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Research Article

Heterosis and combining ability analysis for yield contributing traits and fibre quality traits in interspecific cotton hybrids (*Gossypium hirsutum L. x Gossypium barbadense L.)*

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Abstract

The present study was carried out in inter-specific cotton hybrids of *G. hirsutum* x *G. barbadense* to evaluate the extent of heterosis and combining ability for eight yield and fibre contributing traits. Twenty four interspecific hybrids derived from four different lines of *G. hirsutum* and six testers of *G. barbadense* were assessed for various parameters. Significant heterosis was recorded for the traits under study suggesting that the existence of genetic diversity among parental lines. The hybrid CO16 x RHCB 1014 exhibited significant positive standard heterosis for seed cotton yield per plant followed by CO15 x TCB26 and SVPR6 x DB1602. The hybrid CO15 x CO18 was the best for the number of bolls per plant, plant height and ginning outturn, while, SVPR6 x DB1602 was the best for UHML and bundle strength. Combining ability analysis exhibits the non-additive gene action in all yield contributing and fibre quality traits. The three lines *viz*. CO16, MCU7, SVPR 6 and four testers *viz*.TCB26, DB1602, CCB 143B and CO18 were noted as the best combiners. The hybrids CO16 x CCB 143B, CO16 x DB1601, CO15 x TCB26 and SVPR6 x DB1602 were identified as the best specific combiners and are suggested for advanced breeding programs.

Key words: Cotton, interspecific hybrids, heterosis, combining ability.

INTRODUCTION

Cotton (*Gossypium* spp) is the prominent cash crop and predominant natural fibre crop in India. The attainability to the evolution of genotypes as varieties and amenability for commercial exploitation of heterosis makes cotton a solitary crop. Basically, it is called as “White Gold” due to its inherent properties and has its fame as “King of Fibres”. Enhancement of seed cotton yield and betterment of fibre quality is the current need of farmers and the textile industry. India is the largest producer (371lakh bales, 1bale = 170kg of lint) of cotton reporting about 26 per cent of world production with a productivity of 501 kg/ha and has the largest area (129.57 lakh ha) of about 40 per cent of the world as well as exporters of cotton yarn (COCPC, 2021). In order to increase the genetic diversity among the best germplasm for yield and fibre quality contributing traits *viz*. fibre strength, fineness and length, inter-specific hybrids cross between *Gossypium hirsutum* L. and *Gossypium barbadense* L. is an efficient tool. American cotton (*G. hirsutum* L.) accounts for nearly 90 per cent of global cotton production. *G. barbadense* L. (Egyptian cotton) with extra-long staple and fineness is the second most grown species. Inter-specific tetraploids have the better spinning capacity (70-80 counts) with less inbreeding depression. In India, eight per cent of cotton production is obtained from inter-specific hybrids of *G.hirsutum* L. and *G. barbadense* L. (Singh and Chaudhry, 1997). For assisting in the selection of suitable parents and crosses to breed the high yielding and superior quality cotton hybrids, line x tester analysis is used in the current work (Kempthorne,1957). It was used to estimate general (*gca*), specific combining abilities (*sca)*, heterosis value and gene action for yield and quality characters.

In hybridization programme, heterosis gives an opportunity to select the most appropriate parental lines for improving specific traits (Khan *et al.*, 2010). Heterosis of 50 per cent over the commercial variety and 20 per cent over the commercial hybrid is used for hybrid development in cotton (Singh *et al.*, 2000). The selection and identification of the best F_1 hybrids should be based on their heterotic potential and specific combining ability (Basal *et al.*, 2011). Combining ability analysis is mostly used for choosing suitable parental genotypes and F_1 hybrids as well as to assess the magnitude of gene action involved in the expression of different traits.

MATERIALS AND METHODS

The present research on heterosis studies and combining ability was carried out during Summer, 2020 and 2021 cropping seasons in the experimental field of the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore. During the Summer season of 2020, four *G. hirsutum* genotypes (MCU7, CO15, CO16, SVPR6) were used as lines and six *G. barbadense* genotypes (TCB37, TCB26, CCB143B, DB 1602, DB 1601, RHCB1014) were used as testers. Each of four lines was individually crossed with six testers in the Line x Tester model and hybridization was performed according to Doak's method (Doak,1934). The 24 interspecific hybrids were assessed along with 10 parents and standard check hybrid DCH32 during Summer, 2021. These genotypes were raised in two replications in a Randomized Block Design (RBD). Each hybrid, line and tester were placed in two rows. The spacing adopted was 120 x 60 cm so as to maintain 10 plants in each row. Standard agronomic practices like irrigation, weeding, fertilizer application and plant protection measures were practised to obtain better crop growth. Five plants from each genotype were selected from each replication randomly for examining the biometrical observations *viz*., seed cotton yield (g), plant height (cm), the number of bolls per plant, boll weight (g), ginning outturn (%) and lint index. Samples were ginned and their lint was used for testing fibre quality traits viz., upper half mean length and bundle strength in each replication with minimum of ten grams of lint sample using High Volume Instrument (HVI) 900 classic. The mean data collected from all the parents, F_1's and standard check were statistically analysed using TNAUSTAT software. The total variance was partitioned into replication and treatment for all eight characters. The mean data were tabulated for yield contributing traits and analysis of variance (ANOVA), estimation of standard error and co-efficient of variation was reported in tables for discussion.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) for the Line x Tester mating design was statistically analysed and results are listed in **Table 1**. ANOVA table exhibits significant differences for genotypes, crosses, parents and interactions for all the traits observed. Partition of parents into lines, testers and their interactions showed significant for all the traits. **Table 2** mentioned the *per se* performance of F_1 hybrids for yield and fibre contributing traits. The ranges of seed cotton yield per plant varied between 95.85 and 119.00 g. Cross CO16 x DB1601 recorded the highest seed cotton yield per plant of 119.00 g followed by CO15 x TCB26 (118.88 g). Hybrid SVPR6 x CO18 recorded the least seed cotton yield per plant. MCU7 x DB1602 reported the

Table1. Analysis of variance for yield and fibre quality traits in cotton

Source of variation	df	PH	NBPP	BW	SCYPP	GOT	LI	UHML	BS
Replications	1	2.9403	0.3825	0.0099	2.4815	1.3666	0.0001	0.0147	5.3312
Genotypes	33	756.5420 **	37.4556 **	0.3331 **	219.9750**	12.1035**	0.4702**	12.5134**	12.6890**
Parent	9	140.8667**	35.0412**	0.0176*	27.4688**	6.2701**	0.1894**	5.6524**	18.6710**
Line(c)	3	654.1716**	17.3917**	0.7531**	34.9502**	7.9253**	0.8378**	24.5804**	9.8768**
Test(c)	5	613.5344**	4.3403**	0.0674**	121.2101**	13.7198**	0.5883**	11.3416**	16.1070**
Lines vs Testers	15	364.6153**	9.9167**	0.1865**	141.4370**	10.0072**	0.5213**	9.1227**	2.6966**
Cross	23	456.4960**	9.6794**	0.2345**	123.1510**	10.5427**	0.5772**	11.6213**	6.5485**
Crossvsparents	1	13198.6870**	698.0370**	5.4400**	4179.4790**	100.5020**	0.5359**	94.7818**	100.0975**
Error	33	5.9536	0.6737	0.0071	1.7667	0.9976	0.0059	0.9292	1.9295

** Significant at 1 per cent level, * Significant at 5 per cent level

PH: Plant height, GOT: Ginning outturn, NBPP: Number of bolls per plant, LI: Lint Index, BW: Boll Weight, UHML: Upper Half Mean Length, SCYPP: Seed Cotton yield per plant, BS: Bundle Strength

Table 2. ***Per se*** **performance of 24 hybrids for yield and fibre quality traits in cotton**

Crosses	PH (cm)	NBPP	BW (g)	SCYPP (g)	GOT (%)	LI	UHML (mm)	BS (g/tex)
MCU7 x CO18	116.98	27.10	3.58	105.15	35.60	3.51	32.17	31.82
MCU7 x TCB 26	109.84	25.60	3.78	109.56	34.71	4.02	29.25	28.74
MCU7 x CCB143B	109.00	23.70	3.26	98.57	34.75	4.21	32.17	32.77
MCU7 x DB 1602	146.75	30.90	3.62	116.15	36.04	3.75	29.82	31.81
MCU7 x DB 1601	116.18	25.65	3.38	100.46	39.46	4.38	32.93	31.01
MCU7 x RHCB 1014	119.25	25.05	3.59	113.76	38.65	3.94	29.70	27.92
CO15 x CO18	92.76	32.00	4.00	98.67	39.00	4.21	33.90	33.27
CO15 x TCB 26	86.85	30.10	4.47	118.88	31.33	4.99	31.98	33.30
CO15 x CCB 143B	77.12	26.85	3.70	100.17	32.38	4.26	32.91	31.11
CO15 x DB 1602	126.03	28.70	3.89	108.83	33.51	4.60	28.69	32.71
CO15 x DB 1601	106.99	26.70	4.18	104.73	35.36	4.79	32.11	30.73
CO15 x RHCB 1014	129.10	30.80	3.61	100.58	38.17	4.40	29.10	30.19
CO16 x CO18	115.75	25.80	4.30	103.87	37.38	3.62	33.94	32.12
CO16 x TCB 26	123.65	24.85	3.60	99.20	34.94	3.69	34.61	31.38
CO16 x CCB 143 B	128.89	28.00	4.19	118.03	34.93	3.40	32.63	33.88
CO16 x DB 1602	107.78	25.90	3.79	99.85	36.74	4.09	28.95	32.82
CO16 x DB 1601	114.90	29.95	3.88	119.00	35.55	4.22	31.12	34.02
CO16 x RHCB 1014	105.28	29.95	3.60	110.33	32.82	5.09	33.34	29.07
SVPR6 x CO18	118.01	26.85	3.84	95.85	34.36	3.48	34.33	33.88
SVPR6 x TCB 26	104.85	29.30	4.07	113.85	38.62	4.91	28.96	31.89
SVPR6 x CCB 143B	102.09	27.90	3.89	95.96	34.11	5.10	34.02	34.11
SVPR6 x DB 1602	129.97	29.60	4.60	118.18	35.02	4.29	34.92	34.97
SVPR6 x DB 1601	122.13	28.05	3.98	101.40	39.34	3.38	33.08	31.91
SVPR6 x RHCB 1014	125.26	27.10	4.40	102.99	37.96	4.47	30.96	30.26
Mean	113.98	27.77	3.88	106.42	35.87	4.20	31.90	31.90
SEd	0.99	0.69	0.07	0.89	0.82	0.08	0.77	0.73
CD (0.05)	1.90	1.43	0.15	1.83	1.69	0.16	1.59	1.50
CV %	2.32	3.19	2.27	1.31	2.85	1.85	2.34	4.46

PH: Plant height, GOT: Ginning outturn, NBPP: Number of bolls per plant, LI: Lint Index, BW: Boll Weight, UHML: Upper Half Mean Length, SCYPP: Seed Cotton yield per plant, BS: Bundle Strength

highest value of 146.75 cm for plant height followed by SVPR6 x DB1602 (129.97 cm) and CO15 x CCB143B reported the lowest value (77.12 cm) for plant height. Also, the cross combination CO 15 x CO 18 recorded the maximum number of bolls with 32.00 per plant continued by MCU7 x DB1602 (30.90) and the least number of bolls were observed in MCU7 x CCB143B (23.70). The highest boll weight was recorded in the hybrid SVPR6 x DB1602 (4.60 g) followed by CO15 x TCB26 (4.17 g) and MCU7 x CCB143B cross recorded low boll weight (3.26 g). The highest ginning outturn was observed in the hybrid MCU7 x DB1602 (39.46 %) followed by SVPR6 x DB1601 (39.34 %) and the least was noticed in CO 15 x TCB 26(31.33 %). SVPR6 x CCB143B hybrid showed high lint index (5.10) followed by CO16 x RHCB1014 (5.09) and low lint index was observed in SVPR6 x DB1601 (3.38). The highest value for fibre quality parameter UHML was observed in the cross combination SVPR6 x DB1602 (34.92 mm) continued by CO16 x TCB26 (34.61 mm) and the lowest value was recorded in the cross CO15 x DB1602 (28.69 mm). The hybrid SVPR6 x DB1602 resulted the highest bundle strength value (34.97 g/tex) followed by SVPR6 x CCB143B (34.11 g/tex), and MCU7 x RHCB 1014 (27.92 g/tex) with the lowest value.

The study of data on the performance of hybrids with respect to relative heterosis exposed that twenty four hybrids reveal significant positive relative heterosis, while twenty two hybrids resulted in significantly positive heterobeltiosis for seed cotton yield per plant. The highest significance of mid parent and better parent heterosis for seed cotton yield per plant was expressed by the hybrids CO16 x CCB 143B, CO16 x DB1601, CO15 x TCB26, SVPR6 x DB1602, CO16 x RHCB 1014 and MCU7 x DB1602. Highly positive significant relative heterosis and heterobeltiosis over mid and better parent was recorded in MCU7 x DB 1602 (51.84%) and MCU7 x DB 1602 (31.49%) for number of bolls per plant, SVPR6 x DB 1602 (41.54 %) and (40.03%) for boll weight, SVPR6 x DB1601 (20.04%) and MCU7 x DB1601 (19.21%) for ginning outturn, SVPR6 x CCB 143B (32.64%) and SVPR6 x CCB143B (27.18%) for lint index, and highly negatively significant relative heterosis and heterobeltiosis was observed in CO16 x CCB 143 B (-9.28%) and (-13.84%) for plant height. Among the cotton fibre quality, hybrids SVPR6 x CCB 143B (25.43%) and SVPR6 x CCB 143B (25.33%) for UHML, SVPR6 x DB 1602 (23.11%) and SVPR6 x DB 1602 (11.30%) for bundle strength, were observed, respectively. It was viewed that hybrids showing high relative and better parent heterosis for seed cotton yield per plant also revealed heterotic effects for its contributing traits *viz*. plant height, the number of bolls per plant, boll weight, ginning outturn and lint index as presented in **Table 3**. This study thus justifies the findings of Soomro *et al.* (2006), Patel *et al.* (2012), Isong *et al.* (2019) and Malathi *et al.* (2019).

Out of 24 hybrids, the highest significant standard heterosis was recorded for seed cotton yield per plant in CO 16 x RHCB 1014 (20.03 %), followed by CO15 x TCB26 (19.91 %), SVPR6 x DB1602 (19.21 %), CO16 x CCB 143B (19.06%) and MCU7 x DB1602 (17.15%). Standard heterosis was recorded for the remaining traits *viz*. The number of bolls per plant CO 15 x CO 18 (22.14 %), boll weight SVPR 6 x DB 1602 (20.73 %), ginning outturn MCU 7 x DB 1601(11.72 %) and lint index SVPR 6 x CCB 143B (24.69 %) showed significance. Among all the traits, plant height was observed negatively significant standard heterosis in the cross CO15 x CO18 (-7.18 %). Significant standard heterosis for UHML was observed in the hybrid SVPR6 x DB1602 (20.54 %) and for bundle strength in SVPR6 x DB1602 (13.24 %). The highest expression of heterosis by most of the hybrids for the number of bolls per plant, seed cotton yield per plant and boll weight is in accordance with the results of Soomro *et al.* (2009), Eswari *et al.* (2016), Gohil *et al.* (2017), Naik *et al.* (2020) and Kirthika *et al.* (2020). Based on heterosis breeding and *per se* performance, the best hybrids for commercial exploitations identified were SVPR6 x DB1602,CO 16 x RHCB 1014, CO15 x TCB26, MCU7 x DB1602, MCU7 x DB1601,SVPR6 x CCB 143B andCO16 x DB1601 for future breeding programs. The selected hybrids expressed 50 per cent standard heterosis and heterobeltiosis.

Table 3. Magnitude of relative heterosis, heterobeltiosis and standard heterosis of best interspecific hybrids for various traits (per cent)

Hybrids	PH			NBPP			SCYPP			BW		
	di	dii	dii	di	dii	diii	di	dii	diii	di	dii	diii
MCU7 x CO18	37.63 **	28.55 **	17.05 **	28.44 **	15.32 **	3.44	16.06 **	12.45 **	6.06 **	7.03 **	4.99 *	-6.04 **
MCU7 x TCB 26	51.50 **	39.04 **	9.90 **	25.80 **	8.94 *	-2.29	19.34 **	17.16 **	10.51 **	15.07 **	14.89 **	-0.79
MCU7 x CCB143B	29.37 **	21.78 **	9.05 **	15.47 **	0.85	-9.54 **	10.74 **	5.41 **	-0.57	1.63	-0.46	-14.30 **
MCU7 x DB 1602	74.19 **	63.97 **	46.84 **	51.84 **	31.49 **	17.94 **	27.49 **	24.21 **	17.15 **	10.28 **	10.20 **	-4.99 *
MCU7 x DB 1601	51.37 **	47.06 **	16.24 **	25.12 **	9.15 *	-2.10	11.96 **	7.43 **	1.33	4.31	3.20	-11.15 **
MCU7x RHCB 1014	45.87 **	41.12 **	19.32 **	22.79 **	6.60	-4.39	25.13 **	21.66 **	14.75 **	12.43 **	9.60 **	-5.64 **
CO15 x CO18	8.18 **	1.94	-7.18 **	40.66 **	19.40 **	22.14 **	9.03 **	5.76 **	-0.47	17.67 **	17.16 **	4.86 *
CO15 x TCB 26	18.56 **	7.88 *	-13.11 **	36.82 **	12.31 **	14.89 **	29.64 **	27.41 **	19.91 **	34.03 **	32.25 **	17.32 **
CO15 x CCB 143B	-9.28 **	-13.84**	-22.84 **	21.08 **	0.19	2.48	12.66 **	7.35 **	1.03	13.41 **	9.47 **	-2.89
CO15 x DB 1602	48.26 **	40.81 **	26.09 **	30.45 **	7.09 *	9.54 **	19.60 **	16.64 **	9.78 **	16.88 **	15.24 **	2.23
CO15 x DB 1601	38.06 **	32.91 **	7.05 **	20.54 **	-0.37	1.91	16.85 **	12.24 **	5.64 **	27.01 **	23.82 **	9.84 **
CO15 x RHCB 1014	56.48 **	52.78 **	29.17 **	39.68 **	14.93 **	17.56 **	10.77 **	7.80 **	1.46	11.16 **	6.80 **	-5.25 **
CO16 x CO18	26.50 **	25.82 **	15.81 **	17.14 **	1.78	-1.53	20.28 **	18.44 **	4.77 **	28.02 **	25.95 **	12.73 **
CO16 x TCB 26	56.51 **	34.40 **	23.71 **	16.80 **	-1.97	-5.15	13.30 **	10.10 **	0.06	9.41 **	9.24 **	-5.38 **
CO16 x CCB 143 B	42.02 **	40.09 **	28.96 **	30.54 **	10.45 **	6.87 *	39.25 **	38.85 **	19.06 **	30.02 **	26.97 **	9.97 **
CO16 x DB 1602	18.77 **	17.15 **	7.84 **	21.74 **	2.17	-1.15	14.96 **	12.58 **	0.71	15.11 **	14.85 **	-0.52
CO16 x DB 1601	38.02 **	24.89 **	14.96 **	39.79 **	18.15 **	14.31 **	39.21 **	38.45 **	20.03 **	19.20 **	17.58 **	1.84
CO16 x RHCB 1014	19.30 **	14.44 **	5.34 **	40.45 **	18.15 **	14.31 **	27.31 **	24.93 **	11.29 **	12.24 **	9.09 **	-5.51 **
SVPR6 x CO18	32.23 **	29.69 **	18.08 **	19.47 **	2.29	2.48	4.91 **	0.86	-3.32 **	15.77 **	12.46 **	0.66
SVPR6 x TCB 26	36.62 **	19.83 **	4.91 **	34.87 **	11.62 **	11.83 **	23.00 **	19.81 **	14.84 **	24.98 **	23.56 **	6.69 **
SVPR6 x CCB 143B	15.36 **	14.07 **	2.15 *	27.40 **	6.29 *	6.49 *	6.89 **	0.98	-3.21 **	22.33 **	21.00 **	2.10
SVPR6 x DB 1602	46.86 **	45.22 **	30.05 **	36.25 **	12.76 **	12.98 **	28.65 **	24.36 **	19.21 **	41.54 **	40.03 **	20.73 **
SVPR6 x DB 1601	50.78 **	39.58 **	22.20 **	28.23 **	6.86 *	7.06 *	12.05 **	6.70 **	2.27 *	23.89 **	23.79 **	4.46 *
SVPR6x RHCB 1014	45.65 **	43.15 **	25.33 **	24.45 **	3.24	3.44	12.35 **	8.38 **	3.88 **	39.02 **	36.86 **	15.49 **

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Table 3.Contd.

Hybrids	GOT			LI			UHML			BS		
	di	dii	diii	di	Dii	diii	di	dii	diii	di	dii	diii
MCU7 x CO18	12.90 **	7.65 *	0.79	-8.53 **	-9.77 **	-14.18 **	7.50 **	1.20	11.05 **	16.34 **	3.41	3.04
MCU7 x TCB 26	1.39	-1.94	-1.73	1.71	0.12	-1.71	0.46	-3.05	0.97	4.49	-7.53	-6.93 **
MCU7 x CCB143B	5.12	5.08	-1.61	11.36 **	8.35 **	3.06	16.55 **	14.65 **	11.05 **	15.08 **	-0.76	6.12 *
MCU7 x DB 1602	10.42 **	8.98 **	2.04	-0.13	-3.60	-8.31 **	4.27	2.33	2.93	14.94 **	1.24	3.01
MCU7 x DB 1601	19.27 **	19.21 **	11.72 **	5.54 **	-0.68	7.09 **	15.67 **	14.02 **	13.67 **	11.27 *	-2.51	0.42
MCU7xRHCB 1014	18.77 **	16.87 **	9.43 **	-6.86 **	-13.79 **	-3.67	7.82 **	5.84 *	2.52	3.10	-7.64	-9.59 **
CO 15 x CO18	18.68 **	9.15 **	10.43 **	9.98 **	8.63 **	3.06	11.73 **	6.64 **	17.02 **	12.63 **	8.12	7.74 **
CO15 x TCB 26	-11.89 **	-12.31 **	-11.28 **	26.54 **	24.41 **	22.13 **	8.30 **	6.00 *	10.39 **	12.14 **	7.14	7.84 **
CO15 x CCB 143B	-5.84 *	-9.39 **	-8.32 **	12.83 **	9.92 **	4.28 *	17.46 **	13.91 **	13.60 **	1.45	-5.78	0.74
CO15 x DB 1602	-1.35	-6.21 *	-5.11 *	22.53 **	18.43 **	12.35 **	-1.12	-1.54	-0.97	9.53 *	4.11	5.93 *
CO15 x DB 1601	2.75	-1.04	0.13	15.56 **	8.62 **	17.11 **	11.16 **	11.15 **	10.84 **	2.23	-3.40	-0.49
CO15 x RHCB 1014	12.69 **	6.83 *	8.08 **	4.26 **	-3.61 *	7.70 **	4.08	0.73	0.45	3.14	-0.13	-2.23
CO16 x CO18	14.89 **	6.57 *	5.83 *	-9.46 **	-13.93 **	-11.61 **	10.14 **	6.76 **	17.16 **	12.27 **	4.39	4.02
CO16 x TCB 26	-0.85	-1.30	-1.09	-10.04 **	-12.02 **	-9.66 **	15.35 **	14.72 **	19.47 **	9.09 *	0.97	1.62
CO16 x CCB 143 B	2.57	-0.40	-1.09	-13.58 **	-18.93 **	-16.75 **	14.52 **	9.35 **	12.63 **	13.94 **	2.60	9.72 **
CO16 x DB 1602	9.22 **	4.76	4.03	4.48 *	-2.74	-0.12	-1.83	-2.98	-0.07	13.43 **	4.46	6.28 *
CO16 x DB 1601	4.31	1.37	0.67	-1.86	-4.20 *	3.30	5.99 **	4.29	7.42 **	16.79 **	6.95	10.17 **
CO16 x RHCB 1014	-2.16	-6.43 *	-7.08 **	16.08 **	11.38 **	24.45 **	17.25 **	11.73 **	15.08 **	2.58	-3.84	-5.86 *
SVPR6 x CO18	10.27 **	6.28 *	-2.70	-10.84 **	-13.34 **	-15.04 **	16.59 **	7.99 **	18.50 **	20.66 **	10.11 *	9.72 **
SVPR6 x TCB 26	14.04 **	9.11 **	9.34 **	22.49 **	22.42 **	20.17 **	1.13	-4.01	-0.03	12.94 **	2.61	3.27
SVPR6x CCB 143B	4.36	3.24	-3.41	32.64 **	27.18 **	24.69 **	25.43 **	25.33 **	17.43 **	16.80 **	3.30	10.46 **
SVPR6 x DB 1602	8.51 **	8.30 **	-0.85	12.45 **	6.98 **	4.89 *	24.18 **	19.84 **	20.54 **	23.11 **	11.30 *	13.24 **
SVPR6 x DB 1601	20.24 **	18.85 **	11.38 **	-19.83 **	-23.47 **	-17.48 **	18.19 **	14.54 **	14.19 **	11.57 **	0.31	3.34
SVPR6 xRHCB 1014	17.98 **	17.40 **	7.47 **	4.20 **	-2.19	9.29 **	14.39 **	14.24 **	6.87 *	8.81 *	0.10	-2.01

** Significant at 1 per cent level, * Significant at 5 per cent level

PH: Plant height, GOT: Ginning outturn, NBPP: Number of bolls per plant, LI: Lint Index, BW: Boll Weight, UHML: Upper Half Mean Length, SCYPP: Seed Cotton yield per plant, BS: Bundle Strength

The estimates of *gca* effects of parents for yield and fibre quality traits were listed in **Table 4**. An overall assessment of general combining ability effects manifested that CO16 and MCU7 among the lines were good and uniform general combiners for seed cotton yield and its contributing traits and for fibre quality the best combiner was SVPR 6. Consistent and good general combining ability effects among testers were noted in TCB26 and DB1602 for seed cotton yield per plant and its contributing traits. To improve the fibre quality, CCB 143B and CO18 were the best combiners. In general, the parents which are good and consistent combiners for seed cotton yield per plant were also found to be good combiners for most of its yield contributing traits (**Table 4**). The above mentioned parents are very much effective for improving the yield of cotton. This study thus justifies the findings of earlier workers *viz.* Preetha and Raveendran (2008), Patel *et al*. (2012) and Patil (2018).

The performance of hybrids with respect to *sca* effects are mentioned in **Table 5**. Out of 24 F_1 hybrids, the best five specific combiners for seed cotton yield were CO16 x CCB143B, CO16 x DB1601, CO15 x TCB26, SVPR6 x DB1602 and MCU 7 x RHCB 1014 match with the values of previous workers like Manonmani *et al.* (2020), Monicashree *et al*. (2017). The superior specific combiners for yield contributing traits are MCU7 x DB1602 for the number of bolls per plant, CO16 x CCB143B for plant height, CO16 x CCB143B for boll weight, CO15 x CO18 for ginning outturn, CO16 x RHCB 1014 for lint index, respectively. For fibre quality traits, the top specific combiner is SVPR6 x DB1602 for UHML and CO15 x TCB26 for bundle strength. The promising hybrids CO16 x CCB143B, SVPR6 x DB1602, MCU 7 x RHCB 1014, CO16 x DB1601 andCO15 x TCB26 can be selected for further recombination breeding in the light of their *per se* performance and significant specific combining ability.

Table 4. Estimation of general combining ability for yield and fibre quality traits

LINES	PH	NBPP	BW	SCYPP	GOT	LI	UHML	BS
MCU 7	5.69 **	-1.43 **	-0.35 **	0.86 **	0.67 **	-0.23 **	-0.89 **	-1.23 **
CO 15	-10.84 **	1.43 **	0.09 **	-1.11 **	-0.90 **	0.34 **	-0.45	-0.02
CO 16	2.06 **	-0.36	0.01	1.96 **	-0.47	-0.18 **	0.53 *	0.31
SVPR6	3.08 **	0.37	0.24 **	-1.71 **	0.70 **	0.07 **	0.81 **	0.93 **
SE	0.37	0.28	0.03	0.36	0.33	0.03	0.31	0.29
TESTERS								
CO18	-3.10 **	0.17	0.04	-5.53 **	0.72 *	-0.50 **	1.69 **	0.87 **
TCB 26	-7.68 **	-0.30	0.10 **	3.96 **	-0.97 **	0.21 **	-0.70 *	-0.58 *
CCB 143B	-9.70 **	-1.15 **	-0.12 **	-3.23 **	-1.82 **	0.05	1.03 **	1.06 **
DB 1602	13.66 **	1.01 **	0.09 **	4.33 **	-0.54	-0.02	-1.30 **	1.17 **
DB 1601	1.08 **	-0.18	-0.03	-0.02	1.56 **	-0.01	0.41	0.01
RHCB 1014	5.75 **	0.46	-0.08 **	0.50	1.04 **	0.28 **	-1.12 **	-2.54 **
SE	0.46	0.35	0.04	0.44	0.40	0.04	0.38	0.36

** Significant at 1 per cent level, * Significant at 5 per cent level

PH: Plant height, GOT: Ginning outturn, NBPP: Number of bolls per plant, LI: Lint Index, BW: Boll Weight, UHML: Upper Half Mean Length, SCYPP: Seed Cotton yield per plant, BS: Bundle Strength

Table 5. Estimation of specific combining ability of hybrids for yield and quality parameters in cotton

Hybrids	PH	NBPP	BW	SCYPP	GOT	LI	UHML	BS
MCU7 x CO18	0.41	0.60	0.00	3.41 **	-1.66 **	0.04	-0.52	0.27
MCU7 x TCB 26	-2.15 **	-0.43	0.15 **	-1.67 *	-0.86	-0.15 **	-1.06	-1.36 *
MCU7 x CCB143B	-0.97	-1.48 **	-0.15 **	-5.47 **	0.04	0.20 **	0.13	1.03
MCU7 x DB 1602	13.43 **	3.56 **	-0.01	4.54 **	0.04	-0.20 **	0.12	-0.04
MCU7 x DB 1601	-4.56 **	-0.50	-0.13 *	-6.79 **	1.36 *	0.42 **	1.51 *	0.32
MCU7 x RHCB 1014	-6.16 **	-1.74 **	0.14 *	5.99 **	1.08	-0.30 **	-0.18	-0.21
CO15 x CO18	-7.28 **	2.64 **	-0.02	-1.10	3.32 **	0.17 **	0.77	0.52
CO15 x TCB 26	-8.62 **	1.21 *	0.40 **	9.61 **	-2.66 **	0.25 **	1.23 *	1.99 **
CO15 x CCB 143B	-16.32 **	-1.19 *	-0.15 **	-1.91 **	-0.76	-0.32 **	0.43	-1.84 **
CO15 x DB 1602	9.23 **	-1.50 **	-0.17 **	-0.81	-0.91	0.07	-1.45 *	-0.35
CO15 x DB 1601	2.78 **	-2.31 **	0.24 **	-0.56	-1.16	0.25 **	0.25	-1.17 *
CO15 x RHCB 1014	20.21 **	1.15 *	-0.28 **	-5.23 **	2.18 **	-0.41 **	-1.22 *	0.85
CO16 x CO18	2.81 **	-1.78 **	0.36 **	1.02	1.26 *	0.09	-0.18	-0.96
CO16 x TCB 26	15.28 **	-2.25 **	-0.38 **	-13.14 **	0.51	-0.53 **	2.88 **	-0.26
CO16 x CCB 143 B	22.55 **	1.75 **	0.42 **	12.89 **	1.36 *	-0.66 **	-0.83	0.60
CO16 x DB 1602	-21.92 **	-2.52 **	-0.20 **	-12.87 **	1.89 **	0.09	-2.18 **	-0.57
CO16 x DB 1601	-2.22 **	2.72 **	0.01	10.64 **	-1.40 *	0.21 **	-1.72 **	1.79 **
CO16 x RHCB 1014	-16.50 **	2.08 **	-0.21 **	1.45 *	-3.61 **	0.80 **	2.03 **	-0.60
SVPR6 x CO18	4.06 **	-1.45 **	-0.34 **	-3.32 **	-2.93 **	-0.30 **	-0.07	0.17
SVPR6 x TCB 26	-4.52 **	1.47 **	-0.16 **	5.19 **	3.02 **	0.44 **	-3.05 **	-0.37
SVPR6 x CCB 143B	-5.26 **	0.92	-0.12 *	-5.51 **	-0.63	0.78 **	0.28	0.21
SVPR6 x DB 1602	-0.74	0.46	0.38 **	9.14 **	-1.01	0.04	3.51 **	0.96
SVPR6 x DB 1601	4.00 **	0.10	-0.12 *	-3.29 **	1.21 *	-0.89 **	-0.04	-0.94
SVPR6 x RHCB 1014	2.46 **	-1.49 **	0.35 **	-2.21 **	0.35	-0.08	-0.63	-0.03
SE	0.92	0.69	0.07	0.88	0.82	0.08	0.77	0.72

** Significant at 1per cent level, * Significant at 5 per cent level

PH: Plant height, GOT: Ginning outturn, NBPP: Number of bolls per plant, LI: Lint Index, BW: Boll Weight, UHML: Upper Half Mean Length, SCYPP: Seed Cotton yield per plant, BS: Bundle Strength

The outcome showed that the majority of cross combinations exceeded the standard commercial check for yield and fibre quality traits. In future, most of the cross combinations could be used frequently for attaining high yield performance in cotton.

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