3.10 : Nutrient Management

Nagpur

Gadget to detect N stress and correlation of leaf colour transmittance with soil / plant nutrient status

Sand culture experiments were conducted twice from December 2014 to May 2015 and from June 2015 to December 2015 with varying levels of nitrogen (N) to obtain a range of foliar leaf N deficiency symptoms. The first sand culture experiment was used to correlate nitrogen, chlorophyll and anthocyanin contents of third, fourth, fifth and eight position leaves of plants subjected to varying levels of N ranging from 0 to 100% to RGB values of leaves. Digital images were taken in transmittance mode. Good correlation was obtained between

RGB values with N and pigment contents of leaves. Based on these observations, a gadget was developed to detect N deficiency in cotton. The gadget was calibrated using data obtained from the second sand culture experiment with varying levels of N and another field experiment conducted using different levels of N and P. Studies indicated a correlation coefficient (R^2) of 0.795 between N content and greenness values obtained by the gadget.

Expression studies of DOF1 (DNA-binding with one finger) transcription factor and downstream genes involved in Nitrogen (N) assimilation

Nitrogen assimilation in plants requires carbon skeleton (2-oxoglutarate, 2-OG), produced from photosynthetic metabolic intermediates in addition to inorganic N present in soil. DOF1 (DNA-binding with one finger) transcription factor regulates the key enzymes linking C and N metabolism and was found to improve Nitrogen Use Efficiency (NUE) under N limiting conditions. An attempt was made to study the expression of *DOF1* transcription factor and downstream genes such as Pyruvate Phosphate Dikinase (*PPDK*), Pyruvate Kinase (*PK*) involved in carbon metabolism and Nitrate Reductase (*NR*), Nitrite Reductase (*NiR*), Glutamate Synthase (*GT*), Glutamine Synthetase *(GS)* involved in N metabolism in plants grown under varying levels of N in sand culture. DOF1 transcription factor expression was low under no N when compared to 100% N. However, at 25 % N the expression level of DOF1 transcription factor and other downstream genes were high, indicating the possibility of increased NUE under N limiting conditions by overexpressing *DOF1* in cotton. The *NR* and *NiR* expression levels were higher in cotton irrespective of the expression levels of *DOF1*. The expression levels of chlorophyll ab binding protein were high in N limiting conditions when compared to 100% N indicating N deficiency induced senescence of cotton leaves.

Coimbatore

During the year, commercially available combined and single forms of micronutrient nanofertilizers were evaluated for its effects on cotton growth and yield. Among the combined form of commercially available nanofertilizers (Richfield, Agriklik, Nualgi and Nanomol), seed cotton yield increased significantly (11 – 20.7 %) with foliar application of recommended dose of Nualgi and Nanomol nanofertilizer at 30 and 90 days after sowing along with basal NPK fertilizers. This was followed by Agriklik and Richfield nanofertilizers. Single micronutrient nanofertilizers *viz.*, Nanobor, Nanomag and Nanozinc were also observed as very good nanofertilizers than combined form of micronutrients nanofertilizers for increasing the number of bolls, boll weight and seed cotton yield.

In a field experiment, normal and nano form of metal oxides like magnesium, zinc, copper and iron were compared with normal sulphate form fertilizers. Averaged over two years, more than 22, 33 and 18 per cent of seed cotton yield was obtained by application of metal oxide nano-particles *viz.*, MgO, ZnO and CuO respectively than control. However, sulphate form of fertilizers like magnesium, zinc and copper increased seed cotton yield by 13, 24 and 11 per cent respectively over control. Seed cotton yield increased with application of normal and nano form of oxide type fertilizers as compared to sulphate form of fertilizers. Moreover, fibre quality para-meters like uniformity ratio and fibre strength were improved by the application of metal oxide nano-particles than control.

3.11 : High Density Planting Systems (HDPS) for Maximizing Productivity

Nagpur

On deep black soils (Typic Haplusterts), 13 *G. hirsutum* genotypes were evaluated for their amenability to HDPS at 45 x 10 cm, 60 x 10 cm (both high density) and 60 x 30 cm (normal) spacing at Nagpur. The effect of spacing was not significant but significant difference between genotypes and genotype x spacing was observed for seed cotton yield at 165 and 195 days after sowing (DAS). At 165 DAS, the seed cotton yield of the top 6 genotypes planted at 60 x 10 cm spacing were-LRK 516 (2056 kg/ha), Suraj JT (1960 kg/ha), CNH 1111 (1659 kg/ha), CSH 3075 (1651 kg/ha), CNH 09-4 (1645 kg/ha) and CNH 28I (1608 kg/ha). The effect of spacing on the incidence and damage by sucking pests or bollworms was not significant indicating that planting at high density did not aggravate the pest attack. However, differences among genotypes with reference to both sucking pests and bollworms was evident (Table 3.11.1).

Table 3.11.1: Ranking of genotypes on the basis of pest incidence (Lowest incidence is given top rank)

Pests incidence and/or damage in various genotypes under HDPS (Rank)						
Rank	Aphids	Jassids	Whitefly	Thrips	% Square damage by bollworms	Pink bollworm
I	NH-615	Suraj (JT)	CSH-3075	CCH-4474	Suraj (JT)	Suraj (JT)
II	Suraj (JR)	CNH-1110	Suraj (JT), CNH-1111, 28I	CNH-28I	CNH-09-04	CSH-3075
III	CCH-4474	Suraj	Suraj	Suraj	CSH-3178	CNH-1111
IV	CNH-1111, 28I	CNH-1111	CNH-615	LRK-5166	CNH-1111	CSH-3178
V	CNH-09-04	CNH-139, CNH-09-04	CSH-3178	CNH-1110	Super Okra-1	LRK-516

The pink bollworm infestation in rosette flowers was observed at 60-70 DAS. At 90 DAS the per cent disease incidence differed significantly among genotypes but the spacing effect was not significant. Lowest incidence of bacterial leaf blight was observed in CSH 3075 and Suraj JT. The incidence of *Alternaria* leaf spot and *Myrothecium* leaf spot was lowest in CNH 1111. The boll weight was high in CNH 09-4 (3.9 g) and CNH 39 (3.4 g). Genotypes LRK 516, Suraj JT, CNH 09-04 and NH 615 were early and in these genotypes more than 65 % of the total cotton was picked at 135 days and more than 80% of the cotton was picked by 165 days (Fig. 3.11.1).

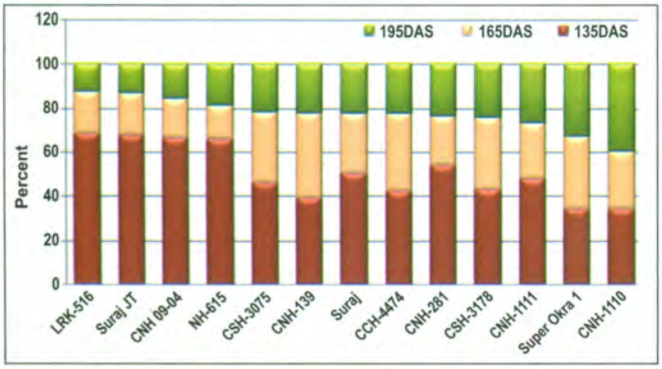


Fig. 3.11.1: Earliness in cotton genotypes planted at 60 x 10 cm spacing expressed as percentage of cotton picked at 135, 165 & 195 days

In another trial 5 genotypes were evaluated at 60 x 10 cm and 60 x 30 cm spacing. The mean yield was 12 % higher at 60 x 10 cm spacing over 60 x 30 cm spacing. The genotypes CNH 25 (2036 kg/ha) and Super Okra 2 (1685 kg/ha) were the highest yielders at 60 x 10 cm spacing.

On rainfed Vertisols, there was a reduction in boll weight at high planting density and 2 sprays of Mepiquat chloride (25 g ai/ha per spray), KNO_3 (3%) and ICAR-CICR nutrient consortia increased boll weight of HDPS cotton and helped to realize equivalent yield to that realized with 125% of RDF (60:30:30).

Clorantraniliprole 18.5 SC and Indoxacarb 14.5 SC were best for the management of bollworms in HDPS. Chlorimuron ethyl 0.07 g L^{-1} as post emergence application was found to be a cheaper alternative herbicide to Pyrithiobac sodium for the control of broad leaf weeds in HDPS. Further, there is no advantage of staggered herbicide application over tank mixture of graminicides and herbicides for broad leaf weed control unless the weed flora is known beforehand.

On deep black soils under rainfed conditions, four *G. hirsutum* entries *viz*., SPS-9.1 ,SPS 27.1, SPS 7.1 and AR-27 were superior to check NH-615 for yield when sown at 60 x 10 cm spacing. Nine entries recorded boll wt. > 3.0 g (maximum 3.8 g). In addition 12 compact type lines (< 60 cm tall) were identified.

Productivity of *G. arboreum* variety Phule Dhanwantary, identified for surgical end use was highest at a spacing of 30 x 15 cm followed by 45 x 15. Among 16 *G. arboreum* genotypes evaluated on rainfed Vertisols at 60 x 10 cm spacing, the seed cotton yield was the maximum with AKA-8 followed by RG-540, CNA-375, Phule Dhanwantary, CNA-418, CNA-423, MDLABB and CISA-6-256. Among these, 11 genotypes *viz*. Phule Dhanwantary, RG-8, RG-540, HD-123, HD-432, CISA-1793, CISA-294, CISA-6-256, MDLABB and CISA-504 were suitable for surgical end use.

Fibre properties of six *G. arboreum* single plant selections *viz*. CNA 2014-2 to 4 and CNA 2014-7 to 9 were analyzed. These cultures were short/ shortmedium staple, coarse cottons with 2.5% span length value between 19.7 to 24.8 mm and micronaire value greater than 5.5. These are thus suitable for making absorbent/surgical cotton and may not be suitable for conventional application of spinning into yarns due to high micronaire and low tenacity (< 20 g/tex).

Coimbatore

Amongst land configurations evaluated for HDPS under winter irrigated conditions with *G. hirsutum* variety Suraj, ridges and furrow method gave significantly higher seed cotton yield (2900 kg/ha) followed by raised bed methods (2820 kg/ha). The control yielded (2370 kg/ha). The gross and net return followed the same trend. Amongst different planters evaluated, inclined plate planter and pneumatic planter distributed seeds within a row uniformly at optimum depth. Manual sowing gave highest yield (2520 kg/ha) but it was statistically at par with inclined plate planter (2450 kg/ha) and pneumatic planter (2430 kg/ha).

Sirsa

Under irrigated conditions on alluvial soils of Sirsa, at 67.5 x 10 cm spacing, the *G. hirsutum* genotypes CPT-50, CSH 3075, CSH 3088, CSH 3114, CSH 3129, SA 1647 and LH 900 out yielded the Bt check Bio-6588. In demonstrations on large plots, CSH 3075 at 67.5 x 10 cm gave 47% increase in yield over Bt check (Bio-6588). Similarly, at 60 cm row spacing, *G. arboreum* cultures CISA 614 and CISA 310 gave 14% and 24% increase in yield respectively when sown in closer (20 cm) intra-row spacing compared to wider (30 cm) intra-row spacing.

3.12 : Weed management

Allelopathy as an alternative weed management strategy for cotton

Nagpur

In the black cotton soils, timely weeding may be difficult during the monsoon season as the soil becomes sticky and wet. Allelopathic cover crop is an option. Twelve cover crops were evaluated for the third consecutive year *vis-à-vis* newspaper and polythene mulch. Weed density and biomass was lower in the cover crop mulched plots than the weedy check and plots without any cover. Effective cover crops were sunnhemp, jowar, bajra, sesame and desmodium. Seed cotton yield was significantly lower in the sorghum and bajra cover crops possibly due to the competitive effects. However, when the same were mulched from the neighbouring plots resulted in the highest seed cotton yields. Methanolic extracts of the effective cover crops were analysed on the GC-MS and major constituents were determined. The maximum relative abundance observed was linolenic acid, methyl ester in jowar and desmodium; ethyl iso-allocholate in pearlmillet; linoleic acid in sunhemp and all trans-squalene, a tri-terpene in sesame.


Newspaper Mulching


Cover Crop Mulching

Coimbatore

Stale seed bed technology (SSBT) and leguminous cover crops (thornless mimosa, sunnhemp, daincha, forage cowpea and Desmanthus) were evaluated as a tool in integrated weed management against the recommended practice of pre-emergence application of pendimethalin and hand weeding done twice. All the cover crop treatments with SSBT recorded significant reduction in weed count ranging from 27 to 42.5 weeds/m^2 as against

163 weeds/m^2 recorded under no SSBT, no cover crop treated with pre-emergence pendimethalin (1.0 kg). Among the cover crops, forage cowpea smothered the weeds efficiently with the lowest weed count of 27/m^2. Seed cotton yield ranged from 3240 to 3581 kg/ha with the cover crops as against pendimethalin (2862 kg/ha).

Survey and identification of weeds of culinary use in cotton based farming system

Survey of the cotton- based farming systems was done and weeds of culinary use were identified. Specimens of weeds were collected from adjoining villages of Nagpur. Some prominent weeds observed were *Celosia argentia*, *Euphorbia hirta*, *Portulaca oleracea*, *Tridax procumbens*, *Commelina bengalensis* and *Digera muricata* (L.) Mart.

3.13: Soil Biology and Biochemistry

Impact of Bt cotton and pesticides on nitrogen fixing soil bacteria

To study the impact of Bt cotton and pesticides on nitrogen fixing soil bacteria in cotton-legume intercropping systems, an experiment with cotton as main crop (Bt and Non-Bt), pigeonpea and soybean as intercrop with three pesticides (Imidacloprid, Thiamethoxam and Monocrotophos) applied as treatments was laid out in replicated strip plot design along with control and respective monocrops. In each plot of intercropping system, two rhizosphere samples each at main crop and intercrop were sampled at various stages of crop growth. Different parameters like beneficial microflora, urease activity, alkaline phosphatase activity, acid phosphatase activity, soil respiration, glomalin content, fluroscent di-acetate hydrolysis, total available nitrogen, Cry toxin and soil microbial biomass carbon were determined. It was found that there was no significant difference between Bt cotton and non Bt cotton, and among different pesticides (Imidacloprid, Thiamethoxam and Monocrotophos) on nitrogen fixing bacteria in cotton-soybean and cotton-pigeonpea inter-cropping systems at different stages of crop growth (60, 90 and 120 DAS and at Harvest). Cry toxins extracted from the rhizosphere soil was not in the detectable range using Bt quant plates. Most of the microbial parameters showed high activity at vegetative and flowering stage.

3.14: Abiotic Stress Management

Role of leaf phytochemicals in cotton leaf reddening and plant response to management

Leaf reddening in cotton hybrid RCH2BG II occurred after first picking during the current season. During the previous season, the mean night temperature reached the lowest (10.8^{0}C) in December and hence severe leaf reddening was observed at peak boll development stage. Contrary to the previous season, the lowest mean night temperature of 11.2^{0}C was recorded during the month of January in the current season and leaf reddening was delayed and occurred mildly only after first picking. Hence yield reduction due to low temperature induced leaf reddening was not pronounced. Differential gene expression studies in complete green and red leaves of cotton confirmed that low temperature induced decline in RUBISCO activity, degradation of chlorophyll ab binding proteins, light harvesting complex II. Subsequent anthocyanin accumulation offered protection to leaves by reduced free radical production as reflected by lower lipoxygenase activity and by enhancing chlorophyll stability index in red leaves. DNA laddering studies indicated that leaf reddening is possibly not a death signal as no fragmentation of DNA was observed.

Response of leaf reddening to management practices was evaluated under field conditions that included 32 treatments comprising of foliar spray of combination of hormones and nutrients at 80 and 110 DAS, spraying of ICAR-CICR Nutrient Consortia resulted in higher yield (3328 kg/ha) when compared to control (2561 kg/ha) which was followed by 2.0 ml/l of Sea Weed Extract (3167 kg/ha) and combination of foliar spray of IBA (10 ppm) at square initiation stage and 2% DAP at 80 and 110 DAS (3042 kg/ha).

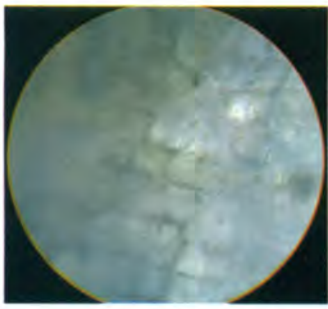
Phenotyping for germplasm lines for drought tolerance

Phenotyping of 104 germplasm lines was done during summer for traits such as mid-day wilting, relative water content and epicuticular wax contents. Fourteen drought tolerant lines and 7 susceptible lines were identified. IC 357406 and Nagpur 9 were found to be highly tolerant to drought. During the regular season, 481 germplasm lines were analysed for epicuticular wax content to correlate with drought tolerance.

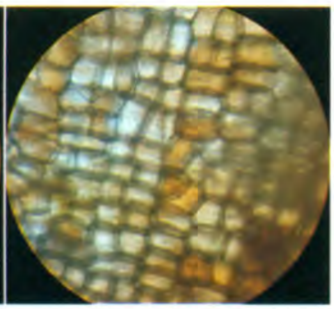
Four lines were identified to have high epicuticular wax content of above 200 µg/cm^2.

Marker assisted selection for waterlogging in cotton

Phenotyping of 2700 germplasm lines was done using the following parameters like plant height, height to node ratio, timing of lenticel formation, formation of adventitious roots, number of red leaves and yellow leaves, stem girth and yield and yield components. Two hundred eleven lines were shortlisted as tolerant and forty four lines were shortlisted as susceptible ones. Fifty lines were found to have adventitious roots, nine hundred eighty nine lines developed lenticels and thirty lines developed both lenticels and adventitious roots. Highly tolerant lines have higher stem girth and highly susceptible lines have lower stem girth. Anatomy of lenticels and normal stem area indicated more or less spherical cells with thin cell walls in lenticels when compared to normal stem area of hexagonal cells with thick cell wall. Thin cell walls facilitate the diffusion of oxygen into the roots and exit of toxic chemicals like ethanol from roots which otherwise would be toxic to the plant.



Section of lenticels



Section of normal stem surface

Effect of elevated CO_2 and temperature on productivity of cotton

Coimbatore

Cotton variety (Anjali) raised under elevated CO_2 atmosphere of 450 ±50 ppm with temperature of 0.5, 1.0 and 1.5°C above ambient in open top chambers revealed that morphological, physiological and yield attributes were found to be very favourable in cotton plants grown under elevated CO_2 atmosphere of 450 ± 50 ppm with 1°C temperature above ambient. Further increase in temperature affected cotton growth and development. For instance, the fruiting coefficient was superior in plants grown at 1°C above ambient with 30.1% while further increase of 1.5°C above ambient reduced the fruiting coefficient significantly to 23.5%. These attributes reflected finally on the yield at harvest. With increase in temperature, yield per plant also increased from 55.1 g in 0.5°C to 61.2 g/plant at 1°C above ambient. However, further increase in temperature of 1.5°C above ambient reduced the yield significantly to 43.1 g/plant.

3.15 : Cropping Systems

Efficient nitrogen fixing legumes for cotton based cropping systems

Nagpur

Twenty different N fixing legumes (food, forage, oil seed and pasture) were evaluated as intercrops in American cotton var Suraj (90 x 10 cm) and *desi cotton* var. Phule Dhanwantry (90 x 10 cm and 60 x 10 cm) to identify compatible legume intercrop for rainfed cotton under deep black soil. Available N status of the soil, morphological and yield parameters were recorded for cotton and the legume during the cropping season. Among intercrops, seed cotton yield was the highest with cluster bean (1408 kg/ha) followed by groundnut and green gram (Fig. 3.15.1a).

Desi cotton when intercropped with groundnut (Fig 3.15.1b) had higher seed cotton yield (2723 kg/ha) followed by intercropping with cluster bean (2455 kg/ha) and soybean (2379 kg/ha).

Desi cotton **+ groundnut**

Coimbatore

Fourteen legume crops were grown as intercrop with Suraj under HDPS (90x10 cm). Intercropping of legumes is beneficial, except vegetable cowpea and Dolichos, which reduced seed cotton yield

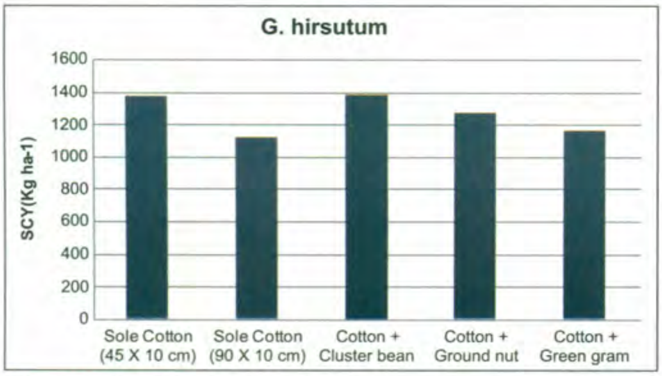


Fig. 3.15.1a: Effect of N fixing legume intercrops on seed cotton yield (kg ha^{-1}) of *G. hirsutum* var. Suraj (90 x 10 cm)

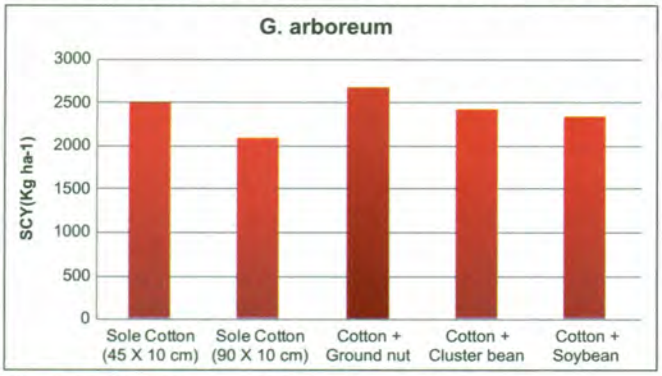


Fig. 3.15.1b: Effect of N fixing legume intercrops on seed cotton yield (kg ha^{-1}) of *G. arboreum* var. Phule Dhanwantry (90 x 10 cm)

significantly. Yield enhancement in cotton due to legumenous intercropping ranged from 1.38 to 13.8 %. Among intercrops, *Desmanthus*, alfalfa and sunnhemp recorded 13.8%, 10.2% and 10.1% enhancement in seed cotton yield due to complementary effect. Cluster bean and redgram enhanced seed cotton yield by 7.86% and 5.82% in addition to 2.83 t and 0.61 t/ha of green pods of cluster bean and 0.61 t/ha of redgram.

Conservation agriculture for cotton-based cropping systems

Coimbatore

Field experiment was conducted with cotton using a strip plot design with three replication. The main plots included conventional system (M_1: Farmer's practice), conservation agriculture (CA) system with minimal land reshaping and partial residue recycling (M_2: 50% of residue from above ground biomass and 100% roots) and CA system with 100% residue recycling (M_3). Beds and furrows system and ridges and furrows systems were used for CA and conventional systems, respectively. The sub plots consisted of four cropping systems *viz.*, S_1: Cotton - Black gram - Maize (for grain purpose); S_2: Cotton - Maize (for green cobs) + Pigeon pea (Strip cropping); S_3: Cotton - Groundnut (for table purpose) + Pigeon pea (Strip cropping) and S_4: Cotton - Fallow (Control). Results of 1st year experiment indicated that there was no significant difference in plant height, dry matter production, number of monopodia per plant, number of sympodia per plant and number of bolls per plant among the treatments. Similarly, analysis of seed cotton yield indicated no significant yield difference in land shaping treatments *viz.*, ridges and furrows (M_1: 3156 kg ha^{-1}), beds and furrows (3059 kg ha^{-1} in M_2 & 3183 kg ha^{-1} in M_3).

3.16: Water Management

Coimbatore

Field experiment was conducted in a split plot design with five replications. Irrigation treatments *viz.*, structured water and bore well water in main plot with four treatments of bio-inoculants in the sub-plot. The structured water irrigated cotton crop was taller, produced more number of leaves had higher chlorophyll content, root cation exchange capacity, nutrient uptake and accumulated higher dry matter production. The structured water irrigated cotton produced significantly higher boll numbers (49.9/plant) as against bore well irrigated cotton (40.1 bolls/plant). The boll weight was also high (5.83 g/boll) as against 5.66 g/boll under bore well irrigation. Averaged over bio-inoculant treatments (sub-plots), the yield gain due to irrigation with structured water was 337 kg/ha. The seed cotton yield with bore well irrigated water was 2836 kg/ha. Irrespective of irrigation treatments, the plots which received combined (seed treatment and soil) application of bio-inoculants + foliar spray of PPFM gave the highest seed cotton yield (Fig. 3.16.1).

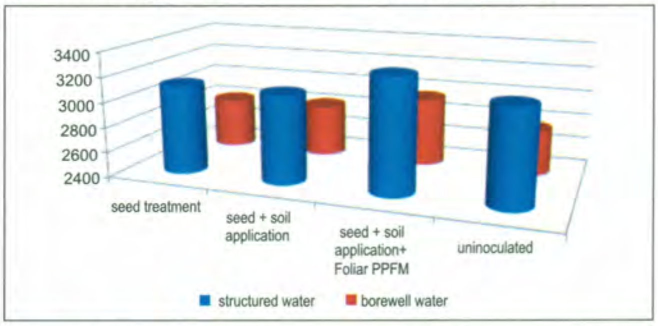


Fig. 3.16.1 : Effect of irrigation treatments and bio-inoculants application methods on seed cotton yield (kg/ha)

3.17 : Morpho-frame / Boll Load Management

Pruning Technique

Coimbatore

Effect of pruning height and time of pruning in cotton

BG II hybrid cotton Bunny, RCH530 and RCH20 were subjected to pruning soon after harvest at various heights at 5, 15, 30, 45 and 60 cm above the soil, while newly seeded crop was raised in an adjacent plot. Study revealed that pruning at 45 cm above soil was characterized with better morphological, physiological and yield attributes at harvest. For instance, yield per plant was 145 g/plant in plants pruned at 45 cm above soil compared to 83.7 g/plant in plants pruned 5 cm above soil. Similarly Bt BG II cotton hybrids namely RCH 530, Bunny and RCH 20 were subjected to pruning at 60, 75 and 90 days after sowing under field condition. Pruning at 60 days after sowing yielded better yield (75.6 g/plant) than pruning at 90 days with 66.2 g/plant while normal crop yielded 89.2 g/plant. The study revealed that in case of complete crop failure during the initial or later stage of crop growth, pruning the whole crop stimulated re-growth with good harvestable yield.

Effect of pruning and seeded crop on yield of cotton

Cotton responded favourably to pruning in both summer and winter crop. Large scale trial revealed that pruning the summer grown crop yielded better than pruned winter crop. Thus one cycle of seeded and pruned crop within a year (winter grown pruned in summer) yielded about 48 q/ha compared to 28 q/ha in single seeded crop. On the contrary, summer grown seeded crop if pruned in winter yielded about 53 q/ha cumulatively while one single seeded summer crop alone yielded 26 q/ha. In both ways, pruning resulted with a beneficial effect not only to increase yield but also double the dry matter production, consequently mitigating climate change by sequestering about 9 tonnes of carbon from atmosphere and fixing in the biomass.

3.18 : Transplanting of Cotton Seedlings

Cotton Transplanting

Coimbatore

Although transplanting technique for cotton has since long been tried and found useful for cotton, cost of raising seedlings remained the main bottleneck in its adoption. A cheap paper-tube technique has been developed to transplant the cotton seedling without disturbing the tap root. Paper tube with size of 1 cm diameter and height of 20 cm were filled (top 1 cm left unfilled to store moisture) with equal portion of vermin-compost, sand and soil and packed gently and compacted. The compactness of the substrate media in every tube is essential for proper germination. Single, healthy seed was dibbled in each tube and water was sprinkled from the top. The tubes were kept in iron tray filled with moist sand (moisture is maintained by sprinkling water) at bottom and covered with wire mesh to keep the paper tubes upright. The seedling at the age of 20 days were transplanted in the main field by planting them in a hole made by crow bar, pressed gently and irrigated immediately. The establishment was quick and complete.

3.19 : Mechanization of Cotton Production

Nagpur

The conceptual mini cotton harvester developed earlier was extended to make a tractor mounted cotton harvester using a 55 hp tractor fitted with a comb type header, a belt conveyor, an onboard field cleaner and a storage tank, under PPP mode with collaboration from ICAR-CICR-CIRCOT and Mahindra & Mahindra tractors. Harvester was evaluated on Bt F_2 hybrid planted at 60 x 10 cm spacing. Machine had a picking efficiency of 97.9% leaving only 2.1% bolls unpicked. However, the header + cleaner + shattering losses were found to be 11.5% with a comb spacing of 16 mm and 12.5 % with a comb spacing of 18 mm. Field capacity of the machine was about 2 h/ha including unloading and idle time of the machine. Onboard cleaner head had an overall efficiency of 54% trash removal lint basis. It was most efficient in removing bur at 64% lint basis as the bur constituted a significant part of the harvested load at header at about 26.6% of the total mass including seed cotton (68.7%) and sticks + leaves + other debris (4.7%). Variables tested in the onboard settings were (1) various grid bar settings i.e., Normal (14-9.5 mm), Uniform 13 mm, Uniform 15 mm and Maximum (16-12.7 mm) and (2) various speed of drum rotation by changing pulley sizes from 200, 175 and 150 mm. Increasing the rpm of drum by replacing the 200 mm pulley with 175 mm pulley could bring down the fibre neps and seed coat neps favourably within acceptable limits, however increasing the rpm of the drum further with a 150 mm diameter pulley had a deteriorating effect on the fibre properties. Keeping this rotational speed and the 175 mm pulley size constant, the various grid bar spacing resulted in least trash content of 10.5% seed cotton basis with the normal grid bar spacing albeit greatly sacrificing the fibre properties. Uniform spacing (15 mm) resulted in 14% trash content. However, Uniform 13 mm grid bar spacing yielded an acceptable trash content of 12.3% with no loss of fibre properties from the manual picking of cotton. When the machine harvested seed cotton was recycled through the onboard cleaner the first time the bur in the harvested seed cotton came down to 12% from 17%. Yet another pass of this recycled cotton through the onboard cleaner brought down the bur to 6% level.

3.20 : Socio Economic Dimensions of Cotton Farming

e-Kapas

ICAR-Central Institute for Cotton Research, Nagpur has introduced the novel extension mechanism 'e-Kapas Network' project in April, 2012. The project is implemented with involvement of scientists of 18 participating centres in eleven cotton growing states of the country including three centres of CICR *viz*. Nagpur, Coimbatore, Sirsa and 15 AICRP- SAUs centres. The aim is to provide cotton growers relevant, location specific, timely agro-advisory services and deliver appropriate cotton technologies to farmers to improve the efficiency of current manual system by saving time, money and making technologies available 'anywhere & anytime' to users. The components of e-Kapas includes farmers' database, FAQs (Frequently Asked Questions) on cotton, content development & recording of voice messages, information delivery as voice calls on mobile numbers, kapas panchang and cotton apps.

Farmer's registration & e-Kapas farmers' database : During 2015-16 total of 65,142 new cotton farmers with their mobile numbers were enrolled from participating centers from major cotton- growing districts. Overall, a total of farmers registered were 2,14,687 as e-Kapas beneficiary from the 18 cooperating centers. Out of these, a total number of 62,097 farmers were registered from CICR (28,163 - CICR Nagpur; 22,947 - CICR Sirsa & 10,987 - CICR Coimbatore).

Information delivery through mobile based voice messages : ICAR-CICR along with cooperating centers are providing appropriate information timely through Mobile technology on mobile numbers of registered cotton growers. The service is provided to all farmers irrespective of telecom network. During the crop season 2015-16, CICR Nagpur sent 10,50,862 voice SMS in Marathi and 7,12,867 attempted successfully. The system was also adopted in case the phone is engaged or outside the coverage area when the voice message is sent, the calls were repeated later a couple of times to ensure that the farmer does not miss the message.

During the year 2015-16, a total of 9274 cotton growers from major cotton growing districts of Tamil Nadu were identified and registered in e-Kapas network. To the beneficiaries, a total of 72 messages, each of 30 seconds were developed and disseminated. The total number of voice SMS alerts pushed during 2015-16 on 72 content was 6,39,445 out of that 4,19,748 were received successfully by the e-Kapas beneficiaries.

Gender Knowledge System in Agriculture

Women are the major source of knowledge for cotton farming and they have accumulated a variety of indigenous technical knowledge. Women perform many tasks in cotton farming. They constitute almost half of the work force engaged in cotton farms. They participate in a broad range of activities in cotton farms such as production, processing, preservation and marketing. They play key roles in the entire cropping system, starting from the selection of seeds through sowing, manuring, weeding, harvesting, cleaning, drying, stacking and storing to marketing. In the decision making process at the farm household level regarding the choice of cotton varieties / hybrids as well as the performing the crop protection measures women are active and play major role. The share of farm women in operations *viz*., land preparation, seed cleaning and sowing, inter cultivation activities, harvesting and post harvesting of cotton are tremendous in cotton farming. During their involvement in farm activities such as spraying, dusting and seed treatment, farm women get exposed directly or indirectly to poisonous plant protection chemicals. They became the head of the families of self murdered farmers and owned more responsibilities. In general, and in particular in cotton sector, the unavailability of Gender Disaggregated Data (GDD) is felt as an important constraint and a limiting factor in properly assessing the women's role and contribution in cotton sector and also for studying the gender issues in cotton. The GDD in cotton is crucial for planning, monitoring and evaluation of gender issues in cotton sector contextually. In order to provide better GDD to cotton researchers, development / extension workers and policy makers in cotton sector the project on Gender Knowledge System in Agriculture is being implemented in the institute. The objectives of the project are to develop gender related data / knowledge bases in Cotton, to facilitate wider sharing of gendered information / knowledge in cotton through appropriate modules and user friendly interfaces and to bring out knowledge products on various issues concerning women in cotton. During the year 2015-16, the frontier technologies in cotton which can empower the farm women from the websites of ICAR- CICR and ICAR-CIRCOT were documented along with the studies, programs and policies from the websites of MoA, DOCD and other State Agricultural Departments.