Seed Production

Nagpur

Under Mega Seed Project, TFL seed production of 24 straight varieties of cotton, *G. arboreum* race *cernuum*, Red Gram cv. BSMR-736, Bengal Gram, certified seed of Gram cv. Jaki 9218 and Digvijay was taken up. Nearly 170 Q quality seeds of cotton including breeder seed of Suraj and DS-5 - female parent of CICR 2; TFL seeds of *G. arboreum* race *cernuum* and 20 varieties of cotton), pigeon pea and chick pea were produced and resource worth Rs. 16 lakhs was generated.

Seed production of *G. arboreum* race *cernuum* was taken up. Wide genetic diversity was observed among the populations. Morphological variants within *G. arboreum* race *cernuum* such as those with different shades of lint, number of locules/ bolls and bolls/plant, erect plants with zero monopodia, etc., were documented. Morphological variants were also evaluated for stability of different traits and trait-wise purification of the material was done.

Four loculed cotton **Variation in boll size** **Coloured lint**

Variability in *Gossypium arboreum* race *cernuum* cotton

Coimbatore

Breeder seed of cotton varieties *viz*., Suraj, LRA 5166, Anjali, Surabhi, Suraj, MCU 5 VT and Suvin was produced at Coimbatore. In all, 239 kg breeder seeds of varieties were supplied to indenters including private seed producers.

Sirsa

At Sirsa, 190 kg breeder seed of *desi* cotton (*G. arboreum*) including parents of CICR-2 and varieties CISA 614 and CISA 310, was produced and distributed to stakeholders and indenters.

3.9: Nutrient Management

Nagpur

Organic nutrient sources with release rates compatible to crop demand is one of the key principles of nutrient management. Therefore, field studies were conducted with four organic components *viz*. FYM, vermicompost, bio-enriched cotton compost and mulching of green manure (sunhemp) besides a control treatment. All organic sources were applied in equal quantities (5t /ha). Two varieties, namely, Suraj (*G. hirsutum)* and JLA 794 (*G. arboreum*) were taken up under organic cotton cultivation. Three sprays of neem oil (@300 ppm) were given for controlling insect pests. Seed cotton yield of 13.6 q/ha was recorded in JLA 794 followed by Suraj (9.8 q/ha). Soil analysis data indicated that application of bio-enriched compost resulted in a buildup of available soil-N and soil organic carbon (SOC). SOC content in the organic manure amended plots ranged from 0.64 to 0.76% which was substantially greater than the SOC content in the farmers' practice plot (0.54%).

Cotton stalk compost was prepared using improved composting technique and the nutrients enriched compost was evaluated as a substitute to FYM. Field experiment was conducted in a split plot design with two main treatments [seed treatment with microbial consortia (MC) and without MC] and 6 sub treatments [recommended NPK (90:45:45 kg NPK/ha), INM Practice (60:30:30 kg NPK + 5 t FYM/ha), modified INM Practice (60:30:30 + 5 t cotton compost), FYM, cotton compost and control]. Bunny *Bt* (NCS-145*Bt*) was used as a test hybrid with a spacing of 60 x 60 cm. All the treatments were replicated 5 times. Results showed significant differences between treatments. Incorporation of cotton compost (the modified INM) was found to be as good as the INM practice comprising FYM. Seed treatment with microbial consortia improved seed cotton yield by 2-5 q/ha compared to the un-treated seeds.

Coimbatore

Recommended NPK with cotton stalk compost @ 2.5 t/ha had seed cotton yield and boll numbers similar to the recommended INM practice (recommended NPK +FYM 12.5 t/ha).

Sirsa

Bioenriched compost evaluation

Cotton stalks compost with and without bio-enrichment was evaluated under field conditions in RBD with six replications using 1947 *Bt* hybrid. Maximum seed cotton yield was observed with the existing INM practice (70:24:24 + 5 t FYM/ha) and was at par with cotton stalk compost. The treatment NPK (70:24:24) had the lowest seed cotton yield and was significantly lesser than the existing INM practice for north zone.

3.10: HDPS for Maximizing Productivity

Nagpur

Thirteen cultivars developed under diverse agro-climate conditions viz., NH 615 and NH 545 (Nanded), ADB 39 and MDLH 1 (Ailabad), Suraj, LRK 516 (Coimbatore), KC 3 (Kovilpatti), RS 875 (Ganganagar), CSH 3178 (Sirsa), F 2383 (Faridkot), H 6 *Bt* (BG II) and H 8 *Bt* (BG II) (Surat) and PKV 081 (Akola) were evaluated at 3 spacings 45x15cm (148000 plants/ha), 60x15cm (111000 plants/ha) and 90x15cm (74000 plants/ha) on a shallow black soil (Vertic Inceptisol). The effect of spacing, cultivars and spacing x cultivar interaction were significant. Across cultivars, yield at 45x15cm and 60x15cm were at par and superior to that at 90x15cm. For both the *Bt* hybrids, H 6 and H 8, 60x15cm was the optimum spacing under HDPS. Genotypes ADB 39 (3000 kg/ha), PKV 081 (3011 kg/ha) and LRK 516 (2814 kg/ha) performed well at 45x15cm spacing whereas genotypes NH 545 (2830 kg/ha), KC 3 (3113 kg/ha) and Suraj (2976 kg/ha) gave highest yield at 60x15cm spacing.

Growth regulators *viz*. Mepiquat chloride (N, N- dimethyl piperidinium) and Stance (Mepiquat chloride + Cyclanalide) were compared at recommended (50 g a.i./ha for Mepiquat chloride and 600 ml/ha for Stance) and 150% recommended dose using different application schedules on 3 varieties *viz*. Suraj, PKV081 and NH615 at 45 x 15 cm spacing. There was a dose dependent reduction in plant height, decrease in height / node ratio an increase in boll weight and a delay in maturity with the application of growth regulators. None of the growth regulator treatments improved yields. Across growth regulator treatments, the varieties Suraj (2147 kg/ha) and PKV 081 (2143 kg/ha) gave significantly higher seed cotton yield than NH 615 (1898 kg/ha).

Under HDPS, effective control of weeds could be accomplished with pendimethalin @ 1kg a.i./ha + 2 intercultures along the row + 1 hand weeding (to remove remaining weeds) + 1 post emergence spray of tank mixed Pyrthibac Na(75 g a.i./ha) and Quizalofop ethyl (50 g a.i./ha).

Coimbatore

Under winter irrigated conditions, 10 cultivars namely, Anjali, C1412, CCH724-5, TCH 1608 ,TCH 1705, KC-3, NH615, MCU7, SVPR-3, PKV081 were evaluated at a spacing of 45 x 15 cm with and without application of growth regulator (mepiquat chloride @ 25 g a.i. at 45, 60 and 75 DAS). Two checks viz. Anjali planted at 75 x 30 cm and RCH 2 Bt planted at 90 x 60 cm were also maintained. Across cultivars, application of mepiquat chloride increased seed cotton yield from 1330 q/ha to 1530 kg/ha. Interaction effect of cultivars and application of mepiquat chloride was significant. Taller cultivars - TCH 1608 and TCH 1705 benefitted with application of mepiquat chloride compared to the other cultivars having a compact growth habit (Fig. 3.10.1).

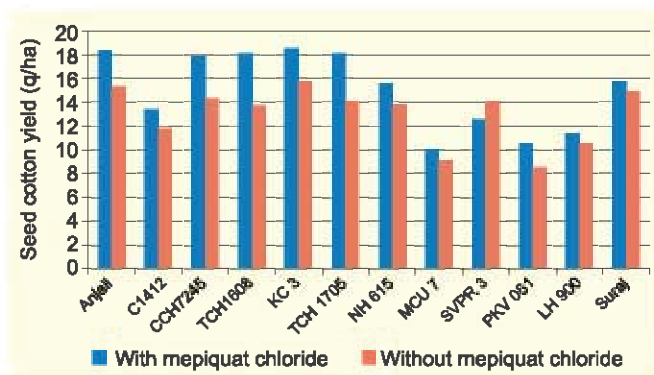

Fig. 3.10.1: Effect of mepiquat chloride application on the seed cotton yield q/ha of cotton cultivars

Weed control for high density planting system under winter irrigated conditions was standardized. Pre-emergence application of pendimethalin (1 kg a.i./ha) followed by post emergence application (tank mix of quizalofop-ethyl (50 g/ha) and pyrithiobac sodium (75 g a.i. /ha) at 30 DAS was an effective weed management strategy. This system had an associated benefit cost ratio of 1.95.

Evaluation of inclined plate planter for sowing under HDPS in winter irrigated cotton

Sowing by tractor drawn inclined plate planter produced a variation in plant to plant spacing. However, plants adjusted and yielded similar to the manual method Although, gross return was higher with manual sowing, higher sowing cost associated with manual method lowered profit as compared to tractor sowing.

Sirsa

Twenty *G. hirsutum* genotypes were evaluated under narrow spacing of 67.5 x 10 cm with RS-875 and *Bt* 3028 as checks. Genotype CSH-3158 gave the highest yield. Six genotypes *viz* ; CSH-3178, CSH-3132, Azon-148, RS-2525, ARBH-2411 and CPT50-C gave at par seed cotton yield with *Bt* check Ankur 3028 BGII (2349 kg/ha). In large plots too, CSH-3178 and CSH-3132 gave seed cotton yield similar to the *Bt* check. CSH-3158 yielded significantly higher than the *Bt* check. CLCuD incidence ranged between 3.0 to 22.6 PDI, leaf hopper population ranged from 1.0 to 1.6, 4.9 to 8.5 for whitefly and boll damage ranged from 0.0 to 13.8%. CSH-3178, CSH-3158, CSH-3132, ARBH-2411 and CPT50-C recorded less than 10 PDI for CLCuV. CSH-3158 and ARBH-2411 had < 10% Bollworm damage.

Six *G. arboreum* genotypes HD-123, RG542, HD-432, CISA-310, CISA-614 and CISA-111 were evaluated at three spacings: 67.5 x 10, 20 and 30 cm. Higher yield, in general, were recorded for 67.5x20 cm spacing followed by 67.5 x 10 cm. However for CISA-310, 67.5 x 10 cm was ideal spacing. There was an increase in yield of 3 to 8 q/ha (10.1 to 27.8% increase) in 67.5 x 20 cm spacing over normal spacing of 67.5 x 30 cm.

Evaluation of Mepiquat chloride

There was an increase in boll weight, boll number and seed cotton yield with mepiquat chloride treatment than the control to an extent of 6- q/ha. Two to three applications of mepiquat chloride (25 g a.i./ha) resulted in (i) Reduction in plant height and number of monopods, (ii) Increase in number of squares and flowers and (iii) Increase in number of bolls, number of nodes and number of sympods.

3.11: Weed Management

Allelopathy as an alternative weed management strategy for cotton

Weed control in rainfed cotton grown on Vertisols is a major issue because soils become sticky and wet after rains and are very hard when dry conditions prevail. Thus, the time when effective weed control is possible is very narrow. Therefore, growing a cover crop that produces allelopathic effects to weeds is considered as a possible solution for integration with mechanical methods. Field studies were conducted at Nagpur and Coimbatore to evaluate the efficacy of cover crops grown in situ as well as using mulch of tree species with known allelopathic effects.

At both the locations, namely, Nagpur and Coimbatore, influence of cover crops on weed count was significant. All the cover crops recorded a significant reduction in weed count. At Coimbatore, it was comparable to sole cotton (RCH 20 *Bt*) which received two additional hand weeding. Among the treatments, the lowest weed count was recorded by sunflower as a cover crop and this may be due to strong allelochemicals of sunflower crop. At Nagpur, significant reduction in weed population and biomass accumulation was observed with cover crops

(Fig. 3.11.1). Among the cover crops evaluated, sorghum was the most effective followed by the leaf mulch of neem and eucalyptus. Weed control efficiency of using sorghum as a cover crop ranged from 76 to 84% compared to the normal weed control practice followed in sole cotton (44 to 50%). This indicates that using a cover crop further improves the efficiency of weed control.

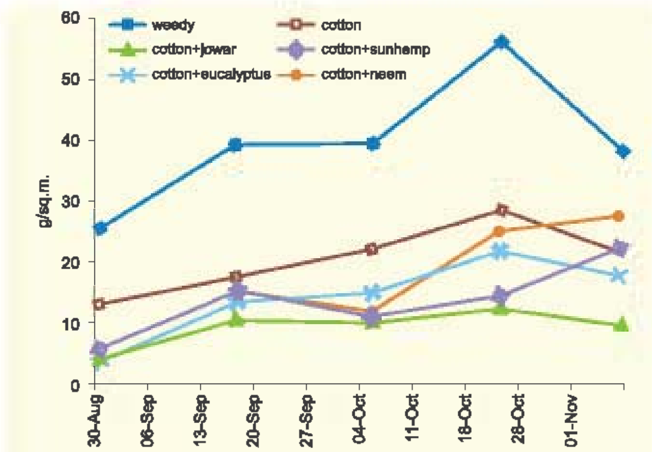

Fig. 3.11.1: Weed biomass accumulation over time with different cover crop treatments

Seed cotton yield increased significantly with cover crops. At Nagpur, cover crop treatments of sorghum, sunhemp, mulch of neem and eucalyptus produced significantly greater seed cotton yield. Yield advantages were restricted not only to effective weed control but also to other benefits accrued such as soil moisture conservation. Soil moisture in the cover treatment plots was nearly 2% greater than the sole cotton plots.

At Coimbatore, covers of wheat, barley, and sunhemp (2688 to 2719 kg/ha) had higher yield compared to sole cotton (2411 kg/ha). Among the cover crop treatments, sunflower had the least seed cotton yield (1280 kg/ha). This was probably due to its allelopathic effects to cotton as well as weeds. Hence, sunflower is not a suitable cover crop with cotton. Covers of sunflower, radish, mustard and cabbage also resulted in significantly lower seed cotton yield than the sole cotton treatment.

Results from the first year field studies indicate that weeds in cotton can be managed by integrated approach with the application of a pre-emergence herbicide such as pendimethalin (1.0 kg a.i./ha) followed by in situ cover crops around 35 - 40 DAS and one hand weeding around 70 -75 DAS to remove the later emerging weeds.

Wheat as cover crop | Barley as cover crop | Sun hemp as cover crop

Sirsa

Biosafety Research Level II trial (BGII RRF)

Biosafety Research Level trial (BGII RRF) was conducted at CICR, RS, Sirsa. The unreplicated trial was sown on 28 May 2012 comprising 8 treatments. A total 3 sprays were applied for weed management at 41, 81 and 133 days after crop sowing. Per cent yellowing data were recorded after 4 days, 7 days, 14 days and 21 days after application of roundup herbicide (MON 76366) spray. At 21 days after spray 64.4%, 86.7% and 89.8% yellowing in MRC 8017 BGIIRRF Roundup sprayed treatment and 74.2%, 95.6% and 85.8% yellowing in MRC 8031 BGIIRRF Roundup sprayed treatment was observed in broad leaves, grasses and sedges, respectively. Among broad leaved weeds, there was 100% yellowing in *Trianthema monogyna* (itsit) and *Digera arvensis* (tandla) after all sprays where as percent yellowing in case of *Convolvulus arvensis* (hiran khuri) and *Euphorbia hirta* (badi dudi) was upto 25 and 63.6%. However, the population of these weeds itself was quite low.

Total expenses of weeding and intercultural operations per ha was calculated at Rs 15075 (high weed intensity trial field).Where as in case of RRF, the total expenses (chemical cost + labour cost) for round up spraying were calculated as Rs 6774/ha. Net saving per ha for weed control by using BGIIRRF was found Rs 8301.However under normal weed intensity under farmer field conditions the net saving per ha for weed control by using BGIIRRF was estimated at Rs 2271.

3.12: Herbicide Resistance

Nagpur

Glyphosate as a pre-plant foliage application twice was less effective on - *Commelina sp., Merremia emarginata* and *Acalypha indica*.

Soybean followed by *Bt* cotton + pigeon pea crop rotation employed a rotation of herbicides. This resulted in significantly lower weed incidence from very high (420 weeds/m^2) to very low (7/m^2). Pre-plant foliage application of glyphosate followed by early post - emergence application of imzethapyr/pyrithiobac Na were ineffective in both seasons and cropping systems on *Echinocloa crussgalli*, *Celosia argentia, Acalypha* *indica*, *Merremia emarginata*, *Tridax procumbence* and *Cyperus rotundus*. *Euphorbea hirta*, *Echinocloa* sp., *Cyperus rotundus* (partial), *Commelina communis* (less), *C. benghlensis* (total), *Cynodon dactylon*, and *Dinebra* were controlled within four days after application of pyrithiobac Na. However, *Digera arvensis* was not affected.

Chlorimuron ethyl : All grasses could be controlled effectively as early post emergence application in soybean. It did not affect G. *barbadense* cotton that succeeded soybean.

Quizalofop : was found to be very effective against a wide range of grasses, except perennials.

Fenoxoprop : It was not effective against *Cyperus rotundus, Commelina bengalensis C. communis*, where as *Echinocloa crussgalli* was effectively controlled.

Propquizafop : Pyrithiobac Na-Propquizafop was a good combination for cotton and effectively controlled *Commelina sp.* and *Cyperus rotundus*.

Coimbatore

Intensive glyphosate usage on farms for nearly 20 years at Rasipuram (Salem (Tamil Nadu) indicated that weed population was significantly reduced. It is also that over the years the weed species shifted from grasses to sedges and broad leaved weeds presumably by the continuous use of glyphosate.

Weed analysis carried out in cotton field applied with fluchloralin/pendimethalin (0.75 kg a.i./ha) for several years. It was observed that over the years, weed species shifted from grassy weeds to broad leaved & sedges by application of fluchloralin/pendimethalin.

Yield modeling

Identification of yield influencing weather parameters were attempted by correlation of weather data with the cotton yield. The correlation analysis with Virdhunagar district found that relative temperature disparity (0-45, 46-90,91-120,121-150 DAS and total), rainfall (0-45, 46-90, 91-120, 121-150 DAS and total), and evaporation (0-45, 46-90, 91-120, 121-150 DAS and total) were positively correlated with yield. The analysis of Tuticorin district found that the significant positive correlation was observed with minimum temperature of 0-45 DAS, growing degree days of 0- 45 DAS, maximum relative humidity of 46-90 DAS and 91-120 DAS,121-150 DAS ,and total ,rainfall 46-90 DAS and total quantity of evaporation .Identification of yield influencing soil parameters for cotton growth and development was studied. The survey was conducted in Kinathukadavu block of Pollachi taluk of Coimbatore district. The study covered three soil series includes Irugur, Palladam and Pilamedu of Kinathukadavu block. Among the factors, significant correlation found with soil productivity, land capability, soil depth, soil texture and cation exchange capacity.

3.13: Agronomy of *G. arboreum* race *cernuum*

Nagpur

G. arboreum race *cernuum* was evaluated at 6 crop geometries (plant populations) *viz*., 45 x 15 cm (148000 plants/ha), 45 x 30 cm (74000 plants/ha), 45 x 45 cm (49000 plants/ha), 60 x 15 cm (111000 plants/ha), 60 x 30 cm (55000 plants/ha) and 60 x 45 cm (37000 plants/ha). Significantly higher yield was oBtained at 45 x 15 cm spacing (2481 kg/ha) and 60 x 15 cm (1879 kg/ha) (Fig. 3.13.1). Yield in the other spacing were at par. Response to mepiquat chloride application (50 g a.i./ha) in two equal split applications was significant. Averaged over six spacing, mean yield advantage was 19.7%. Mepiquat chloride treated plants were dwarf, had higher leaf N, were more compact and had bigger bolls.

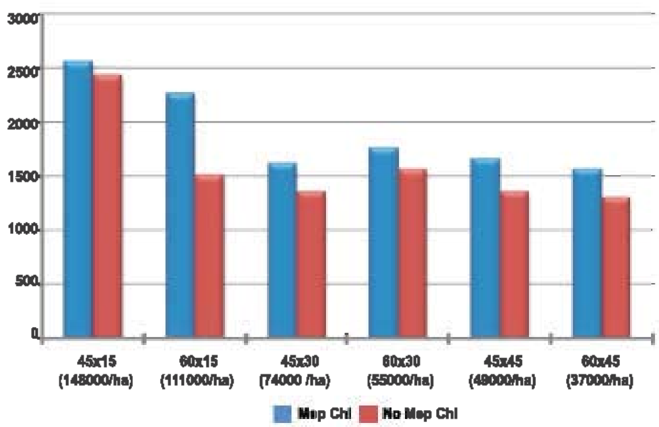

Fig. 3.13.1: Effect of spacing (cm) on yield (kg/ha) of *G. arboreum* race *cernuum* with Mepiquat chloride (Mep Chl) & without Mepiquat chloride(No Mep Chl)

3.14: Soil Biology and Biochemistry

Nagpur

Geo-referenced Soil Information System for Land Use Planning and Monitoring Soil and Land Quality for Agriculture

Survey in established benchmark soil series in Black Soil Region (BSR) of India covering 6 AERs and 17 AESRs was conducted to analyse impacts of bio-climates, cropping systems, soil sub groups, land use, and management practices on soil biological attributes for development of land quality indicators and threshold values. From each benchmark spots, soil samples were collected from individual horizon in two pedons, one each representing low management (LM) and high management (HM) regimes. Three contrasting cropping systems were studied: the legume based, cotton based, cereal based and the sugarcane based systems. The summary of findings is as follows:

a) Soil urease activity

Cropping systems and bio-climates significantly ($p<0.01$) influenced urease activities (Fig. 3.14.1) in soil. Average urease activity in different cropping systems were in decreasing order of legume > **sugarcane > cereals > cotton based cropping systems**.

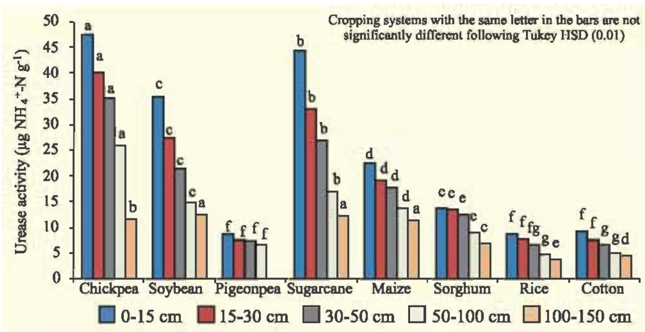

Fig. 3.14.1: Cropping systems on soil urease activity in BSR

b) Dehydrogense (DHA) activity

Cropping systems and bio-climates significantly ($p<0.01$) influenced DHA in soil (Fig. 3.14.2). Significantly (*p*<**0.01**) higher DHA was recorded in sub-humid moist (SHm) bio-climate (**2.45** µg TPF g^{-1}) followed by semi-arid dry (SAd) (**2.00** µg TPF g^{-1}) and the least in arid bio-climate (1.62 µg TPF g^{-1}). Legume-based cropping system recorded higher DHA followed by cereal-based cotton and sugarcane cropping system. Comparison of DHA in different soils indicated significant differences ($p<0.01$) between soil sub groups.

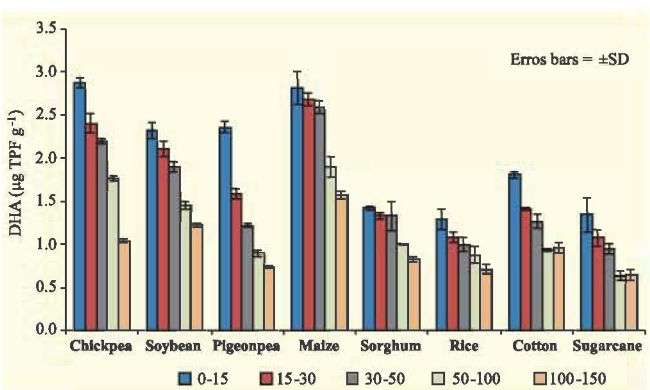

Fig. 3.14.2: Cropping systems on soil dehydrogenase activity in BSR

c) Soil microbial biomass carbon (MBC)

Among cropping systems, legume-based system had higher MBC and the lowest MBC was recorded in cotton-based system (Fig.3.14.3). within soil sub-groups, Halic Haplusterts showed higher MBC (209 µg g^{-1}) followed by Typic Haplusterts (208 µg g^{-1}), while the lowest MBC was observed in Gypsic Haplusterts (98.5 µg g^{-1}). MBC content in soil is significantly and positively correlated with SOC, total microbial population, nitrogen content, and available water content. pH correlated negatively with MBC.

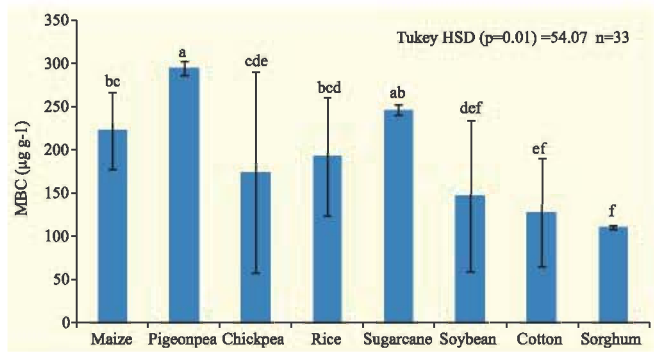

Fig. 3.14.3: Cropping systems on MBC (0-30 cm soil depth) in BSR

d) Soil microbial population

Cropping systems and bio-climates significantly ($p<0.01$) influenced the soil microbial population (Fig. 3.14.4). Significantly higher ($p<0.01$) microbial population was recorded in sub humid moist (SHm) bio-climate (6.26 $\log_{10}$ cfu g^{-1}) followed by sub humid dry (SHd) (6.21 $\log_{10}$ cfu g^{-1}) and the least microbial population was recorded in arid bio-climate (6.14 $\log_{10}$ cfu g^{-1}). Legume-based cropping system recorded significantly ($p<0.01$) higher microbial population (6.23 $\log_{10}$ cfu g^{-1}) followed by cereal based cropping system (6.23 $\log_{10}$ cfu g^{-1}). Pooled comparisons of culturable microbial population in different soil sub groups and management practices indicated a non significant ($p<0.05$) differences.

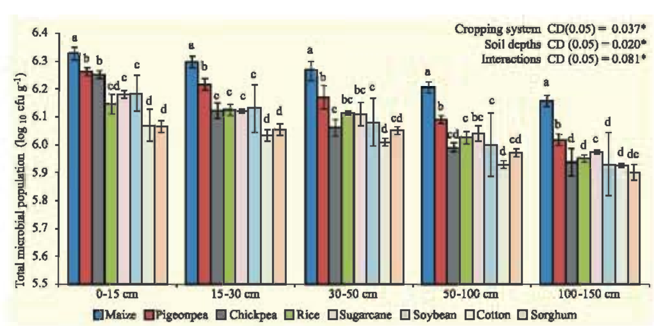

Fig. 3.14.4: Cropping systems on culturable microbial population in BSR

e) Soil culturable microbial diversity

Significantly ($p<0.01$) higher diversity indices was recorded in sub-humid-moist (SHm) bioclimates and the lowest in arid bioclimates (Fig. 3.14.5). Except Shannon

H', other microbial diversity indices were found to be significantly ($p<0.05$) higher in cereal-based cropping system than in legume-based system. Average diversity indices in different soil subgroups were in decreasing order of Typic Haplusterts > Gypsic Haplusterts > Vertic Haplusepts/Sodic Haplusterts > Chromic Haplusterts/Halic Haplusterts > Calcic Haplusterts. Among the soil properties, sand and calcium carbonate percentage were negatively and significantly correlated with microbial diversity indices and accounted for maximum variance at all the soil depths.

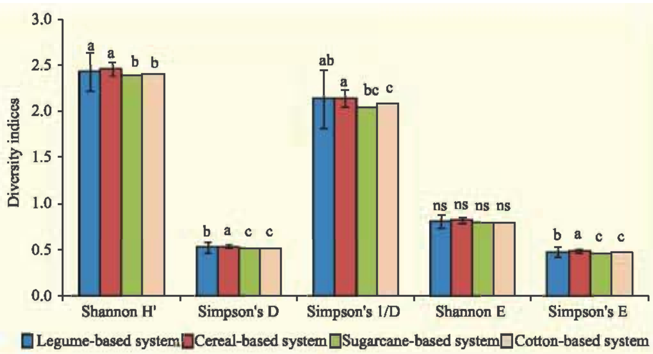

Fig. 3.14.5: Cropping systems on microbial diversity indices (0-15 cm soil depth) in BSR

3.15: Management of Abiotic Stress

Nagpur

Two Potassium silicate formulations (AgriSIL-liquid and Potassium silicate-Powder) were evaluated for their growth promotion efficiency of cotton under field conditions. With the hypothesis that nanoform of potassium silicate may improve cotton yield, potassium silicate formulations were converted to nanoform and tested at square formation stage as soil and foliar application. Field experiment was laid out in a randomized block design with 10 treatments and replicated 3 since. Three cotton genotypes [Bunny *Bt*, Suraj and AKA-5] were used as test material. No significant differences between treatments were observed in the trials conducted in the first year of study.

Amelioration of leaf reddening and parawilt in cotton

Field experiment was laid out with RCH-2 BG II *Bt* hybrid in RBD in 3 replications with 7 treatments (Potash 1%, 3% KNO_3, CCC 20 ppm, monocrotophos 3 ml/litre, lime 0. 5% and Methomyl 90 SP) including control. Early stage leaf reddening did not appear during the season. Red leaves were observed at a later growth stage which was due to senescence.

Leaf chlorophyll content, on an average, was found to be high (0.4 – 0.8 mg/gm fresh wt of leaf) in all the treatments. Since the plants did not experience stress due to leaf reddening, peroxidase activity was similar in all the treatments. Seed cotton yield ranged from 2200 to 2300 kg/ha in treated plants which was higher than the control (1800 kg/ha).

Coimbatore

Effect of Nutrient Consortia Spray on *Bt* Cotton under Elevated CO_2 Atmosphere

Irrespective of *Bt* hybrid plants grown under elevated CO_2 atmosphere was distinct with significant increase in plant height, sympodia number, boll number and yield. Significant increase in boll weight was not observed, probably due excess boll load.

Averaged over three CO_2 levels and *Bt* hybrids, there was an increase in the plant height, leaf number, boll number, boll weight and yield with nutrient spray. Apparent difference in yield could be observed with 90 g/plant in plants that received nutrient spray compared to 76 g/plant in control.

Alleviation of water logging stress under elevated CO_2 atmosphere

Plant height was significantly more in chamber with and without elevated CO_2 atmosphere compared to ambient grown plant irrespective of nutrient spray treatment. Only marginal differences could be recorded with respect to sympodia number, leaf number. However, significant differences with respect to boll number, boll weight and yield could be seen. For instance, the yield per plant was 57.6 g/plant in chamber with CO_2 while in chamber without CO_2 gave 45.6 g/plant.

Plant height and sympodia production was not altered by water logging treatment while a marginal decline in leaf number and boll number was noticed. Significant reduction in yield was observed due to water logging.

3.16: Cotton Mechanization

Nagpur

Design and development of cotton picking head

Fabrication of a Trolley mounted cotton picking head

A conceptual trolley mounted *chain type* and *peg type* pickers were fabricated with variable row to row spacing of 60, 80 and 90 cm. This conceptual design of a medium size cotton picking machine can be operated by a pair of bullocks or a person pushing from behind the machine. The machine has three components i.e. 1) picker trolley 2) crop guider & compressing mechanism and 3) picking mechanism. While the machine moves, the plants are progressively compressed and at the maximum compression, picking units pick the bolls coming in contact with them, doffed and collected at the bottom of the trolley.

Trolley mounted chain and peg picker prototype

Testing and modification of the Trolley mounted cotton picker prototype.

The prototype was tested in the field in different row spacings ranging from 60 to 90 cm row to row spacing on H6 *Bt* hybrid (90 cm), PKV 081 (60 cm) and Suraj (80 cm). It was observed that the machine was unstable and the wheels needed replacement as movement was difficult because the crop lifters were too close to ground. To facilitate multi-row testing the prototype was redesigned and fabricated with variable row to row spacing, reduced height and weight. Picking units were also modified providing more exposure of cotton bolls to chains and pegs, thus giving more response time to the picking units to pick. The throats, from each of the ten picking units were cut to allow for free flow of the picked cotton.

Testing of Prototype Picker in field and sample of machine picked cotton

It was observed that a portion of the picked cotton was falling to the ground through the opening between the lowermost guide bar and the chassis of the machine. Also the picked cotton was being brushed by subsequent branches and carried to the rear of the machine. Further modifications are in progress.

Observations on picking

It was observed that through various modifications the picking rate was increased to 8.9 kg/h compared to 4.1 kg/h with manual picking with an average picking rate of 1.6 kg/h.

Identification of a mini combine harvester for modification into a cotton stripper for small farms

A mini combine harvester was identified and tested.

The combine was run under HDPS system and whole plants were cut at the stem with the reaper portion of the combine and fed into the threshing unit. The seed cotton along with broken stems was discharged through the rice husk outlet of the combine and the finer leaf trash etc got discharged through the grain outlet. However, the stem being wet could not break down to smaller pieces and thus added to the trash load of the discharged seed cotton. The trash was about 50%. The thicker and stronger cotton stems jammed the conveyor unit, and the threshing drum as these were designed for softer plant material.

Threshing whole plants in conventional axial flow thresher

A separate experiment was done to understand the modifications needed in the threshing drum of the existing combine harvester. Whole plants were cut and fed into a conventional axial flow thresher in order to see if these could handle the tougher cotton plant material. Again the seed cotton was threshed from the plant and discharged through the outlet meant for husk and the stem part collected in the concave of the thresher. It was observed that some seeds were crushed because of the vigorous handling by the thresher.

Feeding only cotton bolls harvested manually into the combine harvester

Cotton plants were hand stripped and the whole bolls collected and fed into the mini combine. The seed cotton this time was discharged with considerably less trash as the plant stems were eliminated. The trash came down to 27% and consisted mainly of bracts and smaller stems. Therefore, it was decided to convert the combine harvester into a stripper harvester of cotton.

3.17: Socio Economic Dimensions of Cotton Farming

Technological Needs for Sustainability and Stability of Cotton Production

Concerns of cotton challenges/issues before farmers, extension workers, especially in the context of wide scale adoption of *Bt* technology and priority ranking of technological need was worked out using a detailed questionnaire. The challenges were categorized into five main categories: technological options, socio-economic aspect, transfer of technology, marketing and institutional/operational/structural barriers. Technological need requirement was assessed based on criteria and priority on farmers' income (economic profitability) and social acceptability. Data was collected and analyzed for eighty six respondents (47 farmers and 39 extension officials) from Vidharbha rainfed region from Nagpur, Amravati, Wardha, Chandrapur, Washim and Yeotmal districts. Under technological challenges, majority (77%) of the respondents completely or to a certain degree felt that poor soil and rainfed situation is not ideal for the performance of *Bt* cotton hybrids and ranked first followed by non-availability of exact nutrient requirement strategy for different *Bt* cotton hybrids for shallow soil. Other socio-economic, transfer of technology, marketing and structural/operational impediment statements prioritized by the respondents were climate variation and change are impacting negatively on cotton production. With the entry of *Bt* cotton, the practice of use of 'farm saved seeds' come to permanent halt, scientific knowledge and spurious seed/fertilizers, average farmers is not knowledgeable about market trends or price level. The technological need assessment has come up with the results that the priority technology needed for sustainable cotton production was climate rebelient varieties followed by innovative package of practices for maximizing yield of *Bt* cotton hybrids, insect resistant varieties/hybrid for sucking pests.

E-Kapas Network to Connect 100,000 Farmers for Technology Dissemination and Backstopping

Nagpur

E-Kapas network centres are being developed by creating infrastructure facilities at lead centre CICR; Nagpur. Telecom software i.e. phone recorder software suitable for mobile technology was developed and is being finalized after testing with a few clients. This has to be provided and installed at all cooperating centres. The software created is capable of storing the registered farmer's queries in the database, sending SMS/MMS in the regional language to the farmers. The registered famers may store their query at any time in the call server situated at participating centres and on real time basis the query gets replied to with automated stored message. All centres use the best cotton management practices and make it available on mobile phone of farmers using short message service (SMS) technology in their regional language, also alerts regarding insect pest and diseases management be sent as SMS.

Coimbatore

During the year, a total of 1340 potential and interested farmers in e-Kapas network in major cotton growing districts of Tamil Nadu were identified. From the scoping study it was identified that information with regard to suitable cotton cultivars, price, weed management, farm machineries and tools, Government schemes, weather forecasting, market information, nutrient management, bank credit information and new technologies were the major information need expressed by the interested farmers with regard to cotton.

Impact evaluation of *Bt* cotton in Maharashtra

This project was taken up to evaluate impact of *Bt* cotton in Maharashtra. During the reporting year, data was collected and analyzed from 1200 cotton farmers belonging to 8 cotton growing districts of Maharashtra namely, Yavatmal, Amravati, Akola, Wardha, Nagpur, Chandrapur, Nanded and Parbhani.

Though *Bt* cotton was introduced in 2002, its adoption in the selected districts was very slow up to 2004. Afterwards *Bt* cotton adoption gained momentum and by the end of 2009 almost 90 percent of respondents adopted it. Currently almost all the respondents are growing *Bt* cotton.

Significant changes took place after the introduction of *Bt* and the important ones are listed in the Table 3.17.1 below.

Table 3.17.1: Use of inputs before and after introduction of *Bt* cotton

S. No.	Particular	Before *Bt*	After *Bt*
1.	Seed Quantity (kg/acre) Cost (Rs/acre)	 1.52 926.00	 0.79 1922.00
2.	No of insecticidal sprays	7.4	4.3
3.	Fertilizers Quantity (kg/acre) Cost (Rs/acre)	 106 636	 230 3418
4.	Respondents used weedicides (%)	0.00	21.50
5.	Respondents used growth regulators (%)	0.25	35.08
6.	Yield (q/acre)	4.15	6.32

As per the respondents no new pests were observed after the adoption of *Bt* cotton. Nearly 82 per cent respondents felt that sucking pest problem is increasing year after year. Majority of the respondents (69%) felt that availability of pesticides is not a problem.

As per the respondents there are more than 30 *Bt* hybrids in the market. They mainly depend on the advice of seed dealers/private companies for the selection of hybrid. Alternatively, they observe the performance on the neighbor's field before selecting hybrid suitable to their field. Most of the respondents (62%) felt that selected hybrids are not giving expected yield which indicates that they are unable to make good decision regarding the selection of hybrids. Fifty four percent of the respondents felt that they are unable to get their preferred hybrid at maximum retail price (MRP) and they need to pay more than MRP to get it. High yield, big boll size and quality fibre are the three major traits preferred by the respondents. Mallika, Ajeet and Ankur are the top three preferred brands by the respondents. Most of the respondents (61%) are not using non *Bt* seed as refugia and they are simply throwing them away. Only 39%use non *Bt* seed on borders and those who got redgram seed as refugia are using it as intercrop.

Opinion survey revealed that *Bt* cotton was not responsible for suicides of cotton farmers. Ninety seven percent respondents felt that crop failures are not the reason for suicides and 98 percent felt that *Bt* cotton is not responsible for suicides. Almost all the respondents perceived that there were no incidence of death of animals due to *Bt* cotton and there were no health hazards due to *Bt* cotton cultivation.

3.18: Seasonal Dynamics of Insect Pests and Diseases

Nagpur

Seasonal dynamics of cotton sucking pests and bollworms

Mealybugs *Phenacoccus solenopsis* and *Nipaecoccus* viridis were recorded in some fields with negligible population during late season of crop. Two peaks of aphids were recorded during 34 and 42 SW with highest population of 19.06 and 19.86 aphids per plant coinciding with coccinelid population of 0.54 and 0.64 per plant, respectively. The maximum whitefly population of 3.7 and 3.2 per plant was recorded during 38 and 39 SW respectively when maximum and minimum temperature ranged between 32-35 ^{0}C and 23-25 ^{0}C with corresponding RH (%) range of max 81-90 and min 50-61. Leafhopper activity and damage coinciding with heavy rainfall, when population ranged from 8 to 18.44 leafhoppers/ 3 leaves/ plant peaked at 33-36 SW. Cohabitant thrips were also recorded in greater numbers during this period. Mirid C. livida incidence was low even after recession of rainfall from 40 SW and remained fluctuating till the end of season. The population of *H. armigera, E. vitella, P. gossypiella* and *S. litura* was found negligible on Bt-cotton during the season.

Correlation of insect pest with weather parameters

The population of mirid was negatively correlated with minimum temperature, RH maximum and minimum and rainfall. Similarly, population of leafhoppers and thrips was positively correlated with temperature minimum, RH maximum and minimum, rainfall and rainy days. However aphid, whiteflies and spider population was positively correlated with all the weather parameters under study.

Cropping system based population dynamics for (a) mirid *C. livida*

Highest nymphal population was recorded in cotton surrounded by cotton and soybean (1.32 mirids/ plant) which was at par with cotton surrounded by cotton and canal (1.17 mirids/plant). Comparatively lowest population was recorded in unprotected fields (0.86 mirids/plant) and cotton surrounded by soybean and road (0.87 mirids/plant) and both were statistically non significant. The population dynamics of nymph and adult was similar. The total mirid population was statistically similar in cotton surrounded by cotton and soybean (1.97 mirids/plant), cotton and canal (1.77 mirids/plant), unprotected field (1.18 mirids/plant) and soybean and road (1.21 mirids/plant).

(b) leafhopper Amrasca bigutulla bigutulla

Highest nymphal and adult leafhopper population was recorded in unprotected fields compared to protected fields. The population under protected fields was similar. Maximum population was recorded in research station (2.77 leafhoppers /3 leaves /plant) followed by cotton surrounded by soybean and road (1.69 leafhoppers /3 leaves /plant), cotton and soybean (1.61 leafhoppers /3 leaves /plant) and cotton and canal (1.45 leafhoppers /3 leaves /plant). Leafhopper activity was more in unprotected fields than protected field as expected.

(c) spiders

Overall spider population was high in unprotected condition compared to protected fields. Least population was recorded in cotton surrounded by cotton and canal (0.59 spiders/ plant) which was statistically similar with cotton surrounded by cotton & soybean (0.81 spiders/ plant) and soybean and road (0.69 spiders/ plant). The spider population in unprotected field was always high till 41 SW but thereafter fluctuated.

Investigations on role of plant parasitic nematodes in emerging cotton maladies

Population of plant parasitic nematodes associated with cotton maladies reported from Buldhana, Khargone, Saoner and Wardha were estimated qualitatively as well as quantitatively. The population of Reniform nematode *Rotylenchulus reniformis*, associated with cotton stunting was 300-356 preadult nematodes/250 cc of soil which was well above threshold level. Other nematodes like *Hoplolaimus sp.* (80 nematodes/250 cc soil) and *Pratylenchus sp.* (13 nematodes/250 cc soil) were also recorded from soil samples. Advisory was issued to