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RESEARCH PAPER

Detection of high heterotic crosses for seed cotten yield and fibre quality traits in cotton (*Gossypium hirsutum* L.)

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Abstract: The present investigation was carried out with a vision to study the *per se* performance and heterosis for productivity and fibre quality traits. Fifty five hybrids generated through griffing's half diallel method were evaluated along with eleven parents and two checks RAHH 455 and SHH 818 in 2017-18 at the Main Agricultural Research Station, Raichur. The hybrids SCS-PL-01 × SCS-PL-04, SCS-PL-12 × SCS-PL-51 and SCS-PL-01 × SCS-PL-18 recorded highest yield, UHML and fibre strength among all the fifty five hybrids. Hybrid SCS-PL-01 x SCS-PL-60 expressed highest heterosis over the commercial check. Highest standard heterosis with respect to fibre quality traits was recorded for hybrids SCS-PL-12 × SCS-PL-51, SCS-PL-01 × SCS-PL-18 and SCS-PL-18 × SCS-PL-61.

Key words: Cotton, Fiber quality, Heterosis, Yield

Introduction

Cotton (*Gossypium hirsutum* L.) is the world's leading fiber crop, grown or processed in many countries, providing major contribution to the countries economics. Yield is economically most important to a producer which drives cultivar development and adoption; however fiber quality is the primary focus for spinning mills. The most significant challenge for cotton breeders has been to combine high yield with improved fiber quality, due to negative associations between yield and quality attributes in *G. hirsutum.*

Heterosis has been observed and, in some cases, harnessed in many diverse systems. Heterosis in crop species can be visualized in terms of increases in growth rate, total biomass, stress resistance, seed yield and population fitness (Kalloo *et al.,* 2006). The impressive phenotypic manifestations of heterotic hybrids coupled with the economic importance of hybrid strains have led to extensive research to understand its basis. The fundamental concept of heterosis, as envisioned by Shull, is that deleterious alleles persist in large random-mating populations. Inbreeding due to drift, population isolation, or consanguineous mating by plan or by chance reduces vigour of individuals or populations due to increasing homozygosity of deleterious alleles. Vigour is restored by crossing among divergent types as recessive deleterious alleles are complemented in the hybrid state. This fundamental idea is consistent with many examples of heterosis across species. Heterosis is quantified on an individual or population basis as the difference in the performance of the hybrid relative to the average of the inbred parents (termed the midparent value). For quantitative genetic analysis, the deviation of the hybrid relative to the mid-parent is the relevant value. In a practical context, high-parent heterosis, which measures the superiority of the hybrid relative to the best parent, is the important metric.

The concept of modern cotton breeding is to exploit the global gene pool, create novel variation through hybridization. The present study has been focussed to simultaneously improve the yield and fiber quality traits in the hybrids through careful evaluation and selection.

Material and methods

Varietal genotypes with verified productivity and quality features were selected as parents to establish an 11 × 11 half diallel in the study (Table 1). The half diallel generated fifty five credible hybrids that were evaluated in *kharif* 2018 along with the parental genotypes and checks RAHH 455 and SHH 818 at Main Agriculture Research Station, Raichur. The same were planted in a randomised complete block design with four rows of six meters each in two replications. Spacing of 90cm between rows and 60cm between plants was maintained.

For each genotype and its cross combinations, data were recorded on five randomly selected plants per replication for eight important traits *viz.,*seed cotton yield (kg/ha), lint yield (kg/ha), ginning outturn (%), boll weight (g), bolls per plant, UHML (mm), fibre strength (g/tex) and micronaire (μ/inch). Quality parameters were analyzed by High Volume Instrument (HVI). The expression of heterosis was worked out for all the characters over mid parent, and better parent was estimated in the entire cross combinations under this study. Statistical analysis was carried out by using the mean values over five sample plants (Indostat Statistical Software Package; Indostat Pvt. Ltd., Hyderabad, India).

Results and discussion

Analysis of variance showed significant differences among genotypes for the traits under study, signifying the presence of adequate variability among the genotypes evaluated (Table 2). Significant differences in parents versus hybrids interaction provided adequacy for comparing the heterotic expression for all the characters except ginning outturn. Parents showed significant differences for seed cotton yield, lint yield, ginning outturn and UHML whereas, hybrids showed significant

Table.1 Parental genotypes used in 11×11 half diallel set of crosses

Sl. No.	Parent	Features
1	SCS-PL-01	A tall and robust genotype with high productivity features and having moderate fibre quality parameters derived from intra-hirsutum cross GSHV-99/307 × PUSA 9127.
2	SCS-PL-02	Medium robust hirsutum genotype derived from an intra-hirsutum cross involving GSH99/303 x CCH 510 known to exhibit high fibre strength and fibre length.
3	SCS-PL-18	A stabilized line derived from a cross involving parents PUSA 9127 × NDLH 761 exhibiting open plant type and possessing an ability to yield consistently desirable fibre quality features.
4	SCS-PL-3	A hirsutum line derived from a cross involving two parents ARB 904 × CSH 2572 coming from North zone and south zone respectively exhibiting wide adaptability and high yield.
5	SCS-PL-04	An intra hirsutum derivative involving parents HAG 1055 (high productivity and high fibre strength) and CPD 803 (genotype with high productivity and quality features).
6	SCS-PL-10	An intra hirsutum cross derivative involving the parental lines CCH 510 from Coimbatore (high productivity with consistent fibre strength) and GMR5 from the south zone (high productivity and high strength from the central zone)
7	SCS-PL-12	A high productivity parental line derived from the hirsutum parents namely GSHV99/307 and NDLH761 known to possess robust plant type and bigger boll size.
8	SCS-PL-51	A hirsutum genotype contributed by CICR Coimbatore in AICRP trials exhibiting high fibre strength
9	SCS-PL-59	A *Gossypium hirsutum*line selection from a variable population of BS-59 contributed by Bhavanipatna research station, Orissa known to exhibit high productivity features.
10	SCS-PL-60	A *Gossypium hirsutum* line developed from a intra-hirsutum cross involving NDLH 761 and CCH 510 known to exhibit high productivity features
11	SCS-PL-61	An intra hirsutum cross derivative involving wide adaptability genotype MCU5VT and CCH 510 known to possess desirable quality features

Table 2. Analysis of variance for different quantitative traits.

Source of variation	DF	Bolls/ plant	Boll weight (g)	Ginning outturn	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	UHML (mm)	Fibre strength (g/tex)	Micronaire (μ/inch)
Replicates	1	11.88	0.785 *	32.74	88606.51	707.60	0.26	9.05	0.25
Treatments	65	11.51	0.290 **	12.54	96910.09	15410.55	1.17	1.06	0.27
Parents	10	4.96	0.28	25.14*	78109.82**	20463.47**	1.25*	0.71	0.40
Hybrids	54	10.30	0.211*	10.43	76515.26**	11999.74**	1.14*	1.14	0.24
Parent Vs. Hybrids	1	142.24**	4.65 ***	0.577*	1386234**	149065.12*	1.46*	0.16*	0.72*
Error	65	9.23	0.16	12.50	81980.75	16830.28	0.90	0.88	0.07

differences for seed cotton yield, lint yield, boll weight and UHML.

Mean performance

The mean performance of 55 hybrids is presented in Table 3. The average value of seed cotton yield was 2564.71 kg per ha and the range was between 2159.89 (SCS-PL-51 × SCS-PL-60) and 2932.59 (SCS-PL-01 × SCS-PL-04).The result indicates that the cross SCS-PL-01 × SCS-PL-04 had potentially high yield compared to all the other crosses. Lint yield ranged from 648.54 kg/ha (SCS-PL-02 × SCS-PL-59) to 1070.53 kg/ha (SCS-PL-18 × SCS-PL-51) with an average of 881.26 kg/ha. With respect to ginning outturn the range was from 29.19 (SCS-PL-02 × SCS-PL-59) to 41.21 (SCS-PL-12 × SCS-PL-60) with an overall mean of 34.40 the results were supported by those of Ehsan *et al*. (2008) and Kumar *et al*. (2015). The boll weight ranged from 3.32 (SCS-PL-04 × SCS-PL-51) to 5.12 (SCS-PL-12 × SCS-PL-59) with an average of 4.014. The results were in accordance with Ashokkumar and Ravikesavan, 2013 and Kumar *et al*. (2015). The crosses SCS-PL-02 × SCS-PL-61 (14.00) and SCS-PL-10 × SCS-PL-61 (23.70) exhibited minimum and maximum values for number of bolls per plant with an average value of 18.25. The results indicated that the cross SCS-PL-10 × SCS-PL-61 can be used in breeding programme as parents as the trait is positively associated with seed cotton yield. The results were supported by similar studies of Ashokkumar and Ravikesavan, 2013 and Kumar *et al*., 2015. With respect to fibre quality traits the cross SCS-PL-01 × SCS-PL-03 (27.44) had minimum and SCS-PL-12 × SCS-PL-51 (30.88) had maximum values for UHML. The range for fibre strength was from 22.13 (SCS-PL-04 × SCS-PL-61) to 25.57 (SCS-PL-01 × SCS-PL-18) with an overall mean of 23.95. The crosses SCS-PL-01 × SCS-PL-10 and SCS-PL-18 × SCS-PL-61 exhibited minimum and maximum values for the trait micronaire with an overall mean of 4.09. The crosses with higher length, strength along with high mean yield can be considered as the desired hybrids in terms of the present industrial requirements. The results for fibre quality are supported by Copur (2006), Ehsan *et al*. (2008), Ashokkumar *et al*. (2013) and Kumar *et al*. (2015).

Estimation of heterosis

Assessment of heterotic effects is essential to detect the new cross combinations that are suitable for immediate exploitation. Consequently, the heterotic expressions of fifty five cross combinations over the mid parental and better parental heterosis was examined and the results are presented in Table 4 to 11.

Table 3. Per se performance of fifty five hybrids for yield and fibre quality traits

Crosses	Per se performance							
	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	GOT (%)	Boll weight (g)	Bolls / plant	UHML (mm)	Fibre strength (g/tex)	Micronaire (μ/inch)
SCS-PL-01 × SCS-PL-02	2253.85	789.70	35.04	3.85	16.30	28.17	23.14	3.75
SCS-PL-01 × SCS-PL-18	2373.98	813.37	34.14	3.99	15.40	28.54	25.57	3.55
SCS-PL-01 × SCS-PL-03	2750.64	870.00	31.87	3.98	21.10	27.44	23.96	3.90
SCS-PL-01 × SCS-PL-04	2932.23	933.76	31.85	3.91	16.50	27.68	25.14	4.00
SCS-PL-01 × SCS-PL-10	2602.40	863.78	33.22	3.75	16.00	28.15	24.20	3.25
SCS-PL-01 × SCS-PL-12	2878.19	986.87	34.28	3.91	16.40	28.91	23.85	3.85
SCS-PL-01 × SCS-PL-51	2791.41	918.91	32.91	3.78	21.10	27.95	23.64	3.70
SCS-PL-01 × SCS-PL-59	2418.71	829.93	34.20	4.04	16.00	28.64	23.38	4.05
SCS-PL-01 × SCS-PL-60	2932.59	991.05	33.79	3.54	17.70	28.24	23.63	4.15
SCS-PL-01 × SCS-PL-61	2583.33	980.42	37.54	4.05	18.50	28.33	23.84	4.50
SCS-PL-02 × SCS-PL-18	2778.04	868.68	31.20	4.28	15.90	29.29	23.64	4.40
SCS-PL-02 × SCS-PL-03	2713.57	909.41	33.52	3.74	16.70	28.89	24.63	4.25
SCS-PL-02 × SCS-PL-04	2656.32	890.90	33.70	4.07	19.70	28.27	23.64	4.70
SCS-PL-02 × SCS-PL-10	2521.15	827.80	32.78	4.12	18.70	27.63	23.33	4.70
SCS-PL-02 × SCS-PL-12	2447.06	876.06	35.75	3.79	17.50	29.12	23.02	4.10
SCS-PL-02 × SCS-PL-51	2568.14	843.17	33.20	3.95	17.50	30.14	23.46	4.05
SCS-PL-02 × SCS-PL-59	2227.57	648.54	29.19	4.30	21.40	29.27	23.90	4.65
SCS-PL-02 × SCS-PL-60	2537.81	866.17	33.89	4.05	15.60	29.22	24.48	4.45
SCS-PL-02 × SCS-PL-61	2557.75	852.18	32.79	3.59	14.00	27.95	22.90	4.65
SCS-PL-18 × SCS-PL-03	2549.08	879.46	34.23	4.02	16.70	28.80	24.58	4.45
SCS-PL-18 × SCS-PL-04	2704.10	908.51	33.71	4.30	16.50	30.27	23.43	4.10
SCS-PL-18 × SCS-PL-10	2882.46	962.44	33.42	4.63	21.70	29.06	23.51	4.15
SCS-PL-18 × SCS-PL-12	2842.72	942.42	33.13	4.66	19.10	29.50	24.01	4.25
SCS-PL-18 × SCS-PL-51	2838.50	1070.53	37.64	4.54	17.10	29.06	24.26	4.05
SCS-PL-18 × SCS-PL-59	2683.69	957.05	35.66	4.39	17.90	28.95	24.42	3.95
SCS-PL-18 × SCS-PL-60	2433.18	860.32	35.30	4.45	20.80	28.14	23.54	4.50
SCS-PL-18 × SCS-PL-61	2536.13	877.39	34.88	4.13	16.50	28.20	22.29	4.80
SCS-PL-03 × SCS-PL-04	2855.01	890.84	31.27	4.12	14.20	27.63	24.35	4.25
SCS-PL-03 × SCS-PL-10	2494.42	783.06	31.84	4.35	16.10	30.01	23.75	3.75
SCS-PL-03 × SCS-PL-12	2453.67	792.47	32.04	4.30	20.50	29.66	24.13	4.05
SCS-PL-03 × SCS-PL-51	2720.11	959.07	35.29	3.66	20.00	28.80	23.69	3.65
SCS-PL-03 × SCS-PL-59	2617.25	957.19	36.91	4.27	18.20	28.33	25.41	3.90
SCS-PL-03 × SCS-PL-60	2483.97	752.89	30.02	4.17	19.70	28.53	24.42	3.40
SCS-PL-03 × SCS-PL-61	2786.89	989.14	35.42	3.91	18.10	28.92	24.16	3.95
SCS-PL-04 × SCS-PL-10	2311.24	879.17	38.03	4.09	22.20	29.86	23.18	4.05
SCS-PL-04 × SCS-PL-12	2852.57	989.74	34.67	4.03	16.50	29.65	25.05	4.40
SCS-PL-04 × SCS-PL-51	2482.49	918.45	37.01	3.32	17.10	29.29	23.12	4.60
SCS-PL-04 × SCS-PL-59	2783.28	888.09	31.99	4.26	15.40	29.53	23.61	4.15
SCS-PL-04 × SCS-PL-60	2391.38	730.21	30.63	3.99	20.80	29.61	24.63	4.05
SCS-PL-04 × SCS-PL-61	2508.06	925.58	36.70	4.05	18.80	28.23	22.13	4.55
SCS-PL-10 × SCS-PL-12	2288.16	860.73	37.83	4.04	16.60	28.25	23.90	4.10
SCS-PL-10 × SCS-PL-51	2545.71	917.15	36.10	3.92	17.60	28.75	25.31	3.75
SCS-PL-10 × SCS-PL-59	2482.95	910.14	36.93	3.44	21.30	28.14	24.31	4.25
SCS-PL-10 × SCS-PL-60	2568.71	883.36	34.36	3.88	20.40	28.51	23.43	4.05
SCS-PL-10 × SCS-PL-61	2382.85	815.92	34.26	3.84	23.70	28.00	24.79	3.85
SCS-PL-12 × SCS-PL-51	2539.14	866.48	34.18	4.19	22.90	30.88	25.56	3.85
SCS-PL-12 × SCS-PL-59	2413.28	816.20	33.84	5.12	18.90	28.51	24.06	3.85
SCS-PL-12 × SCS-PL-60	2481.57	1020.68	41.21	3.83	20.30	29.34	24.73	3.95
SCS-PL-12 × SCS-PL-61	2523.24	933.02	37.00	3.58	19.50	28.76	23.54	3.95
SCS-PL-51 × SCS-PL-59	2385.63	831.10	34.76	3.52	20.20	28.99	24.54	3.80
SCS-PL-51 × SCS-PL-60	2159.89	784.12	36.41	3.75	17.00	27.56	24.16	4.10
SCS-PL-51 × SCS-PL-61	2433.15	862.29	35.37	3.77	16.20	28.95	24.16	3.55
SCS-PL-59 × SCS-PL-60	2543.43	889.46	35.00	3.95	20.00	29.70	24.00	4.05
SCS-PL-59 × SCS-PL-61	2356.69	762.28	32.50	3.72	17.10	29.73	23.08	3.60
SCS-PL-60 × SCS-PL-61	2220.14	841.88	37.91	3.89	16.60	28.38	22.81	4.35
Mean	2564.71	881.26	34.41	4.01	18.26	28.81	23.95	4.09
Range	2159.89 - 2932.59	648.54 - 1070.53	29.19 - 41.21	3.32 - 5.12	14.00 - 23.70	27.44 - 30.88	22.13 - 25.57	3.25 - 4.80

Table 4. Heterosis for seed cotton yield (kg/ha)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	2.83	22.28
SCS-PL-01 × SCS-PL-18	7.87	28.8
SCS-PL-01 × SCS-PL-03	9.74	49.24 **
SCS-PL-01 × SCS-PL-04	33.42 **	59.09 **
SCS-PL-01 × SCS-PL-10	16.33	41.19 *
SCS-PL-01 × SCS-PL-12	31.98 **	56.16 **
SCS-PL-01 × SCS-PL-51	27.91 *	51.45 **
SCS-PL-01 × SCS-PL-59	9.11	31.23 *
SCS-PL-01 × SCS-PL-60	35.72 **	59.11 **
SCS-PL-01 × SCS-PL-61	18.62	40.16 *
SCS-PL-02 × SCS-PL-18	23.68 *	50.72 **
SCS-PL-02 × SCS-PL-03	6.34	47.23 **
SCS-PL-02 × SCS-PL-04	18.42	44.12 **
SCS-PL-02 × SCS-PL-10	10.46	36.79 *
SCS-PL-02 × SCS-PL-12	9.92	32.77 *
SCS-PL-02 × SCS-PL-51	15.28	39.34 *
SCS-PL-02 × SCS-PL-59	-1.53	20.86
SCS-PL-02 × SCS-PL-60	15.03	37.69 *
SCS-PL-02 × SCS-PL-61	15.04	38.77 *
SCS-PL-18 × SCS-PL-03	-0.46	38.30 *
SCS-PL-18 × SCS-PL-04	20.07	46.71 **
SCS-PL-18 × SCS-PL-10	25.80 *	56.39 **
SCS-PL-18 × SCS-PL-12	27.19 *	54.23 **
SCS-PL-18 × SCS-PL-51	26.90 *	54.00 **
SCS-PL-18 × SCS-PL-59	18.17	45.61 **
SCS-PL-18 × SCS-PL-60	9.84	32.01 *
SCS-PL-18 × SCS-PL-61	13.62	37.60 *
SCS-PL-03 × SCS-PL-04	11.62	54.90 **
SCS-PL-03 × SCS-PL-10	-3.95	35.34 *
SCS-PL-03 × SCS-PL-12	-3.43	33.13 *
SCS-PL-03 × SCS-PL-51	6.99	47.58 **
SCS-PL-03 × SCS-PL-59	1.57	42.00 **
SCS-PL-03 × SCS-PL-60	-1.46	34.77 *
SCS-PL-03 × SCS-PL-61	9.81	51.20 **
SCS-PL-04 × SCS-PL-10	1	25.4
SCS-PL-04 × SCS-PL-12	27.80 *	54.77 **
SCS-PL-04 × SCS-PL-51	11.14	34.69 *
SCS-PL-04 × SCS-PL-59	22.71 *	51.01 **
SCS-PL-04 × SCS-PL-60	8.1	29.75
SCS-PL-04 × SCS-PL-61	12.51	36.08 *
SCS-PL-10 × SCS-PL-12	0.74	24.15
SCS-PL-10 × SCS-PL-51	11.99	38.12 *
SCS-PL-10 × SCS-PL-59	7.61	34.71 *
SCS-PL-10 × SCS-PL-60	14.09	39.37 *
SCS-PL-10 × SCS-PL-61	5.04	29.28
SCS-PL-12 × SCS-PL-51	14.54	37.76 *
SCS-PL-12 × SCS-PL-59	7.2	30.93
SCS-PL-12 × SCS-PL-60	13.05	34.64 *
SCS-PL-12 × SCS-PL-61	14.06	36.90 *
SCS-PL-51 × SCS-PL-59	5.9	29.43
SCS-PL-51 × SCS-PL-60	-1.68	17.19
SCS-PL-51 × SCS-PL-61	9.91	32.01 *
SCS-PL-59 × SCS-PL-60	13.99	38.00 *
SCS-PL-59 × SCS-PL-61	4.83	27.86
SCS-PL-60 × SCS-PL-61	1.27	20.46
MEAN	8.692	25.5325
RANGE	(-1.68 - 35.72)	(17.19 - 59.11)
S.Ed.	247.96	286.32
C.D. at 5 %	497.13	574.04
C.D. at 1 %	657.99	759.78

Table 5. Heterosis for lint yield (kg/ha)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	-3.97	41.27
SCS-PL-01 × SCS-PL-18	-0.55	45.5
SCS-PL-01 × SCS-PL-03	-4.86	55.63 *
SCS-PL-01 × SCS-PL-04	17.48	67.04 **
SCS-PL-01 × SCS-PL-10	0.44	54.52 *
SCS-PL-01 × SCS-PL-12	23.36	76.54 **
SCS-PL-01 × SCS-PL-51	29.4	64.38 **
SCS-PL-01 × SCS-PL-59	-1.31	48.46 *
SCS-PL-01 × SCS-PL-60	21.29	77.29 **
SCS-PL-01 × SCS-PL-61	23.41	75.39 **
SCS-PL-02 × SCS-PL-18	9.81	55.40 *
SCS-PL-02 × SCS-PL-03	2.45	62.68 **
SCS-PL-02 × SCS-PL-04	15.99	59.37 *
SCS-PL-02 × SCS-PL-10	-0.66	48.08 *
SCS-PL-02 × SCS-PL-12	13.3	56.72 *
SCS-PL-02 × SCS-PL-51	23.38	50.83 *
SCS-PL-02 × SCS-PL-59	-20.35	16.02
SCS-PL-02 × SCS-PL-60	9.6	54.95 *
SCS-PL-02 × SCS-PL-61	11.01	52.44 *
SCS-PL-18 × SCS-PL-03	-0.42	57.32 *
SCS-PL-18 × SCS-PL-04	18.98	62.52 **
SCS-PL-18 × SCS-PL-10	16.13	72.17 **
SCS-PL-18 × SCS-PL-12	22.6	68.59 **
SCS-PL-18 × SCS-PL-51	57.70 **	91.50 **
SCS-PL-18 × SCS-PL-59	18.2	71.20 **
SCS-PL-18 × SCS-PL-60	9.49	53.90 *
SCS-PL-18 × SCS-PL-61	14.97	56.95 *
SCS-PL-03 × SCS-PL-04	3.57	59.36 *
SCS-PL-03 × SCS-PL-10	-15.37	40.08
SCS-PL-03 × SCS-PL-12	-8.41	41.76
SCS-PL-03 × SCS-PL-51	23.68	71.56 **
SCS-PL-03 × SCS-PL-59	5.62	71.23 **
SCS-PL-03 × SCS-PL-60	-14.67	34.68
SCS-PL-03 × SCS-PL-61	15.06	76.94 **
SCS-PL-04 × SCS-PL-10	9.11	57.27 *
SCS-PL-04 × SCS-PL-12	32.73 *	77.05 **
SCS-PL-04 × SCS-PL-51	40.04 *	64.30 **
SCS-PL-04 × SCS-PL-59	12.89	58.87 *
SCS-PL-04 × SCS-PL-60	-4.27	30.62
SCS-PL-04 × SCS-PL-61	25.05	65.57 **
SCS-PL-10 × SCS-PL-12	6.15	53.97 *
SCS-PL-10 × SCS-PL-51	27.2	64.07 **
SCS-PL-10 × SCS-PL-59	6.84	62.81 **
SCS-PL-10 × SCS-PL-60	6.69	58.02 *
SCS-PL-10 × SCS-PL-61	1.31	45.96
SCS-PL-12 × SCS-PL-51	31.09	55.00 *
SCS-PL-12 × SCS-PL-59	3.08	46.01
SCS-PL-12 × SCS-PL-60	32.92 *	82.59 **
SCS-PL-12 × SCS-PL-61	25.19	66.90 **
SCS-PL-51 × SCS-PL-59	18.39	48.67 *
SCS-PL-51 × SCS-PL-60	15.64	40.27
SCS-PL-51 × SCS-PL-61	31.56	54.25 *
SCS-PL-59 × SCS-PL-60	9.96	59.11 *
SCS-PL-59 × SCS-PL-61	-3.05	36.36
SCS-PL-60 × SCS-PL-61	10.43	50.6
MEAN	10.04	39.09
RANGE	(-20.35-57.70)	(16.02 -82.59)
S.Ed.	112.35	129.73
C.D. at 5 %	225.24	260.09
C.D. at 1 %	298.13	344.25

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 6. Heterosis for ginning outturn

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	-6.72	8.47
SCS-PL-01 × SCS-PL-18	-8.32	5.68
SCS-PL-01 × SCS-PL-03	-14.33	-1.36
SCS-PL-01 × SCS-PL-04	-11.88	-1.42
SCS-PL-01 × SCS-PL-10	-13.66	2.82
SCS-PL-01 × SCS-PL-12	-6.63	6.11
SCS-PL-01 × SCS-PL-51	1.01	1.87
SCS-PL-01 × SCS-PL-59	-10.04	5.87
SCS-PL-01 × SCS-PL-60	-10.69	4.6
SCS-PL-01 × SCS-PL-61	3.08	16.2
SCS-PL-02 × SCS-PL-18	-11.5	-3.42
SCS-PL-02 × SCS-PL-03	-4.8	3.76
SCS-PL-02 × SCS-PL-04	-1.35	4.3
SCS-PL-02 × SCS-PL-10	-10.15	1.47
SCS-PL-02 × SCS-PL-12	2.93	10.65
SCS-PL-02 × SCS-PL-51	8.51	2.77
SCS-PL-02 × SCS-PL-59	-19.00 *	-9.66
SCS-PL-02 × SCS-PL-60	-5.47	4.89
SCS-PL-02 × SCS-PL-61	-4.78	1.49
SCS-PL-18 × SCS-PL-03	-1.87	5.96
SCS-PL-18 × SCS-PL-04	-0.36	4.33
SCS-PL-18 × SCS-PL-10	-7.58	3.44
SCS-PL-18 × SCS-PL-12	-3.69	2.55
SCS-PL-18 × SCS-PL-51	24.35 *	16.51
SCS-PL-18 × SCS-PL-59	-0.12	10.39
SCS-PL-18 × SCS-PL-60	-0.63	9.26
SCS-PL-18 × SCS-PL-61	2.27	7.97
SCS-PL-03 × SCS-PL-04	-7.46	-3.22
SCS-PL-03 × SCS-PL-10	-11.84	-1.44
SCS-PL-03 × SCS-PL-12	-6.75	-0.82
SCS-PL-03 × SCS-PL-51	16.75	9.24
SCS-PL-03 × SCS-PL-59	3.51	14.25
SCS-PL-03 × SCS-PL-60	-15.4	-7.09
SCS-PL-03 × SCS-PL-61	3.97	9.63
SCS-PL-04 × SCS-PL-10	8.46	17.71
SCS-PL-04 × SCS-PL-12	4.09	7.31
SCS-PL-04 × SCS-PL-51	26.87 *	14.56
SCS-PL-04 × SCS-PL-59	-7.57	-0.99
SCS-PL-04 × SCS-PL-60	-11.03	-5.2
SCS-PL-04 × SCS-PL-61	11.19	13.6
SCS-PL-10 × SCS-PL-12	6.15	17.09
SCS-PL-10 × SCS-PL-51	14.59	11.75
SCS-PL-10 × SCS-PL-59	-0.03	14.3
SCS-PL-10 × SCS-PL-60	-6.52	6.35
SCS-PL-10 × SCS-PL-61	-3.06	6.04
SCS-PL-12 × SCS-PL-51	14.89	5.79
SCS-PL-12 × SCS-PL-59	-3.82	4.74
SCS-PL-12 × SCS-PL-60	17.75 *	27.55 *
SCS-PL-12 × SCS-PL-61	10.18	14.53
SCS-PL-51 × SCS-PL-59	11.94	7.58
SCS-PL-51 × SCS-PL-60	17.95	12.69
SCS-PL-51 × SCS-PL-61	20.1	9.49
SCS-PL-59 × SCS-PL-60	-3.59	8.33
SCS-PL-59 × SCS-PL-61	-6.84	0.59
SCS-PL-60 × SCS-PL-61	9.25	17.35
MEAN	-0.93	6.10
RANGE	(-19 - 26.87)	(-9.66-27.55)
S.Ed.	3.06	3.53
C.D. at 5 %	6.13	7.08
C.D. at 1 %	8.12	9.38

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 7. Heterosis for boll weight (g)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	8.99	10.79
SCS-PL-01 × SCS-PL-18	6.41	14.68
SCS-PL-01 × SCS-PL-03	19.46	14.39
SCS-PL-01 × SCS-PL-04	19.12	12.52
SCS-PL-01 × SCS-PL-10	2.32	7.77
SCS-PL-01 × SCS-PL-12	11.55	12.52
SCS-PL-01 × SCS-PL-51	17.97	8.63
SCS-PL-01 × SCS-PL-59	14.55	16.12
SCS-PL-01 × SCS-PL-60	-2.48	1.87
SCS-PL-01 × SCS-PL-61	27.06 *	16.55
SCS-PL-02 × SCS-PL-18	10.38	23.17 *
SCS-PL-02 × SCS-PL-03	7.95	7.48
SCS-PL-02 × SCS-PL-04	19.18	17.12
SCS-PL-02 × SCS-PL-10	8.64	18.56
SCS-PL-02 × SCS-PL-12	4.19	9.06
SCS-PL-02 × SCS-PL-51	18.53	13.67
SCS-PL-02 × SCS-PL-59	17.65	23.74 *
SCS-PL-02 × SCS-PL-60	7.51	16.4
SCS-PL-02 × SCS-PL-61	7.98	3.17
SCS-PL-18 × SCS-PL-03	9.46	15.68
SCS-PL-18 × SCS-PL-04	18.4	23.60 *
SCS-PL-18 × SCS-PL-10	15.48	33.09 **
SCS-PL-18 × SCS-PL-12	20.91 *	33.96 **
SCS-PL-18 × SCS-PL-51	28.07 **	30.65 **
SCS-PL-18 × SCS-PL-59	13.51	26.33 *
SCS-PL-18 × SCS-PL-60	11.82	27.91 *
SCS-PL-18 × SCS-PL-61	16.77	18.71
SCS-PL-03 × SCS-PL-04	28.19 *	18.42
SCS-PL-03 × SCS-PL-10	21.11 *	25.04 *
SCS-PL-03 × SCS-PL-12	25.13 *	23.60 *
SCS-PL-03 × SCS-PL-51	17.03	5.32
SCS-PL-03 × SCS-PL-59	23.77 *	22.88
SCS-PL-03 × SCS-PL-60	17.22	20
SCS-PL-03 × SCS-PL-61	25.36 *	12.37
SCS-PL-04 × SCS-PL-10	15.46	17.7
SCS-PL-04 × SCS-PL-12	18.97	15.97
SCS-PL-04 × SCS-PL-51	7.54	-4.6
SCS-PL-04 × SCS-PL-59	24.96 *	22.45
SCS-PL-04 × SCS-PL-60	13.45	14.68
SCS-PL-04 × SCS-PL-61	31.76 **	16.4
SCS-PL-10 × SCS-PL-12	7.3	16.26
SCS-PL-10 × SCS-PL-51	13.15	12.66
SCS-PL-10 × SCS-PL-59	-9.05	-1.01
SCS-PL-10 × SCS-PL-60	-0.26	11.65
SCS-PL-10 × SCS-PL-61	11.24	10.36
SCS-PL-12 × SCS-PL-51	26.63 *	20.43
SCS-PL-12 × SCS-PL-59	41.01 **	47.19 **
SCS-PL-12 × SCS-PL-60	2.54	10.22
SCS-PL-12 × SCS-PL-61	8.58	2.88
SCS-PL-51 × SCS-PL-59	5.94	1.29
SCS-PL-51 × SCS-PL-60	9.18	7.77
SCS-PL-51 × SCS-PL-61	26.19 *	8.49
SCS-PL-59 × SCS-PL-60	5.13	13.53
SCS-PL-59 × SCS-PL-61	12.39	7.05
SCS-PL-60 × SCS-PL-61	13.68	11.8
MEAN	10.83	12.06
RANGE	-2.48 to 47.01	-4.6 to 47.19
S.Ed.	0.34	0.40
C.D. at 5 %	0.69	0.80
C.D. at 1 %	0.91	1.06

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 8. Heterosis for bolls per plant

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	-2.40	6.54
SCS-PL-01 × SCS-PL-18	-6.10	0.65
SCS-PL-01 × SCS-PL-03	46.02 *	37.91
SCS-PL-01 × SCS-PL-04	8.91	7.84
SCS-PL-01 × SCS-PL-10	3.23	4.58
SCS-PL-01 × SCS-PL-12	3.80	7.19
SCS-PL-01 × SCS-PL-51	43.05 *	37.91
SCS-PL-01 × SCS-PL-59	3.23	4.58
SCS-PL-01 × SCS-PL-60	23.78	15.69
SCS-PL-01 × SCS-PL-61	13.50	20.92
SCS-PL-02 × SCS-PL-18	-9.66	3.92
SCS-PL-02 × SCS-PL-03	6.71	9.15
SCS-PL-02 × SCS-PL-04	20.49	28.76
SCS-PL-02 × SCS-PL-10	11.98	22.22
SCS-PL-02 × SCS-PL-12	2.94	14.38
SCS-PL-02 × SCS-PL-51	9.72	14.38
SCS-PL-02 × SCS-PL-59	28.14	39.87 *
SCS-PL-02 × SCS-PL-60	0.65	1.96
SCS-PL-02 × SCS-PL-61	-20.00	-8.50
SCS-PL-18 × SCS-PL-03	8.79	9.15
SCS-PL-18 × SCS-PL-04	2.80	7.84
SCS-PL-18 × SCS-PL-10	32.32 *	41.83 *
SCS-PL-18 × SCS-PL-12	14.37	24.84
SCS-PL-18 × SCS-PL-51	9.27	11.76
SCS-PL-18 × SCS-PL-59	9.15	16.99
SCS-PL-18 × SCS-PL-60	36.84 *	35.95
SCS-PL-18 × SCS-PL-61	-4.07	7.84
SCS-PL-03 × SCS-PL-04	0.71	-7.19
SCS-PL-03 × SCS-PL-10	11.42	5.23
SCS-PL-03 × SCS-PL-12	38.98 *	33.99
SCS-PL-03 × SCS-PL-51	45.99 *	30.72
SCS-PL-03 × SCS-PL-59	25.95	18.95
SCS-PL-03 × SCS-PL-60	48.68 *	28.76
SCS-PL-03 × SCS-PL-61	18.69	18.30
SCS-PL-04 × SCS-PL-10	46.53 **	45.10 *
SCS-PL-04 × SCS-PL-12	6.80	7.84
SCS-PL-04 × SCS-PL-51	18.75	11.76
SCS-PL-04 × SCS-PL-59	1.65	0.65
SCS-PL-04 × SCS-PL-60	49.10 *	35.95
SCS-PL-04 × SCS-PL-61	17.87	22.88
SCS-PL-10 × SCS-PL-12	5.06	8.50
SCS-PL-10 × SCS-PL-51	19.32	15.03
SCS-PL-10 × SCS-PL-59	37.42 *	39.22
SCS-PL-10 × SCS-PL-60	42.66 *	33.33
SCS-PL-10 × SCS-PL-61	45.40 **	54.90 **
SCS-PL-12 × SCS-PL-51	52.16 **	49.67 *
SCS-PL-12 × SCS-PL-59	19.62	23.53
SCS-PL-12 × SCS-PL-60	39.04 *	32.68
SCS-PL-12 × SCS-PL-61	17.47	27.45
SCS-PL-51 × SCS-PL-59	36.95 *	32.03
SCS-PL-51 × SCS-PL-60	25.46	11.11
SCS-PL-51 × SCS-PL-61	4.18	5.88
SCS-PL-59 × SCS-PL-60	39.86 *	30.72
SCS-PL-59 × SCS-PL-61	4.91	11.76
SCS-PL-60 × SCS-PL-61	9.93	8.5
MEAN	8.90	16.64
RANGE	(-20 - 52.16)	(-8.50 -54.90)
S.Ed.	0.79	0.92
C.D. at 5 %	1.60	1.85
C.D. at 1 %	2.10	2.41

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 9. Heterosis for UHML (mm)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	2.47	-1.73
SCS-PL-01 × SCS-PL-18	1.63	-0.45
SCS-PL-01 × SCS-PL-03	-4.6	-4.29
SCS-PL-01 × SCS-PL-04	-3.02	-3.45
SCS-PL-01 × SCS-PL-10	0.02	-1.81
SCS-PL-01 × SCS-PL-12	1.89	0.84
SCS-PL-01 × SCS-PL-51	-0.21	-2.51
SCS-PL-01 × SCS-PL-59	3.3	-0.1
SCS-PL-01 × SCS-PL-60	1.54	-1.5
SCS-PL-01 × SCS-PL-61	-0.04	-1.19
SCS-PL-02 × SCS-PL-18	4.86	2.16
SCS-PL-02 × SCS-PL-03	0.97	0.77
SCS-PL-02 × SCS-PL-04	-0.43	-1.4
SCS-PL-02 × SCS-PL-10	-1.29	-3.61
SCS-PL-02 × SCS-PL-12	3.19	1.59
SCS-PL-02 × SCS-PL-51	8.20 **	5.15
SCS-PL-02 × SCS-PL-59	6.17 *	2.11
SCS-PL-02 × SCS-PL-60	5.65	1.94
SCS-PL-02 × SCS-PL-61	-0.86	-2.51
SCS-PL-18 × SCS-PL-03	-1.35	0.47
SCS-PL-18 × SCS-PL-04	4.45	5.58
SCS-PL-18 × SCS-PL-10	1.67	1.36
SCS-PL-18 × SCS-PL-12	2.4	2.91
SCS-PL-18 × SCS-PL-51	2.15	1.36
SCS-PL-18 × SCS-PL-59	2.8	0.98
SCS-PL-18 × SCS-PL-60	-0.37	-1.83
SCS-PL-18 × SCS-PL-61	-2	-1.62
SCS-PL-03 × SCS-PL-04	-6.83 *	-3.61
SCS-PL-03 × SCS-PL-10	2.57	4.69
SCS-PL-03 × SCS-PL-12	0.58	3.47
SCS-PL-03 × SCS-PL-51	-1.11	0.47
SCS-PL-03 × SCS-PL-59	-1.76	-1.17
SCS-PL-03 × SCS-PL-60	-1.38	-0.49
SCS-PL-03 × SCS-PL-61	-1.82	0.89
SCS-PL-04 × SCS-PL-10	2.82	4.15
SCS-PL-04 × SCS-PL-12	1.31	3.44
SCS-PL-04 × SCS-PL-51	1.34	2.18
SCS-PL-04 × SCS-PL-59	3.17	3
SCS-PL-04 × SCS-PL-60	3.14	3.28
SCS-PL-04 × SCS-PL-61	-3.45	-1.53
SCS-PL-10 × SCS-PL-12	-2.15	-1.45
SCS-PL-10 × SCS-PL-51	0.86	0.3
SCS-PL-10 × SCS-PL-59	-0.28	-1.83
SCS-PL-10 × SCS-PL-60	0.7	-0.56
SCS-PL-10 × SCS-PL-61	-2.92	-2.34
SCS-PL-12 × SCS-PL-51	7.46 *	7.73 *
SCS-PL-12 × SCS-PL-59	0.19	-0.56
SCS-PL-12 × SCS-PL-60	2.79	2.34
SCS-PL-12 × SCS-PL-61	-1.06	0.33
SCS-PL-51 × SCS-PL-59	3.2	1.12
SCS-PL-51 × SCS-PL-60	-2.19	-3.87
SCS-PL-51 × SCS-PL-61	0.84	0.98
SCS-PL-59 × SCS-PL-60	6.50 *	3.61
SCS-PL-59 × SCS-PL-61	4.62	3.72
SCS-PL-60 × SCS-PL-61	-0.44	-0.99
MEAN	0.6878	0.347962963
RANGE	(-6.83 - 8.20)	(-4.29 - 7.73)
S.Ed.	0.82	.094
C.D. at 5 %	1.64	1.90
C.D. at 1 %	2.18	2.51

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 10. Heterosis for fibre strength (g/tex)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	-5.44	-3.38
SCS-PL-01 × SCS-PL-18	7.00 *	6.74
SCS-PL-01 × SCS-PL-03	1.44	0.02
SCS-PL-01 × SCS-PL-04	5.65	4.97
SCS-PL-01 × SCS-PL-10	2.77	1.04
SCS-PL-01 × SCS-PL-12	-1.59	-0.42
SCS-PL-01 × SCS-PL-51	0.12	-1.29
SCS-PL-01 × SCS-PL-59	-2.25	-2.38
SCS-PL-01 × SCS-PL-60	-0.04	-1.34
SCS-PL-01 × SCS-PL-61	-1.2	-0.48
SCS-PL-02 × SCS-PL-18	-4.18	-1.29
SCS-PL-02 × SCS-PL-03	0.94	2.82
SCS-PL-02 × SCS-PL-04	-3.8	-1.29
SCS-PL-02 × SCS-PL-10	-4.1	-2.59
SCS-PL-02 × SCS-PL-12	-8.00 *	-3.9
SCS-PL-02 × SCS-PL-51	-3.84	-2.07
SCS-PL-02 × SCS-PL-59	-3.23	-0.21
SCS-PL-02 × SCS-PL-60	0.25	2.21
SCS-PL-02 × SCS-PL-61	-8.05 *	-4.38
SCS-PL-18 × SCS-PL-03	3.18	2.61
SCS-PL-18 × SCS-PL-04	-2.36	-2.17
SCS-PL-18 × SCS-PL-10	-1.01	-1.84
SCS-PL-18 × SCS-PL-12	-1.77	0.23
SCS-PL-18 × SCS-PL-51	1.85	1.27
SCS-PL-18 × SCS-PL-59	1.24	1.96
SCS-PL-18 × SCS-PL-60	-1.29	-1.73
SCS-PL-18 × SCS-PL-61	-8.38 *	-6.93
SCS-PL-03 × SCS-PL-04	2.63	1.65
SCS-PL-03 × SCS-PL-10	1.16	-0.86
SCS-PL-03 × SCS-PL-12	-0.12	0.75
SCS-PL-03 × SCS-PL-51	0.63	-1.11
SCS-PL-03 × SCS-PL-59	6.57	6.1
SCS-PL-03 × SCS-PL-60	3.63	1.96
SCS-PL-03 × SCS-PL-61	0.46	0.88
SCS-PL-04 × SCS-PL-10	-2.02	-3.24
SCS-PL-04 × SCS-PL-12	2.9	4.57
SCS-PL-04 × SCS-PL-51	-2.52	-3.47
SCS-PL-04 × SCS-PL-59	-1.74	-1.44
SCS-PL-04 × SCS-PL-60	3.71	2.82
SCS-PL-04 × SCS-PL-61	-8.67 *	-7.6
SCS-PL-10 × SCS-PL-12	-0.8	-0.21
SCS-PL-10 × SCS-PL-51	7.82 *	5.66
SCS-PL-10 × SCS-PL-59	2.23	1.48
SCS-PL-10 × SCS-PL-60	-0.31	-2.19
SCS-PL-10 × SCS-PL-61	3.35	3.49
SCS-PL-12 × SCS-PL-51	5.78	6.7
SCS-PL-12 × SCS-PL-59	-1.67	0.44
SCS-PL-12 × SCS-PL-60	2.25	3.26
SCS-PL-12 × SCS-PL-61	-4.6	-1.73
SCS-PL-51 × SCS-PL-59	2.92	2.44
SCS-PL-51 × SCS-PL-60	2.54	0.88
SCS-PL-51 × SCS-PL-61	0.47	0.88
SCS-PL-59 × SCS-PL-60	0.53	0.19
SCS-PL-59 × SCS-PL-61	-5.25	-3.65
SCS-PL-60 × SCS-PL-61	-5.28	-4.78
MEAN	-0.025	0.001
RANGE	(-8.67 - 7.82)	(-6.93 - 5.66)
S.Ed.	0.81	0.93
C.D. at 5 %	1.62	1.87
C.D. at 1 %	2.14	2.48

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Table 11. Heterosis for micronaire (ì/inch)

Cross	Hmp	Hcc
SCS-PL-01 × SCS-PL-02	-12.79 *	-2.6
SCS-PL-01 × SCS-PL-18	-14.97 **	-7.79
SCS-PL-01 × SCS-PL-03	3.31	-18.577
SCS-PL-01 × SCS-PL-04	2.56	3.9
SCS-PL-01 × SCS-PL-10	-18.75 **	-15.58 *
SCS-PL-01 × SCS-PL-12	3.36	0.1
SCS-PL-01 × SCS-PL-51	-6.33	-3.9
SCS-PL-01 × SCS-PL-59	7.28	5.19
SCS-PL-01 × SCS-PL-60	-1.19	7.79
SCS-PL-01 × SCS-PL-61	25.87 **	16.88 *
SCS-PL-02 × SCS-PL-18	-1.68	14.29 *
SCS-PL-02 × SCS-PL-03	4.29	10.39
SCS-PL-02 × SCS-PL-04	11.90 *	22.08 **
SCS-PL-02 × SCS-PL-10	9.3	22.08 **
SCS-PL-02 × SCS-PL-12	1.86	6.49
SCS-PL-02 × SCS-PL-51	-4.71	5.19
SCS-PL-02 × SCS-PL-59	14.11 *	20.78 **
SCS-PL-02 × SCS-PL-60	-1.11	15.58 *
SCS-PL-02 × SCS-PL-61	20.00 **	20.78 **
SCS-PL-18 × SCS-PL-03	12.66 *	15.58 *
SCS-PL-18 × SCS-PL-04	0.61	6.49
SCS-PL-18 × SCS-PL-10	-0.6	7.79
SCS-PL-18 × SCS-PL-12	8.97	10.39
SCS-PL-18 × SCS-PL-51	-1.82	5.19
SCS-PL-18 × SCS-PL-59	0.00	2.6
SCS-PL-18 × SCS-PL-60	2.86	16.88 *
SCS-PL-18 × SCS-PL-61	28.00 **	24.68 **
SCS-PL-03 × SCS-PL-04	15.65 *	10.39
SCS-PL-03 × SCS-PL-10	-0.66	-2.6
SCS-PL-03 × SCS-PL-12	15.71 *	5.19
SCS-PL-03 × SCS-PL-51	-2.01	-5.19
SCS-PL-03 × SCS-PL-59	9.86	1.3
SCS-PL-03 × SCS-PL-60	-14.47 *	-11.69
SCS-PL-03 × SCS-PL-61	17.91 *	2.6
SCS-PL-04 × SCS-PL-10	3.85	5.19
SCS-PL-04 × SCS-PL-12	21.38 **	14.29 *
SCS-PL-04 × SCS-PL-51	19.48 **	19.48 **
SCS-PL-04 × SCS-PL-59	12.93 *	7.79
SCS-PL-04 × SCS-PL-60	-1.22	5.19
SCS-PL-04 × SCS-PL-61	30.94 **	18.18 **
SCS-PL-10 × SCS-PL-12	10.07	6.49
SCS-PL-10 × SCS-PL-51	-5.06	-2.6
SCS-PL-10 × SCS-PL-59	12.58 *	10.39
SCS-PL-10 × SCS-PL-60	-3.57	5.19
SCS-PL-10 × SCS-PL-61	7.69	0.11
SCS-PL-12 × SCS-PL-51	4.76	0.1
SCS-PL-12 × SCS-PL-59	10.00	0.12
SCS-PL-12 × SCS-PL-60	0.64	2.6
SCS-PL-12 × SCS-PL-61	19.70 **	2.6
SCS-PL-51 × SCS-PL-59	2.01	-1.3
SCS-PL-51 × SCS-PL-60	-1.20	6.49
SCS-PL-51 × SCS-PL-61	0.71	-7.79
SCS-PL-59 × SCS-PL-60	1.89	5.19
SCS-PL-59 × SCS-PL-61	7.46	-6.49
SCS-PL-60 × SCS-PL-61	15.23 *	12.99
MEAN	2.06	2.22
RANGE	(18.75 - 30.94)	(-18.57 - 24.68)
S.Ed.	0.22	0.26
C.D. at 5 %	0.45	0.52
C.D. at 1 %	0.60	0.69

Hmp: Heterosis over mid parent and Hcc: Heterosis over commercial check

Manifestation of heterosis for seed cotton yield

The hybrid SCS-PL-03 × SCS-PL-10 and SCS-PL-01 × SCS-PL-60 expressed minimum and maximum heterosis over the mid parent with a general mean of 8.69. A total of ten hybrids exhibited significant positive heterosis over the mid parent. With respect to standard heterosis the cross SCS-PL-51 × SCS-PL-60 expressed minimum and SCS-PL-01 × SCS-PL-60 expressed maximum heterosis with an overall mean of 25.53. Nearly forty three crosses exhibited significant heterosis over the commercial check.

Manifestation of heterosis for lint yield

Four crosses exhibited significant heterosis over the mid parent and forty three crosses expressed the same over the commercial check. The hybrid SCS-PL-03 × SCS-PL-10 showcased minimum (-15.37) and the cross SCS-PL-18 × SCS-PL-51 expressed maximum (57.70) heterosis over the mid parent. With regard to standard heterosis SCS-PL-02 × SCS-PL-59 and SCS-PL-18 × SCS-PL-51 expressed minimum (16.02) and maximum (91.50) heterosis repectively.

Manifestation of heterosis for GOT (%)

Three crosses exhibited significant positive heterosis and one cross expressed significant heterosis in negative direction over the mid parent. SCS-PL-02 × SCS-PL-59 (-19.00) and SCS-PL-04 × SCS-PL-51 (26.87) expressed minimum and maximum values over the mid parent with the overall mean of -0.93. Only one cross showed significant positive heterosis SCS-PL-12 × SCS-PL-60 (27.55) over the commercial check. The range of heterosis was from -9.66 to 27.55 with an overall mean of 6.10.

Manifestation of heterosis for boll weight (g)

The crosses SCS-PL-10 × SCS-PL-59 and SCS-PL-12 × SCS-PL-59 exhibited minimum and maximum heterosis over the mid parent with an average heterosis of 10.83. Thirteen crosses exhibited significant positive heterosis over the mid parent. Eleven crosses showcased significant heterosis over the commercial check and the range for the same deviated from -4.60 (SCS-PL-04 × SCS-PL-51) to 47.19 (SCS-PL-12 × SCS-PL-59) with a general mean of 12.06.

Manifestation of heterosis for number of bolls/plant

Sixteen crosses expressed significant positive heterosis over the mid parent. The range for the trait deviated from -20 (SCS-PL-02 × SCS-PL-61) to 49.10 (SCS-PL-04 × SCS-PL-60) with an overall mean of 8.90. In terms of standard heterosis the range was from -8.50 (SCS-PL-02 × SCS-PL-61) to 54.90 (SCS-PL-10 × SCS-PL-61) with an overall mean of 16.64. Five crosses showcased significant positive heterosis over the commercial check.

Manifestation of heterosis for UHML (mm)

The range of heterosis over the mid parent deviated from -6.83 (SCS-PL-03 × SCS-PL-04) to 8.20 (SCS-PL-02 × SCS-PL-51) with an overall mean of 0.69. Four crosses exhibited significant positive heterosis and one cross exhibited the same in negative direction over the mid parent. In case of commercial heterosis only one cross *viz.,* SCS-PL-12 × SCS-PL-51 show cased significant positive heterosis. The range of heterosis was from -4.29 (SCS-PL-01 × SCS-PL-03) to 7.73 (SCS-PL-12 × SCS-PL-51) with an overall mean of 0.35.

Manifestation of heterosis for Fibre strength (g/tex)

Two crosses exhibited significant positive heterosis and four crosses exhibited significant negative heterosis over the mid parent. The range of heterosis was from -8.67 (SCS-PL-04 × SCS-PL-61) to 7.82 (SCS-PL-10 × SCS-PL-51) with an overall mean of -0.02. The range of heterosis over the commercial check was from -7.60 (SCS-PL-04 × SCS-PL-61) to 6.74 (SCS-PL-01 × SCS-PL-18) with an overall mean of 0.001.

Manifestation of heterosis for Micronaire (µ/inch)

Sixteen crosses expressed significant positive heterosis over the mid parent and four crosses expressed the same in negative direction. The crosses SCS-PL-01 × SCS-PL-10 and SCS-PL-04 × SCS-PL-61 showed minimum (-18.75) and maximum (30.94) heterosis values respectively with an overall mean of 2.06. In terms of commercial heterosis thirteen crosses expressed significant positive heterosis and two crosses expressed significant negative heterosis. The range of heterosis was from -18.57 (SCS-PL-01 × SCS-PL-03) to 24.68 (SCS-PL-18 × SCS-PL-61) with an overall mean of 2.74.

The results discussed above with respect to heterosis are in accordance with Gaurav *et al*. (2007), Nidagundi *et al*. (2012), Ashokkumar and Ravikesavan (2013), Baloch *et al*. (2014), Saifulla *et al*. (2014), Tuteja and Agarwal (2014), Kumar *et al.* (2015), Srinivas and Bhadru (2015) and Lingaraja *et al*. (2017).

Conclusion

The development of cotton cultivars possessing enhanced yield along with cotton fibre quality is essential for sustaining long-term cotton production in any region. Cultivars possessing a genetic capacity for higher fibre quality can build and sustain greater marketability and price. Therefore the present study involving crossing of eleven parents in half diallel fashion to generate fifty five hybrids was advanced to derive the hybrids having both the yield and fibre quality features. The hybrid SCS-PL-01 × SCS-PL-04 possessed both high seed cotton yield and fibre strength whereas another hybrid SCS-PL-02 × SCS-PL-18 was identified with potential yield and higher fibre length.

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