Theme2: Accelerating genetic gains for productivity and quality and climate resilience

2.1 Project name: Development of broad based high yielding varieties of diploid and tetraploid cotton through recurrent selection

Dr. V N Waghmare (PI), Co-PIs - Dr. S.K. Verma and Dr. S.K. Sain

Importance of the study: Narrow genetic base is the major limitation for genetic improvement of cotton. Development of cotton varieties with broad genetic base through population improvement approaches such as recurrent selection and intermating is aimed for improving yield, fiber quality and tolerance to biotic and abiotic stresses.

Salient findings

Population Improvement

Evaluation of single plant selection: About 1680 superior single plant selections were planted for evaluation as plant to row progenies. Based on the performance and uniformity/plant progenies were identified for evaluation in replicated trial. Selection of single superior plants from the segregating progenies was carried out for further evaluation.

Evaluation of advance cultures: 174 *G. arboreum* and 52 *G. hirsutum* cultures were evaluated in 9 replicated trials (4 rows plots in 2 replications) during the crop season 2020. In all, 7 trials of *G. arboreum* and 2 of *G. hirsutum* were conducted following spacing of 60 x 45 cm.

Evaluation of sterile plants: Based on evaluation of 3269 single sterile plants from random mating population (1244 of *G. arboreum* and 2054 of *G. hirsutum*), superior progenies for specific traits namely boll weight, GOT and seed cotton yield were identified. By employing selection pressure, about 10-15% superior progenies for specific traits were identified. The remaining seeds of the identified progenies from the previous year in equal quantity bulked together to raise traits-specific population which were evaluated as plant to row progenies to access its superiority for specific trait. All the single plant progenies were monitored for segregation and sterile and fertile plants were tagged. Fertile plants were evaluated for economic and quality traits to identify progenies for specific superior traits.

Evaluation of GMS based *G. arboreum* Hybrids: Four GMS based hybrids were evaluated for seed cotton yield with two check hybrids AAH 1 and CICR 2. One GMS based hybrid CISAA 19-5 (2802.7 kg/ha) could record significantly higher seed cotton yield than the check hybrid CICR 2 (2466.2 kg/ha) and CISAA 19-4 (2659.0 kg/ha). Two GMS based hybrids CISAA 19-5 (2802.7 kg/ha) and CISAA-19-4 (2659.0 kg/ha) could record significantly higher seed cotton yield than another check hybrid AAH1 (2252.0 kg/ha).

Evaluation of Spinnable *G. arboreum* cultures: Fourteen cultures were tested in RBD along with two checks CISA 614 (2344.0 kg/ha) and PA 255 (2350.4 kg/ha). Three genotypes namely CISA 33-3 (3036.2 kg/ha), CISA 33-1 (2899.5 kg/ha) & CISA 33-2 (2854.2 kg/ha) gave significantly higher yield than the checks (PA 255) and (CISA 614). Six genotypes CISA 10, CISA-6-295, CISA-33-8, CISA 33-1, CISA 33-2 and CISA 44-1 were having UHML (mm) >25.0mm and strength ~25.0 g/tex (in HVI mode).

Evaluation of high yielding *G. arboreum* genotypes: Fourteen genotypes were

evaluated in RBD with two check varieties CISA 614 and CISA 310. Three genotypes CISA 33-7 (2782.7 kg/ha), CISA 8 (2708.2 kg/ha) and CISA 33-5 (2704.7 kg/ha) gave significantly higher seed cotton yield than high yielding local checks CISA 614 (2253.0 kg/ha) and CISA 310 (2396.7 kg/ha).

Maintenance of GMS lines: Four GMS lines (DS5, CISA 2, GAK 413A, CISG-20) and 18 newly identified GMS lines [CISG-1, CISG-2, CISG-4, CISG-8, CISG-9, CISG-10, CISG-11, CISG-13, CISG-14, CISG-15, CISG-16, CISG-17, CISG-18 (narrow leaf), CISG-18 (broad leaf), CISG-19, CISG-21, CISG-22 (narrow leaf) and CISG-22 (broad leaf)] were maintained through sibmating. Pigmented GMS lines CISG 4, CISG-8, CISG-10 & CISG-13 had red flower colour with petal spot.

Fig. 2.1.1: *G. arboreum* Variety CNA1032

Crosses with GMS lines: Ten crosses were attempted with the GMS line GMS 16A to introgress CLCuD resistant trait in random mating population. Backcrosses were also attempted involving GVS9 genotype to increase the frequency of CLCuD resistance in the population.

Identification and release of variety: CNA 1032, a *G. arboreum* genotype tested in Agronomy trial in Central Zone during 2019-20 was identified for commercial cultivation by Varietal Identification Committee under the chairmanship of Dr. T.R. Sharma, DDG (CS). Subsequently the variety CNA1032 (Fig. 2.1.1) was released during the 84th CVRC meeting held on 10th July, 2020 and notified in the Gazette vide S.O. 3482(E) dated Oct. 7, 2020. The salient features of the variety are provided in Table 2.1.1.

Table 2.1.1: Features of *G. arboreum* variety CNA 1032

S. No.	Characters	Value
1	Boll weight (g)	2.50
2	Ginning Outturn (%)	34
3	Seed cotton yield (Kg/ha.)	1317
4	Days to maturity (days)	150-160
	Fibre characteristics	
5	Fibre length (at 2.5% SL)	28.7mm
6	Micronaire (µg/inch)	5.7
7	Bundle strength (g/tex)	27.9
8	Zone of cultivation	Central Zone

2.2 Project name: Development of compact plant types with improved quality traits through selective mating system in G. hirsutum L

Dr. Suman Bala Singh (PI), Co-PIs - Dr. Jayant Meshram, Dr. J. Amudha

Importance of the study: Biotic and abiotic stresses represent major production constraints in cotton. Genetic approaches like

selective intermating are considered important in breaking the undesirable linkages and developing superior varieties. Development of stress resilient, compact upland cotton varieties with improved fibre quality is the purpose of the project.

Salient findings

Evaluation of advance generation of crosses for yield and economic characters under rainfed conditions was carried out under replicated trial with three replications and plot size of 14.4 sq. m. Of these, 11 genotypes were at par to the check Suraj which recorded seed cotton yield of 1886.39 kg/ha. Seed cotton yield (SCY) ranged from 1391.65 (DTS 414) to 2884.62 kg/ha (DTS 423). Highest SCY was recorded for DTS 423 followed by DTS 421, DTS 410, DTS 403, DTS 409 and recorded more than 20% increase over the check. Boll weight ranged from 3.2 (DTS 404) to 4.67g (DTS 410) and ginning percentage from 33.85% (DTS 401) to 41.81 % (DTS 423). DTS 420, DTS 401, DTS 406, DTS 412, DTS 408, DTS 405 recorded good boll weight (>4.0 g) while DTS 421, DTS 413, DTS 420 recorded better GOT (>39%).

In F_4 generation of crosses involving compact plant type (Fig. 2.2.1), cluster boll bearing and other important traits were evaluated in replicated trial with plot size of 14.4 sq.m. Twenty five crosses were at par to the check Suraj which recorded SCY of 1847.90 kg/ha. Seed cotton yield ranged from 1488.26 (DTS-CP 103) to 3361.08 kg/ha (DTS-CP 128). DTS-CP 128, DTS-CP 125, DTS-CP 105, DTS-CP 115, DTS-CP 130 recorded more than 50% increase over the check Suraj. Boll weight ranged from 3.2 (DTS-CP 121) to 5.05 g (DTS-CP 113). DTS-CP 101, DTS-CP 105, DTS-CP 129, DTS-CP 124, DTS-CP 114 recorded >4.5g boll weight. GOT ranged from 36 (DTS-CP 106 and DTS-CP 112) to 44 % (DTS-CP 114 and DTS-CP 119). DTS-CP 128, DTS-CP 129, DTS-CP 103, DTS-CP 111, DTS-CP 120 more than 40 % GOT.

Advance generation of seven backcross and six genotypes were tested in replicated trial with three replications and plot size of 21.6 sq. m. Six genotypes were at par to the check Suraj which recorded SCY of 2556.92 kg/ha. Seed cotton yield ranged from 1865.92 (DTS-BC 112) to 2764.22 kg/ha (DTS-BC 102). DTS-BC 101, DTS-BC 113, DTS-BC 109, DTS-BC 114, DTS-BC 108 were other promising entries with performance better than check variety Suraj. Boll weight ranged from 3.3 (DTS-BC 108) to 4.5g (DTS-BC 107). DTS-BC 102, DTS-BC 106 recorded more than 4.0g boll weight. GOT ranged from 39 (DTS-BC 112) to 44 % (DTS-BC 109). DTS-BC 105, DTS-BC 108, DTS-BC 110, DTS-BC 113 > 42 % GOT.

A total of 119 single plant progenies were raised and intermating was carried out between 15 lines showing stability and uniformity for zero monopodia. Around 680 single plant selections were evaluated and promising ones were selected for earliness, fibre quality, plant type and susceptibility to sucking pest. Considerable variation was recorded for different fibre quality traits within crosses. In some of the selections, the fibre strength up to 34.6 g/tex was recorded with fibre length of 32.2 mm.

Two F_5 generations of eight and ten parental crosses were raised for developing MAGIC RILs. Single plant picking was carried out for these two populations. 1000 lines were evaluated for leaf temperature and chlorophyll content which ranged from 24.1 to 29.5^{o}C and 18.8 to 65.9 µmol/m^2 respectively while, 250 lines were evaluated for proline content that ranged from 1.4 to 2.18 µmol g^{-1} FW.

Fig. 2.2.1: Compact plant types

2.3 Project name: Breeding of upland cotton for improved fibre yield, quality and resistance to biotic stress (jassid)

Dr. S. M. Palve (PI); Co-PIs - Dr. (Mrs.) Rachna Pande, Dr. Pradeep Mandhyan (ICAR-CIRCOT, Mumbai)

Importance of the study: The aim of the project is to develop a breeding population with improved seed cotton yield, fibre quality and resistance to jassid. Utilization of interspecific crosses between *G. hirsutum* and *G. barbadense* in the breeding programme would certainly help in releasing additional genetic variability for fibre quality traits in populations generated.

Salient findings

Among 180 entries evaluated for seed cotton yield, fibre properties and jassid resistance, CNH 54-18 recorded highest length of 31.2 mm with fibre strength of 30.4 g/tex. CNH 58-46 recorded length of 32.2 mm and fibre strength of 28.3 g/tex. CNH 121-13, CNH 54-18, CNH 58-46, CNH 24-51, CNH 2SP-11 and CNH 72-35 were identified as tolerant to jassid (Grade I). CNH 09-70, CNH 09-23, CNH 09-12-3, and CNH 09-45 were tolerant to jassid.

Single plant selections (205 F_5) were advanced to F_6 progeny rows for evaluation of yield, earliness and fibre properties. Similarly, promising 292 F_6 and 80 F_7 progenies were evaluated for yield and fibre properties.

In interspecific crosses of *G. hirsutum* × *G.barbadense,* promising introgression lines (ILs) for specific traits like high ginning outturn percentage, cluster bolls and round bolls were developed (Fig. 2.3.1). In case of clustered boll lines, CNH 2020-7, CNH 2020-15, CNH 2020-16, CNH 2020-17, CNH 20 SP 2, CNH 20 SP-4 and CNH 20 SP -5 were promising for seed cotton yield. While in round boll lines, CNH 4822, CNH 4823, CNH 48-46, CNH 48-50, CNH 48-51, CNH 48 SP-1, CNH 48 SP-2, CNH 48 SP-4 and CNH 48 SP-5 were promising. The average fibre length, fibre maturity, micronaire and fibre strength values of the BC_1F_5 progenies were generally closer to the recipient *G. hirsutum* parent Suraj. Amongst ILs, CNH 44-31, CNH 45-31, CNH 47-31 and CNH 48-31 were tolerant to jassid (Grade I). In addition, 10 ILs had dark brown, medium brown and light brown lint colour variation (Fig. 2.3.1).

The average value for ginning out turn percentage and fibre quality traits of 201 backcross inbred lines and released varieties Suraj, NH 615 and Suvin was estimated over two years (2018 and 2019). The ILs CNH 20378, CNH 20387, CNH 204710 and CNH 204910 were identified for higher ginning outurn percentage (Table 2.3.1).

(a) Cluster bolls

(b) Dark Brown Lint

Fig. 2.3.1: Identified introgressed lines with distinct traits.

Table 2.3.1: Mean values of selected progenies for ginning outturn, boll weight and fibre properties

SPS	GOT (%)			Boll wt. (g)			UHML (mm)			MIC (µg/inch)			Strength (g/tex)		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
CNH 20378	44.3	43.5	**43.9**	5.9	3.8	**4.8**	28.9	30.0	**29.4**	4.3	3.8	**4.0**	29.1	28.4	**28.7**
CNH 20387	44.8	42.4	**43.6**	4.8	4.7	**4.7**	28.2	29.4	**28.8**	3.9	4.3	**4.1**	28.8	27.2	**28.0**
CNH 204710	45.7	43.3	**44.5**	5.9	4.5	**5.2**	28.7	29.4	**29.0**	3.7	4.2	**3.9**	29.8	23.1	**26.4**
CNH 204910	43.0	44.5	**43.7**	5.8	3.8	**4.8**	28.5	28.1	**28.3**	4.3	4.4	**4.3**	28.6	230	**25.8**
Suraj	36.0	36.4	**36.2**	4.1	4.9	**4.5**	31.3	31.1	**31.2**	4.3	3.0	**3.6**	27.1	27.2	**27.1**
NH 615	37.6	37.0	**37.3**	4.2	3.2	**3.7**	27.5	29.6	**28.5**	3.8	3.5	**3.6**	24.4	25.6	**25.0**
Suvin	31.2	31.6	**31.4**	3.1	2.6	**2.8**	36.8	39.9	**38.3**	3.0	3.6	**3.3**	30.1	32.7	**31.4**

2.4 Project name: MAS/MAB for Waterlogging resistance

Dr Vinita Gotmare (PI); Co-PIs - Dr M Saravanan , Dr Jayant Meshram, Dr Annie Sheeba

Importance of the study: Cotton in India is grown in different agro-climatic conditions and it experiences waterlogging at one or other stages of its life cycle because of recent climate change scenarios. Information on the genetic variation for waterlogging tolerance in cotton is meager. This project is aimed to derive insights on waterlogging tolerance in *G. hirsutum* germplasm.

Salient findings

A total of 7500 *G. hirsutum* germplasm accessions were evaluated under field and pot condition over the years simultaneously at Nagpur and Coimbatore and promising tolerant and susceptible accessions for waterlogging tolerance were identified. Four accessions each of tolerant (IC359979, IC359245, IC563998 (INGR 08093), LRA5166) and susceptible (IC357558, IC359242, IC357607, IC356708) group (Fig. 2.4.1) were characterized and molecular diversity was analyzed using SSR markers. The development of mapping population using these identified accessions is underway.

IC356708 IC357607 LRA5166 IC563998

Fig. 2.4.1: Waterlogging susceptible and tolerant accessions

2.5 Project name: Breeding to improve performance of *Gossypium herbaceum* for adaptation to climate change in Central India

Dr. D.V. Patil (PI)

Importance of the study: One of the major reasons of low cotton productivity in central zone is abiotic and biotic stresses. *Gossypium herbaceum* can grow in difficult weather conditions under low fertile soils with poor management. It has immense inherent of abiotic tolerance. This project aimed to identify genotypes suitable for early maturity traits that escape late season water stress in addition to fitting the crops in available short windows of cropping systems.

Salient findings – 2020

Evaluation of advance generation populations of *G. herbaceum*

Twenty one F_4 populations were evaluated. The population of cross IC371437 × IC371362, IC371437 × GVHV655, Baluchistan 1 × IC371437, Jayadhar × IC371437, Jayadhar × IC371362 and Jayadhar × GVHV655 exhibited higher seed cotton yield compared to checks. The population of cross IC371437 × IC371362

had maximum UHML (27.7mm), UI (80%), MIC (4.5µg/inch), bundle tenacity at 3.2 mm gauge (27.0g/tex) and EI (4.4%) whereas, lowest fibre quality parameters were recorded in cross Jayadhar × GVHV655 (UHML 23.4mm, UI 77%, MIC 4.5µg / inch, bundle tenacity 21.6 g/tex and EI 5.6%).

Evaluation of interspecific population of G. *herbaceum* × *G. arboreum*

Twelve F_4 populations of interspecific crosses of *G. herbaceum* × *G. arboreum* (Fig. 2.5.1) were evaluated. IC371437 × PA785, Baluchistan1 × PA785, GVHV655 × PA785, IC371437 × PA812, Jayadhar × PA812 and IC371362 × PA785 produced higher seed cotton yield. Fibre quality parameters were tested in interspecific crosses. The population of cross IC371362 × PA785 had maximum UHML (30.1mm), UI (83%), MIC (3.3µg/inch), bundle tenacity (31.3g/tex) and EI (6.1. The genetic gain due to back crossing was maximum in the cross PA785 × IC371437 × PA785 (UHML 29.7mm, UI 84%, MIC 3.7µg/inch, bundle tenacity 29.4 g/tex, and EI 5.

Fig. 2.5.1: Interspecific hybridization (G. *herbaceum* × *G. arboreum*) in desi cotton

2.6 Project name: Development of high yielding, early maturing Asiatic cotton (*G. arboreum*) genotypes suitable to south zone

Dr. A.Manivannan (PI); Co-PIs- Dr. M. Saravanan; Dr. V. N. Waghmare

Importance of the study: Desi cotton (*G. arboreum*) resilient to many biotic and abiotic stresses is considered as a sustainable solution for fight against climate change. The demand for short stable cotton is almost double the production which highlights the scope for increasing area and productivity of desi cotton. In order to harness the short window of rainfed regions of central and south zone, this project envisaged to develop early maturing, high yielding *G. arboreum* genotypes.

Salient findings – 2020

Coimbatore

G. arboreum accessions screened for high yield and early maturity, based on Specific Combining Ability (SCA) and Standard heterosis (SH) with *per se* performance. Ten brown linted F_3 progeny families of crosses *viz.*, 1422 × Indicum 12-SP1, Desi 77 × *Arboreum* 12 , G725-SP1 × Indicum12 , H492 × 30839, Desi 56 × Indicum 12-SP1 (Fig. 2.6.1), Indicum12-SP1 × H502, Indicum12-SP1 × H480, H480 × Indicum12-SP1, 30814 × AC 3066 and AC514 × Desi 56, and 14 white linted F_3 progeny families of crosses *viz.*, 4725 SP1 × Indicum 12, NA48 × H 483, H 493 × NH-54-31-32, AC514 × AC 3066, NH-54-31-32 × GMS, Desi 70 × RG18, Desi 77 × AC3066, Desi 56 × AKA 57, Desi 56 × 30810, Malvi × 10 NA 40, 1422 × 19, AC 3066 × 19, Desi70 × AC 3066, and NA 48 × 30839 are being evaluated

Fig. 2.6.1: Field view of F_3 progeny family of brown linted *G.arboreum* Desi 56 × Indicum 12-SP1

Nagpur

BC_3F_1, BC_2F_2 and F_4 population of long linted genotypes *viz.*, PA255, PA812, PA740, PA783 and KWAN3 crossed with Phule Dhanwantari were evaluated. Based on plant type and fibre quality traits, superior progenies (Fig. 2.6.2) were identified and used in the backcrossing (BC_4F_1 and BC_3F_2) and generation advancement (F5)

Fig. 2.6.2: Promising progenies and single plant selections of *G. arboreum*

2.7 Project name: Breeding for early maturity, compact plant type and jassid tolerance in cotton

Dr. H. B. Santosh (PI); Co-PIs- Dr. S. Manickam & Dr. K. P. Raghavendra

Importance of the study: High density planting system (HDPS) is recognized for higher productivity of cotton across countries. Availability of cotton cultivars with compact plant architecture is a basic requirement for the success of HDPS. This project envisages to develop cotton varieties which will have the potential to produce higher yield per unit area (under HDPS) and per unit time (due to early maturity) along with inherent resilience to jassids, better yield and fibre quality attributes. Early maturing cotton variety can also help escaping pink bollworm damage.

Salient findings

A total of 165 single plant selections and 85 progenies selected from the segregating populations for earliness, jassid tolerance, compact plant architecture, good boll weight and yield were evaluated. Many single plant selections (Table 2.7.1) and progenies having early maturity along with better fibre quality and yield potential were identified. Crop duration and plant architecture was severely impacted by the incessant rains which also lead to heavy infestation of sucking pests. Taking advantage of pest pressure, material was thoroughly screened for jassid tolerance and promising lines/progenies were identified. Eighty one single plant selections and 53 progenies were categorized as Grade 1 for jassid tolerance. Promising plants from different progenies were intermated and multi-parent crosses were attempted to combine early maturity and fibre quality along with compact plant architecture, jassid tolerance and yield potential. Three non-Bt entries *viz.,* CNH 20-31, CNH 20-32 and CNH 20-33 were sponsored for evaluation under AICRP on Cotton [IET Br 06 (a) trial] during 2020-21. Molecular divergence among jassid tolerant and susceptible upland cotton genotypes was studied using 50 polymorphic markers. Number of alleles detected by the marker ranged between 2 to 5 with a mean of 2.71. Average polymorphism information content (PIC) value ranged from 0.12 to 0.68 with a mean of 0.41. The genotypes were grouped into 3 major clusters which were further divided into sub-clusters (Fig. 2.7.1).

Table 2.7.1: Single plant selections of upland cotton possessing early maturity, jassid tolerance, compact plant architecture along with better yield and fibre quality attributes.

Selections	Plant Height (cm)	Plant width (cm)	Boll opening (%) @150DAS	Boll Weight (g)	Plant Yield (g)	Fibre length (mm)	Micronaire (µg/inch)	Fibre strength (g/tex)
SPS191-068	99	45	100.00	4.33	86	26.1	3.2	23.9
SPS191-048	98	31	100.00	3.67	75	27.8	3.4	27.8
SPS191-070	98	53	100.00	3.00	69	31.1	3.3	32.0
SPS191-049	103	33	97.37	3.00	105	29.4	4.4	31.2
SPS191-033	109	39	97.30	3.33	89	26.7	3.9	28.1
SPS191-036	91	27	93.94	4.33	94	33.0	3.5	29.6
SPS191-066	125	31	93.10	4.33	83	27.8	5.1	26.3
SPS191-069	127	35	88.46	4.00	100	28.5	4.5	25.0
SPS191-023	92	27	88.24	4.67	53	27.5	3.0	26.4
SPS191-067	98	34	86.96	3.33	72	28.2	3.8	28.5
SPS191-042	104	33	84.62	4.33	78	27.1	3.2	26.7
SPS191-024	86	32	82.14	4.67	102	28.5	3.1	26.6
SPS191-035	88	34	81.82	4.67	102	28.3	3.3	29.4
SPS191-027	118	27	78.95	4.33	116	24.4	4.5	26.2
SPS191-026	124	42	75.51	4.00	114	27.7	4.0	29.8
SPS191-037	98	36	74.07	5.00	96	26.6	3.7	27.4

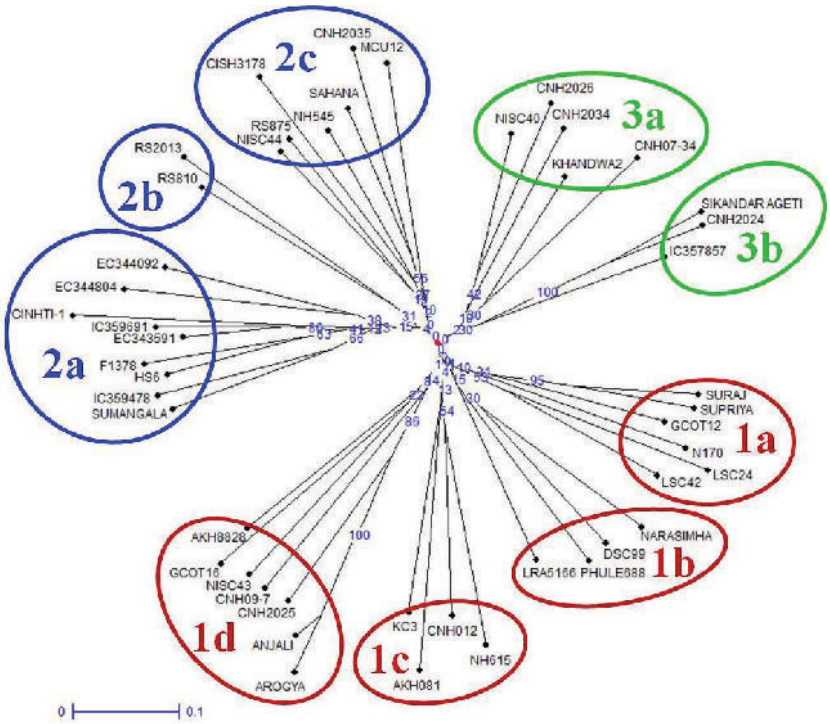

Fig.2.7.1: Clustering of upland cotton genotypes varying for jassid tolerance based on their genetic dissimilarity as revealed by polymorphic SSR markers

2.8 Project name: Breeding for high yielding, early maturing sucking pest tolerant extra-long staple *G. barbadense* genotypes with improved fibre properties

Name of PI & Co-PIs: Dr. KPM Dhamayanthi (PI); Co-PI's: Dr. A. Manivannan, Dr. K. Rameash

Importance of the study: In India, Extra Long Staple (ELS) Cotton (*G. barbadense*) demand is high than current production. The existing *G. barbadense* germplasm has a narrow genetic base and it became a major constraint to sustain progress in the development of ELS cotton cultivars to meet the needs of textile industry requirements. Hence, the project was formulated to improve yield and fiber quality in *G. barbadense* to meet the requirement of the textile industries.

Salient findings – 2020

Release of ELS variety: CCB-51, an ELS cotton genotype (Fig. 2.8.1) was released for irrigated conditions of South Zone (Andhra Pradesh, Telangana, Karnataka and Tamil Nadu). It has an yield potential of 1464kg/ha with duration of 165-170 days. It has a fibre length of 37.4 mm, micronaire of 3.3 and tenacity of 38g/tex. It showed resistance to grey mildew and bacterial leaf blight and showed tolerance to jassids, whiteflies, thrips and aphids.

Fig. 2.8.1: CCB 51 *G. barbadense* variety

Seed multiplication of the promising genotypes identified for the Station & AICRP-2020-21 trials.

Seed multiplication of two advance cultures (CCB6 and CCB-15) for initial evaluation trial and CCB-26,CCB-29, CCB-51, CCB-51-2, CCB-64, CCB-64 B, CCB-129, CCB 141, CCB 142, and CCB-143B for various breeding trials was undertaken. Six new promising advanced lines namely CCB3, CCB4, CCB5, CCB7, CCB8, CCB12, CCB13, and CCB28 were multiplied for sponsoring in AICRP next year. Seed for large scale demonstration of newly identified variety CCB 51 was multiplied in large scale.

2.9 Project name: Development of high strength cotton genotypes by reducing short fibre content

Dr. S. Manickam (PI); Co-PIs- Dr. B. Dharajothi; Dr. J. Gulsar Banu; Dr. A. H. Prakash; Dr. K. Rameash; Dr. A. Sampath Kumar

Importance of the study: The long and extra-long staple varieties capable of spinning 60s count yarn occupies a sizeable area in the South Zone but are poor in fibre tenacity which make them unsuitable for spinning to optimum yarn counts. The upgradation of textile mills from ring spinning to open end rotor spinning require high strength cotton fibres to realize their spinning potential. Development of high strength culture will be useful for further breeding programmes.

Salient findings – 2020

- **CICR-H Cotton 36 (Suraksha)**, an extra long staple variety (Fig. 2.9.1) was identified for release in 2020 for both Central and South Zone States in irrigated condition with an yield potential of 4019 kg/ha. The average values of Upper Half Mean Length of 32.4 mm, micronaire of 3.7 and tenacity of 34.3 g/tex in HVI mode in South Zone and Upper Half Mean Length of 31.9 mm, micronaire of 4.4 and tenacity of 33.5 g/tex in HVI mode in Central Zone indicates its superior fibre quality. The variety is resistant to Bacterial Leaf Blight, Grey Mildew, Root rot, Tobacco Streak Virus, Tolerant to Alternaria Leaf Spot and, Rust. The variety is tolerant to Jassids, Whitefly, Thrips, Aphids, and Mirid Bug. It has been listed as Leaf hopper tolerant culture in both the zones.
- The long staple cultures CCH 19-2 and CCH 19-4 showed superior performance in AICRP multi-location trials and were promoted to zonal trials in both Central and South Zone for further evaluation during 2020-21.
- Several big boll progenies having boll weight of more than 5.0 g with good fibre quality has been identified and are being evaluated for further utilization.

a) Plant view b) Green Boll c)Boll opening

Fig. 2.9.1: CICR-H Cotton 36 (Suraksha) – a) plant view; b) green boll; c) boll opening

2.10 Project name: Development and evaluation of ELS interspecific hybrids with better yield and fiber quality

Dr. K. Baghyalakshmi (PI); Co-PIs- Dr. M. Amutha, Dr. A. Sampath Kumar, Dr. A. Manivannan

Importance of the study: In India, the Extra Long Staple (ELS) cotton production is less than the textile mills requirement. In order to meet the demand, the interspecific (H×B) hybrids need with quality sought by modern textile mills need to be developed.

Salient findings

Fifty *G. barbadense* lines were evaluated and based on primary morphological data seven male parents *viz.*, ICB 161 (compact type), CCB 11A (early maturing), CCB 29 (Advance culture for yield), Suvin (fibre quality), ICB 124 (High leaf trichome), CCB 25 (Epicuticular wax content), ICB 46 (High gossypol glands), and four female parents namely Suraj, Surabhi, MCU5 VT, CCH 15-1 were selected. Among the 50 genotypes, genotype with highest boll weight was CCB 143 B (5.35 g), ginning percent ICB 176 (37.5), fiber length CCB 11A (39.4), fiber strength CCB 28 (44.1). The 50 parents were analysed for PCA. About 91.45% of total variability found to be explained by PCA1, PCA2 and PCA3 components. PCA1 explained 39% of the variation for traits like mean length, UHML, fiber strength, boll shape and uniformity index. Diversity analysis (Fig. 2.10.1) grouped the accessions into four major clusters with two sub cluster in group 2, 3 and 4, hence forming seven groups. The minimum distance (0.56) was observed between ICB 176 and CBB 11 while, the maximum distance (3.11) was observed between ICB 174 and ICB 1. The parents ICB 99 for zero branching type, ICB 176 for GOT (37.5%), fibre length (35.4mm), fibre strength (40.7g/tex), ICB 264 for higher trichome density and higher gossypol content, ICB 284 for uniformity index of 87%, ICB 174 for early maturing and higher cuticular wax content, ICB 258 for early maturing with 4.1 micronaire and CCB 143B for higher boll weight of 5.35g were selected for crossing during next season (Table 2.10.1).

Table 2.10.1: Genotypes selected for crossing programme during 2020-2021

Genotype	NS	NM	FPF	BW	TL	GL	CW	GP	UHML	UI	FS	MIC
ICB 99	21	0	76	4.54	31.67	16.67	8.819	34.529	29.2	83.0	32.4	4.4
ICB 176	21	4	73	4.24	45.00	45.00	1.808	37.508	35.4	87.0	40.7	3.9
ICB 264	23	4	67	3.69	111.67	126.67	4.542	31.377	31.8	85.0	31.5	4.6
ICB 284	27	2	84	4.92	90.00	51.67	4.939	35.803	33.3	87.0	35.2	4.7
ICB 174	18	0	65	5.21	63.33	100.00	11.112	31.871	33.7	84.0	35.5	4.8
ICB 258	26	2	67	3.81	60.00	28.33	4.762	31.411	33.0	85.0	35.5	4.1
CCB 143 B	29	4	70	5.35	115.00	76.67	6.438	32.466	39.1	87.0	41.4	4.1

*NS- Number of Sympodia, NM-Number of Monopodia, FPF-50% Flowering, BW-Boll Weight(g), TL-Leaf Trichome numbers (no/sq cm), GL-Leaf Gossypol Glands (no/sq cm), CW-Cuticular wax (µg/sq.cm), GP- Ginning Percent, UHML- Upper Half Mean Length (mm), UI- Uniformity index (%), FS-Fiber Strength (g/tex), MIC- Micronaire

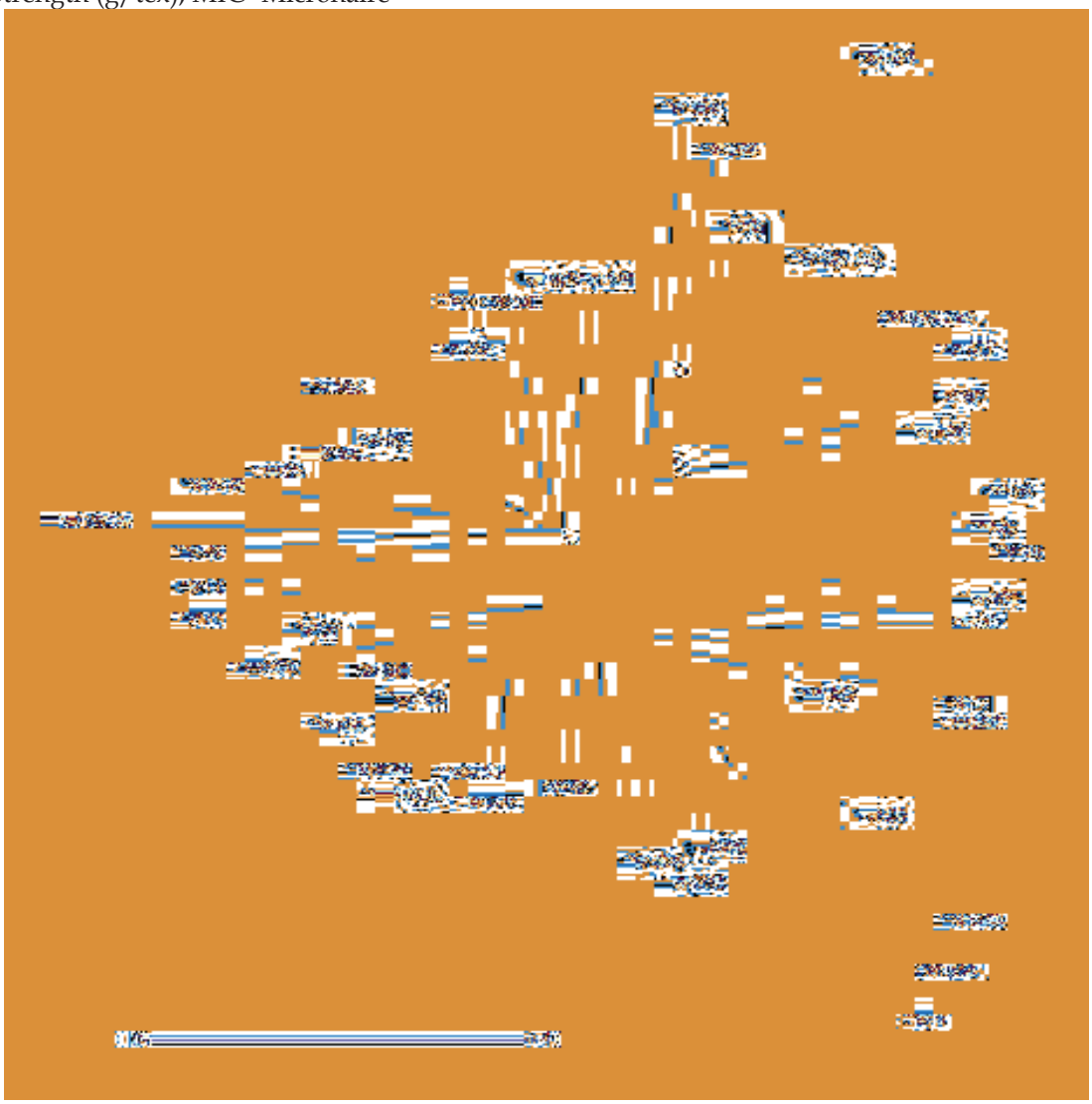

Fig. 2.10.1: Diversity analysis of 50 *barbadense* genotypes

2.11 Project name: Identification of male sterile plants in genetic male sterility (GMS) using molecular markers

Dr. O. P.Tuteja (PI); Co-PIs- Dr. S. B. Singh, Dr. Saravanan, M.

Importance of the study: Hand emasculation and pollination is laborious and the use of male sterility can make hybrid seed much cheaper. Use of GMS for commercial hybrid seed production is a better approach for tetraploid and diploid hybrids. GMS system involving two recessive genes *ms5ms5ms6ms6* found in Gregg MS is the only stable source utilized in India. The seed production plots of GMS female contain 50 percent fertile plants which need to be rouged out during flowering but before pollination. Identification of male sterile plants using molecular markers will help in making GMS based hybrid seed production profitable and sustainable.

Salient findings – 2021 A total of 24 samples representing 12 male sterile and 12 male fertile plants submitted for SNP genotyping. The seed of 12 CMS and its maintainer lines, 28 GMS and 25 Restorer lines were submitted for medium term storage (MTS).

2.12 Project name: Development of varieties of upland cotton having better fibre traits and tolerance to CLCuD

O. P. Tuteja (PI); Co-PIs- Dr. V. N. Waghmare, Dr. S. K. Verma, Dr. D. Monga and Dr. Rishi Kumar

Importance of the study: CLCuD is a major problem for cotton production in north India. As it is a vector transmitted viral disease, its management is very difficult. This project was initiated for development of varieties of upland cotton having good fibre traits and tolerance to CLCuD.

Salient findings

An F_2 population of seven crosses *viz*., CSH-46 × Bhiyani 251, CSH-46 × Bhiyani 251, CSH-27 × CSH-46, CSH-27 × HS 6, CSH-27 × F 846, CSH-46 × F 846 and CSH-538 × HS 6 were evaluated and 21 CLCuV free (0 grade) plants were identified and advanced. Following crosses were attempted involving GVS 9: F1 (GVS-9 × HS-6), BC1 (GVS-9 × HS 6) × GVS 9, BC2 (GVS-9 × HS 6) × HS 6, Selfing of F_1 (GVS-9 XHS-6) to develop F_2 population.

Out of two lines, GVS-8 (EC881780) and GVS-9 (EC881781) (both lines ratooned) showing resistance to CLCuD, the line GVS-9 was crossed with two CLCuD susceptible genotypes, CSH 3129 and F 2228, and F_1 was produced. The F_1 plants were screened for disease reaction which was observed to be resistant (ratooned), also the F1 was selfed for generation advancement. The segregation behavior of disease reaction on F_2 showed a segregation pattern of 3 (resistant): 1 (susceptible) ratio. The chi-square for goodness of fit confirmed that the resistance to CLCuD is governed by a single dominant gene.

Testing of entries in Institute Common Trial of *G hirsutum and G. arboreum*

In *G. hirsutum*, 13 entries and 6 entries in case of *G. arboreum* were evaluated along with checks for seed cotton yield and fibre properties for identifying promising entries for sponsoring in coordinated trials.

Table 2.12.1: The list of entries sponsored in Institute Common Trial 2020-21

Species	Entry
G. hirsutum	CNH 57-12, CNH 58-46, CNH 19276, CNDTS 289, CNH 1144, CNH 57-12, CNH 24-51, CNH 451, CNDTS 290, CNDTS 291, CNDTS 292, CNH 19295, CNH 1145
G. arboreum	CNA 2044, CNH 1077, CNH 1078, CNA 19086, CNA19048, CNA1076

Table 2.12.2: The list of entries sponsored for ICAR-AICRP trials 2020-21.

Trial	Entry
IET of *G. hirsutum* Br 02(a)	CSH 89, CSH 90
IET of *G. hirsutum* Br 02(b)	CNH 18298 , CNDTS 287, CNH 18173, CNH 1137, CNH 2131, CNH 119
IET of *G. hirsutum* Colour cotton trial Br 02 (a/b) CC	CNH 19325, CNH 19480
IET of compact *G. hirsutum* Br 06 (a)	CSH 49, CSH 50, CNH 20-31
IET of compact *G. hirsutum* Br 06 (b)	CNH 1139, CNH 1140, CNDTS 5114, CNDTS 5170, CNH 120, CNH 121, CNH 20-31, CNH 20-32, CNH 20-33
Br 13(a) IET	CCB-6, CCB-15
IET of *G. arboreum* Br 22 (a/b)	CNA 2034, CNA 1071, CNA 1072, CNA 18408, CNA18392, CISA 6-3, CISA 33.5
IET of *G. arboreum*, Long linted Br 22 (a/b) LL	CNA1074, CNA1075
IET of *G. arboreum* Colour cotton Br 22 (a/b) CC	CNA 1092, CNA 19975
Br 25 (a) PHT *G. arboreum*	CISAA 19-3, CISAA 19-4

Table 2.12.3: Entries promoted and retained in ICAR-AICRP on Cotton during 2020-21

Trial code	Entries promoted	Entries retained
Central zone		
Br.03(a) PVT irrigated	CCH 19-2	CNH 17395
Br.03(a) Coloured Cotton	CNH 18528, CNH 18529, CCHC 19-1, CCHC 19-2	
Br.06 (a)	CCH 19-2, CCH 19-4	
Br.13 (a) PVT *G. barbadense*	CCB-141	CCB-64
	CCB 64-B	
Br 13(a) IET	CCB-6, CCB-15	
Br.14(a) CVT *G.*	CCB 51-2, CCB 143-B	

barbadense		
Br.03(b) PVT Rainfed	CNH 1134	
Br.06 (b) CVT compact culture rainfed	CNH09-77, CNH 19-4	
Br.24(b) CVT- *G. arboreum*	CNA2035, CNA2036	
Br.24(b) CVT-Long linted *G. arboreum*	CNA 1069	CNA1065
Br.24(b) CVT- Coloured Cotton trial of *G. arboreum*	CNA 18562, CNA 18563	CNA17522, CNA1091
South zone		
Br.03(a) PVT irrigated	CCH 19-2	
Br.03 a/b (CC) Colour Cotton irrigated	CNH 18529, CNH 18528, CCHC 19-2, CCHC 19-1	CNH 17395
Br.06 (a) CVT Compact culture irrigated	CCH 19-2, CCH 19-4	
Br. 13 (a) PVT *G. barbadense*	CCB 141, CCB 142, CCB 64-B	CCB 51, CCB 29, CCB 64, CCB 26
Br. 14 (a) CVT *G. barbadense*		CCB 51-2, CCB 129
Br.03 (b)	CNH 1134, CNH 09-119	
Br.06(b)	CNH 2046, CCH 19-4, CNH09-77	CNH 11-28
Br. 24 (b) CVT *G. arboreum*	CNA2035	CNA1031,CNA1054
Br. 24 (b) CVT long linted *G. arboreum*	CINA 1069, CINA 1068, CINA 1067	CINA 1065
Br. 24 a/b- CVT *G. arboretum* CC- Rainfed	CNA18562, CNA18563	CNA1091, CNA17522
North zone		
Br 06 (a)	CSH 100	

Table 2.12.4: Bt. entries sponsored for ICAR-AICRP trials 2020-21

Name of the trial	Name of the entry- Sponsored
NORTH ZONE	
IET of Bt cotton varieties	CICR 20 Bt , CICR 44 Bt
CENTRAL ZONE	
Irrigated	
IET of *G. hirsutum* variety	CICR Bt 20-31, CICR 18 Bt, CICR 20 Bt
AET Advanced evaluation trial of *hirsutum* variety	CICR Bt19, CICR Bt 21, CICR Bt 22
Rainfed	
IET of intra-*hirsutum* hybrid	CICRHH 11
IET of *G. hirsutum* varieties	CICR 18 Bt, CICR 19 Bt, CICR Bt 20-31, CICR Bt 1141, CICR Bt 1142

AET Advanced evaluation trial of *hirsutum* variety-I	CICR 24 Bt, CICR Bt 19-32, CICR Bt 19-32, Bt 183059-4
AET Advanced evaluation trial of *hirsutum* variety-II	CICR 20 Bt, CICR 21 Bt, CICR 22 Bt
SOUTH ZONE	
Irrigated	
IET of *G. hirsutum* variety	CICR 20 Bt, CICR 61 Bt, CICR 1002 Bt, CICR Bt 20-31
AET Advanced evaluation trial of hirsutum variety	CICR 25 Bt, CICR 26 Bt
Rainfed	
IET of *hirsutum* variety	CICR Bt 1141, CICR Bt 1142, CICR 20 Bt, CICR Bt 20-31, CICR 61- Bt, CICR 1002 Bt
AET Advanced evaluation trial of *hirsutum* variety	CICR Bt 19-31, Bt 183059-2

Table 2.12.5: Entries developed by ICAR-CICR proposed for Agronomy trial 2020-21

Zone	Species	Variety / Hybrid	Irrigated / Rainfed	Name(s) of the entries
Central Zone	*G. hirsutum*	Variety	Rainfed	CNH 11-11
	G. arboreum	Variety	Rainfed	CNA1054, CNA1031
South Zone	*G. hirsutum*	Variety (Coloured Cotton)	Rainfed	16301 DB
		Compact Variety	Rainfed	CNH 1128
	G. arboreum	Variety (Coloured Cotton)	Rainfed	CNA405
	G. barbadense	Variety	Irrigated	CCB 143B