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Short Communication

Evaluation of breeding potential of introgression lines developed from inter-specific crossing between upland cotton (*Gossypium hirsutum*) and *Gossypium barbadense*

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Abstract

Interspecific crosses were attempted between Suraj (*G. Hirsutum*) and Suvin (*G. Barbadense*) in order to introgress fibre quality genes in elite genotypes of upland cotton. The results of 201 BC_1F_4 individual single plant selections of 19 progenies indicated that the average values of introgression lines for all the yield components except boll number had higher values than the parental gentotypes. The ginning percentage (40.9-47.2%), boll weight (2.5-8.4g) and fibre strength (21.6-31.2 g/tex) indicated genetic improvement of the traits. BC_1F_4 progenies SPS 32-94, SPS 33-94, SPS 39-94, SPS 45-31, SPS 46-31, SPS 48-31, SPS 49-31 and SPS 50-31 were found to be promising for use in cotton breeding programme.

Key words: Backcross, cotton, correlation, fibre quality traits, *G. barbadense*, introgression progenies, yield components

Cotton (*Gossypium* spp.) is one of the most important natural fibre and oilseed crop. *Gossypium* comprises approximately 50 species, of which four species, *viz*., two diploids (*G. arboreum* L. and *G. herbaceum* L.) and two tetraploids (*G. hirsutum* L., *G. barbadense* L.) are cultivated in India.

G. hirustum and *G. barbadense* are easily crossable, however, gene transfer between these species are marked with several obstacles (Reinisch et al. 1994). In advanced generations, linkage drag and a high level of epistasis among fibre quality quantitative trait loci (QTLs) was reported by Jiang et al. (2000). World-wide cotton improvement attempts through conventional breeding, cytological applications and molecular approaches to incorporate genes form *G. barbadense* into upland cotton has resulted into valuable genetic resources.

In the present investigation, efforts were made to introgress fibre quality specific alleles from *G. barbadense* to *G. hirsutum*. The crosses were made between Suraj (*G. hirsutum*) as female parent and Suvin (*G. barbadense*) as the male parent during 2013-14 at ICAR-Central Institute for Cotton Research, Nagpur. The F_1 (Suraj × Suvin) was then backcrossed to Suraj to produce BC_1F_1 population during 2014. In 2015, BC_1F_1 population was grown and extensively self-pollinated. In subsequent generations upto BC_1F_4, continued self-pollination of selected single plant progenies was done. In 2018 crop season, 201 plants from 19 BC_1F_4 families were field tested under irrigated condition and data was collected on yield components and fibre properties upper half mean length (UHML), uniformity ratio (UR), micronaire (M), fibre strength (FS) and elongation percentage (E %). The length of the each plot was 4.5 m with two rows spaced 0.6m apart. The lint of individual single plants was tested for fibre quality traits using High volume instrument (HVI) at ICAR-Central Institute for Research on Cotton Technology, Mumbai.

The ranges of trait values for all the traits were wide. The variation in plant height (88.0cm-160.0cm), boll number (8.0-32.0), ginning percentage (29.0%-

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Table 1. Descriptive statistical analysis of fibre properties of introgreessed progenies and check varieties

SPS	Parameters	UHML (mm)	Maturity (%)	Micronaire (μg/inch)	Strength (g/tex)	Elongation (%)
32-94	Mean± SD	28.75±0.47	84.78±1.30	4.09±0.36	27.00±0.57	5.96±0.19
	Min. – Max.	28.1-29.6	83.0-87.0	3.6-4.7	26.2-27.9	5.6-6.2
33-94	Mean± SD	27.97±0.98	83.82±0.75	3.84±0.28	26.83±1.18	6.37±0.29
	Min. – Max.	26.5-29.6	83.0-85.0	3.5-4.3	24.8-28.3	5.8-6.7
34-94	Mean± SD	28.23±1.07	83.8±1.03	3.84±0.32	27.52±1.27	5.95±0.23
	Min. – Max.	26.4-30.2	82.0-85.0	3.3-4.3	25.9-29.8	5.4-6.3
35-94	Mean± SD	28.6±0.83	84.2±1.24	3.9±0.57	26.9±1.14	5.9±0.31
	Min. – Max.	27.3-29.9	82.0-87.0	2.7-4.8	24.929.5	5.3-6.5
36-94	Mean± SD	28.1±1.00	84.5±1.29	3.9±0.51	27.7±1.56	6.3±0.25
	Min. – Max.	27.1-29.4	83.0-86.0	3.2-4.4	25.6-28.9	6.0-6.6
37-94	Mean± SD	28.3±0.86	83.7±0.71	4.2±0.33	27.6±1.33	6.0±0.33
	Min. – Max.	27.1-29.5	83.0-85.0	3.8-4.7	25.4-29.1	5.5-6.5
38-94	Mean± SD	27.7±0.57	83.5±1.43	4.2±0.41	28.3±0.87	5.47±0.30
	Min. – Max.	27.1-28.8	81.0-86.0	3.5-4.6	27.1-29.6	5.1-5.9
39-94	Mean± SD	28.59±1.00	84.8±1.19	4.18±0.34	26.13±1.73	5.82±0.28
	Min. – Max.	26.9-30.1	83.0-87.0	3.4-4.7	23.5-29.1	5.3-6.2
40-94	Mean± SD	28.34±0.44	84.00±0.95	4.08±0.40	25.90±0.74	5.76±0.32
	Min. – Max.	27.5-28.9	83.9-86.0	3.0-4.5	24.8-27.1	5.1-6.2
41-94	Mean± SD	28.8±0.79	84.3±1.07	4.0±0.53	27.1±1.50	5.7±0.28
	Min. – Max.	27.5-30.4	83.0-86.0	3.2-4.6	23.7-29.4	5.3-6.2
42-94	Mean± SD	28.31±0.71	83.88±0.83	3.95±0.36	27.34±1.42	5.74±0.28
	Min. – Max.	27.329.7	83.0-85.0	3.5-4.6	25.2-29.1	5.5-6.3
43-94	Mean± SD	28.09±0.51	83.54±1.20	4.08±0.45	26.32±1.99	5.77±0.30
	Min. – Max.	27.4-28.8	81.0-85.0	3.4-4.8	21.6-28.7	5.3-6.3
44-31	Mean± SD	27.34±0.79	82.6±0.84	4.21±0.39	27.36±1.15	5.43±0.34
	Min. – Max.	26.4-28.9	81.0-84.0	3.7-4.7	25.1-29.2	4.8-6.1
45-31	Mean± SD	29.3±0.53	84.5±0.90	3.8±0.38	27.0±1.31	6.0±0.19
	Min. – Max.	28.4-29.9	83.0-86.0	3.1-4.3	24.7-29.1	5.7-6.3
46-31	Mean± SD	28.9±0.95	84.5±1.27	3.7±0.33	27.5±1.26	6.3±0.40
	Min. – Max.	27.2-30.5	82.0-86.0	2.7-4.0	24.8-29.3	5.8-7.0
47-31	Mean± SD	28.9±0.72	84.3±1.25	3.8±0.39	27.8±1.22	5.9±0.24
	Min. – Max.	27.6-30.1	81.0-86.0	3.1-4.4	26.1-30.2	5.5-6.3
48-31	Mean± SD	28.02±0.50	84.6±0.89	3.78±0.42	28.84±1.55	5.42±0.51
	Min. – Max.	27.3-28.7	84.0-86.0	3.3-4.4	27.1-31.2	4.7-6.0
49-31	Mean± SD	28.7±0.61	84.4±1.03	4.0±0.35	28.6±0.98	5.8±0.22
	Min. – Max.	28.1-30.0	82.0-86.0	3.3-4.3	27.1-30.1	5.4-6.2
50-31	Mean± SD	28.2±0.76	84.6±1.04	4.2±0.40	28.9±1.14	6.0±0.54
	Min. – Max.	26.7-29.4	82.0-86.0	3.3-4.7	27.5-30.7	5.2-7.2
Suraj	Mean	31.94±0.84	85±1.41	3.66±0.52	29.1±1.66	5.78±0.51
	Min. – Max.	30.9-32.8	84.0-87.0	2.9-4.3	27.1-31.5	5.1-6.4
Suvin	Mean	38.0±2.84	85.29±1.38	2.89±0.21	32.19±2.40	5.41±0.69
	Min. – Max.	35.3-42.6	84.0-87.0	2.7-3.2	29.5-35.7	4.7-6.5
	Mean N 201	28.43±0.86	84.12±1.16	3.98±0.42	27.33±1.49	5.88±0.39
	Range	4.1	6	2.1	9.6	2.5
	Min.–Max.	26.4-30.5	81.0-87.0	2.7-4.8	21.6-31.2	4.7-7.2
	Skewness	-0.06	-0.16	-0.36	-0.32	0.16
	Kurtosis	-0.45	0.15	-0.16	0.63	0.66

UHML = Upper half length (mm); FM = Fiber maturity (%); MV = Micronaire value (μg/inch);
FS = Fiber strength(g/tex); FE = Fiber elongation (%); Min = Minimum; Max = Maximum and SD = Standard deviation

47.2%), boll weight (2.5g-8.4g) and seed index (7.1g-13.9g) was highest among the component traits. Zeng et al. (2007) reported that lint percentage was significantly lower in the species polycross (SP) population than the average of the standards, while seed weight and boll weight were significantly higher

Table 2. Correlations between yield components and fibre traits of introgressed lines

	GP	BW	SI	UHML	FM	MV	FS	FE
GP	1	-0.018	0.142*	0.028	0.049	0.077	-0.023	-0.036
BW		1	0.366*	0.316*	0.232*	0.023	0.166*	-0.014
SI			1	0.346*	0.279*	0.074	0.225*	0.171*
UHML				1	0.540*	-0.229*	0.243*	0.099
FM					1	-0.072	0.365*	0.101
MV						1	-0.049	-0.227*
FS							1	0.050

GP = Ginning percentage; BW = Boll weight (g); SI = Seed index, UHML = Upper Half Length (mm); FM = Fiber maturity (%); MV = Micronaire value (ìg/inch); FS = Fiber strength (g/tex); FE = Fiber elongation (%)

* Sinificant at the 0.05 probability level

than the commercial cotton cultivars. Shi et al. (2020) also reported abundant genetic variation in the introgression lines of *Gossypium hirsutum* × *G. barbadense* produced by advanced backcrossing and continuous self-crossing. The average values of BC_1F_4 progenies ranged from 29.0 (SPS32-94) to 47.2 per cent (SPS40-94) (Table 1). Recipient and donor parents had mean values of 35.6% and 31.6%, respectively. Thus, majority of BC_1F_4 families had positive transgression. Boll weight ranged from 2.5g to 8.4g. SPS32-94 had minimum boll weight of 4.0g and maximum of 8.4g. Thus, positive transgression in majority of BC_1F_4 families suggested that several new adaptive gene combinations might have formed by interspecific hybridization. Lacape et al. (2013) observed transgression for reproductive and quality traits among recombinant inbred line (RIL) population derived from an interspecific cross between *G. hirsutum* and *G. barbadense*.

The mean values of fibre quality traits of parents and BC_1F_4 families are presented in Table 1. Fibre elongation displayed a wide range of variation (4.7 to 7.2%). BC_1F_4 progenies had higher average values of elongation percentage compared to the recipient *G. hirsutum* parent Suraj and donor parent Suvin. These results indicated positive transgression for elongation percentage in BC_1F_4 progenies. Chee et al. (2005) reported that the BC_3F_2 individuals showed a difference of 1.3%. A chromosome-specific recombinant inbred line (CS-B05shRIL) released on the basis of their improved elongation ranged from 7.37% to 7.84 %. (Saha et al. 2017).

The variation among the quality traits was highest for fibre length (26.4-30.5mm) and fibre strength (21.6-31.2g/tex). Progeny SPS48-31 had minimum value of 27.1 g/tex and maximum of 31.2g/tex followed by SPS50-31 (27.5-30.7g/tex). Lacape et al. (2010) found that fibre length values in RILs were the most biased towards the *G. hirsutum* parent. Kannan et al. (2011) also obtained high productive interspecific progenies (*Gh* × *Gb*) with high fibre strength that ranged from 30.0 to 35.7g/tex in BC_1F_8 generation.

The absolute skewness and kutrosis of all the traits except ginning percentage was <1, indicating that the yield components had a normal distribution in BC_1F_4 generation. Percy et al. (2006) identified transgressive segregants in recombinant inbred population for both high and low lint percentage. Kumar et al. (2019) observed continuous variation and transgressive segregation in $F_{2:3}$ and $F_{2:4}$ populations derived from crosses between Sealand population and upland cotton cultivars.

The significant positive correlation between ginning percentage and seed index (0.142) indicates that both the traits can be improved simultaneously (Table 2). Seed index had significant positive correlation with fibre length (0.346), maturity (0.279), fibre strength (0.225) and elongation percentage (0.171). Fibre maturity positively correlated with fibre strength (0.365). Micronaire had significant negative correlation with elongation percentage (-0.227). Among quality traits, fibre length significantly correlated with maturity (0.540) and fibre strength (0.243), however it had negative correlation with micronaire. Population developed from multiple crosses between *G. barbadense* and Acala 1517–type cultivars had shown that lint per seed was favourably correlated with lint percentage, elongation, span lengths, and fineness (Zeng et al. 2009). However, Chandnani et al. (2018) found transgressive segregation in BC_4F_1 for all fiber quality traits in both G. *hirsutum* and *G. barbadense* backgrounds.

This study demonstrated that the BC_1F_4 interspecific progenies *viz*., SPS32-94, SPS33-94, SPS39-94, SPS45-31, SPS46-31, SPS48-31, SPS49-31 and SPS50-31 were enriched with large phenotypic variation for yield components and fibre quality traits which could be a valuable resource for further cotton genetics and breeding studies.

Author's contribution

Conceptualization of research (SMP, VNW); Designing of the experiments (SMP, NK); Contribution of the experimental materials (SMP); Execution of field/lab experiments and data collection (SMP, PKM, NK); Analysis of data and interpretation (SMP, PKM, NK); Preparation of manuscript (SMP,VNW, PKM).

Declaration

The authors declare no conflict of interest.

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