Zone	Trial name	Entries Promoted / Retained*
SOUTH	Br 13 (a)	CCB 143 b, CCB 64, CCB 129, CCB29*, CCB51*
	Br-03 (b)	CNH09-70
	Br06 (b)	CNH 1128, CNH09-62
	Br-24 (b): CVT -*G. arboreum*	CNA 1054, CNA1031*
	Br-24 CVT -LL– *G. arboreum*	CNA1037
	Coloured Cotton Trial: *G. hirsutum*	16315 LB, 16301 DB, 16337 LB
	Coloured Cotton Trial: *G. arboreum*	CNA407 SLP, 16378 LB-1, CNA405, CNA407 and 16377 LB-A

Note: entries marked with asterisk (*) denotes retained entries

Entries Proposed for Agronomy Trial

Central zone: CCH 15-1, *G. hirsutum,* Variety (Irrigated), CSA 1028, G. *arboreum* Variety, (Rainfed); **South zone:** CCH 15-1 *G. hirsutum,* Variety (Irrigated)

In multilocation evaluation of pre-release Bt varieties with deregulated event Mon 531, six, three and two entries were promoted in North, Central and South zones, respectively (Table 3.2.7).

Table 3.5.3 : Bt entries from ICAR-CICR under testing in AICCIP trials

Year (2017-18)	ZONE	Name of the entries
11 entries	North	CICR 242 BT, CICR 562 BT, CICR76 BT, CICR 98 BT, CICR 38BT, CICR 861 BT,
	Central (Rainfed & Irrigated)	CICR 81 BT, CICR16 BT, CICR 2017 BT
	South (Rainfed & Irrigated)	CICR 902 BT, CICR23 BT

3.6 : Enhancing resource use efficiency through climate smart agro-techniques

Nagpur

Allelopathy an alternative weed management strategy in cotton

Timely weeding is a major issue in the sticky black cotton soils on which cotton is grown. Furthermore, cost of weeding is substantially higher that leads to a reduction in profitability of cotton production. Therefore, devising alternate weed control strategies using allelochemical producing cover crops were considered as a possible solution. The cover crops were evaluated under rainfed conditions at Nagpur and winter irrigated conditions at Coimbatore.

Field studies were conducted to screen cover crops in the rainy season as well as the winter season to study their efficacy in controlling weeds and on cotton productivity. Among the 12 cover crops evaluated, sunnhemp, sorghum, sesame were found to not only smother the weeds effectively but also had high seed cotton yields (Fig. 3.6.1).

Using the GC-MS, cover crops were analyzed for the allelochemicals. The allelochemicals belonged to the category primarily of fatty acids and their derivatives, terpenes, sterol, aliphatic hydrocarbon and aldehydes. The major compounds identified in cover crops under study were, phytol and pentadecanoic acid,1,4-methylene methyl ester in sorghum; 9,12-octadecadienoic acid (Z,Z) - methyl ester and neophytadiene in pearl millet; squalene & linolenic acid in sunnhemp; 9,12-octadecadienoic acid, 9,12-octadecatrienoic acid (Z,Z) & their methyl esters in sesame; quinic acid & decanal in marigold; γ-sitosterol & octatriconyl pentafluropropionate in bitter cumin; 9,12,15-octadecatrienoic acid and strearic acid methyl ester in desmodium.

With regard to soil biochemical properties, the plots with the sunnhemp as a cover crop had better enzymatic activity (Acid phosphatase, Alkaline phosphatase and β-glucosidase) as compared to the other cover crops as well as mulch of the polythene and newspaper. Sorghum as a cover crop had the highest dehydrogenases activity.

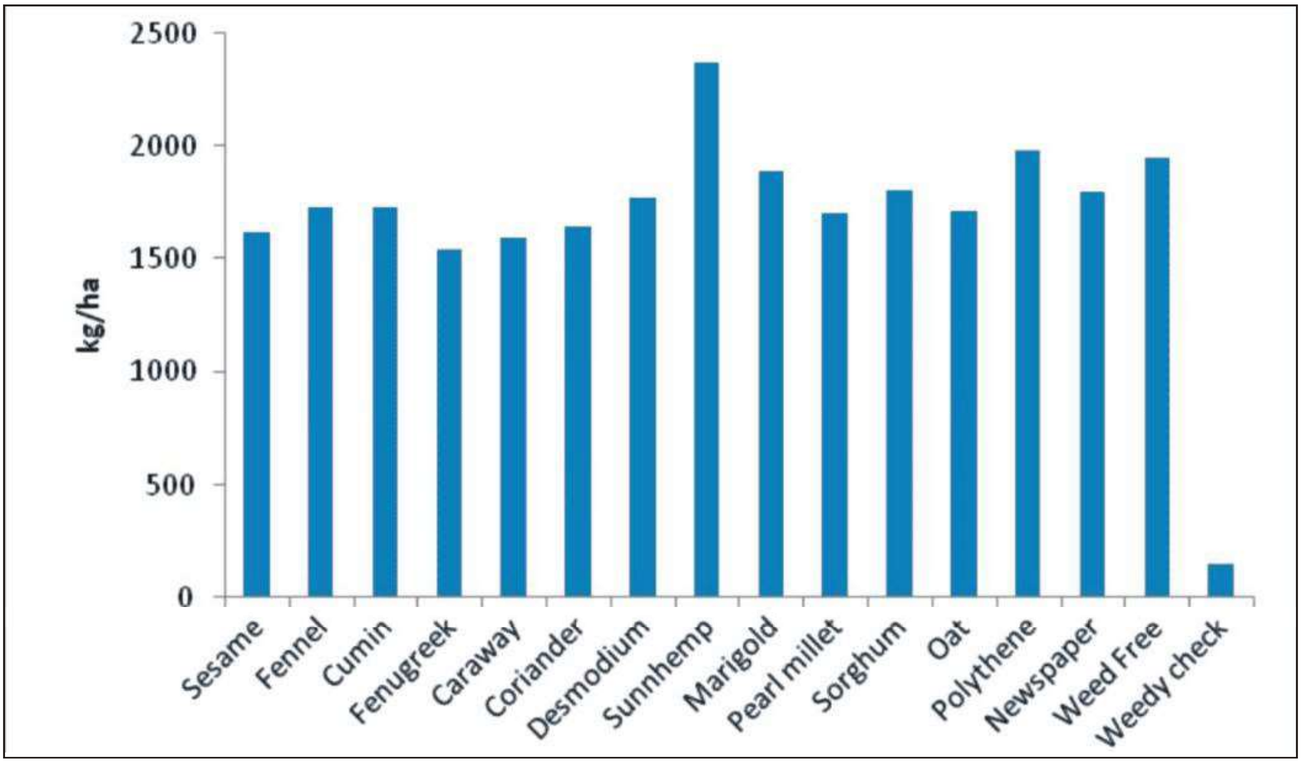


Fig. 3.6.1: Effect of cover crops on seed cotton yield

Inter-row cover of sorghum at Nagpur

Weed free cotton with Desmanthus cover at Coimbatore

Coimbatore

Five legume cover crops were evaluated for two consecutive years (2015-16 and 2016-17). All the legume cover crops were equally effective in reducing weed density, but the cover crop of sesbania had reduced the boll number significantly and consequently resulted in a reduction in seed cotton yield (Table 3.6.1). Forage cowpea and sunnhemp had significantly higher seed cotton yield than the traditional weed control method. The seed cotton yield was similar with all the five legume cover crops.

Table 3.6.1: Yield attributes and seed cotton yield as influenced by cover crops at Coimbatore*

Treatments	Bolls/plant	Boll Wt (g)	SCY (Kgs/ha)
SSBT** followed by Thornless mimosa +one HW	28.0	6.15	2203
SSBT followed by Sunhemp + one HW	33.4	6.08	2463
SSBT followed by Daincha (Sesbania +one HW)	24.8	6.28	2143
SSBT followed by Forage cowpea +one HW	34.0	6.03	2494
SSBT followed by Desmanthus + one HW	28.2	5.92	2276
No SSBT (pendimethalin 1.0 kg) as pre emergence + HW (Twice)	24.9	5.82	1959
SEd	1.63	0.17	105.36
CD (P=0.05)	3.49	NS	224.58

* Pooled data for 2015-16 and 16-17, ** Stale Seed Bed Technique

Across locations and years, it is evident that sunnhemp as a cover crop is an option for effective weed control. Furthermore, it also provides the benefit of nitrogen (N) fixation.

Alleviating soil compaction – a production constraint in cotton

Excessive use of machinery has created problems of soil compaction. Tractors are employed to cultivate soils when the soils are wet leading to sub-soil compaction. Most often, the common problem faced by cultivators is poor root growth of cotton. This may be due to a hard compact zone at a lower depth. As a result, the crop growth is adversely affected. Therefore, large-plot field experiments were conducted to evaluate the effects of sub-soiling on crop growth and yield. In the first year of the study, it was observed that seed cotton yield was not significantly different with or without sub-soiling (Fig 3.6.2). However, shallow sub-soiling resulted in 5.7 to 8.6% greater seed cotton yield than the control treatment. The sub-soiled treatments also had a deeper root system (79.3±14.9 cm) than the control treatment (72.0±8.5 cm).

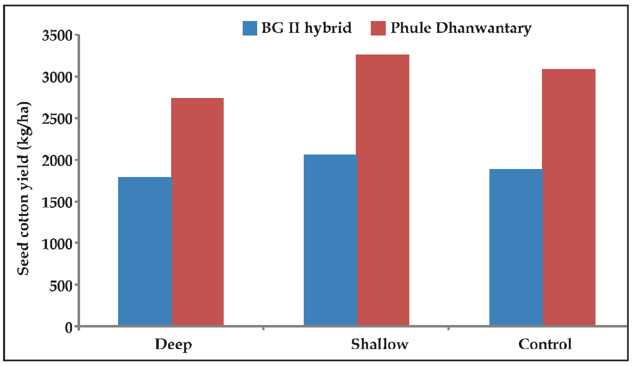


Fig 3.6.2: Effect of sub-soiling (deep and shallow) on seed cotton yield of Ajeet-104 BG II hybrid and Phule Dhanwantary as compared to the control

Exploring the productivity potential of long-linted *G. arboreum* cotton

Desi cotton (*G. arboreum*) is a potential alternative to obtain sustainable yields under sub-optimal agro-climatic conditions. However, non-availability of long staple *G arboreum*'s, with comparable fibre properties of their hirsutum counterparts is the main hurdle in deploying them. The project was conceived to provide location specific long linted arboreums tailored with an agronomic package to maximize the productivity of cotton and climate proof the cotton growers.

Nagpur

- Seven *G. arboreum* genotypes (6 long linted - DLSA 17, PA 528, PA 402, PA 812, PA 760, CNA 1037 and short stapled Phule Dhanwantary were evaluated under rainfed conditions at 2 spacings (60x10-HDPS and 60x 30 cm-normal) on a shallow inceptisol (Typic Haplustept) and a deep vertisol (Typic Haplustert) on two sowing dates - June 22 and July 7, 2017. The highest yield of 2522 kg/ha was realized with CNA 1037 planted at 60x10 cm on June 22, 2017 on an inceptisol.
- The gain yield with 60x10 cm spacing over 60x30 cm spacing was 19.1% in D1 on an inceptisol, 23.5% in D2 on an inceptisol, 14.8% in D1 on a Vertisol and 22.9 % in D2 on a vertisol.
- Averaged across the soils and sowing dates the seed cotton yield of the different genotypes under normal spacing and HDPS is depicted in Fig 3.6.3. The yield gain under HDPS ranged from 10.3% with PA 760 to 27.6% with CNA 1037.

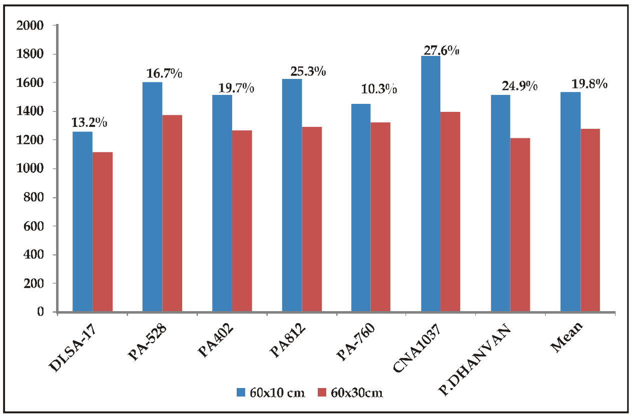


Fig 3.6.3: Seed cotton yield (kg/ha) of different desi cotton genotypes under normal spacing (60x30 cm) and HDPS (60x10 cm)

- Test of homogeneity in yield for soil types and dates of sowing indicated that genotypes DLSA 17, PA 812 and Phule Dhawantary shows homogeneity for different soil types and dates of sowing for the spacing 60x10 cm. Similarly, under 60x30 cm spacing, the genotypes PA 402 and PA 760 shows homogeneity for different soil types and dates of sowing
- Among 8 treatments used for modifying crop architecture, de-topping + side shoot removal and application of Mepiquat chloride @ 50 g ai/ha were effective in reducing plant height and significantly improving the yield of *G. arboreum* var Cv. PA 255.
- East-west direction of row planting produced significantly higher seed cotton yield than other row directions in variety PA 255. North-South direction of row planting gave more seed cotton yield over North West-South East row direction in varieties Phule Dhanwantary. There was no significant effect of row direction planting at boll position of upper and lower half of cotton plant in both the varieties
- Estimation of ethylene level in young cotton bolls was done in six long linted desi cotton genotypes. There were significant differences among the genotypes. Expression analysis of two major enzymes of ethylene biosynthesis (ACCS and ACCO) was performed using qRT-PCR, to correlate their expression with ethylene level. The expression of ACCS was more or less same as of ethylene level in respective varieties.
- Eight long linted cotton genotypes were evaluated in pots for root traits. Amongst the genotypes, DLSA-17 had the maximum root length of 64 cm at 60 DAS with Ralligold @ 5g Mycorrhizal biofertilizer

Coimbatore

- Seven long linted *G. arboreum* genotypes (DLSA 17, PA 760, PA 812, PA 402, PA 528, K12 and Phule Dhanwantery) were planted in two dates of sowing (4th August and 4th September, 2017). Amongst them, genotype, K-12 registered the significantly higher seed cotton yield (1360 kg/ha) followed by Phule Dhanwanthry (1050 kg/ha) and DLSA-17(929 kg/ha). Between the dates of sowing, significantly higher yield was recorded with 4th August sowing (1060 kg/ha) than 4th September sowing (810 kg/ha).
- The productivity of *G. arboreum* was assessed with respect to row orientation (North- South, East – west and diagonal) using two contrasting (tall and short) genotypes (K 11 and DLSA 17) under HDPS. Significant difference was observed with respect to growth characters (monopodia and dry matter production) which were higher with north-south row orientation. However, the same was not reflected in seed cotton yield.

Participatory evaluation of technology for improving profitability in calcareous soils.

Cotton grown on the rainfed black calcareous soils are prone to moisture and multi-nutrient stresses. On-station field experiment was conducted with a *G. hirsutum* cultivar (PKV081) and a BG II hybrid (Ankur 3028) with fourteen different nutrient treatments. Seed cotton yield (SCY) of the cotton variety PKV081 was improved by the nutrient interventions over no fertilizer nutrient control. There was no significant difference among the different interventions. However, the hybrid Ankur 3028, SCY was significantly enhanced by the treatments T_2 (seed treatment with biofertilizers + 125% RDF (NPK)+ Mg, S (10, 10 kg ha^{-1})+Micronutrients (Fe, Mn, Zn, B) as per soil test + Opening of ridges & furrows after 1st interculture) and T_8 –(T_2+Humic acid treated fertilizers (0.02%) + Micronutrients soil application (15 kg ha^{-1}) by 11.3 and 10.3%, respectively, over the control (Fig. 3.6.4). From the experiment, it was inferred that on calcareous soils, moisture stress could be overcome by opening ridges and furrows with first hoeing operation and multiple nutrient stresses can be managed by use of biofertilizer (*Azotobacter* spp, PSB, *Trichoderma* spp) treated seeds along with 125% RDF and micronutrient applied as per soil test.

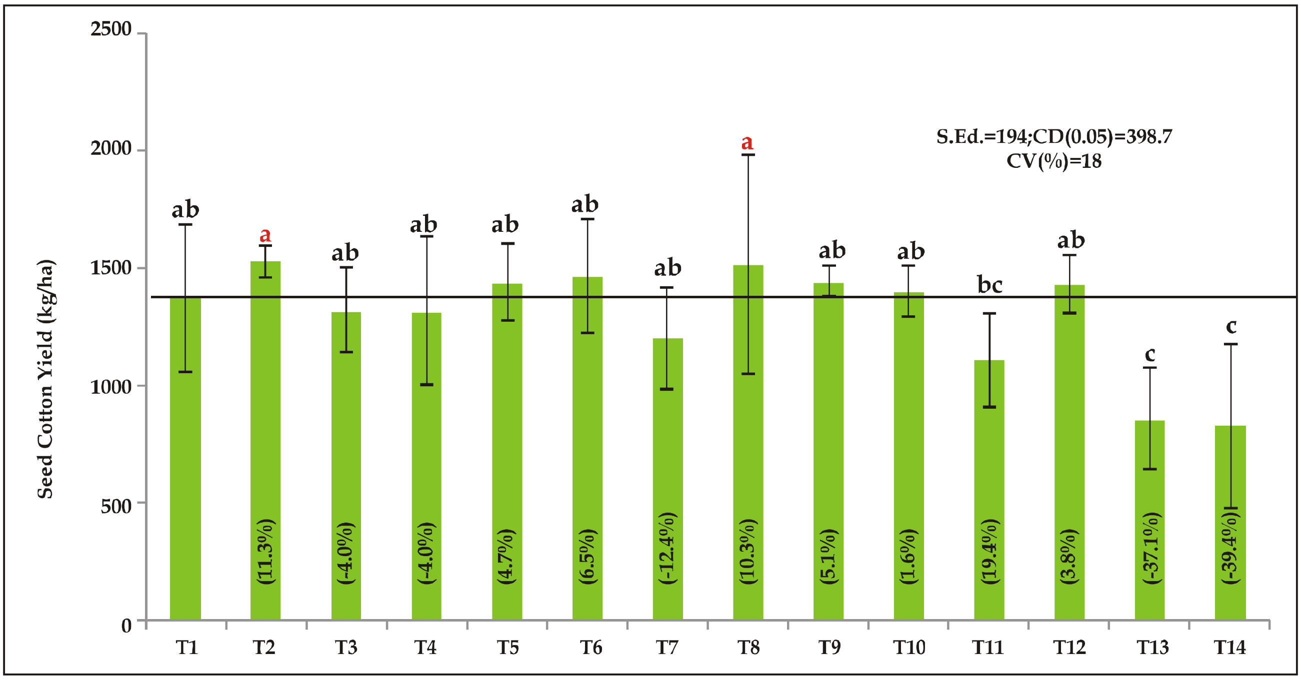


Fig. 3.6.4 : Effect of input management on seed cotton yield (kg ha^{-1}) of BG II hybrid Ankur 3028 under rainfed black calcareous soil

T_1- Control (100% RDF)(N, P, K, Zn (12.5 kg ha^{-1})+ B (5 kg ha^{-1}) + RF; T_2-125% RDF (NPK) + Mg, S (10 kg: 10kg ha^{-1})+Micronutrients (Fe, Mn, Zn, B) as per soil test + ST(B)+ RF; T_3-100% basal+ 25% P, K, Mg split soil application @ 45 DAS ST(B)+RF; T_4-125% RDF (NPK)+ Micronutrients (0.05% B+ 0.5% Fe +0.3% Mn + 0.5% Zn Sulphate) @ 45 DAS+P (2% DAP @ 75 DAS) Foliar Spray + ST(B)+ RF; T_5-125% RDF (NPK)+ Chelated Micronutrients 2 kg ha^{-1} (Soil application)@ 45 DAS+ ST(B) +RF ; T_6-125% RDF (NPK)+ Chelated Micronutrients 0.5% (Foliar Spray) @ 45 DAS + ST(B)+ RF; T_7-125% RDF (NPK) + Animal Manure in Root Zone (2 t ha-1) + Micronutrients soil application (15 kg ha^{-1}(Hybrid)/ 12 kg ha^{-1} for Variety +ST(B)+ RF ; T_8-125% RDF (NPK) + Humic acid treated fertilizers (0.02%) + M Micronutrients soil application (15 kg ha^{-1}(Hybrid)/ 12 kg ha^{-1}for Variety +ST(B)+ RF; T_9-125% RDF (NPK) + Chelated Micronutrients soil application 2 kg ha^{-1} + ST(H)+ RF; T_{10}-125% RDF (NPK)+ Chelated Micronutrients 0.5% (Foliar Spray) @ 45 DAS +ST(H)+ RF; T_{11}-100% RDF+ Micronutrients (Zn, B, Mn, Fe) (12.5:5:5:5 kg ha^{-1}); T_{12}-125% RDF alone (NPK only); T_{13}-RF(Nil fertilizers); T_{14}-Absolute Control (Nil fertilizers). [RF-Opening of ridges & furrows after 1st interculture; ST (B)- Seed treatment with biofertilizers (Azotobacter, PSB, Trichoderma); ST(H)- Seed treatment with humic acid (0.02%)]. Data represent means and error bars refers standard deviation of three independent replicates. Statistically significant differences with LSD test at CD (0.05) are indicated by different characters. The horizontal line represents the SCY in control and percent variation depicted in parenthesis. Based on ranking, a has the best and c has the poorest performing groups.

Identification and characterization of water deficit period

The objective of the study was (i) to identify water deficit and water surplus period with climatic water balance study, (ii) to assess the impact of drought stress indicators on cotton yield under rainfed condition, (iii) to categorize severity of drought index based on the water balance data, and (iv) to identify the length of the growing season based on reference ET and rainfall at micro level.

Climatic water balance was computed as per Thornthwaite and Mather procedure (1955) to assess the daily soil moisture status and other soil water components. The reference evapotranspiration was calculated by temperature based method of Hargreaves and Samani (1985).

The storage capacity of 0-142 cm soil depth was 262.7 mm. When the climatic water balance computation was initiated from 1.1.2017 and continued up to 31.12.2017, the available soil water on 1.6.2017 was only 10.2 mm, which was further, increased through rainwater recharge by rainwater to its full capacity of 262.7 mm on 19.8.2017. Thereafter, it was fluctuating within a range of 226.1 to 262.7 mm up to 21.9.2017 depending upon the amount of rainfall received during this period. Within this period, about 135.1 mm excess rainwater was recorded. After termination of monsoon rainfall on 21.9.2017, the depletion of available soil moistures continued to meet the ET demand of the crop and 50 % depletion of soil moisture was observed on 3.11.2017 (Fig. 3.6.5).

If the climatic water balance components are considered in 0-60 cm soil depth with available water storage capacity of 111.6 mm, the soil profile of 0-60 cm was fully recharged to its maximum potential of 111.6 mm on 2.7.2017 (3.6.6). During the rainy season particularly after complete saturation of the soil profile, 236.1 mm surplus rainwater was available up to 21.9.2017 and depletion of available soil moisture was started from 21.9.2017 and 50% depletion was recorded quite early on 13.10.2017 as compared to the whole soil profile soil moisture, which was considered for study. As the root density beyond 60 cm soil depth is limited, the availability of soil moisture in below layer is also quite high for longer period. It has been observed that the soil profile of 61-142 cm depth was fully recharged by the receipt of rainfall on 18.7.2018 and this trend was continued up to 21.9.2017 with slight depletion depending upon the interval of non-rainy days (3.6.7). During this period, about 211.6 mm rain water was found to be non–effective.

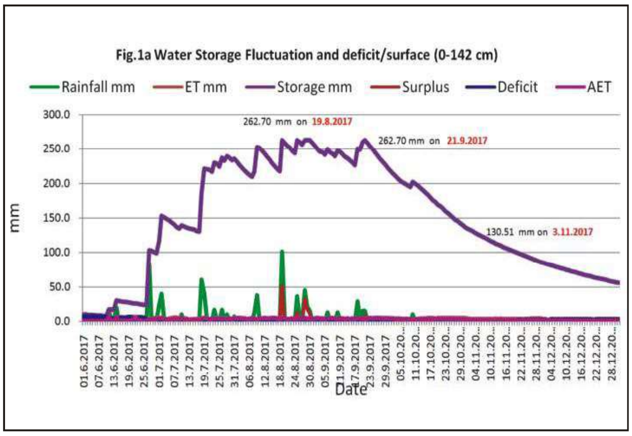


Fig.3.6.5 : Water Storage Fluctuation and Deficit/surface (0-142 cm)

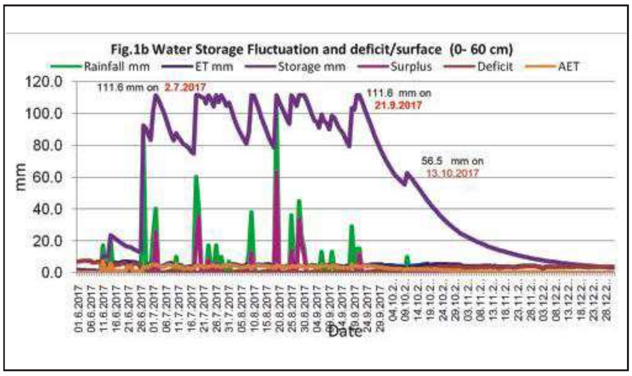


Fig.3.6.6 : Water Storage Fluctuation and deficit / surface (0-60 cm)

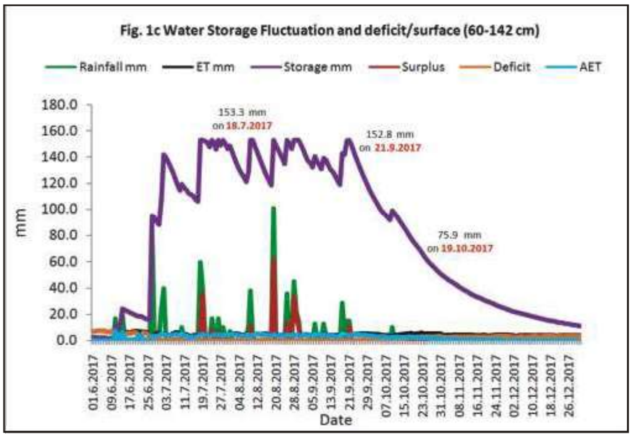


Fig.3.6.7 : Water Storage Fluctuation and Deficit / surface (60-142 cm)

Aridity Index

The aridity index = {(ETo-AET/ETo)*100}, was calculated by considering two parameters of water balance ETo and AET showed severe drought (>50% aridity index) in 0-142 cm soil depth during early growth period due to in-adequate amount rainfall and dryness of soil profile (Table 2). There after due to receipt of good amount of rainfall, the soil profile was fully recharged and the soil moisture stress in terms of aridity index nil (1-25%) was negligible as significant amount of moisture from below layer contributed towards evaporative demand of the atmosphere even up to mid of October. From 16 October on wards, the soil moisture depletion was in increasing trend and severe stress was recorded beyond this period. The depletion of soil moisture in case of first soil layer (0-60 cm) was quite fast and the severe stress was recorded from first fortnight of October where the number of immature cotton bolls were high in all Bt hybrids and Bt varieties.

Hence, it is highly essential to correlate development pattern of bolls, opening of the bolls of each variety to select an appropriate Bt variety or Bt hybrids for harvesting potential seed cotton yield from medium to heavy soil.

Table 3.6. 2 : Aridity index of the experimental field in different soil depth (cm)

Period	Aridity Index (%)		
	0-142 cm	**0-60 cm**	**61-142 cm**
1-15 June	82.7	83.2	85.9
16-30 June	67.8	58.5	63.2
1-15 July	30.0	11.0	12.3
16-31 July	9.10	3.80	3.4
1-15 Aug	9.60	10.4	8.0
16-31 Aug	4.10	7.70	5.8
1-15 Sept	4.70	10.4	7.7
16-30 Sept	6.40	13.7	10.4
1-15 Oct	19.7	38.7	30.7
16-31 Oct	38.4	66.3	55.6
1-15 Nov	53.6	82.8	72.7
16-30 Nov	63.0	89.9	81.5
1-15 Dec	70.3	94.0	87.3
16-31 Dec	77.4	96.4	91.7

Phenotyping of root system architecture in cotton (*Gossypium hirsutum* L.) for its adaption to drought

Forty five cotton genotypes were evaluated for their root architecture in acrylic glass tubes. Cotton genotypes were grown in the tubes and water was withhold for a week period after 20, 30, 40 DAS along with control. Soil media mixture used for growing cotton seedling in acrylic tubes was consisted of soil, sand, FYM and Vermi-compost in 2:1:1:1 (w/w) ratio. After 60 DAS, best genotypes were identified based on root architecture (Table 3.6.3).

Root characters of *G. hirsutum* accessions

Genotype	Root /shoot characteristics
IC 357429, 5133, CHO09-5, IC 357103, 5095, LRA ZFP, IC 359024 and IC 358108	High tap root length: >79.3 cm (19.5 cm – 79.3 cm)
Suraj, N-108, Rajat and IC-357103	High shoot dry weight: >2.38 g (1.15 g- 2.38 g)
IC-357103 and Suraj	High root dry weight: >0.82 g (0.40 g – 0.82 g)
5144, 30I and DCI-453	High fresh shoot weight: > 49.1 g (5.2 g – 49.1 g)
DCI-453, CNH 09 – 5, LRK-DREB/A and DTS 108-09	High fresh root weight: > 39.2 g (1.9 g – 39.2 g)
IC-358108, Suraj, DCI-453 and IC-359035	High root/shoot dry weight ratio: > 0.43 (0.24 – 0.43)
DCI-453, DTS 155-09 and DTS 108-09	High root/shoot fresh weight ratio: > 0.94 (0.41 – 0.94)

Table. 3.6.3: Root /shoot characteristics of cotton genotypes after 60th DAS

Metabolite exploration of drought stress in cotton :

Extreme environmental conditions, such as drought affect growth, productivity and quality of crop adversely. The impacts of drought on cotton are widespread and varied. A new metabolic path "alarm photosynthesis" pathway was discovered in some of the model plants, aiding them in sustaining under drought stress conditions well enough. The project was initiated to explore the existence of this pathway in cotton along with characterizing the effect of drought stress on metabolites at different stages of growth. All the four *Gossypium* spp. (*G hirsutum*: DTS-44 - drought tolerant & 3763 - drought susceptible, *G. arboreum*: Phule Dhanwantary, *G. barbadense*: Suvin and *G. herbaceum*: G-cot 25) were subjected to drought stress by withdrawing irrigation for 10 days. Expression analysis (qRT-PCR) of GLP/oxalate oxidase (major gene of alarm photosynthesis pathway) was performed in cotton leaves, cotyledon, root as well as 10 DPA (days post anthesis) and 25 DPA ovule, all of them showed Oxalate oxidase (OxO) expression in the respective tissue, except the root (Fig. 3.6.8 & 3.6.9). OxO enzyme assay was done in cotton leaves, seeds and fiber tissues and compared with sorghum. Cotton leaves showed activity, but it was less as compared to sorghum a C- 4 plant. Compared to other tissues (leaves, fiber), seeds were found to have maximum OxO activity. Among the treatments, drought stressed leaves were observed to have more OxO activity than control samples.

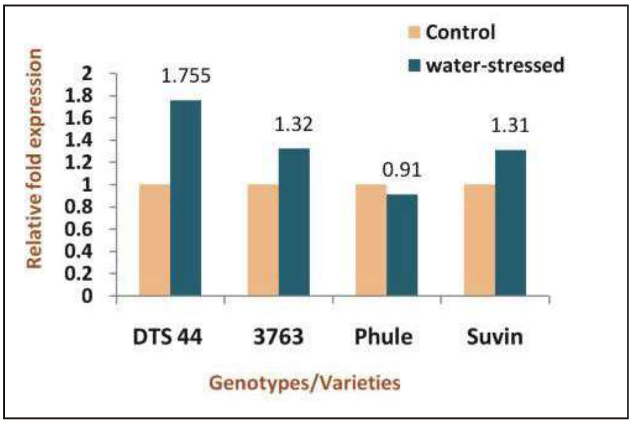


Fig. 3.6.8 : Expression analysis of oxalate oxidase

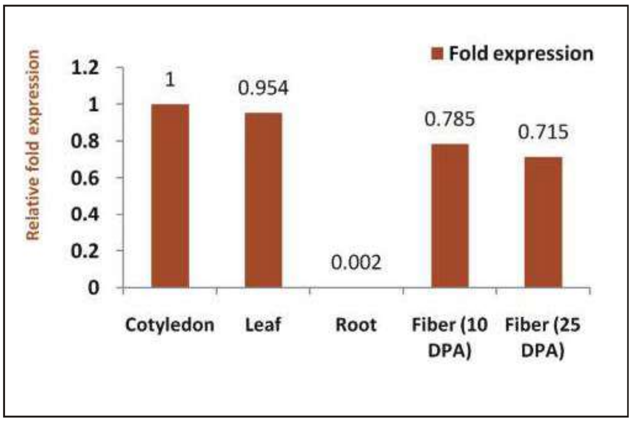
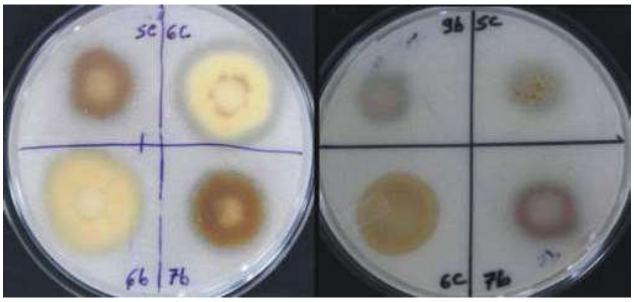


Fig.3.6.9 : Expression analysis of oxalate oxidase (OxO) of different cotton species (OxO) in different cotton tissues

Microbial interventions for potassium (K) nutrition in cotton.

To isolate K-solubilising microorganisms, cotton rhizosphere samples were collected from different cotton growing districts of Vidarbha region. The isolates obtained on specific media were further screened for K solubilisation. Among 20 isolates that showed significant zone of solubilisation on specific media, five isolates had 1 mm zone of solubilisation, 10 isolates had 2 mm zone of solubilisation, three isolates showing 2.5 mm zone of solubilisation and two isolates ≥ 3 mm zone of solubilisation indicating their potential for use as K solubilizing bioinoculant for cotton.



Screening for zone of potassium solubilisation

Development of microbial biofilm formulations for cotton

Native bacterial and actinobacterial isolates were isolated from cotton ecosystem comprising soil, plant parts using diverse growth media including nutrient agar, soil extract agar, Pseudomans agar, Kings B agar, Dexria agar, Startch agar, Ashby mannitol agar, Jenson's agar, LB agar, Pikovaskya agar, Yeast extract mannitol agar, Kenknight agar, Sabourd agar, Czapeks agar, Actinomycetes agar Potato dextrose agar. The isolates which have shown higher polysaccharide production has been selected for further biofilm development using fungal matrix such as Trichoderma, Metarhizium, Beauveria, Verticillum.

Refining, up-scaling and large-scale evaluation of tractor mounted ICAR-Mahindra Brush type cotton harvester vs. available cotton harvesting techniques

A tractor mounted brush type stripper was developed earlier in order to bring down the trash content in machine stripped cotton. The brush type header consists of two numbers of rotary brushes for stripping of cotton from plants and two auger conveyors for collection of the stripped cotton, which was fed to a belt conveying system. From the header the stripped cotton was conveyed through a perforated conveyor to the field cleaner mounted at the back of the tractor and finally after cleaning the cotton was conveyed into a wire mesh storage tank. The trash content of brush type harvester was found 10.8 % seed cotton basis. Trash content analysis of the machine harvested cotton and cleaning in a commercially available boll crusher machine was done (Table 3.6.3). The brush stripped cotton contained 16.5% trash initially (seed cotton basis), which was then pre-cleaned to 7% in a commercially available low cost boll crusher machine. The fibre quality of pre cleaned cotton in a boll crusher did not significantly differ from that of brush type harvested cotton (Table 3.6.4). Cost of harvesting cotton with a brush type stripper harvester and subsequently cleaning machine-harvested cotton in a traditional pre cleaner factory set up and in a low cost boll crusher machine is given in Table 3.6.5. Hand picking cost is assumed to be Rs. 5/kg on an average and cleaning would require another Rs. 1/kg bringing the total cost of hand picking and cleaning cotton to Rs. 6/kg. Cost of harvesting cotton in a brush type harvester works out to be Rs. 1.10/kg. In a pre-cleaning factory the cost of cleaning a stripper harvested cotton is Rs. 3/kg bringing the overall cost of stripper harvesting and cleaning in a factory set up to Rs. 4.10/kg. Whereas, if the stripper harvested cotton is cleaned in a commercially available low cost boll crusher machine the cost of cleaning comes to a mere Re 0.9/kg. Hand harvesting the left over cotton from a brush type stripper would cost another Rs. 0.6/kg bringing the overall cost of stripper harvesting and cleaning cotton in boll crusher to Rs. 2.6/kg.

Table 3.6.3: Trash constituents of machine harvested and pre cleaned cotton in a Boll crusher machine

Sample code	Bracts / Burrs (%)	Sticks (%)	Dry Leaves Fine Trash (%)	Total trash (%)
Brush stripper harvested cotton	2.54	1.71	12.21	16.46
Pre cleaned in Boll crusher (Setting 1)	0.14	0.92	6.12	7.17
Pre cleaned in Boll crusher (Setting 2)	0.22	0.87	5.93	7.02

Table 3.6.4: Fibre quality analysis of brush type stripper harvested cotton and boll crusher pre cleaned cotton

Sample Code	UHML (mm)	UI %	MIC µg/ inch	Tenacity 3.2 mm (g/tex)	EL %	SFI
Brush stripper harvested cotton	28.1	84	3.8	30.0	5.4	8.1
Pre cleaned in Boll crusher (Setting 1)	27.4	83	4.0	28.2	5.2	8.3
Pre cleaned in Boll crusher (Setting 2)	28.0	83	3.8	28.3	5.5	8.5

Table 3.6.5: Cost (Rs/kg) comparisons of harvesting and cleaning machine harvested cotton

Harvesting method	Harvesting cost	Cleaning cost			Hand harvesting left over	Total cost
		Manual cleaning	Pre cleaner Factory	Boll Crusher		
Manual picking	5	1	-	-	-	6
Brush type stripper cotton cleaned in pre cleaner factory set up	1.1	-	3	-	-	4.1
Brush type stripper cotton cleaned in a low cost boll crusher	1.1	-	-	0.9	0.6	2.6

Seed cotton yield and quality of ELS cotton

The field experiment was conducted with three dates of sowings (4th July, 4th August & 4th Sept.), three foliar spraying of nutrients (N1. Recomended nutrients, N2. N1+Foliar application of K_2SO_4 @ 1% at 75,100,125 DAS and N3.N1+Foliar application of KNO_3 @ 1% at 75,100,125 DAS) with two genotypes (Suvin, MRC 7918 BG II) to assess the effect of environment and foliar spraying of nutrient on seed cotton yield and micronaire of ELS cotton. Seed cotton yield was significantly influenced by dates of sowing, genotypes and foliar spraying of nutrients. Sowing on 4th August registered significantly higher seed cotton yield (22.4 q/ha) which was 1.4 and 1.8 fold higher than 4th July (9.3) and 4th Sep. (7.9 q/ha) sowing respectively. The genotype, MRC 7918 BG II registered significantly higher yield (17.5

q/ha) than Suvin (8.9 q/ha). Amongst foliar spraying of nutrients, application of recommended nutrients with KNO_3 @ 1% at 75,100,125 DAS registered significantly higher yield (17.3 q/ha). The interaction results revealed that planting of MRC 7918 BG II on 4th August and foliar application of KNO_3 @ 1% at 75,100,125 DAS registered significantly highest yield of 38.3 q/ha. However, significant improvement was not observed in micronaire with different times of sowing and foliar spraying of nutrients and their interactions.

Evaluation of nano-formulated micronutrients foliar spray for yield maximization in different cotton genotypes

Field experiment was conducted to evaluate the effectiveness of different dosages of best performed commercially available nano-fertilizers like Nualgi and Nanomol with or without surfactant on cotton. As like seed cotton yield during 2016-17 winter irrigated season, fibre quality parameters were also not influenced by foliar application of nano-fertilizers with or without surfactant. However, nualgi nano-fertilizer without surfactant and nanomol with surfactant showed the significant effects on increasing the nitrogen concentration in the cotton plants as compared to phosphorus and potassium content.

Another field experiment was carried out to study the interaction effect of best performed four different types of metal oxide nano-particles like zinc, iron, copper and magnesium with organic fertilizer i.e. seaweed liquid fertilizers. The individual and combined form of metal oxide nano-particles along with seaweed liquid fertilizers had a significant influence on fibre quality parameters like fibre length and strength. Regarding the effect of metal oxide nano-particles on macro nutrient concentration of cotton plants, single form of metal oxide nano-particles viz., Zn, Mg, Cu and Fe with and without seaweed liquid fertilizers significantly increased the total nitrogen concentration as compared to combined metal oxide nano-particles. Inversely, the combined form of Zn + Fe, Zn + Mg + Cu and Zn + Mg +Cu + Fe metal oxide nano-particles without seaweed liquid fertilizers significantly increased the total P content. Foliar application of single metal oxide nano-particle i.e. ZnO with and without organic fertilizer had antagonistic effect on phosphorus and synergistic effect on nitrogen and potassium concentration of cotton. All the metal oxide nano-particles like zinc, magnesium and copper except iron significantly increased the total potassium concentration in cotton.

Exploiting the epigenetic transgenerational inheritance of stress responsive traits for imparting abiotic stress tolerance in cotton

Phenotyping of 145 advanced lines of previously stressed Suraj and LRA 5166 was carried out during summer 2017. Tolerant lines were identified based on Relative Water Content, SPAD values, and other morphological parameters. Generation will be further advanced to screen for drought tolerance.

Experimental view of summer sown *G. hirsutum* lines predisposed to drought stress

Experimental view of plants treated with epigenetic regulating chemicals

Epigenetic regulating chemicals (ERC) did not cause any phytotoxicity or adverse effect to cotton plants. Among the different treatments, seed treatment with Nicotinamide @ 35 µM increased the plant height, number of leaves and number of bolls in case of Suraj and seed treatment with epigallocatechin @ 100 µM increased the number of bolls in LRA 5166. Since ERCs did not affect the normal physiology of the plant, generation advancement of ERC treated lines are being carried out for screening the progenies for drought tolerance.

Waterlogged plants showing Fe deficiency symptoms

Screening for water logging tolerance

Pot culture experiment was conducted with fifteen lines shortlisted from 210 lines based on replicated field trial. The lines were screened for waterlogging tolerance at 5 Days after waterlogging under pot culture conditions. Out of the lines, 8 lines (169, 192, 193, 209, 167, 15, 89 and check (LRA 5166) were found to be tolerant in terms of lenticel formation and absence of Fe deficiency. Line No. 180, 30, 162 are highly susceptible lines. Both susceptible and tolerant lines will be used for Marker Assisted Breeding for waterlogging tolerance.

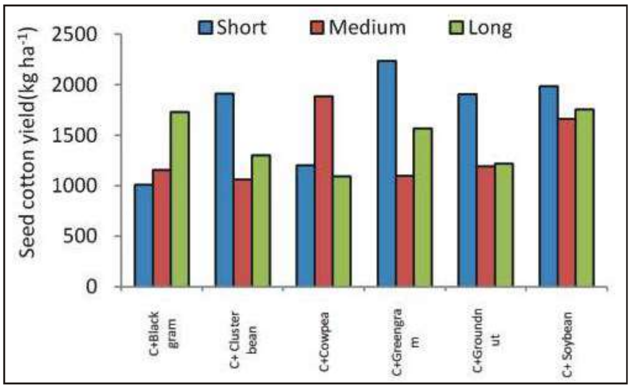
3.7: Sustainable farming systems through conservation agriculture and precision techniques

Nagpur

Efficient nitrogen (N) fixing legumes for cotton based cropping systems.

In order to identify compatible N fixing legume variety for cotton based inter-cropping systems, six different legumes with three varieties (short, medium and long duration) were tested under rainfed conditions at 1:1 ratio with spacing of 90 x 10 cm in *G. hirsutum* var Suraj as well as in *G. arboreum* var Phule dhanwantary. Legumes were sown 15 days later. Overall legume intercropping improved seed cotton yield. Averaged over varieties, higher seed cotton yield of Suraj was recorded with greengram (2235 kg ha^{-1}), cowpea (1885 kg ha^{-1}) and soybean (1754 kg ha^{-1}), respectively (Fig. 3.7.1a). In case of *desi* cotton higher seed cotton yield was recorded with groundnut (1786 kg ha^{-1}), cowpea (1967 kg ha^{-1}) and soybean (1998 kg ha^{-1}) (Fig. 3.7.1b). Similar trend was observed for the cotton equivalent yield.

Based on the seed cotton yield and cotton equivalent yield, greengram, cowpea, soybean of short, medium and long duration variety was found suitable for rainfed areas for *G. hirsutum* var Suraj, respectively. Short, medium and long duration variety of groundnut, cowpea and soybean was identified for *G. arboreum* var Phule dhanwantary, respectively.



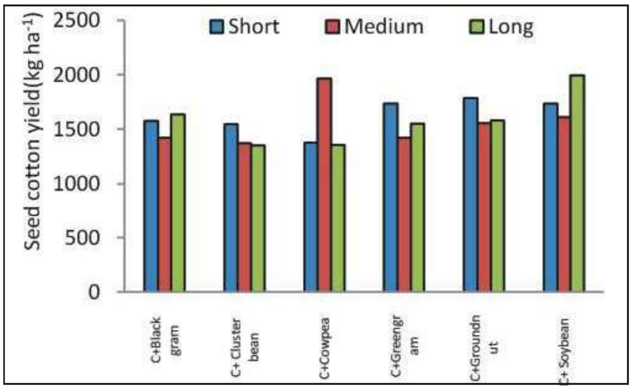


Fig. 3.7.1 : Effect of N fixing legumes on SCY (kg ha^{-1}) (a) Suraj (90 x 10 cm); (b) Phule Dhanwantary (90 x 10 cm)

Cotton (Suraj) + legume intercropping in 1:1 ratio

Cotton (Phule Dhanwantary) + legume inter-cropping (1:1 ratio)

Coimbatore

Efficient nitrogen fixing legumes for cotton cropping systems : Alley cropping of perennial legumes with cotton

The feasibility of growing perennial legumes as alley cropping with cotton for sustainability was initiated during 2016-17 cropping season. Three perennial legumes *viz.*, Desmanthus virgatus (hedge lucerne), Medicago sativa (lucern) and Mimosa invisa (Thornless mimosa) were grown as alley crop with cotton and compared with sole cotton (without perennial legumes). The recommended spacing of 90x60cm was followed for sole cotton. In perennial legume plot, the spacing followed was 90x45cm. Every fifth row was sown with two rows of perennial legume without sacrificing the cotton plant population as compared to sole cotton. After the harvest of cotton, the maize crop was grown as a succeeding crop. Based on this study, Desmanthus virgatus has been identified as suitable perennial legume to be grown as alley crop with cotton. This legume crop is fast growing, hardy, withstands drought, has no pest and disease problem and is amenable for pruning. So far since 2016-17, six prunings were made with the fresh biomass addition of 44,252 kgs/ha (13.25 t/ha on dry weight basis) with the nitrogen content of 3.15%. while, other two perennial legumes were not amenable for pruning and contributed lesser biomass (4211 kgs and 475 kgs/ha with Mimosa and Medicago respectively). Alley cropping of Desmanthus virgatus resulted in reduction in soil pH (8.74) and electrical conductivity (0.480 dSm^{-1}) as against sole cotton without alley cropping with the pH of 8.77 and EC of 0.516 dSm^{-1}). The nitrogen content of cotton plants with alley cropping of Desmanthus enhanced to 1.75% as compared to cotton crop under sole cotton with the nitrogen content of 1.57%. Growing of Desmanthus virgatus as alley crop and addition of pruned lopping from perennial legume to cotton and maize crop enriched the soil and resulted in additional seed cotton yield of 2 q/ha and maize grain yield of 3 q/ha over sole cotton without alley cropping.

Alley cropping of cotton + Hedge lucern

Table 3.7.1 : Seed cotton yield, maize grain yield, number of pruning and total biomass added due to perennial legumes

Treatments	Seed cotton yield (kg/ha)	Maize grain yield(kg/ha)	Number of pruning	Total Biomass added since 2016 (t/ha)
Cotton +*Desmanthus virgatus*	1314	2303	6	44252
Cotton +*Mimosa invisa*	1122	2214	2	4211
Cotton + *Medicago sativa*	1272	2259	2	475
Sole cotton	1106	1984		
SEd	210.9	276.8		
CD (p=0.05)	NS	NS		

Integrated farming system to double the income of cotton farmer

Field surveys were conducted in Nagpur and Wardha districts of Maharashtra under agro ecological subregion (AESR) 10.2 with five blocks in each districts and one village in each block to study the existing farming systems. Six farmers were selected from each village. During survey, it was found that 35% farmers had only agriculture and no other allied activities. The remaining farmers had different enterprises such as dairy, goatery, poultry, and horticulture, but very few were doing these allied enterprises on commercial level. Majority of small and marginal farmers had to supplement the income earned from sole agriculture through daily wage work. Average return from daily wage work for small and marginal farmers was Rs. 56,500 per family/annum. Average cost of cultivation recorded was Rs. 15,100/acre (no family labour considered) with average gross returns from crops and cropping systems was Rs 27,310/acre/annum. Average return from allied enterprises (Dairy, poultry, goatery, horticulture) was Rs. 21,700 per household. Many traditional crops like jowar, sesame, linseed, moong, urd were abandoned by farmers due to poor productivity, lack of quality seeds, damage by wild animal, poor price support, etc. Honey bee diversity was studied and bee flora calendar was developed for Wardha and Nagpur districts.

Development of remunerative cotton based cropping systems using conservation agriculture principles under irrigated condition

Field experimentation is in progress from 2015 onwards by combining land shaping with residue retention coupled with location specific remunerative cropping systems for improving system productivity and soil quality under conservation agriculture (CA) vis-a-vis conventional practices under irrigated condition. The main plots involved conventional system (Farmer's practice, M_1), CA system with minimal land reshaping and partial (50% of residue from above ground biomass and 100% roots) residue recycling (M_2) and CA system with 100% residue recycling (M_3). The subplots involved four different cropping systems. viz., S_1: Cotton - Black gram - Maize (for grain purpose); S_2: Cotton - Maize (for green cobs) + Pigeon pea (Strip cropping@ 4:2 ratio); S_3: Cotton - Groundnut (for table purpose) + Pigeon pea (Strip cropping @ 8:2 ratio) and S_4: Cotton - Fallow (Control).

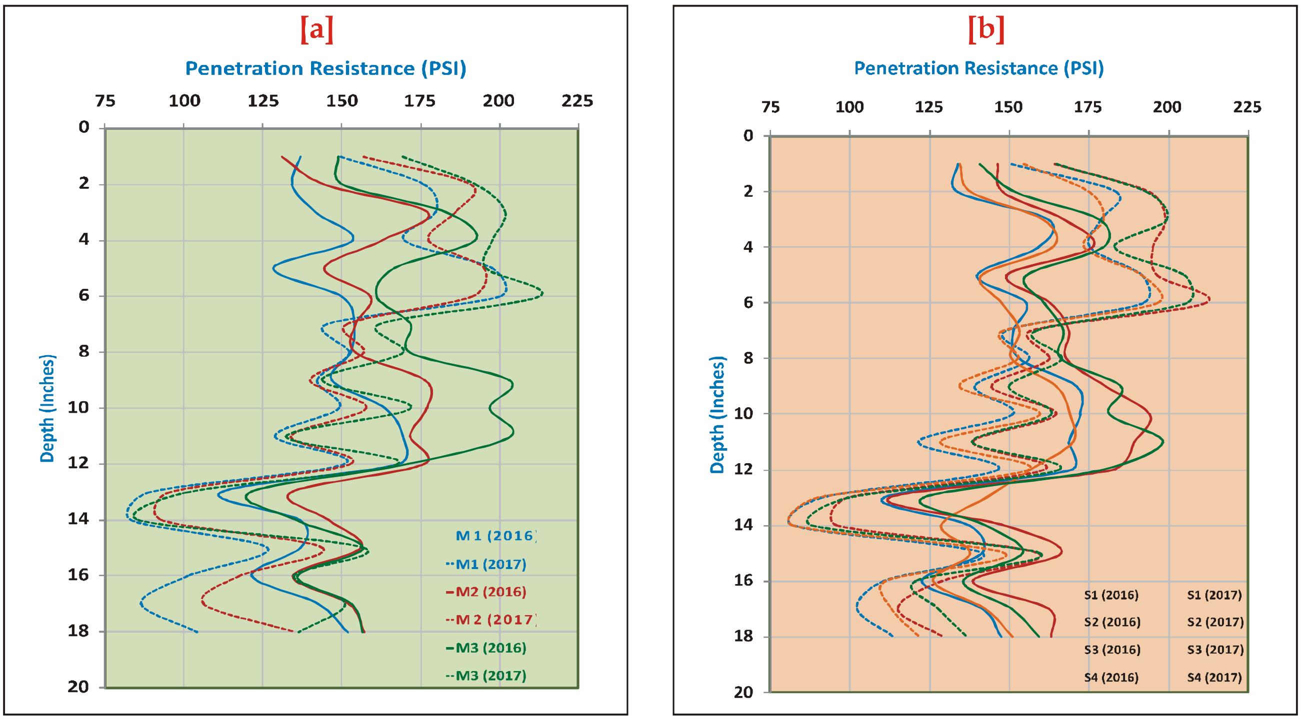


Fig. 3.7.2: Soil Penetration Resistance recorded at different soil depths (inches) in different land shaping treatments (a) and cropping systems (b) during I and II Cropping Sequences

Analysis of seed cotton yield and Cotton Equivalent Yield (CEY) indicated no significant yield difference in land shaping treatments during the second cropping sequence (2016-17 sequence). Among the cropping systems evaluated during second cropping sequence, Cotton-Black gram-Maize (for grain purpose) registered significantly higher CEY of 4174 kg ha^{-1} followed by Cotton-Groundnut (for table purpose) + Pigeon pea (Strip cropping @ 8:2 ratio) registering CEY of 3148 kg ha^{-1}; Cotton – Maize (for green cobs) + Pigeon pea (Strip cropping @ 4:2 ratio) recorded CEY of 2884 kg ha^{-1} which was significantly higher than the conventional Cotton – Fallow system (CEY of 1223 kg ha^{-1}). Analysis of seed cotton yield of third year cotton crop indicated significant difference in yield among land shaping treatments viz. Ridges and furrows (M_1: 1875 kg ha^{-1}), and Beds and furrows (2051kg ha^{-1} in M_2 & 2157 kg ha^{-1} in M_3). In terms of cropping systems, highest seed cotton yield of 2159 kg ha^{-1} was recorded in Cotton–Black gram–Maize (for grain purpose) plots followed by 2070 kg ha^{-1} in Cotton–Maize (for green cobs) + Pigeon pea (Strip cropping @ 4:2 ratio) plots and 1996 kg ha^{-1} in conventional Cotton – Fallow system.

To study the effect of CA practices on soil compaction, soil penetration resistance (Cone index) was recorded using Cone Penetrometer during 2016 (I Cropping Sequence) and 2017 (II Cropping Sequence). Pooled analysis of soil penetration resistance (Fig. 3.7.2) using MSTATC over two cropping sequences revealed significant difference among land shaping treatments viz., Ridges and furrows (M_1: 143 PSI), and Beds and furrows (153 PSI in M_2 & 163 PSI in M_3) as well as cropping systems (S_1: 146, S_2: 159, S_3: 147 and S_4: 159). However, interaction effects of land shaping treatments and cropping systems at different depths over first and second cropping sequences were not significant.

3.8: Economics and extension research and e- communication tools

Dynamics of cropping pattern in cotton growing districts of Maharashtra

The fluctuations in cropping patterns will have important implications for the supply-demand balances of not only cotton but also the competing crops. Shifts in crop areas will lead to deficit of particular crop in the domestic market and pressures for increased imports. If the processes underlying the crop use shifts are quantified, then future adjustments in land use can be projected and actions can be taken to achieve desirable land use. This study was under taken to analyze the transactions of area among different crops in relation to cotton in major cotton growing districts of Maharashtra and to find out the factors influencing the changes in crop area. The secondary data on area under all major crops in selected 18 cotton growing districts of Maharashtra was collected for the period 2000-01 to 2014-15 and preliminary analysis was done.

Changes in cotton area : Preliminary analysis indicated that in 13 districts cotton area increased during the study period (Fig 3.8.1). In four districts i.e. Aurangabad, Beed, Jalna and Dhule, increase in cotton area was more than one lakh ha. In another seven districts i.e. Jalgaon, Nanded, Ahmednagar, Nandurbar, Chandrapur, Parbhani and Wardha, increase in cotton area was between 0.50 lakh to 1.0 lakh ha. In Nagpur and Nashik, the increase in cotton area was less than 0.50 lakh ha. Highest increase in cotton area was observed in Aurangabad district followed by Beed and Jalna districts. In Aurangabad cotton area increased from 136400 ha to 434400 ha. In Beed and Jalna increase in cotton area was 258767 ha and 146267 ha respectively. Five districts *viz.*, Amravati, Akola, Washim, Buldhana and Yavatmal recorded a decrease in cotton area during the study period. Highest decrease in cotton area was observed in Amravati, followed by Akola, and Washim. In Amravati, cotton area decreased from 304233 ha to 194400 ha. in Akola and Washim districts decrease in cotton area was 82392 ha and 72167 ha, respectively.

Changes in crop pattern : Aurangabad, Beed, Jalna, Dhule, Jalgaon, Nanded, Ahmednagar, Nandurbar, Chandrapur, Parbhani, Wardha, Nashik and Nagpur are the 13 districts in which area of cotton increased during the study period. Along with cotton, area of soybean, maize and pigeon pea also increased. Major crops that lost area include pearl millet, jowar and moong. In Yavatmal, Buldhana, Washim, Akola and Amravati cotton area decreased. Along with cotton, area of jowar and moong decreased during the study period. In these districts area of soybean, arhar and maize increased.

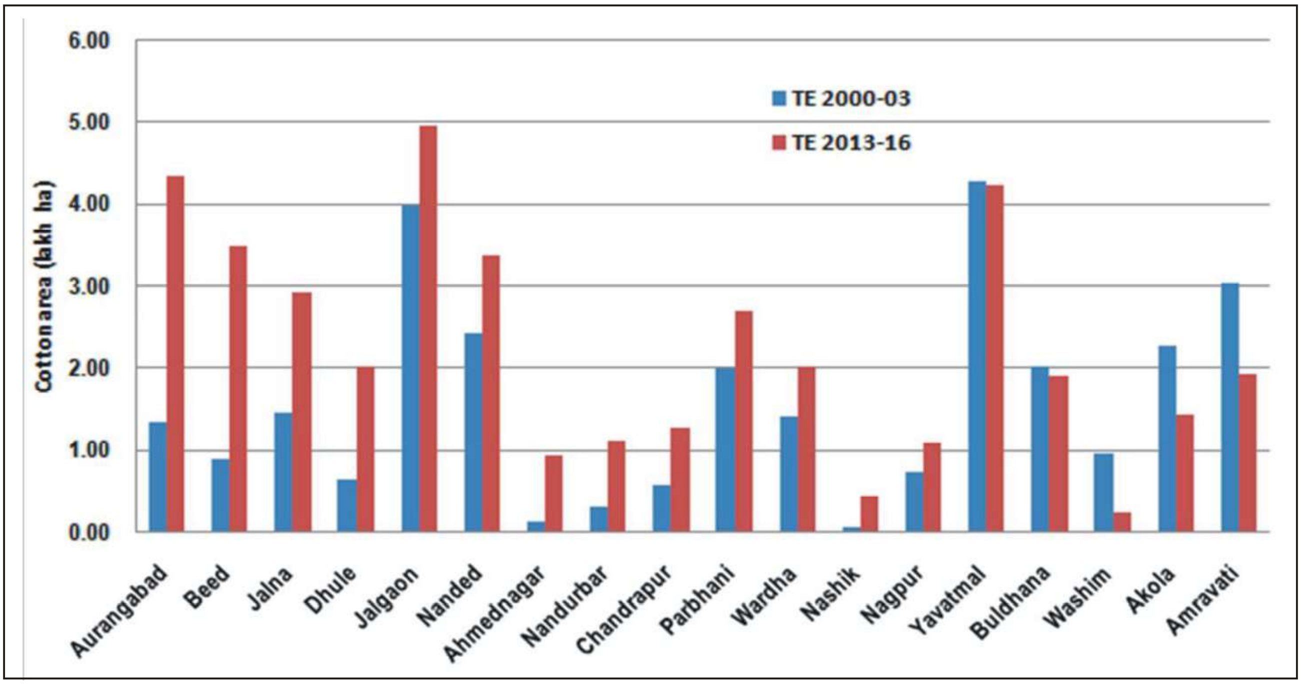


Fig.3.8.1: Change in cotton area during 2000-01 to 2015-16

Impact analysis of shift in global cotton trade on Indian cotton scenario

India, USA, China, Pakistan, Uzbekistan, Brazil, Burkino Faso are the major countries where in the cotton area share is maximum. Major cotton growing countries showing positive trend in cotton area from 2006 to 2017 are Peru (+144.49%), Mexico (+103.88%), South Africa (+94.74%), Argentina (+66.67%), Egypt (+65.45%), Greece(+25.01%), B. Faso (+21.43%), USA (+19.36%), Brazil (+19.15%) and India (+13.36%) whereas negative trend was seen in Afghanistan(-11.63%), Iraq (-23.08%), Australia (-25.01%), Indonesia (-33.33%) and Chad (-61.90%).

In case of world cotton producing countries, India, China, USA, Pakistan, Brazil, Australia, Turkey, Uzbekistan, Mexico, Turkmenistan, Burkino Faso, Greece occupy the major share. Positive trend over the same years seen in countries like South Africa (+143.06%), Peru(+138.10%), Mexico(+101.74%), Egypt (+76.47%), Zimbabwe (+64.23%), Turkey(+25.01%), Argentina(+24.13%), USA(+23.84%), China(+20.88%), India(+5.56%) while negative trend seen in Colombia (-6.98%), Israel(-13.85%), Afghanistan(-14.63%), Iraq (-34.78%) and Indonesia(-40.70%). The major cotton producing countries with high productivity are Australia, Turkey, China, Israel, Mexico, Brazil, Venezuela, Greece, South Africa and USA. Positive trend in yield growth rate in major cotton producing countries registered in Columbia (+97.64%), Zimbabwe (+67.81%), Australia (+44.87%), South Africa (+24.85%), Senegal (+34.85%), Ethiopia (+15.43%), Turkey (+6.37%) and USA (+3.74%). India showed negative trend with -7.01 per cent along with Uzbekistan (-2.33%), Greece (-4.00%), Pakistan (-8.73%), Indonesia (-9.92%), Iraq (-15.06%), Burkino Faso (-18.18%) and Argentina (-25.59%).

Cotlook index was low from 2000 to 2009 hovering around 45 to 62 cents. Sharp increase was seen during 2010 and 2011, later it dropped to 95 to 82 to 74 during 2012 to 2016. Finally, it got stabilized with a slight increase to 86 cents during 2017. The transition period changes in cotton trade flows resulting in new importers and exporters on the world market. The leading exporters throughout the outlook period are the United States, Brazil and Australia. Surge in productivity and production, India has become a major player on the world cotton market, accounting for as much as 17 per cent of the world's cotton exports. Sub-Saharan African countries continue to be a major source of cotton exports to the world market. As per the data received from various trade sources, the CAI estimates cotton arrivals up to 28th February 2018 at 247.10 lakh bales. The recent trade war between the United States of America and China has sparked a ray of hope for Indian exports such as cotton, soyabean and maize to Asian markets, especially to China. As China imposes tariff barriers to

US products, Indian exports are expected to increase. China is the largest market for India's cotton yarn, yet exports halved from $2.2 billion in 2013 to $1.1 billion in 2016. The decline is attributed to China's increasing import of cotton yarn from Vietnam, which registered an 88 per cent increase over the same period. China has shifted from India to Vietnam/Indonesia as they have duty free access while Indian yarn carries 3.5 per cent import duty.

The growth in cost of cotton production was worked out for the periods 2005-10 and 2011-16. The growth rate of cost of cultivation (Rs./ha) during both the periods was between 15 to 19% per annum in the States of Karnataka, Maharashtra and Rajasthan where as it was 8 to 10% per annum in other cotton growing states including Orissa. The growth rate of cost of Production (COP) (Rs./qtl.) was to the tune of 8 to 11% per annum in the states of Haryana, Gujarat, Maharashtra, Karnataka Andhra Pradesh and Tamilnadu during these two periods. In Punjab and Rajasthan it was 11 to 12% per annum and in Orissa it was 16 to 18% during the same period. The lowest growth rate in the cost of production was observed in Madhya Pradesh which was in the range of 4 to 6%.

Among the inputs, human labour registered maximum growth rate (20 to 22%) in Rajasthan, Maharashtra and Karnataka during these two periods. The growth of wage rate in India is higher than Bangladesh, but lower than China and Vietnam. China has the highest labour wages amongst the competing nations, but it has developed sufficient training infrastructure to meet industry requirements. On the other hand, there is limited availability of skilled labour in Bangladesh, India and Vietnam. The cost of power in India is high when compared with Bangladesh and Vietnam.

e-Communication : Dissemination of Cotton Technology

e-Kapas network project proved beneficial for effective transfer of knowledge among registered cotton growers in ensuring the availability of right information at right time at the doorstep of clients. The efforts were continued in e-Communication dissemination of cotton production technology project with the objectives : (i) to deliver voice messages to registered farmers of CICR (Nagpur, Coimbatore & Sirsa), (ii) to prepare cotton-production advisories and publish weekly/ fortnightly in news-papers (iii) to develop and exchange images and video based information for illiterate & tribal farmers, (iv) to develop monthly calendar of operations for Vidarbha cotton farmers.

Weekly/Fortnightly cotton production advisories in Marathi language were prepared and published regularly in news papers agro-one, Sakal, Deshonnati, Krushokonnati for wide dissemination among the growers. More than 6.11 lakh noise free and clear-recorded voice messages were uploaded in the form of automatic phone calls to 87,132 registered farmers' mobile numbers of Nagpur. During the season, there was a heavy incidence of pink bollworm in Maharashtra and providing timely voice messages on taking the proactive corrective measures proved to be highly beneficial to the farmers.

Grow Good Cotton- a mobile app for cotton pest management

Methodology for the development of Android based mobile application for the cotton pest management has been developed. The Mobile application included interactive Decision Support system where user can interact and chose the option for the pest management based on Economic Threshold Levels. The application is also incorporated with voice module and pictorial representation to select the correct symptoms of damages on cotton plant and also to break the language and literacy barriers.

Cotton Portal – Information for global reach

The cotton Portal – CICR website has four sub-domain websites – www.cicr.org.in; www.aiccip.cicr.org.in; www.tmc.cicr.org.in; www.kvknagpur.org.in. The website has around 8000 individual pages including HTML, pdf and more than 2500 images. The CICR website has wide range of information including research reports, annual reports, institute publications,

and databases. AICRP website has information including AICRP reports for the past 18 years, FLD reports, Bt Cotton evaluation reports etc. The Krishi Vigyan Kendra under CICR website has detailed activities of KVK including training programmes and extension activities.

www.cicr.org.in

www.aiccip.cicr.org.in

www.tmc.cicr.org.in

www.kvknagpur.org.in

Development of Transfer of Technology Innovations for Bridging up the Yield and Knowledge Gap in Cotton

Cotton yields are stagnated for the past few years due to various factors. Cotton research system has develoed and released many technologies to improve the yield under various agro-ecological conditions. However, there is always a gap between the potential yield of the technologies claimed by the technology inventors and the actual yield realized by the farmers in the fields. Studies say that the yield gap between potential and realized yield on farmers field is more than 30%. Analysis on yield enhancement due to Front Line Demonstrations (FLD) revealed that an average of 18.70 % increase over the normal farmers' practices was obtained in various locations. Therefore, there are possibilities of bridging the gap in cotton yield by properly identifying the causes of gap, devising appropriate management options to close the gap, fitting TOT innovations to disseminate the gap reducing technologies and implementing the package in the poor small and marginal farmers' fields. Similarly a gap exists among the cotton growers about the knowledge of novel yield enhancing cotton cultivation technologies. Hence, a study to assess yield gap in cotton between the potential, actual and attainable yields, the knowledge gap among cotton growers and to find out the reasons for the yield and knowledge gap and propose appropriate TOT innovations to reduce the gaps is planned.

During the year 2017-18, the various types of yields *viz.*, potential yield, actual yield and attainable yield and yield gaps were operationalized for the study. The average yield details of the states and the FLDs in the respective states were collected from the available secondary data from the AICRP- FLD reports and CAB from 1997-98 to 2017-18 and yield gap was analyzed. Analysis revealed that the national average seed cotton yield of FLD was 1686 kg/ha as compared to the local farmers' practices 1433 kg/ha (1997-98 to 2017-18). The average yield gap between the seed cotton yield of FLD and farmer's practice over 20 years was 254 kg/ha. To know the potential yield of cotton at station with all recommended technologies of CICR, one acre potential yield trial with cotton variety Suraj (0.5 acre) and Jadoo Bt BG II (0.5 acre) was conducted at ICAR-CICR, Regional Station, Coimbatore. The cotton variety (Suraj) with all recommended technologies of CICR yielded 2721 kg/ha and the Bt cotton hybrid Jadoo Bt BG II gave 2580 kg/ha seed cotton yield.

Socio-technological analysis of drip irrigation in cotton cultivation

Surveys were undertaken in Erode and Namakkal districts of Tamil Nadu to explore the impact and constraints for drip irrigation in cotton cultivation. Adoption of farmers for cotton technologies were significantly at higher rate in the study area. The major varieties cultivated in this area were, ATM Bt (KCH 311 Kavery seeds), Jadoo Bt (KCH 14K59, Kavery Seeds), Jackpot Bt (15K39, Kavery seeds), MRC 6918, RCH 2, and RCH 625 (Bumbag). Major observations on impact made by the drip irrigation are : a) There was a yield increase due to adoption of drip irrigation, b) Drip irrigation made soil into more friable condition and increased root growth, c) Soil compaction was reduced, d) Thrips and other sucking pest population was reduced, e) Water saving was about 30-40%, f) Cotton boll size was higher, g) Seed germination was good and, h) Weed population was reduced in drip irrigated fields. The survey revealed that the major cropping pattern available in this area are, Cotton-Maize-Green gram or Onion-Groundnut-Maize and Green gram or Cotton-Onion–Green gram. Constraint analysis revealed that the major issues for drip irrigation in cotton cultivation are 1. Not exactly 100 percent subsidy by state government, 2. Non-availability of water even for drip irrigation, 3. Damage to drip laterals due to rodents, 4. Crop specific subsidy for drip irrigation for specific year, 5. Getting subsidy documents from Village Administrative Office is cumbersome, 6. Clogging in drippers due to poor quality of water, 7. Accelerated price due to increased tax slab rate of 12-18% in the present GST for drip system, and 8. Standard technical specifications for drip installation does not match with local farm condition.

3.9 : New eco-compatible pest management strategies

Cotton bollworm Management

Nagpur

Push-Pull strategy for management of pink bollworm

The 'push-pull' strategy is an novel ecological pest management strategy to be utilized in integrated pest management programs. This relies on the manipulation of pest behaviour through the use of behaviour modifying stimuli to alter the distribution and abundance of insect pest. For isolation and identification of oviposition deterrent volatiles, field population of pink bollworm from Nagpur (ICAR-CICR farm) was established in the laboratory. The eggs and faecal pellets of pink bollworm were collected in five solvents namely hexane, acetone, methanol, dichloromethane and pentane with difference in polarity. The samples were analysed in GC-MS for identification of volatiles. Results were obtained in methanol as solvent for egg extract and with solvent as acetone, dichloromethane and methanol for faecal pellet extracts. Fatty acids like Palmitic acid, Linoleic acid, Oleic acid, Stearic acid and their methyl esters were identified from eggs (E) and faecal pellet (FP). (Table 3.9.1) These need to be further subjected to lab bioassays evaluation for oviposition deterrent effect.