacterial blight, Myrothecium, Cercospora and Alternaria leaf spots, respectively. The highest per cent disease control was recorded in copper oxychloride plus streptocycline sulphate to the extent of 60.5; 55.1; 55.5; and 62.7% of bacterial blight, Myrothecium, Cercospora and Alternaria leaf spots respectively with the highest seed cotton yield (31.9 g/ha). Therefore these chemicals could retain efficacy for longer time and give disease control over extended period of time.

### 3.41

# Chemical management of grey mildew caused by *Ramularia areol* Atk of diploid cotton

### S. W. KHODKE AND B. T. RAUT

Zonal Agricultural Research Station, Yavatmal 445 001

A field trial was conducted during 2003-2004 to 2005-2006 for evaluating the efficacy of different chemicals against dahiya disease of cotton caused by *Ramularia areola Atk*. The disease pressure ranged between 12.53

to 49.63 per cent. Two sprays of Propiconazole (0.05%) stood first and recorded maximum reduction of the disease (49.50%). Tridemorph (0.07%) recorded 19.92 per cent disease intensity while it is equally effective with other test chemical except mancozeb (0.25%) and neem seed extract (5%). Maximum seed cotton yield (7.89 q ha<sup>-1</sup>) followed by (7.18 q ha<sup>-1</sup>) was achieved due to tridemorph and propiconazole treatments, respectively. Thiophanate M (0.2%) and carbendazim (0.1%) recorded 6.90q and 6.89 q ha<sup>-1</sup> seed cotton yield, respectively. Tridemorph recorded highest (CBR 3.97) followed by propiconazole (3.80, CBR) with monetary returns of rupees 4347/- and Rs. 3707/- per hectare, respectively.

### 3.42

# Evaluation of new molecules through foliar spray against sucking insect pests on cotton in north-west Rajasthan

### VICHITER SINGH AND RAMESH CHANDER

### Rajasthan Agricultural University, Agriculture Research Station, Sriganganagar-335 001

Investigations undertaken during Kharif 2006-07 and 2007-08 for two years at Agriculture Research Station, Sriganganagar, Rajasthan to evaluate the efficacy of new molecules against sucking insect pests viz., whitefly, jassid and thrips on cotton in comparison to conventional insecticides viz., acetamiprid 20 SP and triazophos 40 EC revealed that the maximum mean reduction (40.69%) jassid population was offered by Spinosad 45 SC W/W @ 187.5 ml/ha in comparison to check Acetamiprid 20 SP @ 40g/ha (26.87%) and triazophos 40 EC @ 1500ml/ha (20.32%). In case of whitefly, the maximum reduction (29.96%) was recorded in BYI 08330 150 OD applied @ 500ml/ha. Maximum mean reduction in the population of thrips was recorded in the plots treated with spinosad 45 SC WW @ 150ml/ha (44.01%) followed by BYI 08330 150 OD @ 500ml/ha (40.72%). Highest mean seed cotton yield was obtained from the plots treated with BYI 08330 150 OD @ 500ml/ha (29.03q/ha).

### 3.43

# Emamectin benzoate 5% WSG : a safer insecticide for cotton bollworm complex management

### YOGESH PATEL, H. B. SHARMA AND S. B. DAS RVS Krishi Vishwa Vidhyalaya, College of Agriculture, Ganjbasoda, Vidisha-464 221

Uses of chemicals have been recognized as the only practical approach so far, which is available to the farmers for the immediate control of insect pests. Inspite of availability of effective chemical control measures, they have not been used judiciously by the farmers which has resulted in the development of resistance and resurgence. A study was conducted at Regional Agriculture Research Station, JNAU, Khandwa (M.P.) during 2004-05 and 2005-06 to assess the impact of six insecticides namely Emamectin benzoate 5% WSG, Spinosad 45% SC, cyhalothrin 5% EC, Indoxacarb14.5% SC, Profenophos 50% EC and Cypermethrin 10% EC on the predator population i.e. Lady Bird Beetle, Coccinellids and Green lacewings, Chrysopids. Mean predator population i.e. Lady Bird Beetle, Coccinellids and Green lacewings, Chrysopids was low in all the insecticidal treated plots in comparison to untreated control. However among the insecticidal treatments, highest population was recorded in plots treated with Emamectin benzoate @ 8 g a.i. /ha followed by Emamectin benzoate @ 9.8 g a.i. /ha, Spinosad 45 SC @ 75 g a.i. /ha and Spinosad 45 SC @ 100 g a.i. /ha respectively that were statistically significant. The minimum reduction in population of natural enemies Lady Bird Beetle, Coccinellids and Green lacewings, Chrysopids over control, were recorded in plots treated with Emamectin benzoate @ 8 g a.i. /ha followed by Emamectin benzoate @ 9.8 g a.i. /ha, Spinosad 45 SC @ 75 g a.i. /ha and Spinosad 45 SC @ 100 g a.i. /ha respectively. Emamectin benzoate had minimum negative impact on the predator population and may be considered as ideal chemical for use in Integrated Pest Management programmes.

# 3.44 Incidence of yellow mite, *Polyphagotarsonemus latus* (Banks) on *Bt* cotton

### A. C. HOSAMANI, M. BHEEMANNA, SHARANABASAPPA, S. G. HANCHINAL AND SHIVALEELA

#### University of Agricultural Sciences, Regional Agricultural Research Station, Raichur-584 102

Cotton is the most important commercial and natural fibre crop which plays vital role in Indian economy. It is estimated that Bt cotton occupies 76 % of the total cotton area in India. Due to the introduction of Bt cotton the total number of insecticide sprays drastically reduced and it may have led to the outbreak of sucking pests like mirid bug and mealy bug. In current kharif season out break of yellow mite, *Polyphagotarsonemus latus* (Banks) (Tarsonemidae: Acari) was noticed in Raichur taluk. The occurrence of yellow mite on cotton was earlier reported by Channabasavanna and Puttarudriah during 1959. Both adults and nymphs of *P. latus* suck the sap continuously resulting in reduction in size of the leaves and browning. At severe stage, the upward curling of leaves is common and the later leaves turns hard and twisted. Overall growth of the mite infested plants will be severely affected and appears stunted. Roving survey conducted in Raichur taluk of major cotton growing areas clearly indicated high mite population at Matmari village (35.80 mites/ leaf) follwed by Udamgul Khanapur (23.26 mites/ leaf) and Nelhal village (20.13 mites/ leaf) of Raichur Taluk. In Bijnagera and Jambaladinni villages, mite population ranged from 20.15 to 36.20 mites per leaf.

### 3.45

## Effectiveness of *Bt* cotton in pest management as an integral component of IPM

#### YOGESH PATEL AND VINOD KUMAR GARG

#### RVS Krishi Vishwa Vidhyalaya, College of Agriculture, Ganjbasoda, Vidisha-464221

In the present study Bt hybrids RCH-2 was compared as a component of IPM with conventional Cotton hybrids JKHy-1. The field trial was conducted in farmers field, Khandwa (MP) under the Technology Mission on Cotton. Bt hybrids RCH-2 and popular hybrid JKHy-1 were planted in 50 farmers' field. The observations on the population of sucking pest, bollworm and their natural enemies were recorded at weekly interval. Seed cotton yield of each field was also maintained to three pickings. Insecticides were sprayed based on the Economic threshold level the pest. The study clearly showed that the Bt hybrid was found more resistant and able to produce higher yield than conventional hybrid. The pest population and damage due to bollworm were comparatively less in Bt cotton but population of sucking pest were not very much different conventional cotton field. Further, in IPM treated field, both the hybrids i.e. Bt and CC harboured low pest complex population, but the population of beneficial insects was quite higher than non-IPM fields. The results clearly revealed that Bt hybrids accrued higher seed cotton yield in IPM field and also needed less number of sprays.

### 3.46

## Insecticidal toxins from entomopathogenic nematodes for insect pest management- alternate to Bt toxin

#### NANDINI GOKTE-NARKHEDKAR, N. V. LAVHE, ANITA SHENDE AND K. R. KRANTHI Central Institute for Cotton Research, Nagpur-440 010

In recent years extensive use of chemical insecticides for insect pest management has raised environmental and health concerns for all concerned. This has lead to revival of interest in using bio-agents as an option for pest management. The biological control agents as *Bacillus thuringiensis* expressed in transgenic plants has provided efficient management of cotton bollworms. However, the emergence of resistance in crop pests to the well established crystal protein toxins of *B. thuringiensis* has necessitated the search for new molecules with insecticidal properties. Entomopathogenic nematodes (EPN) with their bacterial symbionts offer alternate biocontrol option for insect control.

Insect mortality caused by EPN is attributed to potent complex of insecticidal toxins released largely by the bacterial symbiont of nematode. The bacterial symbiont occurs in two phases- Primary and Secondary. Primary Phase is toxin producing and a good substrate for nematode multiplication while secondary phase is poor producer of toxin. Comparison of protein profiles of primary and secondary phases of *Photorhabdus* 

*luminescens*, symbiont of EPN *Heterorhabditis indica* has revealed several unique bands of proteins that were present in the former but were either missing or expressed in lower concentrations in the latter. Isolation and characterization of toxin protein has revealed the presence of 5 units with 48, 30, 20, 160 21 kDa. These insecticidal proteins besides being effective when injected in insect haemocole also had oral toxicity against *H.armigera*. The toxin gene from EPN will provide further armour in fight against cotton insect pests and serve as the potential transgene for genetic enhancement of cotton for pest tolerance.

### 3.47 Microflora assay from *Bt* cotton seedling rhizosphere

### R. C. UKEY

### Central Institute for Cotton Research, Nagpur-440 010

As the result of observations of 10 to 40 per cent loss in germination of different Bt cotton hybrids in 2008-2009 at CICR Farm, it was thought worthwhile to study the potential biological antagonists in Bt cotton seedlings from its rhizosphere. The different microflora assessed were *Alternaria tenuis, Alternaria microspora, Aspergillus flavus, Aspergillus nidulans, Aspergillus niger, Aspergillus sydowii, Aspergillus sp., Ceratocyst sp., Chetomium sp., Cladosporium herbarium, Curvularia lunata, Fusarium moniliforme, Fusarium oxysporum, Mortieriella sp., Mucur racmosus, Myrothecium sp., Penicillium sp., Phoma exigua sp., Rhizopus oryzus, Steptomyces sp.+, Trichoderma viride, Bacillus substalis+, Pseudomonas sp.+ In assay, in all 23 microorganisms were observed. In these organisms, four fungal organisms, and three bacterial organisms were observed as antagonists to seed and seedling pathogens such as Xanthomonas bacterium, Colletotricum sp., Myrothecium sp., Alternaria microspora, Fusarium and Rhizoctonia sp.* 

The above study is being carried over in Bt cotton hybrids because microflora interacts and affects the growth and development of seed and seedling and also the plants, as well as inhibits the growth and spread of the pathogenic organisms. As such, it was thought important to establish the potency of biological antagonists to enable their formulations for soil, seed and foliar application

# 3.48 Response of *Bt* cotton to foliar disease under field conditions

#### R. R. PERANE, N. B. PAWAR AND P. A. NAVALE Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722

Alternaria leaf blight(ALB), bacterial leaf blight(BLB) and Myrothecium blight (MB) are major diseases on *kharif* sown Bt cotton. The percent disease intensity (PDI) of ALB, BLB, and MB was 10-40 per cent, 5-30 per cent and 0-25 percent, respectively, during 2004-05 to 2007-08. The para wilt incidence was 0-15 percent and leaf-rending intensity was 10-80 per cent on Bt cotton. Forty-two Bt cotton entries were tested under field condition for their response to foliar diseases during 2007-08 at Cotton Improvement Project, MPKV, Rahuri. The foliar diseases viz. Alternaria leaf blight *(Alternara macrospora)* and bacterial leaf blight *(Xanthomonas oxanopodis pv. malvaciarum)* were appeared on the crop 80-90 days after sowing. The percent disease intensity from 0.00 to 36.33 per cent on different entries. Among the forty two Bt entries, seven entries namely KDCHH-665, SP505, Ankur-1950m, Nam Cot-405, KDCHB-407, RCHB-708, KDCHB-5402, DCHB-407 and two entries DCHB-407 and RCHB-708 were free from Alternaria leaf blight and bacterial leaf blight, respectively. Thirty four Bt entries were resistant to ALB and seventeen entries were resistant to BLB disease. The remaining entries were moderately resistant to both ALB and BLB diseases. None of the entries were susceptible to both the diseases.

### **3.49** Need for insect resistance transgenic cotton hybrids with herbicide resistance technology in India

#### P. J. KULKARNI, C. B. CHAPORKAR AND USHA ZEHR Maharashtra Hybrid Seeds Company Limited, Jalna-431203

Bt technology based hybrids have played major role in the increase in cotton production and productivity of India. Majority of cotton is cultivated in three different climatic zones and Bt cotton is being adapted on more than 90 per cent of the total cotton area, much of which is in rainfed conditions. In all cotton growing area weeds are the main limitations for cotton growers. The loss in yield in cotton crop due to weed competition is more pronounced under rainfed cultivation. Herbicide tolerance technology coupled with insect resistance is a new advancement in cotton biotechnology intended to increase yield by allowing effective control of weeds and bollworms. The major challenges for weed control are non-availability of labour during peak period, continuous rain during critical growth stages of cotton crop, which makes it difficult for farmers to manage the weeds by traditional practices. Under these situations, chemical weed control is relevant for obtaining higher productivity and production in cotton. Critical weed free window from planting through 8-10 weeks is extremely important to harvest optimum yields. The transgenic cotton hybrids with herbicide and insecticide tolerance will provide risk free weed control system, reduced labour cost, increased grower profitability and broad compatibility with IPM practices.

### 3.50

# Bio-efficiency of second generation *Bt* cotton genotype against *Spodoptera litura* (Fabricus)

#### S. G. ONKARAMURTHY.Y, K. BASAVANA GOUD AND S. S. UDIKERI University of Agricultural Sciences, Dharwad-580 005

Season long bioefficacy of *Bacillus thuringiensis* insecticidal protein against *Spodoptera litura* (Fabricius) in Bt transgenic, cotton RCH-2 BG-II (carrying Cry lAc+cry2Ab) and RCH-2 Bt (carrying cry lAc gene) were investigated in Dharwad region of Karnataka, India, in 2007-08. The result showed that, the toxin content (larval mortality) in Bt cotton gradually declined with the advancement of the cropping season. Generally, insecticidal protein (larval mortality) levels were high during the early stage of the crop growth, which gradually declined over time. The expression (mortality) of crylAc+cry2Ab protein in RCH-213G-II was significantly (77.76%) high during the whole cropping period compared to RCH-2Bt (8.76% mortality). Thus the second generation Bt cotton genotype RCH-2 136-iI with Cry I Ac + Cry 2Ab found to be effective against *S. litura* a potential threat in cultivation of Bt cotton expressing only for Cry IAc toxin.

### 3.51

## Performance of second-generation Bt cotton hybrids against bollworms in rainfed condition

#### S. G. ONKARAMURTHY, Y. K.BASAVANA GOUD AND S. S. UDIKERI University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted at MARS, Dharwad under rainfed conditions to assess the performance of second generation Bt cotton hybrids expressing Cry 1 Ac +Cry 2Ab toxin genes. Six such BG-II genotypes were compared with two BG-I RCH 2Bt, Bunny Bt (cry IAc) and two non-Bt hybrids in RBD replicated thrice under unprotected condition against bollworm complex. The incidence of *Helicoverpa armigera* (Hub) larvae reached ETL by 80 DAS in non-Bt hybrids viz., DHH-1I and RCH-2. In all BG-II hybrids (MRC-7351, 7201, KDCHH-621, RCH-2, RCH-530, Bunny) larval incidence did not reach ETL. In first generation Bt genotypes with Cry 1 Ac genotypes the bollworms crossed economic threshould level twice. The maximum population observed was 0.5 larvae/plant, whereas BG hybrids harboured >1/plant by 110 DAS. *Earias vittella* (Biosd.) was not recorded BG-II hybrids while it was negligible (0.10 to 0.27/plant) in BG hybrids. In DHH-11 and RCH-2 incidence of E. *vittella* went upto 2.57 larvae/plant at 65 DAS. Appreciable incidence of *Spodoptera* 

*litura* (Fab.) was not noticed in the experimental area. Similarly, the incidence of pink bollworm *Pectinophora gosypiella* (Saund) was also very low in BG-11 cotton compared to BG Bt hybrids in terms of flower rosetting, green boll damage as well as larval population. In conventional hybrids PBW larvae was 1.07 to 1.47/10 bolls leading to >22.2-23.8 per cent locule damage. The over all damage to fruiting bodies was least in BG-II genotypes (3.77 to 5.37%) as against 7.26-8.03 per cent in Bt cotton with cry IAc and 14.92-17.3 per cent in non Bt hybrids.

Thus there was a high degree of protection in second generation Bt hybrids through out the season due to stacked Cry1Ac and Cry2Ab genes. The seed cotton yield was also high in these genotypes as revealed by 20.37q/ha from MRC-735, followed by >19q/ha from MRC-7201, KDCHH-621 and Bunny Bt-2. In BG hybrids RCH-2Bt and Bunny Bt the seed cotton yield was 17.19 and 17.98q/ha, respectively. Conventional cotton in the absence of genetically modified Bt trait yielded about 11 to 12q/ha only.

### 3.52

# Avoidable loss and management of mirid bugs (*Creontiades biseratense* (Distant)) - an emerging threat on *Bt* cotton

### S. S. UDIKERI., K. R. KRANTHI., S. B. PATIL., H. M. SHAILA., P. V. MATTI., G. S. GURUPRASAD., R. B. HIREKURUBAR AND B. M. KHADI

### University of Agricultural Sciences, Agricultural Research Station, Dharwad Farm, Dharwad-580 007

Broad scale adoption of insect resistant GM cotton that offer protection against bollworms and shift towards integrated pest management practices has led to marked reduction in insecticide application and change towards use of more selective insecticides on cotton. But these changes have allowed other pests to survive and emerge as important ones. Thus mirid bugs are emerging as a major pest on Bt cotton. Field experiments were laid out in RBD at ARS; Dharwad to assess avoidable loss due to mirid bugs and to determine the effective control measures for its management. In both experiments Bunny Bt was used as test cultivar. Application of acephate 70SP (Starthane) at 1400,700,350 and 175 gai/ha twice at 15 days interval during peak incidence of mirid bugs exerted differential efficacy leading to population variation. Thus the mean population in the experimental unit ranged from 7.80 bugs (Acephate @ 1400 gai/ ha) to 53.70 bugs (no spray). The highest yield of seed cotton (2770 kg/ha) was harvested from the treatment which received acephate @ 1400 gai/ ha which could suppress the pest to the maximum extent. Thus considering optimum protection rendered, the avoidable yield loss was 290 kg/ha or 11.69 per cent compared to no protection. Different insecticides and biorationals were spraved four times at fortnightly intervals from 40DAS onwards to manage mirid bugs. Acephate 70SP @ 700 gai/ha found to suppress the pest significantly with mean population 9.53 mirid/ 25 squares with seed cotton yield of 3441 kg/ha. Acetamiprid 20 SP and Imidacloprid 200 SL were also found to check mirid incidence effectively.

### 3.53

# Morphological characters and virulence studies of *Sclerotium rolfsii* Sacc. on *Bt* and non *Bt* cotton genotypes

### S. N. CHATTANNAVAR, S. A. ASHTAPUTRE, G. N. HOSAGOUDAR, O. M. BAMBAWALE AND B. M. KHADI

### University of Agricultural Sciences, Agricultural Research Station, Dharwad-580 007

Growth rate of *Sclerotium rolfsii* isolates varied significantly at 6 DAI and isolates U.A.S Dharwad-2 and Lokur were fast growers i.e.@ 8.85 cm. Sclerotia production, size and colour also varied significantly. Garag isolate produced maximum sclerotia (174) followed by Lokur isolate (135). Relatively bigger (2.0-2.5mm diameter.) sized clerotia were produced by U.A.S.Dharwad 1 and 2, Chandanamatti-2, Kallur, Mallapur and Tadakod, isolates. The colour of the sclerotia did not show significant variation. It was mostly dark brown at maturity with an exception of Amminabhavi isolate being reddish brown even after maturity. Among the seventeen isolates tested, Lokur isolate showed least in mean percent germination (13.33%) in two Bt (RCH-2 Bt and Bunny Bt) one non Bt (RCH-2 Non Bt) genotypes, followed by Tadakod isolate (16.67%). Marewad and Lokur isolates had 89.17% mean death of seedlings in two Bt (RCH-2 Bt and Bunny Bt) and one non Bt (RCH-2 non Bt) genotypes, followed by Tadakod isolate (87.50%).

### 3.54 Biochemical studies in *Bt* and non-*Bt* cotton genotypes against foliar diseases

### GOVINDAPPA N. HOSAGOUDAR AND S. N. CHATTANNAVAR University of Agricultural Sciences, Dharwad-580 005

Biochemical studies were carried out on non-Bt genotypes Laxmi, Abhadita, DCH-32 and Bt genotypes RCH-2 Bt, JKCH-1 Bt, JKCH-2 Bt. All the test genotypes were found susceptible to the foliar diseases. The results indicate that non-Bt genotypes recorded high amount of total protein (9.18 to 14.99%) as compared to Bt genotypes, but total phenol (-12.76 to -18.39%), total sugar(-12.17 to-12.22%) and reducing sugar(-10.50 to -19.05%) were at lower concentration compared to Bt genotypes. High amount of non-reducing sugar (2.18%) content at early stage (90 DAS) and low amount (-25.63%) at later stage (120 DAS) were observed in non Bt as compared to Bt genotypes. Further, there was decrease in total protein (-23.41 to -25.38%), total phenol (30.84 to 33.37%), total sugar (23.68 to 34.68%), reducing sugar (26.09 to 29.26%) and non-reducing sugar (-27.99 to -41.44%) was in infected leaves as compared to healthy leaves for foliar diseases under study.

### 3.55

# Screening of American cotton genotypes for reaction to bollworm, sucking pest and major diseases

### A. R. GAIKWAD, D.B. DEOSARKAR AND S.S. BHATADE

### Marathwada Agricultural University, Cotton Research Station, Nanded-431604

An experiment was conducted at Cotton Research Station; Nanded to screen twenty-three cotton genotypes against sucking pest complex using unprotected conditions. One infector row of Bhendi was planted. The genotypes CCHL-S-3, CCHLS-4, P-72-37, BS-111 recorded lowest population of aphids per plant (below 8 aphids per plant) as compared to the check NH-545 (14.6). P-21-15, GSHV-153, F-2178, and AKH-05-05 were on par with check NH-545 with reference to jassids tolerance. The genotypes TCHH-58111, GSHV-154, CCHL-S-3 recorded lowest population of thrips (below 13 thrips per plant) as compared to the check NH-545 (14.77). Whitefly population on three genotypes namely BS-111, RSA-2496 and CCHL-S-3 recorded lowest population of whitefly per plant (less than two whitefles per plant) as compared to the check NH-545 (2.62 whiteflies per plant). Thus the genotypes CCHL-S-3 demonstrated multiple resistance to all the sucking pest. The three genotypes namely BS-111, RSA-2496 and P-21-15 recorded significantly lower infestation (below 8.38%) as compared to check NH-545 (11.26). Genotypes P-72-37, GSHV-153 & F-2164 recorded lowest locule infestation (below 8.3) as compared to check NH-545 (29.41). The genotypes RS. 2468, BS-111, RSA-2496, AKH-05-06, CSH-2572 and CSH-3047 were found promising for multiple resistance to bacterial blight, alternaria and grey-mildew diseases.

### 3.56

## Evaluation of *Bt* and conventional cotton entries against foliar diseases of cotton

# SUDHEENDRA A. ASHTAPUTRE, S. N. CHATTANNAVAR, RAJESH PATIL, G. N. HOSAGOUDAR, K. N. PAWAR, I. S. KATAGERI, S. S. PATIL AND MANJULA MARALAPPANNAVAR

#### University of Agricultural Sciences, Agricultural Research Station, Dharwad Farm, Dharwad-580 007

Three hundred and twenty six entries of Bt and conventional cotton were screened against major foliar diseases under epiphytotic conditions during *kharif* 2007 at Agricultural Research Station, Dharwad with the objective to identify source or sources of resistance. Field screening study indicated that, out of 326 entries evaluated, almost all arboreum lines showed immune reaction to bacterial blight. Among Bt cotton hybrids KCH-135 Bt, DBTHH-01 and in conventional cotton entries LD-8, LD-105, LD-102, DT-109 showed highly resistant reaction to Alternaria blight. Entries H-1287, LH-2076, CPD-814, ADL-903, TCH-1705, RACH-11 showed moderately resistant reaction to bacterial blight and Bt hybrids, viz., ACH-155 Bt, VCH-III Bt, PCH-930 Bt, NCS-950 and NCS-990 exhibited highly resistant reaction to bacterial blight and HHB-5, HHB-6 entries

showed highly resistant reaction to grey mildew. Bt hybrids viz., Kashinath Bt and NCS-990 showed highly resistant reaction to grey mildew, where as RAH-221, RAHH-95, CPD-813, CCH-1831 exhibited moderately resistant reaction, conventional cotton entries DLSa -1004, AK-235, Arb-510, Arb-516, DLSa-1001, 17, 4350502YC, Arb-520-6 and Bt hybrids VCH-III Bt, Tulasi-117 Bt, KDCHH-9810, PCH-2270 Bt, NCS-990, NCHB-992 showed highly resistant reaction to rust disease.

### **3.57 Incidence of mealybug** *Phenacoccus solenopsis* **Tinsley and its natural enemies on cotton in Karnataka**

#### S. G. HANCHINAL, B. V. PATIL, M. BHEEMANNA AND A. C. HOSAMANI University of Agricultural Sciences, College of Agriculture, Raichur-584 101

Survey was conducted during 2008-09 cropping season to assess the level of incidence of cotton mealybug, *Phenacoccus solenopsis* in Karnataka. Incidence was assessed on 0 to 4 scale range. Mealybug population was ranged between 1 to 4 in the Thungabhadra project area (TBP) and upper Krishna project area (UKP), which comprises majority of the irrigated cotton area in the districts of Raichur, Bellary and Gulbarga. In other parts of Karnataka *ie* Haveri, Dharwad and Belgaum districts, incidence ranged between zero to 3 scale. Incidence was severe in some places at the end of the cropping season. Natural enemies were also recorded. Major parasitoids belonged to Hymenoptera in TBP and UKP area. Parasitoids such as *Aenasius bambawalei* Hayat *Homalotylus eytelweinii* (Ratzeburg) *Prochiloneurus pulchellus* Silvestri *Anagyrus dactylopii* (Howard) belongs to Encyrtidae family and *Promuscidea unfasciativentris* Girault belong to Aphelinidae family. Among these *Aenasius bambawalei* was the dominant species.

### 3.58

## Natural occurrence of entomopathogenic fungi in mealy bug, *Phenococcus* solenopsis (Tinsley) (Hemiptera : Psuedococcidae) in India

### J. GULSAR BANU, T. SURULIVELU, M. BALAMURUGAN, M. AMUTHA AND N. GOPALAKRISHNAN

Central Institute for Cotton Research, Regional Station, Coimbatore-641 003

Mealy bugs (Hemiptera : Psuedococcidae) are small sap sucking insects and some species can cause severe economic damage to wide range of crops. Earlier, mealy bugs were considered to be non pests or as major pest in sporadic instances, but now they have become a major threat to cotton production in almost all cotton growing states of India. This exotic pest introduced accidentally created havoe not only on cotton but also on other crops, thereby threatening sustainable agricultural production in India. Several approaches for their control are presently under investigation including microbial agents. In order to get information on the role of naturally occurring pathogens in the regulation of mealy bug population, survey was carried out under farmer's field condition during 2007 and 2008. In infested cotton fields, dead mealy bug , *Phenococcus solenopsis* were collected and brought to the laboratory for the isolation of entomopathogens. These surveys resulted in the recovery and isolation of the following fungi from mealy bug. *Aspergillus clavatus*, *A. oryzae*, *A.terreus*, *Verticillium* sp. and *Lecanicillium lecanii* (Zimm.) Zare & Gams. Among them *L.lecanii* was found to be highly pathogenic to *P.solenopsis* under laboratory condition. At an initial inoculum of 1 x 10<sup>4</sup> conidia mL<sup>-1</sup>, lethal time (LT  $_{50}$ ) was 3.77 and 2.51 days for nymphs and adults respectively. This is the first report on the natural occurrence of entomopathogenic fungi from mealy bug.

### 3.59 Epidemiological studies on bacterial blight of cotton

### RAKESH KUMAR, S. K. GANDHI AND SATISH KUMAR CCS Haryana Agricultural University, Hisar-125 004

Bacterial blight of cotton caused by *Xanthomonas axonopodis* pv. *malvaceraum* is a serious disease and causes enormous losses. Studies were conducted to determine the relationship between angular leaf spot of cotton and weather variables, susceptible cultivar HS-6 was planted on different dates during 2002, 2003, 2004 and 2005 crop seasons. Another cultivar F-846 was planted during 2004 and 2005 crop season only. The field was artificially inoculated with bacterial suspension of 24 hrs. old culture. The disease severity was recorded on standard scale of 0-7, periodically. The data on weather variables corresponding to the disease observation interval were obtained from Automatic weather station. Maximum disease intensity was observed during 2004 maximum disease intensity (46.9%) was observed in the last week of June and thereafter it started declining. However, during 2005 disease did not progress further even in the inoculated plants. Disease progress was faster when maximum temperature. ranged between  $30-35^{\circ}$ C and morning relative humidity >75%. Correlation coefficient was significant and positive with RH (M) and negative with maximum temperature. For prediction of disease, multiple regression analysis was done and regression equations were derived. Based on coefficient of multiple determination (R<sup>2</sup>) values for different years, 56-75% variations in disease development could be accounted.

### 3.60

### Performance of various *Bt* cotton entries against sucking pests

### P. R. ZANWAR, D. B. DEOSARKAR, G. A. YADAV AND L. T. SHELKE

### Marathwada Agricultural University, Cotton Research Station, Nanded-431 604

Sixteen popular Bt cotton entries were screened in replicated experiment against sucking pests viz., aphids, jassids, thrips and whiteflies during *kharif*, 2008-09 at Cotton Research Station, Nanded. The entries VBCH-1503 BG II and KCH-135 BG II recorded lowest number of aphids 0.20 and 0.23 per three leaves respectively. Incidence of jassids 2.13 and 2.43 per three leaves was minimum in Tulsi-4 BG II and SP-499. Bt cultivars VBCH -1505 BG II and SP-1037 BG II recorded lowest of 5.40 and 5.90 thrips per three leaves. Lower population of whitefly 2.63 and 3.10 were recorded in RCH-2 BG II and PRCH-505 BG II respectively. However, highest seed cotton yields 14.03, 12.64 and 11.71 q/ha were recorded from NSPL-999, KCH-135 BG II and NSPL-405 respectively.

# **3.61** Evaluation of new molecules against mealy bug on *Bt* cotton

### NAVEEN AGGRAWAL, VIKAS JINDAL, SATNAM SINGH, SUNEET PANDHER, VIKRAM SINGH AND JAGDEV S. BRAR

Punjab Agricultural University, Regional Station, Faridkot-151203

A total of nine treatments of Spirotetramat and Imidacloprid in mixtures and singly at different doses including two checks (Thiodicarb 75 WP (Standard Check) 750 g ai/ha (Larvin75 WP) and Profenophos 50EC) were compared to test their effectiveness against mealy bug infestation on RCH 134 Bt cotton in 2007 at farmer's field. After first spray Profenophos 50 EC (check) recorded the highest (70.05%) mortality over control and was the most effective treatment. Spirotetramat 150 OD (24 g ai/ha) was the effective treatment at 7 DAS with 52.04 per cent mortality over control and further it was at par with Imidacloprid 200 SL (72 g ai/ha) (55.45%), Spirotetramat 150 OD (36 g ai/ha) (57.38%), Imidacloprid 200 SL (108 g ai/ha) (57.57%) and Spirotetramat BYI 08330 150 OD (93.75 g ai/ha) (57.76%). However, both the checks were on par with each other and proved superior over other treatments in terms of the percent mortality.

Both the checks remained on par with each other after 2<sup>nd</sup> spray again however, at 3 DAS Profenophos 50 EC (check) recorded 93.73 per cent mortality over control and was on par with Spirotetramat 12% + Imidacloprid 36% 480 SC (36+108 g ai/ha) (85.09% mortality) and Thiodicarb 75 WP 750 g ai/ha (84.48% mortality).

Similar trend was observed at 7 DAS with Profenophos 50 EC recording the highest (98.18%) mortality over control and further at par with Spirotetramat 12% + Imidacloprid 36% 480 SC (24+72 g ai/ha) (91.80%), Spirotetramat 12% + Imidacloprid 36% 480 SC (36+108 g ai/ha) (95.03%) and Thiodicarb 75 WP 750 g ai/ha (97.72%). Mealy bug mortality with single molecule at different doses ranged between 53.04 and 62.39 per cent and all treatment were on par with each other. The checks showed promising results as compared to other treatments after the first spray whereas Spirotetramat + Imidacloprid mixture of different concentrations proved better as compared to their individual applications and were at par with the checks only after the second spray.

## 3.62 **Population dynamics of different pests of** *Bt* **cotton under rainfed condition**

### D. G. MORE, A. N. GITTE, B. B. BHOSLE, HASAN BIN AWAZ AND S. U. PAWAR *Marathwada Agricultural University, Parbhani-431 402*

An experiment was conducted at the Farm of Cotton Research Scheme, Marathwada Agricultural University, Parbhani with Bunny Bt hybrid to study the population dynamics of different pests of Bt cotton under rainfed condition during *kharif* season of 2007-08. Incidence of aphids started in last week of July and reached its peak of 52.20 per three leaves during first week of September. Second peak of aphid was observed during last week of October recording 51.80 aphids per three leaves. Jassids and thrips recorded highest population of 6.90 and 40.80 per three leaves, respectively during fourth week of August. The population of whitefly was found below Economic Threshold Level throughout the crop season. However, the population reached to its peak of 8.00 whiteflies per three leaves during first week of September. The overall fruiting body damage due to bollworms ranged in between 0.30 to 3.55 per cent, with a peak of 3.55 per cent during second week of October. While a maximum of 1.0 pink bollworm larvae per 20 green bolls was observed.

# **3.63** Expert system on cotton insect pest

### M. SABESH, S. VENNILA, B. DHARAJOTHI, N. GOPALAKRISHNAN Central Institute for Cotton Research, Nagpur-440 010

Cotton is one of the important commercial crops in India and plays a dominant role in the agricultural and industrial economy of the country. Plant protection constitutes an important component in agricultural production system. In India, about 40% of cotton production is lost every year due to pests and nearly 55% of the total pesticides applied to agricultural crops are used to control the pest of cotton. Though major attention is paid for crop protection, the losses due to pests are unpredictable. These losses are mainly due to non availability of timely guidance to the farming community, communication gap between extension personnel and research station, wrong diagnosis, untimely and improper application of chemicals, etc. the development of farmer friendly Cotton Pest Expert System on pest control management is indispensable. Some system use natural language that accepts verbal responses but here we use graphical user interface (GUI) that is, the symptoms of damage were represented in pictorial form with a mouse device to allow the user to choose the right symptoms which are close or exactly similar to the one seen in field to arrive appropriate diagnosis. The GUI is the most natural and more helpful to users less familiar with the domain knowledge and it also overcomes the language barriers. We have used both forwards and backward chain reasoning to identify or diagnose pest and control measures. Algorithms rather rule formulation is a complex, interactive and often unanticipated process. The knowledge engineers, assembled information for rule specification in several ways. Unstructured and semi-structured taped information were used to initiate this process. The backbone to any expert system is the inference engine, the software which processes the rules and data and decides what to do next. Here we used rule based reasoning, since expressing thinking in terms of rules has wide applicability and great flexibility. A typical rule for identifying the pest Aphid based on the symptoms of damages are, IF (the leaves curl downward along their edges)

AND (accumulation of honeydew causing the appearance of sticky and shiny leaf surface)

THEN (the identified pest is Aphid)

There is chance of uncertainty in the argument also like the AND condition after the IF in the above reasoning that is "accumulation of honeydew causing the appearance of sticky and shiny leaf surface" is may also be due to whitefly. To surmount this problem we prepared further fine-tuning of information for the accurate identification of the pest. While developing this expert system, we have reviewed some of the expert system

already developed for other agricultural purposes especially for the diagnostic tools and its advantages and disadvantages were critically evaluated and necessary corrective measures were incorporated to improve the system. Detailed description each insect/pest which include description of the pest, life cycle, host plant, symptoms of damage, bioecology, host range, favourable condition for the pest, natural enemies, etc, were also collected, which will be provided as a separate module in the system as information resource for each cotton pest.

### 3.64

## Adoption of insect pest resistance management strategies in *Bt* cotton in Karnataka

# S. S. UDIKERI, VENKATESHALU., B. C. HANUMANTHASWAMI, K. B. YDAHALLI, D. C. CHOUGALA, HOSMANI VENKATESH., P. V. MATTI., H. M. SHAILA, S. B. PATIL, M. V. NAGARAJ, S. SHASHIKUMAR, AND B. M. KHADI

University of Agricultural Science, Agricultural Research Station, Dharwad Farm, Dharwad-580 007

Aiming sustainability of cotton production with help of Bt cotton the IPRM strategies have been disseminated in three selected districts viz., Gulbarga, Haveri and Belgaum of Karnataka during 2007. The project encompassed a total of 2405 ha with the involvement of farmers. Mirid bugs appeared as key sucking pests in Bt cottons with a huge population of 34-65 bugs/25 squares in Haveri district from September to November. The average incidence of mirid bugs was 43, 18 and 14 bugs /25 squares in Haveri, Belgaum and Gulbarga districts respectively. Aphid incidence was very severe in Gulbarga (59-63 aphids/ 3 leaves) by the end of the season. In all the districts leaf hoppers crossed ETL in the month of August. The incidence of thrips was relatively more in Gulbarga and Haveri districts. Incidence of *Helicoverpa armigera* and *Earias vittella* was low in all the fields. Incidence of PBW was 11-15 larvae/ 20 green bolls. The overall damage due to boll worms was kept below 5 percent. The activity of natural enemies was appreciable in project fields. Thus the natural enemy population build up was more of IPRM fields than non-IPRM fields.

With intervention of IPRM policies there was a tremendous impact on insecticide usage pattern. In the state average number sprays given by IPRM farmers were 3.4 against 5.9 sprays by non-IPRM farmers. Thus about 2.5 rounds of spray application were avoided by project farmers. The quantity of insecticides was 2.8, 3.5 and 5.19 litre per ha by IPRM farmers and non-IPRM farmers (5.0, 5.49 and 6.13 lit/ha) respectively in Gulbarga, Haveri and Belgaum districts leading to savings in insecticide to the tune of 30.8, 53.29 and 20.00 pre cent. Thus the savings in cost of protection was Rs.1333/ha (Haveri), Rs.1800/ ha (Gulbarga) and Rs.2295/ ha (Belgaum) through IPRM strategies. Seed cotton yield reaped by the project farmers was 26.53, 18.00 and 18.90 q/ha in Gulbarga, Haveri and Belgaum districts as against 26.0, 17.00 and 17.09 q/ha by nonIPRM farmers of respective districts. Thus there was an yield advantage of 1.29 quintal per hectare through IPRM practices in the state.

### **3.65 Pesticide resistant might be solution Bio-informatics**

### G. J. PAWAR AND P. B. KUMBHAR

### Yasawant Collage of Biotechnoly and Bioinformatics, Parbhani-431 402

Now days Bt varities are used for cultivation for more yield but lipedopterian pest develop resistant against Bt toxin group. Likewise some other pest develop resistant to pesticide for this might be bioinformatics is solution. As bioinformatics is application of IT to solve biological problem gives way to develop new pesticide for conrollin pest insect having two types mechanism to pesticide first to produce large amount of enzyme esterase & mutation of insecticide target side i.e alteration of binding side of responsible protein tus one can design Protein agents that side, by bioinformatics tool can easily get complementary sequence of DNA which is used for development new crop In some cases pesticide resistant is multigene mechanism by bioinformatics tools & databases one can detect how rietant developed that gives new method to control pest. With help of comparative genomics tool comparative study of structure & function of entire genome is providing powerful tool for elucidation resistant mechanism Bt toxin is grope of chemicals used to control lipedoptran pest as resistant developed by pest for one toxin with help of bioinformatics one can find another Bt toxin fit for killing pest

# **3.66** Evaluation of some newer insecticides for the control of cotton whitefly

### S. K. PARSAI AND P. P. SHASTRY

#### RVSKVV, Regional Agriculture Research Station, Khandwa-450 001

With the introduction of Bt Cotton sucking pests have emerged as major pests of cotton causing significant economic losses every year. Among these pests whitefly *Bemisia tabaci* is of regular occurence in cotton growing areas of Madhya Pradesh. Several insecticides were recommended and used for the control of whitefly resulting in resistance development therefore, an effort have been made to evaluate some newer insecticides for the control of white fly. The studies were conducted at Main Cotton Research Station, Khandwa during 2005-06 with cotton variety Khandwa-2. The crop was sown on 28.6.05 in plots of 6.0 x 4.8 m with four replications in randomized block design. There were six treatments including untreated control. Insecticidal treatments were Polo 50 SC 300 g., 400 g, 500 g ai/ha, Trizophos 40 EC 600 ml ai/ha and Acetamaprid 20 SP 40 gai/ha. The insecticides were sprayed twice when whitefly population was at peak. Pretreatment and post treatment (7 and 14 DAS) population of whitefly were recorded after each spray. The white fly population was recorded from lower, middle and upper leaves from five tagged plants selected randomly. The yield was also recorded from each plot. There was uniform population of whitefly before spray in all the treatments. Significantly less white fly population was recorded in Polo 50 SC 500 g ai/ha after 7 and 14 days of 1<sup>st</sup> spray. It was followed by Polo 50 SC 400 gai/ha. The population of whitefly was again lowest in Polo 50 SC 400 gai/ha.

SC 500 gai/ha after 7 and 14 days of IInd spray. However it was at par with Polo 50 SC 400 ga i/ha. Significantly highest yield was recorded in Polo 50 SC 500 gai/ha. it was followed by Polo 50 SC 400 gai/ha and Acetamiprid 20 SP. Polo 50 SC 500 gai/ha and Polo 50 SC 400 gai/ha was found most effective for the control of white fly.

### **3.67** Seasonal incidence of key pests and their natural enemies on cotton

### S. K. PARSAI AND P. P. SHASTRY

### RVSKVV, Regional Agriculture Research Station, Khandwa-450 001

Seasonal incidence of key pests and their natural enemies on cotton variety JK-4 were recorded during 2005-06 and 2006-07 at Main Cotton Research Station Khandwa. The crop was sown in a plot of 0.50 acre on 1<sup>st</sup> July during both the years with recommended agronomic practices. In this unreplicated trial half of the block was kept under natural condition (unprotected) for recording the observations on sucking pests and their natural enemies. The remaining half block was exclusively used for recording the incidence of bollworms. The population build up of different pests were recorded at weekly intervals on ten plants in each block. The data on the incidence of sucking pests were recorded on three leaves per plant selected from the top, middle and lower portion, while the population of natural enemies and minor pests was observed on whole plant. The infestation of bollworms were recorded on shoots, squares, flowers, green bolls and locules. During both the vears the incidence of aphids started from 29 SMW and continued upto 1 SMW and it was maximum (35.1-45.7 / 3 leaves) during 33 SMW and it's population was maximum (8.3-12.3 / 3 leaves) during 37 SMW. Thrips were observed from 39 to 46 SMW with its peak (12.5-23.5 / 3 leaves) during 42 SMW. The incidence of white fly was observed from 33-48 SMW with its maximum (21.1 - 31.1 / 3 leaves) incidence during 31 SMW. Population of predators (Coccinellids and Chrysopa) was observed from 30-50 SMW. It means that predators were present all the time when there was incidence of sucking pests. American bollworm was observed from 38 - 1 SMW with its peak population (3.1 - 5.1 leaves / 5 plants) during 44 SMW. The population of spotted bollworm was observed from 32-50 SMW with its peak (5.9 larvae/5 plants) during 36 and 40 SMW of 2005-06. However its population was maximum (4.1 larvae/5 plants) during 42 SMW of 2006-07. The population of pink boll worm was more during 2005-06 and low during 2006-07 its incidence was observed from 44-2 SMW with its peak (9.1 larvae/20 green bolls) during 45 SMW of 2005-06 and peak (1.8 larvae/20 green bolls) during 52 SMW of 2006-07. The impact of bollworms on fruiting bodies have been seen from 35-2 SMW. It ranged between 0.04 - 18.5 percent. It was maximum (18.5%) during 40 SMW of 2005-06 and was maximum (10.5%) during 41 SMW of 2006-07.

### 3.68 In vivo efficacy of bio-control agent Pseudomonas fluorescens Pf-1 against Myrothecium leaf blight of cotton (Myrothecium roridum Tode ex. Fr.)

### P. P. SHASTRY AND B. K. PATIDAR

#### R V S Krishi Vishwa Vidyalaya, Main Cotton Research Station, Khandwa 450 001

Myrothecium leaf blight of cotton disease caused by *Myrothecium roridum* Tode ex. Fr. is a key factor for instability and low yields mainly in Malwa and Nimar region of Madhya Pradesh. In Madhya Pradesh, Myrothecium blight has been appearing in significant proportions in all the pockets almost every year during the last decade. Biological control of plant disease is one of the cheapest and most efficient way of controlling disease or reducing the amount of the effect of pathogens. *Pseudomonas fluorescens* Pf-1 has been successfully used as an antagonist against various foliar disease of cotton. Based on three year (2006, 2007 and 2008) field studies, efficacy of *Pseudomonas fluorescens* Pf-1 against Myrothecium leaf blight of cotton caused by *Myrothecium roridum* Tode ex. Fr. was studied. The investigation revealed that Copper oxychloride 0.3 % + Streptocycline 100 ppm recorded minimum percent disease incidence and maximum seed cotton yield followed by seed treatment with *Pseudomonas fluorescens* Pf-1 @ 10g / kg seed + foliar spray @ 0.2% on 30, 40, 50, 60, 70, 80 and 90 DAS and seed treatment with *Pseudomonas fluorescens* Pf-1 @10g / kg seed + foliar spray @ 0.2% on 30, 50, 70 and 90 DAS.

### 3.69

## Incidence of different pests in *Bt* and non-*Bt* cotton hybrid in relation to weather parameters under south Gujarat condition

### H. R. DESAI, I. M. MAISURIA, C. J. PATEL, V. Y. SOLANKI, S. BHADAURIYA AND V. KUMAR *Navsari Agricultural University, Main Cotton Research Station, Surat-395 007*

Incidence of sucking pests and Bollworms under natural condition on RCH 2 Bt and G. Cot. Hy.10 was recorded for 2007-08 and 2008-09 at Main Cotton Research Station, Surat. Activity of jassids was noticed throughout the crop period being higher during 34<sup>th</sup> (Mid August) to 44<sup>th</sup> (End of October) Standard Meteorological Week. Population build up of jassids was comparatively more on RCH 2 Bt than G. Cot. Hy.10 and vis-a-vis for aphids, thrips and whitefly. Irrespective of Bt and non-Bt hybrid, positive and significant correlation was observed with maximum temperature (aphid & whitefly), minimum temperature (jassids & thrips), average temperature (jassids), relative humidity (aphids & thrips) and negative and significant correlation with evening and average relative humidity (whitefly) and rainfall (aphid). Based on trap counts, American bollworm and *Spodoptera* showed significantly positive correlation with maximum temperature. However, negative correlation of Spotted Bollworm as well as Pink Bollworm was observed with minimum and average temperature, relative humidity (morning, evening and average), rainfall and rainy days. On RCH-2 Bt, bollworms and fruiting body damage was negligible compared to G.Cot.Hy.10. Positive and significant correlation was observed with larval population and fruiting body damage by American and Spotted bollworm.

### 3.70

## Host range of mealybugs *Phenoccocus solenopsis* Tinsley in cotton+pigeon pea cropping system of central India

### A. J. DESHMUKH, S. VENNILA, D. B. PINJARKAR B. S. GHODKI AND K. R. KRANTHI Central Institute for Cotton Research, Nagpur-440 010

Mealy bugs, *Phenococcus solenopsis* Tinsley was the dominant species over large areas of all the three cotton growing regions widely cultivating Bt hybrids across cropping systems in India. Although the infestation levels of mealybugs in the cotton + pigeon pea + fallow system of Central Indian rainfed cotton were trace and disjunctive and was not alarming in majority of fields of cotton growers during 2008-09. The survey for host range under the rainfed cotton production system revealed a total record of 91 host plants spread across 24 families. *P.solenopsis* was found multiplying on 30 host plants during the cotton growing season and 61 plants exclusively during off-season. Ten and 27 host plants had the highest severity of Grade 4 during cotton and off

seasons, respectively. Plant species from three families' viz., Compositae, Leguminaceae and Malvaceae constituted 50% of the host plants of *P.solenopsis*. The rank of families with at least two plant species of plant kingdom supporting *P.solenopsis* build up is of the order: Compositae(10) >Leguminaceae and Malvaceae(eight each) >Amaranthaceae, Euphorbiaceae Solanaceae and (four each)>Graminae(3)>Convolvulaceae and Labiatae(two each). Off season hosts were higher than the growing season indicating the strong carry over between cotton seasons. While many host plants of *P.solenopsis* could delay the outbreaks on any one crop plants the numerous and widespread host plants would facilitate spatial spread of the insect. Since the occurrence of *P.solenopsis* is on large number of weed hosts over agriculturally important crop plants, cultural management practices such as field sanitation and weed removal with contained disposal during crop and off seasons play a significant role in preventing spread of *P. solenopsis*. Thus the host plant diversity for *P.solenopsis* can be a boon and bane in rainfed Bt cotton production system.

### 3.71

# Diversity and abundance of Hymenopteran parasitoids of mealybugs in rainfed cotton

### D. B. PINJARKAR, S. VENNILA, V. V. RAMAMURTHY, K. R. KRANTHI, B. S. GHODKI AND A. J. DESHMUKH

#### Central Institute for Cotton Research, Nagpur-440 010

Solenopsis mealy bug Phenacoccus solenopsis Tinsley and pink hibiscus mealy bug Maconellicoccus hirsutus (Green) occur on rainfed cotton dominated by BT transgenic hybrids of Central India. A survey conducted on the occurrence of natural enemies of mealy bugs during 2007 and 2008 seasons on cotton led to records of higher diversity and abundance of hymenopterous parasitoids on M. hirsutus than P. solenopsis. A total of three and nine parasitoids were documented on P. solenopsis and M. hirsutus, respectively. While Aenasius recorded only on P.solenopsis, two species viz., Promuscidea bambawalei Hayat (Encyrtidae) was unfasciativentris Girault (Aphelinidae) and Aprostocetus bangaloricus Narendran (Eulophidae) were recorded on both P. solenopsis and M hirsutus. M.hirsutus was additionally parasitized by five encyrtids viz., Encyrtus aurantii (Geoffroy), Prochiloneurus pulchellus Silvestri, Anagyrus dactylopii (Howard), Anagyrus mirzai Agarwal & Alam and Homalotylus albiclavatus (Agarwal) and one each of Signiphoridae (Chartocerus kerrichi (Agarwal)) and Pteromalidae (Pachyneuron leucopiscida Mani). Seasonal mean parasitization of P. solenopsis by A. bambawalei and P. unfasciativentris together was estimated to be 21 per cent with a maximum of 48 per cent during August. The control offered by these hymenopterans on M.hirsutus based on the abundance of adult emergence was of the order *E.aurantii* > *P. unfasciativentris* > *P. pulchellus* > *C.* kerrichi. Since parasitoids regulate the population of P. solenopsis and M.hirsutus effectively under field conditions, strategies of mealybug management placing priority for natural control coupled with cultural control before the curative measure of spray of insecticides would go a long way in tackling mealy bugs in cotton fields.

### 3.72

## Evaluation of *Bt* cotton hybrids for diseases under unprotected field conditions

#### P.V. PATIL

#### Navsari Agricultural University, Main Cotton Research Station, Surat-395 007

A field trial in RBD design with three replications was conducted at Main Cotton Research Station, NAU, Surat during 2002 kharif season for evaluation of five Bt cotton hybrids viz., RCH 2, RCH 20, RCH 134, RCH 138 and RCH 144 along with their non Bt counterpart hybrids against bacterial blight disease. Bacterial inoculum was sprayed twice for proper evaluation. Other diseases did not appear. Observations in 0-4 scale were recorded on five randomly selected plants of each plot and PDI was worked out. The yield of seed cotton was also recorded.

The results revealed that differences in bacterial blight disease intensity between Bt cotton hybrids and their counterpart non Bt cotton hybrids was not significant. Based on mean maximum grade observations, NHH 44 and G.Cot.Hy 8 indicated moderately susceptible reaction, whereas rest of the hybrids exhibited susceptible reaction. All the Bt cotton hybrids significantly gave much higher yield of seed cotton once their respective non-Bt counterparts.

### 3.73 Reduction of mirid bug (*Campylomma livida* Reuter) population by employing different methods of application of insecticides and bio-formulations

#### V. S. NAGRARE, S. KRANTHI, K. R. KRANTHI Central Institute for Cotton Research, Nagpur-440 010

Field experiment against mirid bug (Campvlomma livida Reuter) population infesting cotton (RCH -2 Bt BG I) was carried out by taking 9 foliar treatments of recommended doses (1 X) comprising of Neem oil (2.5 lit/ha), Verticillium lecanii (10ml/l), Mealy-Quit (10ml/l), Imidacloprid (20 g a. i./ ha), Acetamipird (20 g a. i./ ha), Chlorpyriphos (250 g a. i./ ha), Thiomethoxam (100 g a. i./ ha), Acephate (292 g a. i./ ha) and untreated control (water), eight stem application at ten times higher dose (10X) comprising of Neem oil (25 lit/ha), Mealy-Quit (100ml/l), Imidacloprid (200 g a. i./ ha), Acetamipird (200 g a. i./ ha), Chlorpyriphos (2500 g a. i./ ha), Thiomethoxam (1000 g a. i./ ha), Acephate (2920 g a. i./ ha) and control (water) and 4 soil drenching treatments at ten times higher doses (10x) comprising of Imidacloprid (200 g a. i./ ha), Chlorpyriphos (2500 g a. i/ ha), Acephate (2920 g a. i/ ha) and control (water). Pretreatment observations were recorded one day before treatment application and post treatment observations at 4 and 8 days after treatment (DAT) on mirid bug population reduction. Foliar spray (1X): at 4DAT mirid bug population reduction was maximum with Imidacloprid (63.33%), Thiomethoxam (62.37%) and Acephate (56.00%). Eight DAT population reduction was maximum with Imidacloprid (83.52%) followed by Thiomethoxam (83.52%). Followed by above treatments, higher population reduction with Acetamipird (76.42%), Chlorpyriphos (70.80%) and Acephate (70.59%) was observed. Mealy-Quit showed moderate mortality (51.82%) of mirid bug population. Stem application (10X): Maximum mirid bug population reduction at 4DAT was recorded with Imidacloprid (54.59%) followed by Acetamipird (51.92%) while remaining treatments have not shown encouraging results. At 8 DAT maximum population reduction of mirid bug was recorded with Thiomethoxam (65.05%) followed by Imidacloprid (63.60%) while moderate population reduction was recorded with Acetamipird (55.79%), Neem oil (53.48%) and Acephate (52.50%). Soil drenching (10X): Amongst different soil drenching treatments only Imidacloprid reduced population up to 57.89%, whereas remaining treatments were ineffective at 4DAT. At 8DAT maximum mirid bug population reduction was recorded with both Acephate 60.40% as well as Imidacloprid (57.89 %). Maximum cotton yield was recorded with foliar spray of Thiomethoxam (2547 kg/ha) whereas Imidacloprid, Acephate and Acetamipird were found to be equally effective in enhancing cotton yield up to 2271, 2246 and 2068 kg/ha respectively.

### 3.74

# Selection of bioagents from Bt cotton rhizosphere soil for the management of major soil borne diseases

### M. PARAMASIVAN, A. CHANDRASEKARAN, HEMALATHA AND S. RAJARATHINAM *Tamil Nadu Agricultural University, Coimbatore-641003*

The effect of talc based bioformulation of antagonistic microorganisms like Fungi (Trichoderma), Bacteria (Pseudomonas and Bacillus), Actinomycetes (Streptomyces)), and fungicides were tested against Rhizactonia fusacrium, Macrophomina in cotton under glass house conditions. The individual strains were performed better in all experiments in vitro conditions. The applications of the biocontrol agents and fungicides through seed and soil have significantly reduced the disease incidence under glass house condition. The maximum reduction of disease incidence was observed in bacterial strain BsC5 isolate (seedling disease 21.45 percent, wilt disease 22.40 percent and root rot 26.33 percent) where as in control, 75 percent disease incidence was recorded. These biocontrol isolates induced the expression of b 1-3 glucanases, peroxidase, polyphenol oxidase, phenylalanine ammonia lyase and phenol accumulation in cotton leading to reduced incidence of diseases. Generally the talc based formulation of Bacillus subtilis isolate BsC5 and Carbendazim + Mancozeb were most effective in managing the major soil borne diseases of cotton.
### 3.75

## Management of foliar disease of Bt cotton through plant growth promoting rhizobacteria (PGPR)

### A. CHANDRASEKARAN, M. PARAMASIVAN, K. SIVARANJANI AND S. RAJARATHINAM Tamil Nadu Agricultural University, Coimbatore-641003

Inducing the plant's own defense mechanisms by prior application of a biological inducer is thought to be a novel plant protection strategy. Plant growth promoting activities of antagonistic microorganisms, plant extracts and fungicides were assessed based on the seedling vigour index by the standard roll towel method (ISTA, 1993). The antagonistic strains were found to increase the vigour index of cotton seedlings significantly with the maximum vigour index of 1226.47 in cotton seedlings treated with *A.alternata* and Pf1 suspension. This treatment also enhanced the root and shoot length of cotton seedlings. Increased levels of phenol, peroxidase (PO), polyphenol oxidase (PPO) and PAL accumulation were observed in *P. fluorescens* (Pf1) and *B. subtilis* (BsC5) pre treated plants challenge inoculated with the pathogen in the pot culture experiments. The activity of peroxidase and PPO activity increased significantly from first day after challenge inoculation and reached the maximum on fifth day after challenge inoculation. Seed treatment with *P.fluorescens Pf*-1 @ 10 g/kg seed plus foliar spray @ 0.2% on 30, 40, 50, 60, 70, 80 and 90 DAS was most effective against all foliar diseases.

# **3.76** Variability in *Fusarium oxysporum* causing wilt disease of cotton in India

### M. K. MESHRAM, S. J. GAWANDE AND K. R. KRANTHI Central Institute for Cotton Research, Nagpur-440010

India is the only cotton growing country in the world which grows, short staple / Asiatic / diploid cottons viz. Gossypium arboreum and G. herbaceum as well as the medium to long staple / New world / tetraploids cottons i. e. G. hirsutum and G. barbadense. Fusarium wilt disease caused due to the soil inhabiting fungus Fusarium oxysporum f. sp. vasinfectum was described first in U.S.A. by Atkinson in 1892 in G. hirsutum cotton, while in India the disease was first recorded by Evans in 1908 at Nagpur in 'Desi' / indigenous / G. arboreum cotton. In India, till the release of wilt resistant G arboreum and G. herbaceum varieties, losses ranging between 5 to 60 per cent were commonly observed. The American and Egyptian cottons (G. hirsutum and G. barbadense) were immune to the Indian isolate of Fusarium wilt pathogen. Currently, with popularization of Bt cotton (G. *hirsutum*) varieties and hybrids in India, the presence of *Fusarium oxysporum* has been observed repeatedly on the cotyledon. Existence of other races of the pathogen besides Race 4 is no speculated. Pathogen isolates obtained from different cultivars and from different locations in the country showed slow to rapid growth with raised to smooth surface and regular to irregular margin. Highly variable pigmentation i. e. dark violet, violet, pink, pinkish white and white were recorded in different isolates on potato dextrose broth (PDB), boiled rice and sorghum grains. Distinct variability was also observed in the isolates for their salt tolerance capacity. Pathogenic variability of various isolates was tested on susceptible G. arboreum cultivar G-27. The mortality of seedlings varied between 40 to 90 per cent due to various isolates after 30 days of seed germination. Forty different isolates of *Fusarium oxysporium* were categorized on the basis virulence, species specificity, growth, pigmentation etc. To study their genetic diversity at molecular level, SSR primers were synthesized from SSR motifs of nine different locus of Fusarium genome. The polymorphism obtained revealed the genetic diversity among various F. oxysporium isolates.

# **3.77** Detection of tobacco streak virus infecting cotton in India

### S. J. GAWANDE, M. K. MESHRAM AND K. R. KRANTHI Central Institute for Cotton Research, Nagpur-440010

In recent years, Bt cotton crops across the cotton growing regions of Andhra Pradesh have been infected by an unknown plant disorder. The disorder was widespread and caused severe symptoms on cotton plants during the year 2005, 2006 and 2007 in Andhra Pradesh. The Reports confirmed the cause of the disorder as the pathogen Tobacco streak virus (TSV). The survey was conducted in cotton growing states of India to see the magnitude and intensity of the disease. Symptomatic samples were collected from different locations in Punjab (Abohar, Bhatinda), Haryana (Sirsa, Hissar, Fatehabad), Rajasthan (Hanumangarh, Sriganaganagar), Maharashtra (Nagpur), Andhra Pradesh (Warangal, Karimnagar) and Tamil Nadu (Coimbatore, Erode). The symptomatic plants were observed in Warangal and adjoining area of Andhra Pradesh while the presence of TSV virus like symptoms were not observed in rest of the area surveyed. RNA from symptomatic samples was extracted and PCR primers were designed from flanking region of TSV coat protein gene. Further the protocol was validated by testing TSV symptomatic leaf samples. The presence of TSV detected on six Bt hybrids (RCH2 Bt, Bramha Bt, Nirja Bt, Dyana Bt, Sigma Bt, Mallika Bt) and two non-Bt pre-released hybrids (Warangal HH2 and Warangal HH3) in samples collected from Andhra Pradesh.

### 3.78

## Insect visitors and nectar sugar concentration of *Bt* cotton flowers at Hisar, India

#### RACHNA GULATI, S. K. SHARMA AND ASHA CCS Haryana Agricultural University, Hisar-125 004

Cotton is an important cash crop, which is grown for fulfilling the domestic and export requirements. It contains number of floral and extra floral nectaries which attract insects including Asian bees. Before the introduction of Bt cotton, non Bt cotton was badly damaged by several pests including bollworms. To control pest menace, lots of insecticides were applied which adversely affected the honeybee foragers at the time of flowering. After the introduction of Bt cotton in Haryana in May, 2007, there was decline in insecticide load and beekeepers were encouraged to keep apiaries near cotton crop. It not only provides pollen and nectar to honeybees during dearth period in this region but farmers are benefited by bee visits in terms of high yield, quality of their produce and honey production as the crop has the potential to produce 50-60 Kg honey per hectare. To ascertain the pollinator attraction, Bt cotton crop was grown in randomized block design following recommended agronomical practices. Studies revealed that during full bloom, eight visitors viz., Apis dorsata Fabricius, A. mellifera L., A. cerana Fabricius, Polistes hebareus Fabricius, Vespa orientalis L., Myllocerus undecimpustulatus Faust, Mylabris phalerata Pallas, Pieris brassicae (L.) were observed. Out of these, A. dorsata, A. mellifera and A. cerana were recorded foraging on both nectar and pollen. All the three Apis spp. were top workers. Polistes sp. visited both flower and extra floral nectaries on leaf for nectar collection. Nectar samples of five each of bud, fresh flower and one-day-old flowers were collected at 9.00 AM and measured by Phenol method. Sugar content was significantly higher in fresh Bt cotton flowers, which was recorded as 1.56 mg/ flower. It decreased to 1.03 mg/ flower in one day old flowers. Sugar content in bud stage was found to be 1.05 mg/ bud.

### 3.79

## JTHC 1104-genetic stock of *Gossypium hirsutum* with higher compensation for bollworm damage

### LOKHANDE, R. K., S. VENNILA, VINITA GOTMARE<sup>1</sup> AND B. M. KHADI Central Institute for Cotton Research, Nagpur-440 010

Jassid Tolerant Higher Compensating genetic stock, JTHC 1104 of upland cotton Gossypium hirsutum L, with uniqueness of higher tolerance to bollworm damage through phonological mechanism of compensation

combined with jassid tolerance was developed and validated. The plants of JTHC 1104 produce additional fruiting structures that contribute to higher yields, despite higher damage due to bollworms. JTHC 1104 originated from plant selections made from the progeny of a cross between Mysore and NC 51 as parents from the germplasm working collection of the Central Institute of Cotton Research, Nagpur. While selections from  $F_2$  population were made on an individual plant basis for jassid tolerance cum higher yields, plant to progeny rows of  $F_3$  were grown both under unprotected and bollworm protected situations. Best row showing highest yield level under unprotected over protected conditions (measured as genotypic resistance ratio (GRR);  $GRR=Y_{up}/Y_p$ , where  $Y_{up}$  and  $Y_p$  are the yields of unprotected and protected plants or plot, respectively) was chosen and grown in multiple rows in  $F_4$  under protected and unprotected regimes. Generations of  $F_5$  and  $F_6$  were raised under completely unprotected situation along with checks. The feature of higher compensation was confirmed in the homogenous progeny of  $F_5$  and tagging studies on JTHC 1104 and the check variety LRA 5166 proved higher production of squares in response to higher bollworm damage levels through phonological tolerance mechanism of compensation with higher yields in JTHC 1104 over LRA 5166.

### 3.80

## Management of cotton leaf curl virus disease : Preview and prospects of genetically modified Indian cotton cultivar

#### POONAM DHAWAN, NARAYAN RISHI AND H. S. SAVITHRI CCS Haryana Agricultural University, Hisar-125 004

Cotton is an important fibre crop and its procuction has been decreasing in the cotton growing belt of Harvana due to insect pests and cotton leaf curl virus(CLCuV) disease. This disease is vectored by whitefly Bemisea tabaci which are very difficult to manage by the use of insecticide and other means. Therefore, breeding for disease resistance by conventional method or development of genetically modified (GM) cotton resistant to CLCuV disease needs to be focussed and attempted. Existence of six symptom-based variants of CLCuV were established on the basis of extensive field surveys in Harvana. Multiplication and maintenance of pure culture of different isolates were carried out in the glasshouse on highly susceptible cotton cultivar HS-6 and supplied to collaborating scientist at Indian Institute of Science, Banglore for transformation, Sequencing studies carried out for different symptom-based variants revealed these to be genetic variants also. Phylogenetic analysis showed that cotton leaf curl Kokhran virus – Dabwali (CLCuV-Dab) isolate collected from Dabwali, Haryana was close to cotton leaf curl Kokhran virus – Faisalabad 1 and happened to be the most commonly occurring isolate under natural conditions. Resistance in highly susceptible Indian cotton cultivar F-846 was achieved by integrating movement protein gene (AV2) of CLCuKV-Dab isolate in antisense orientation via Agrobacterium tumefaciens. The T4 generation of GM cotton F-846 gave complete resistance under high inoculum pressure of virus charged whitefly under contained glasshouse conditions. The artificially inoculated cotton plants did not produce any visible symptoms and tested negative by PCR as the amplification of virus did not happen. The morphological characters, phenotypic attributes, yield parameters and fibre quality in GM and non-GM cotton were foud in close conformity and almost at par. GM cotton cv. F-846 has proved to be a promising cultivar. It is previewed that after undergoing stringent tests specified by DBT, there is a potential for CLCuV management, thus proving to be a boon with bright prospects for profitable cotton cultivation for the farmers of Haryana.

## POST HARVEST TECHNOLOGY AND SOCIO-ECONOMICS AND DEVELOPMENT

## **ORAL PRESENTATIONS**

### 4.1

## Impact of transfer of technology programme in cultivation of non-*Bt* and *Bt* cottons in Haryana

#### P. D. SHARMA, ASIF TANWEER AND A. K. BASU Bayer Crop Science Ltd, Mumbai-400 019

Transfer of Technology Projects were undertaken by Bayer Crop Science (BCS) for improvement of productivity and quality of cotton in Haryana during 2006-07 in non Bt and 2007-08 in Bt Cotton. In non Bt Cotton the numbers of sprays were higher in Demonstrations plots (6.0) than project area (5.75) and non-project area plots of cotton (4.95) with corresponding increase in cost of plant protection. This was compensated by higher yield with better cost-benefit Ratio . Seed cotton yield of 2580 kg, 2592kg, 2498 kg and 1890kg/ha respectively was recorded in general, varietal and non project area respectively. Amongst 22 Bt varietal Demonstration of 9 hybrids, IT-905 of BCS & 6488 Bio Seed Bt plots in project area recorded seed cotton yield of 2613 kg/ha, 2631 kg/ha respectively which out yielded other. Bt hybrids. IT905 also showed good fiber properties of 26.8 mm fiber length, 4.0 micronaire and strength of 21.8 g/tex. Data further showed that deep ploughing alone recorded 7.6% higher yield than non deep ploughing and DAP application fully at sowing gave 7.6% higher yield than other methods.

### 4.2

## Economics of cotton grown under organic and inorganic farming in Parbhani district of Maharashtra

### T. G. SATPUTE, S. S. MORE, D. J. SANAP AND M. S. DESHMUKH Mavathwada Agricultural University, Parbhani-431 402

A survey was conducted during Kharif season of 2006-2007 at Parbhani district of Maharashtra to find out the economics of cotton grown under organic and inorganic farming. Results revealed that, per hectare production of organic cotton was 19.86 quintal and inorganic cotton was 22.48 quintal. The gross returns were Rs. 54,427.08 and Rs.51, 036.07 per ha for organic and inorganic cotton, respectively. Net profit of organic cotton farming was Rs. 6,422.95 per ha higher than inorganic cotton. Per hectare total cost required for organic cotton production was Rs.29, 085.38, which was Rs. 3,031.94 less than inorganic cotton production. Price of organic cotton was 1.87 and 1.58. In organic cotton, plant protection and vermicompost was found significant, whereas in inorganic cotton bullock labour and plant protection was found significant. Hence organic cotton production was beneficial than inorganic cotton production.

## 4.3 *Bt* cotton-Global and Indian scenario

### S. L. MEHTA

#### CCS Haryana Agricultural University, Hisar-125 004

Because of consistent and substantial benefits during the first dozen years of commercialization of biotech crops from 1996 to 2007, farmers have continued to grow more biotech crops every single year. Growth has been to the extent of 12%-reaching 114.3 million hectares globally. In 2007, the number of countries planting biotech crops increased to 23, comprising of 12 developing countries and 11 industrial countries. Of the global total of 12 million biotech farmers in 2007, 11 million were small and resource-poor farmers from developing countries. Of these 11 million small farmers, most were Bt cotton farmers, 7.1 million in China (Bt cotton), 3.8 million in India (Bt cotton) and the remaining in the Phillipines (biotech maize), South Africa (cotton, maize and soybeans) and the other eight developing countries. India's cotton area represents 25% of the global area of cotton. In the past it produced only 12% of world production because yields were some of the lowest in the world. India, the largest cotton growing country in the world, with an area of 9 to 9.5 million hectares cultivated by approximately 5 to 5.5 million farmers in 2007, reported 54,000 farmers growing 50,000 hectares of Bt cotton in 2002. In 2007, Bt cotton area has increased to 6.2 million hectares grown by 3.8 million small and resource-poor farmers. Bt cotton has increased yield by up to 50%, reduced insecticide sprays by half, and increased income by up to US \$ 250 or more per hectare. With the steep increase in adoption of Bt cotton, the average yield of cotton in India, which was lowest in the world, increased from 308 kg per hectare in 2001-02, to 520 kg per hectare in 2006-07 and 560 kg per hectare in 2007-08. With the boom in cotton production in the last five years. India has become transformed from a net importer to a net exporter of cotton.

### **4.4**

### A study on marketing and constraints of Bt-cotton in Haryana and Karnataka

### C. L. SHIV KUMAR, V. P. MEHTA AND D. P. MALIK CCS Haryana Agricultural University, Hisar-125 004

With the introduction Bt-cotton in India, there is spurt in cotton production. The increased productivity as well as higher MSP of cotton will enhance the income of cultivators. But there are number of market intermediaries reduced the share of producer in consumer's price. Therefore, the present investigation was carried in Haryana and Karnataka state with specific objective to examine the marketing pattern, costs and margins of Bt-cotton through different channels and to identify constraints in production and marketing of Bt-cotton. Sirsa in Haryana states and Dharwad district in Karnataka state ranked first in area under Bt-cotton. The information pertaining to marketing pattern of Bt-cotton was collected from cotton growers of the study area. The data related to various marketing cost and margins were collected from the various selected market functionaries such as commission agents and wholesalers of the feeding area. Appropriate analytical techniques were employed to draw meaningful inferences.

The results of the study show that marketing pattern of Bt-cotton showed about 95 of cotton produce was disposed off in regulated market in both states and remaining was sold in village itself. About 80 percent of the total produce was sold by cultivators in peak period of sale. Three marketing channels were found more common in the study area i.e. Channel-I (Producer – Ginning mill), Channel-II (Producer-Wholesaler- Ginning mill) and Channel-III (Producer-Commission agent-Ginning mill). But channel-I was found to be more efficient as cultivators received highest share of miller's price in both states. The constraints faced in marketing of Bt-cotton were adultered and high cost seed, lack of labour in picking period, inadequate dissemination of production technology, low price of produce, mixing of Bt-cotton and non-Bt-cotton, lack of extension and marketing facilities, non-availability of adequate processing units, high transportation costs.

## **POSTER PRESENTATIONS**

### 4.5 Blended cotton for apparel enterprise

#### NISHA SANGWAN AND K. KHAMBRA

#### College of Home Science, CCS Haryana Agricultural University, Hisar-125004

India has a long tradition of producing cotton, enjoying a strong position in the textile fibre complex. Being the producer of cotton, rural people or the farmers utilize it more widely and easily for the manufacture of clothing articles i.e., apparel, daree, khes, etc. Therefore the work was planned to select and blend the best spinnable cotton variety and to study the mechanical and dimensional properties of weft knitted blended fabric. Six cotton varieties HS-6, H-1117, H-1098, HHH-81, HHH-223 and H-974 were taken for the study. The fibre properties (fineness, mean fibre length, bundle strength, maturity coefficient and uniformity ratio) of all the cotton varieties were analyzed to select one of the best spinnable variety. Fibre Quality Index (FQI) was calculated and it was observed that FQI was maximum i.e., 47.23 for the H-1098. This variety had maximum mean fibre length, bundle strength and maturity coefficient value. Based on the preference of respondents and experts polyester fibre was selected for blending and spinning with the cotton. Polyester is the most engineerable and diverse polymer that mankind has developed. It has an environment friendly production process and disposal method. The selected variety of or its blend can be used to produce different type of apparels or garments with improved overall performance including better serviceability, wear comfort and other desirable properties. The present work on weft knitted cotton blended knitted fabrics is perhaps one of the very few attempts made in this direction to meet the dire need of meeting the raw material crisis of natural fibres and to produce some low priced substitute.

### 4.6

### Prospects of Bt-cotton cultivation in Haryana state

#### PURAN MAL, SIEGFRIED BAUER AND D. P. MALIK CCS Haryana Agricultural University, Hisar-125004

India is an important grower of cotton on a global scale. It ranks third in world cotton production after the United States and China; with 9.14 million hectares grown in 2006-07. However, yields of cotton in India are low, with an average yield of 422 kg/ha compared to the world average of 580 kg/ha. Cultivators face the challenge of losses due to various insect pests. The first genetically modified crop in India, Bt cotton, has been introduced to address bollworm infestation in year 2002. This paper presents an analysis of data collected from a sample of farmers growing both conventional and Bt cotton under real commercial field conditions in Hisar and Sirsa districts of Harvana. Farmers were personally interviewed, and data on cotton production (seed quantity/costs, number and cost of sprays, yields, cotton prices obtained, etc.) were collected. The results revealed that cotton acreage increased in the state and constituted more than 8.5 percent of total cropped area. The area under Bt-cotton is more that 80 percent of total area under cotton in the state. The production of cotton reached to the level of 0.88 million bales in the year 2005-06. But the productivity of cotton in Haryana state ranked next to Punjab i.e. 437 kg/hectare. The cost of cultivation calculated for Bt-cotton and Cotton (American) based on selected sample of farmers showed that there was reduction in expenses incurred on Btcotton as compared to Cotton (American). This was mainly due to less number of sprayers ultimately reducing the quantity of pesticides used. The seed cost of Bt-cotton recorded was high. The cultivators received higher income from cultivation of Bt-cotton as result of higher yield. Cultivators reported only adulteration in seed and there is need of Govt. intervention to make adequate quantity of good quality seed. The cultivation of Btcotton is a positive step towards environmental protection through possible reduction of the pesticides load in the environment and reduces handling of such chemicals by farmers.

### 4.7 Role of different *Bt* cotton hybrids in cotton cultivation of Punjab

## G. S. BUTTAR, PARAMJIT SINGH, ANUREET KAUR AND A. P. S. BRAR *Punjab Agricultural University, Regional Station, Bathinda-151 001*

The Bt cotton is the only transgenic used for insect resistance, which has been widely adopted in, developed as well as developing countries by small holders also. In India, the expansion of area under Bt cotton was very rapid and it increased from 0.038 m ha in 2002 to 5.2 m ha in 2007. The magnitude of the expansion of area under Bt cotton was highest than any other country of the world. Although unapproved and illegal Bt cotton has started growing in Punjab since 2002, the GEAC gave first official approval for the commercial cultivation of six Bt cotton hybrids for cultivation in Punjab during 2005. The Punjab Agricultural University had recommended four Bt cotton hybrids viz. RCH 134 Bt, RCH 317 Bt, MRC 6301 Bt and MRC 6304 Bt for cultivation in Punjab during Kharif 2006. Subsequently two more Bt cotton hybrids RCH 308 Bt and RCH 314 Bt had been recommended by PAU in 2008. At present there are about 32 Bt cotton hybrids of different companies approved by GEAC for Punjab. During kharif 2008 more than 50% area has been sown by PAU recommended Bt hybrids. Due to introduction of Bt cotton in Punjab, the area of cotton increased to 6.18 lakh ha with a production of 27 lakh bales in 2006-07 from 4.52 lakh ha with a production of 14.78 lakh bales in 2003-04. According to a survey conducted by PAU Regional Station, Bathinda a total of 18.83 lakh packets of Bt cotton seed were sold in Punjab for sowing during kharif 2008. Out of these 10.12 lakh (53.75%) are of six PAU recommended Bt hybrids, 4.18 lakh packets (22.20%) of Bt hybrids approved by GEAC but not recommended by PAU, 1.53 lakh (7.13%) of BG-II hybrids and about 3 lakh (15.93%) undescriptive/unnamed hybrids and varieties. The major share from PAU recommended Bt hybrids is from RCH 134 Bt i.e.4 lakh packets (21.24%) followed by MRC 6304 Bt i.e. 2.70 lakh packets (14.34%) and RCH 314 Bt i.e.0.8 lakh (4.34%). But the number of Bt hybrids approved by GEAC but not recommended by PAU is quite large and major share from these are from Bio 6488 Bt i.e. 0.7 lakh (3.72%), Ankur 2226 Bt i.e. 0.45 lakh (2.39%), IT-905 Bt i.e. 0.40 lakh (2.12%) and OM 333 Bt i.e.0.35 lakh (1.86%). From BG-II hybrids 1.35 lakh (7.17%) packets of RCH134 Bt, 0.33 lakh (1.77%) of Nikki 7017 Bt and 0.32 lakh (1.70%) of Tulsi 9 Bt. There is a need to increase the share of PAU recommended Bt cotton hybrids which has been released owing to their suitability in agro climatic conditions of Punjab for increasing the cotton productivity and production.

### 4.8

### Impact of prices and trend in cotton production

### N. V. SHENDE

### Dr. Panjbrao Deshmukh Krishi Vidhyapeeth, Akola-444 001

Cotton (Gossypium spp.), the 'white gold' is one of the most important cash crop in the world. Cotton plays an important role in Indian economy as it contribute significantly to both agriculture and industry in terms of farm income, employment, and export earnings. India also has distinct advantage of cultivating all the four species of cotton, namely Gossepium barbedence, G. hirsutum, G. herbaceum and G. arboreum are grown by matching the climatic requirement of a particular species with that region. Maharashtra is the largest cotton growing State in the country. It covers about 36.3% of total cotton area and contributes 22.21% of the production. Where as Marathwada region accounts 35 per cent of area, which contributes about 30 per cent production in the state. This study was conducted to estimate the quantitative variation & growth in area, Production and productivity of cotton across the major growing districts of Marathwada region and the state as a whole, and counteract differences thereof. Documentation of such estimates proves useful for policy makers in formulating policy instruments for the betterment of cotton farming in the state.

District wise time series secondary data for Marathwada region of Maharashtra for the year 1960-61 to 2006-07 were used for analyzing the Coefficient of variation, Compound Growth Rates, Correlation, Decomposition analysis and also the Nerlovian coefficient of adjustment, which provides information about the speed of adjustment of acreage to changing level of explanatory variable in the supply response equation. The extent of instability in cotton production in the region decreased from 31.24 & 37.17 percent in I & II period to 28.88 per cent in third period. This instability of cotton in the region was the effect of the instability experienced by cotton growing district probably due to the introduction of improved cotton technology in the farming system.

The results further clearly indicate that, yield was a major contributor to the increased production of the cotton in the region. This happed due to advancement in research pertaining to evolution of high yielding varieties of cotton over the period of time & adoption of improved technology by the cotton grower in the region. The empirical result on the extent of responsiveness of price and non-price factors in area allocation under cotton for Marathwada region revealed that the coefficient ranged from a low of 0.196 to a high of 9.408. The impact of lag yield & price risk was found most pronounced on area allocation under cotton. Its elasticities were also positive & significant in Marthwada region. This implies that farmer in Marathwada region consider lag yield & price risk as one of the factors in land allocation under cotton. The elasticities are positive & significant in case of lag year acreage, which represent that farmers are also seemed to be responsive to this factors where the coefficient is 0.70.

It is further very interesting to note that, the value of  $R^2$ , was 0.845 indicating that the model found most appropriate function for Marathwada region, which explain 85 percent magnitude of variation in the area allocation to Cotton. Thus the study reflected substantial variability in growth performance of cotton production across district & between the periods. Further, trend in area & production of cotton across the districts were found to be correlated compared to the trend in yield and production in the entire period. This suggests the need for stabilization policy in cotton to facilitate variety development program that has the characteristics of cost effectiveness.

### 4.9 Indian cotton portal

### M. SABESH, N. GOPALAKRISHNAN, G. MAJUMDAR

#### Central Institute for Cotton Research, Regional Station, Coimbtore-641 003

The nature of information resources is changing rapidly as a result of application of Information Communication Technologies (ICT). The proliferation of sources for digital information advances in computing systems, and the continuing networking and communications revolution have rapidly expanded the ability to produce, process, and provide access to digital information. The Indian Cotton Portal contains different types of data files to satisfy the needs of information consumers. This repository acts as a single window system for cotton information since it includes information from seed to fabric.

Indian agriculture is still facing a plethora of problems to maximize productivity. Due to several reasons, the majority of the farming community is not getting upper bound yield despite successful research on new agricultural technologies by inventing new crop cultivars, crop cultivation and pest protection techniques. One of the reasons is that the appropriate and timely scientific advice about farming is not reaching the farmers. In order to bridge the gap between potential and actual yields, it is necessary to have better farmer – scientist linkage and the information technology will have to be adequately synchronized with a strong transfer of technology through web enabled advisory system. With the introduction of cotton interactive web server, the farming community, researchers and common people, would directly interact with scientific community to get their first hand information to overcome day to day cotton cultivation problem.

Large volumes of data as well as documents on all aspect of cotton from different sources were collected, digitized and suitable databases were created. User-friendly information retrieval system using Visual Basic.NET as well as ASP.NET was developed to float at web site portal. Apart from Information retrieval system we have release CDs on Cotton Cultivars, Digital Cotton Library. Bilingual format (both English as well as Hindi) of the web contents is under preparation.

Indian Cotton Portal (www.cicr.org.in) maintained with latest and user need information on aspect of cotton. The web site contains around 500 pages of information in the form of HTML, doc and PDF format, around 450 images in the image gallery. The web portal contains: Large volume of database, Research findings, farmers advisory system, Indigenous Technical Knowledge in cotton production and protection, IPM package, IRM package for Cotton, Bt Cotton reports, TMC Research findings, AICCIP proceedings and PC reports, Vision 2025 document for CICR, Package of practices for cotton for different states; Link established with other cotton related web portals.

# 4.10 Attitude of *Bt* cotton growers towards raising the refugee crops in *Bt* cotton

### S. USHA RANI AND G. SELVARAJ

Central Institute for Cotton Research, Regional Station, Coimbtore-641 003

In India, the commercial adoption of Bt cotton technology has been considered as one of the most rapid cases of technology diffusion in the history of agriculture. Even though the technology crowns the credits of various benefits, it's end users have certain concerns about it's bio-safety, ethical, social, health, economic and environmental implications. Among the various concerns, fear of development of resistance by bollworms: the target pest is the major one addressed by all the stakeholders, which, shakes the sustainability of the technology itself. The regulatory bodies of biotech crops have suggested raising refugee crop to manage the resistance development by pests to Bt cotton. But, studies across the country reveal that majority of the growers had not adopted the technology and few of them had adopted the technology with modifications of their own. Since attitude of the end users plays a major role in determining the adoption of any technology, a study was conducted to find out the attitude of Bt cotton growers towards raising the refugee crops in Bt cotton among 120 Bt cotton growers in Tamil Nadu using simple random sampling method. A scale was constructed following the Thurstone's Equal Appearing Interval method. A total of 68 statements concerning the psychological object were collected and edited by Edwards' criteria. Finally, 60 statements were selected which formed the universe of content. These were then subjected to 70 judges for their opinion with a fivepoint continuum ranging from most desirable to most undesirable. Based on the scale and Q values were computed and the final scale was constructed with ten statements. The reliability and validity of the scale were tested using the Spearman - Brown formula and content validity method. Scale was administered to 120 Bt cotton growers using three- point continuum "Agree', "Disagree" and "undecided" by personal interview method. More than 60 per cent of the respondents had unfavourable attitude towards raising refugee crops in Bt cotton. The fear of increase in production cost, yield loss, reduction in net gain and troublesome work of spraying separately for non-Bt cotton were the major concerns which compelled them to have unfavourable attitude towards this technology.

### 4.11

## Economics of *Bt* cotton production in Wardha and Yevatmal districts of Maharashtra

### SACHIT M. YELEKAR, A. R. REDDY AND ISABELLA AGARWAL Central Institute for Cotton Research, Nagpur-440 010

A study was conducted in Yawatmal and Wardha districts of Maharashtra to work out the economics of Bt cotton production. Data were collected from 70 farmers on various aspects of costs and returns in bt cotton production. Collected data were analyzed using suitable statistical techniques. It was found that 100 percent of cotton area of sample farms was under Bt cotton cultivation. Total cost of cultivation of Bt cotton per hectare was Rs 13483 while non Bt cotton was Rs. 11600. Cost of human labour accounted for 38.75 percent of total cost. Cost of seed, bullock labour and fertilizers accounted for 19 percent, 18 percent and 11 percent of total cost respectively. Cost of plant protection chemicals accounted for only 3 percent. Total cost of production was higher in large and medium farms when compared with small and marginal farms. Gross returns and net returns were also higher in large and medium farms when compared with small and marginal farms. Human labour consumption was 23 percent more in Bt cotton when compared with non Bt cotton. Seed cost was 86 percent more and cost of fertilizers was 83 percent more in Bt cotton than in non Bt cotton production. It was found that cost of plant protection was only Rs. 405 per ha were as it was Rs. 2142 per ha in non Bt. Plant protection costs reduced by 81 percent after adoption of Bt cotton. Seed cotton yield of Bt cotton was 13.16 g per ha where as it was 9.69 q per ha in non Bt cotton. Net returns obtained was Rs. 22468 per ha in Bt cotton while it was Rs. 14872 per ha in non Bt cotton. Net returns were 51 per cent more in Bt cotton production when compared with non Bt cotton production. Opinion survey of the respondents reveled that profit from cotton increased after adoption of Bt cotton. Most of the farmers opened that demand for labour and fertilizers increased after the adoption of Bt where as demand for pesticides decreased.

### 4.12 Total factor productivity of cotton in Marathwada region of Maharashtra

### A. R. REDDY, SACHITA M. YELAKAR AND ISABELLA AGGARWAL Central Institute for Cotton Research, Nagpur-440 010

Total input, output and productivity indices were worked out for five important cotton growing districts of Marathwada region of Maharashtra for the period 1990-2008. These growth rates were worked out separately for the periods before introduction of Bt cotton and after introduction of Bt cotton as well as overall period. Before introduction of Bt cotton TFP growth was significantly positive in Jalna only. In all other districts it was nonsignificant. After the introduction of Bt cotton is after 2002-03 TFP growth was positive and significant in Aurangabad, Beed, Jalna and Parbhani. In Jalna though it is not significant it was positive. Growth rates of TFP were also high in this period when compared with previous period. During the overall period of analysis TFP was positive and significant in all the districts expect Beed. In Beed district though it was nonsignificant it was positive. Growth of output index was also positive and high during this period when compared with previous period. Moreover output index exhibited positive growth, though there was a nonsignificant increase in input growth. This trend indicates that introduction of Bt cotton have positive on effect on output growth through productivity increase. During the overall period input index as well as output index showed positive significant growth in almost all districts. Total factor productivity growth was also positive and significant in all the districts except Beed. Contribution of productivity growth to total output growth ranged from 45.22 percent to 76.35 percent. It was highest (76.35 percent ) in Nanded followed by Jalna and Parbhani.

### 4.13

production in this zone itself.

## Profit and profitability of hybrid seed production of genetic male sterility based *desi* cotton AAH-1 hybrid

### K. S. NIRANIA, YAGYA DUTT, K. L. CHHABRA AND P. P. JAIN

### CCS Haryana Agricultural University, Cotton Research Station, Sirsa-125055

Cotton hybrid seed production is done mainly through hand emasculation and pollination, which is very laborious and expensive. However, in the year 1999, the first Desi cotton hybrid based on genetic male sterility system was released by CCS Haryana Agricultural University, Hisar in North Zone. Being male sterile, the process of hand emasculation is not required thereby reducing the cost of hybrid seed production. At CCSHAU, Cotton Research Station Sirsa Production Technology of desi cotton hybrid AAH-1 was demonstrated to the farmers, they were supplied the parental seed of the hybrid AAH-1 and were trained & encouraged for cotton hybrid seed production at their own field since 2001. Thereafter, study was conducted at field of four farmers in villages Begu, Baruwali, Bharokhan and Handikhera during the year 2005-06 and Begu, Khai Sher Garh and Begu-II during 2006-07 in Sirsa district. The objective of present study was to work out the economics of hybrid seed production of genetic male sterility based Desi cotton (AAH-1) hybrid. In the present study, the average cost of one-kilogram seed production was Rs. 138/- to Rs.171/- during 2005-06 and Rs.181/- to 218/-, during 2006-07 with over all mean Rs. 175/- per kg. The net return of Rs. 69744 to 127804 during 2005-06 and Rs 90145/- to Rs 125363/- during 2006-07 with Rs. 101960/- over all mean of two years was recorded from one acre hybrid seed produced by the farmers. The benefit cost ratio was 2.13 to 2.92 during 2005-06 and 1.45 to 1.95 during 2006-07. The study revealed that hybrid seed production is profitable and could increase the income and improve the socio-economic condition of the farmers in this zone. Farmers also benefits due to increased employment opportunities, optimum utilization of farm labour during off-season and attraction of entrepreneurship. By little efforts depleting returns in the cropping system shall increase and

seed production of genetic male sterility based hybrids could act as precursor of Bt cotton hybrid seed

# 4.14 The adoption of *Bt*-cotton–a survey in the east Nimar (M.P.) region

#### **KUMUD DUBEY**

S. N. Govt. P. G. College, Khandwa-450 001

GM Crops made their appearance in the world about a decade ago have gained sustainable popularity and acceptance in many parts of the world. An experience has shown the benefits of transgenic insect resistance crops in terms of increased yields, chemical inputs and as a knock on effect improved farmer and consumers health. Fiber yielding plants are second of food plants in their usefulness. Cotton world's most important non-food agricultural commodity and first vegetable fibre used for textile purpose and today also it is unchallenged a natural textile fibre. Cotton is a major crop in India but it is affected with the problems like extensive pest damage and poor yields.Bt-Cotton offers a solution for these problems. The Incidence of the pest is considerable lower in Bt- cotton than Non-Bt- cotton. The present study is made with a survey to assess the views related with pest incidence, pesticide cost, cotton quality yield and profit. Many of the farmers indicated that they plan to plant Bt- Cotton in future.

### 4.15 Cotton in Punjab : *Arboreum* to *Bt* hybrids

### PARAMJIT SINGH, G. S. BUTTAR AND SUDEEP SINGH

#### Punjab Agricultural University, Regional Station, Bathinda-151 001

Through centuries, Punjab was content with the growing of short staple desi cotton (G. arboreum) to meet domestic requirements. To find an alternative source of supply, the East India Company laid out extensive trials with exotic cottons in different parts of India. The first attempts at growing American cottons in the Punjab were made during 1853 in Shahpur district (now in Pakistan) and then during 1876-77 in other parts of the Punjab and the popular variety of American cotton grown came to be known as narma on account of its soft feel. It culminated in the development of 3F and 4F Punjab Americans in 1912. In 1928 robust, vigorous plant with good fluffy opening of bolls was selected from a field of 4F cotton at Lyallpur which was acutely suffering from bad opening of bolls (tirak) resulted in the development of new variety LSS and its release in 1933 made a land mark in the history of the Punjab American cottons. The partition of the country in 1947 snatched cotton growing area from hold of present Punjab, as a result of which the total production in Punjab was only 2.54 lakh bales in 1950-51 with productivity of 250 kg/ha. The introduction of Mexican wheat during nineteen seventies forced the Puniab cotton to survive and flourish under new cotton-wheat cropping system. Then concentrated efforts led to a gradual increase in area, production and productivity of cotton in the state, which reached to 607 kg/ha in 1991-92. A severe out break of insect-pests in 1983 and then in 1993 gave serious jolt to the cottons of Punjab. After this the production and productivity started decreasing with all time low productivity of 201 kg/ha in 1998-99. This decline was mainly due to bad weather, higher incidence of bollworms specially outbreak of American bollworm, indiscriminate use of insecticides, and development of resistance to insecticides. But the crop has revived again after 2002 and the release of Bt cotton hybrids is one of the most important factors for the revival of cotton cultivation in Punjab. The technology was found to result in many positive benefits for cotton cultivation in Punjab, especially in terms of reducing farmer stress from management issues related to cotton bollworm. Due to introduction of Bt cotton in Punjab, the area of cotton increased to 6.18 lakh ha with a production of 27 lakh bales in 2006-07. But some farmers and NGO's were raising concerns constantly from time to time regarding cultivation of Bt cotton, especially of illegal Bt cotton varieties which were not tested for bio-safety, risk of secondary insect pests. It is clear from the journey of cotton in Punjab that cotton production and research has not been the same ever and neither is it going to stay as it is today. Efficient management and as well as the most economical use of resources demand that research efforts be planned today to meet tomorrow's needs and challenges.

### 4.16 *Bt* cotton in Rajasthan : Prospects and problems

### C. J. KAPOOR

### Rajasthan Agricultural University, Agricultural Research Station, Sriganganagar-335 001

Bt Cotton is a transgenic plant that produce an insect controlling protein Cry 1 A (C), the gene for which has been derived from the naturally occurring bacteria, Bacillus thuringiensis sub sp. kurstaki (B.t.k). The cotton containing Bt gene produce own toxin for bollworms and thus significantly reduce the insecticide use and providing a major benefit to cotton growers and environment. During 2003-2004, different Bt hybrids were tested in ICAR, AICCIP research trials, RCGM trials and large-scale trials in the state. Based on the yield performance, the GEAC gave first official approval for the commercial cultivation of six Bt cotton hybrids in the state in 2005. In 2006, GEAC gave approval for cultivation of another eight Bt cotton hybrids. In 2007, 18 Bt cotton hybrids were approved for the state. In 2008, on the basis of performance in the research trials conducted in kharif 2007 at Agricultural research station Sri Ganganagar, six Bt hybrids were recommended by zonal advisory research and evaluation committee (ZAREC) for general cultivation in Rajasthan. They are JK1947 Bt, Rassi-134 Bt, Rassi-314Bt, MRC-6301 Bt, MRC-6325 Bt and NCEH-6 Bt. Though the area under Bt hybrids in Rajasthan state is 12000 to 15000 ha only. The performance of Bt hybrids in Rajasthan state was assessed by post release monitoring team in the year 2007 and 2008. Survey of Sri Ganganagar, Hanumangarh, Nagour, Jodhpur, Ajmer, Alwar, Pali and Sikar districts was conducted during both the years, matching boll development and at maturing stage. During survey of districts of Rajasthan it was observed that cultivator's method of planting of Bt cotton hybrids and seed rate used was erratic (i.e. not as per recommended practice) spacing row-row/ plant to plant was not properly maintained. This practice resulted in getting less number of bolls per plant and shedding of squares and bolls, ultimately resulted in less yields. Cultivators were also not using recommended fertilizer dose of nitrogen (150kg N/ ha) for Bt cotton hybrids. With regard to irrigation farmers of Sri Ganganagar and Hanumangarh district were applying more than required irrigation which resulted in more vegetative growth and reduced reproductive growth ultimately less yield was obtained. It was also observed that Bt cotton hybrids did not provide control of sucking pests and tobacco caterpillar especially in BG-1. Mealy bug causes serious damage to Bt hybrids in Sri Ganganagar and Hanumangarh districts. The attack of spotted, pink and American bollworms was observed in non-Bt plants grown around Bt crop. The problem of foliar diseases such as Alternaria, parawilt has been noticed in greater intensity on Bt cotton hybrids compared to conventional cotton varieties. For control of insect-pest and diseases farmers applied 0-3 sprays in Bt hybrids where as it ranged from 4-10 sprays in conventional varieties, which has reduced the cost of cultivation. There is urgent need to develop appropriate package of practices for each Bt cotton hybrids of different agro- ecological conditions by the seed companies selling the Bt cotton hybrids. Transfer of proper technology will enhance the yield potential of the farmers as well as the state.

### 4.17

### Prospective utilization of Bt cotton at farmers' field in Madhya Pradesh

### VINOD KUMAR GARG AND YOGESH PATEL

#### Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, College of Agriculture, Ganj Basoda, Vidisha-464221

Cotton is the most renewable natural textile fibre and the sixth largest source of vegetable oil in the world. The area under cotton in the Madhya Pradesh has remained static over the last decade hovering about 6.30 lakh hectares. The average productivity of sate is higher than the national average productivity but lower than the world average. The field study was conducted for four years from 2003-04 to 2006-07 to know the performance of Bt cotton hybrid at farmers' field in the village Balwada of Khandwa, Madhya Pradesh under the jurisdiction of Regional Agricultural Research Station, Technology Mission on Cotton, Khandwa (MP). The highest Seed cotton yield (21.85 q/ha) was recorded during 2006-07 in Bt cotton hybrid field over farmers' practices (non Bt cotton hybrid). the average seed cotton yield in Bt hybrid over the years was 20.30 q/ha in contrast to farmers' practices (15.40 q/ha). Cost of production per quintal was less in Bt cotton when compared with farmers' practice. Highest net return of Rs. 24970.83/- per ha was obtained in Bt field;. The profitability of Bt cotton was when compared with non-Bt cotton hybrid field. The highest input output ratio of Bt cotton hybrid was 1:2.28 as against to 1:1.52 in the field sown with non-Bt cotton hybrid.

### 4.18 Protection of plant varieties with special reference to *Bt* cotton in India

### F. B. PATIL

### Ajeet Seeds Ltd., Aurangabad

Protection of Plant Varieties and Farmers' Rights (PPV & FR) Act, 2001, fulfills country's obligations under Article 27, sub-section 3(b) of the Trade Related IntellectualProperty Rights (TRIP). The Act provides an effective *sui generis* system for protection ofPlant Varieties, protects the rights of farmers and plant breeders to stimulate investments both, in public and private sectors, for developing of new plant varieties aiming toaccelerate agricultural development in the country. During 2002-2008, GEAC has approved 279, Bt cotton hybrids involving four events for commercial cultivation in the country, which has resulted in doubling the cotton production & productivity. One of the emerging threats in Bt Cotton is likely duplication of promising Bt hybrids, depriving the original breeder /organization, from monitory gains out of such invention. The registration of such hybrid(s) & or their parental lines under PPV & FR Act, can be the vital alternative. Bt Cotton is a transgenic variety, which can be protected as i) Essentially Derived Variety (EDV) ii) New variety iii)Extant Variety & iv) Variety of Common Knowledge(VCK), whose seed is being marketed as truthfully labeled . The detailed procedure and requirements for protection of Bt Cotton under each of these categories are discussed. The issues like whether Bt hybrid per se is EDV? , registering Bt cotton as a new variety or VCK with out DUS test, protection of Bt cotton variety.

### 4.19

## Desi Cotton : Present status and future scope in respect of non-desi cottons in Gujarat

### B. G. SOLANKI, V. KUMAR, D.M.PATEL AND V. Y. SOLANKI

#### Navsari Agricultural University, Main Cotton Research Station, Surat-395 007

Cotton is grown in more than 70 countries. India has distinction of growing all the four cultivated species viz., G.herbaceum, G.arboreum, G.hirsutum and G.barbedence. India rank first in acreage for cotton crop. At the time of partition desi cotton had dominancy in cultivated area. Release of first commercial hybrid viz., Hy-4 had changed the scenario of cotton cultivation in respect of share of different species. After 1970-71 slight decline trend was observed for desi cotton area. Even though for prolong period desi cotton covered nearly 51 per cent area of total cotton cultivated area but the introduction of Bt hybrid cotton pushed back the desi cotton area to only 15 per cent area of total area. Despite of low yield, late maturity, difficult picking, small boll size, poor fibre quality and cultivation on poor fertile soil desi cotton has its own importance. If the weakness of desi cotton can be rectified desi cotton is the best option for organic cotton cultivation because it has the inherent capacity of tolerance to biotic and a biotic stresses.

### 4.20 Shifting trends in cotton production in Gujarat state

### V. KUMAR

### Navsari Agricultural University, Main Cotton Research Station, Surat-395 007

Gujarat is a leading state in cotton production in Western India. Nearly 22 percent cropped area of the state is occupied by cotton, which plays a vital role in its economy. Nearly one third of agricultural gross domestic production (GDP) of the state comes from cotton production. In the last forty-eight years of formation of Gujarat State, cotton has undergone major changes in type of varieties, crop duration, fertilizer use, irrigation system, pest and pesticides and diseases. All these for a favourable increase in productivity and production so much so that the average productivity of the state has gone up from 139 kg in 1960 to 743 kg in 2007. Detailed analysis of the shift in various components of cotton production and their impact is presented.

### 4.21 *Bt* Cotton-a boon to farmers : five years study in Andhra Pradesh

## M. CHANDRASEKHARA REDDY, K. GURAVA REDDY, V. CHENGA REDDY AND S. RATNAKUMARI

### Acharya N. G. Ranga Agricultural University, Regional Agricultural Research station, Lam, Guntur-522 034

This study has been undertaken to assess the economic effectiveness of Bt -cotton in the state of Andhra Pradesh. The transgenic Bt. cotton hybrids from different seed companies had been used effectively for tackling the menace of *Helicoverpa* boll worm. A sample of ten experimental plots with Bt-cotton and ten control plots with non-Bt had been taken in nine villages consecutively for 5 years period as part of TMC MM 5.1 project during 2002-07. The Bt-cotton hybrids developed by Rasi, Mahyco, JK, Ankur and Nuziveedu seed companies had been used to test the impact on plant protection and overall economics. The study revealed that the adopters of Bt cotton got 9 per cent higher yields as compared to that of non-adopters. These technologies have been found cost-effective due to reduced cost of per quintal production by Rs 231/-. These technologies have been found to generate more income as the adopters could earn Rs 5073/ha more compared to that of nonadopters. This intervention has greatly reduced the cost of plant protection by 36 per cent. Total number of sprays reduced considerably with adoption of Bt cotton. This was apparent from the results that saving in plant protection by adoption of Bt-cotton is 3093/- per ha. The cost-benefit analysis has shown that this technology is economically viable. The Bt technology do not have any impact on the quality parameters of cotton.

### 4.22

## Economic evaluation of insecticide resistance management (IRM) for sustainable cotton production and quality in Andhra Pradesh

## K. GURAVA REDDY, M. CHANDRASEKHARA REDDY, V. CHENGA REDDY AND S RATNAKUMARI

Acharya N. G. Ranga Agricultural University, Regional Agricultural Research station, Lam, Guntur-522 034

This study has been undertaken to assess the impact of Insecticide Resistance Management (IRM) technologies. A sample of ten experimental and ten control plots has been taken for each technology in one village every year consecutively for 5 years period. Every year the farmers were changed from the same village. The study has revealed that the adopters of IRM could get comparable yield as that of non-adopters. These technologies have been found cost-effective due to reduced cost per quintal production by Rs 14/-. These technologies have been found to generate comparable income. The IRM technologies have reduced the cost of plant protection about 14 per cent. Total number of sprays reduced considerably by 1.8 sprays with adoption of IRM. This was apparent from the results that saving in plant protection by adoption of IPM is 1079/- per ha. The cost-benefit analysis has shown these technologies to be economically viable. The IRM technologies will reduce the chemicals-consumption and enhance the productivity of cotton on sustainable basis.