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Studies on heterosis for yield and yield attributing traits in American cotton (*Gossypium hirsutum* L.)

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Abstract
The present study was made in upland cotton with 10 x 10 half diallel to assess the extent of heterosis over standard check (LAHH 5) for seed cotton yield and its related traits at Regional Agricultural Research Station, Lam, Guntur. The highest heterotic effect were recorded in the hybrids SCS-1207 × GSHV-177, GSHV-177 × L1231 and SCS-1207 × PBH-13 were promising hybrids in this study over the standard check for seed cotton yield per plant and its most of the yield attributing traits. Those hybrids exhibiting high heterosis for seed cotton yield per plant also had high heterosis for yield attributing characters. The study reveals good scope for commercial exploitation of heterosis as well as isolation of pure lines among the progenies of other heterotic F1 hybrids.

Keywords: Heterosis, *Gossypium hirsutum,* seed cotton yield, attributing traits

Introduction
Cotton (*Gossypium hirsutum* L.) is an important fibre crop and plays a vital role as a cash crop in commerce of many countries such as USA, China, India, Pakistan, Uzbekistan, Australia and Africa. Cotton plays an important role in Indian economy and it is most important natural fibre for India's textile industry. Sufficient cotton production is required to meet the ever increasing fibre demand of growing World's population. In India cotton is being grown over an area of 122 lakh ha with an annual production of 377 lakh bales (1bale = 170kg of lint) and productivity of 524 kg lint ha^{-1} (AICCIP, Annual Report, 2017) [1]. Development of new variety with higher yield and fibre quality are the primary objectives of cotton breeding programmes. The first step in successful breeding program is to select appropriate parents. Diallel analysis provides a systemic approach for the identification of suitable parents and cross combination for the investigated traits. (Griffings, 1956) [4]. Cotton being highly amenable for heterosis breeding of commercial exploitation of heterosis in cotton has achieved spectacular success in India, as is evident from the widespread use of inter-specific and intra specific hybrids. All the hybrids being cultivated are single cross hybrids only. The present study was undertaken with the objective of finding out the extent of heterosis over mid parent, better parent and standard check for seed cotton yield per plant and its attributing traits in cotton.

Material and Methods
The present study was carried out by selecting the ten parents *viz*., L788, HYPS-152, L770, L1493, L1231, SCS-1207, PBH-13, GJHV-497, GSHV-177 and GTHV-13/32 and forty five intra-specific cross combinations which were generated in half-diallel fashion. The evaluation of hybrids along with parents and standard check (LAHH-5) was done at Regional Agricultural Research Station, Lam, Guntur during *kharif*, 2017-18. Observations were recorded on five randomly selected plants from each genotype per replication. The data were recorded on plant height (cm), number of bolls $plant^{-1}$, boll weight (g), seed index (g), ginning outturn (%) and seed cotton yield plant $^{-1}$ (g) were used for statistical analysis for estimation of heterosis. The heterotic effects were measured as deviation of F_1 mean from mid parent (relative heterosis), better parent (heterobeltiosis) and the standard check (standard heterosis). Heterosis over mid parent, better parent and standard check were estimated as per the formula given by Liang *et al.* (1971) [7].

Results and Discussion

The heterosis observed over the mid parent, better parent and standard check for seed cotton yield and fibre quality traits are presented in Table 1 and best heterotic combinations were represented in Table 2. The results indicated that the phenomenon of heterosis was observed for all the characters, however, its magnitude varied with the characters.

Heterosis for seed cotton yield^{-1} over mid parent, better parent and standard check ranged from -6.55 (L1493 × GSHV-177) to 93.14 (SCS-1207 × GTHV 13/32), -20.21 (L770 × PBH-13) to 69.85 (SCS-1207 × GTHV 13/32) and -30.87 (L770 × GTHV-13/32) to 52.59 (SCS-1207 × GSHV-177) with mean values of 29.12, 19.13 and 6.25, respectively. The hybrid combinations, *viz.*, (HYPS-152 × SCS-1207), (L770 × GSHV-177), (SCS-1207 × PBH-13), (SCS-1207 × GJHV-497), (SCS-1207 × GSHV-177), (SCS-1207 × GTHV 13/32), (PBH-13 × GJHV-497), (PBH-13 × L1231), (GSHV-177 × GTHV-13/32) and (GSHV-177 × L1231) exhibited significant positive heterosis over mid parent, better parent and standard check. These results are in agreement with the findings of Balu *et al.* (2012) [3], Sekhar *et al.* (2012) [12], Patel *et al*. (2012) [9], Punitha *et al*. (2012) [10], Kumar *et al*. (2013) [6], Nassar (2013) [8], Srinivas and Bhadru (2015) [13], Abdul *et al*. (2016) [2] and Jayshankar (2017) [5] who had reported significant positive heterosis for seed cotton yield plant^{-1}.

Heterosis for plant height over mid parent, better parent and superior check stretched between -9.55 (L788 × GSHV-177) to 22.07 (GTHV-13/32 × L1231), -14.51 (L788 × GSHV-177) to 18.67 (HYPS-152 × SCS-1207) and 8.55 (L1493 × L1231) to 41.21 (SCS-1207 × GTHV-13/32) with mean values of 7.15, 0.14 and 22.57 per cent, respectively. The hybrids *viz.*, (HYPS-152 × L1493), (L770 × L1493), (L1493 × SCS-1207), (L1493 × L1231), (SCS-1207 × GTHV-13/32) and (GTHV-13/32 × L1231) showed positive significant heterosis over mid parent, better parent and standard check. The top three heterotic crosses combinations for plant height were HYPS-152 × SCS-1207, PBH-13 × GTHV-13/32 and GSHV-177 × GTHV-13/32. The results are in agreement with the research findings of Patel *et al.* (2012) [9], Punitha *et al.* (2012) [10], Sekhar *et al.* (2012) [12], Reecha *et al*. (2016) [11] and Jayshankar (2017) [5].

The mean values of heterosis for number of bolls plant^{-1} over mid parent, better parent and standard check were found to 21.85, 11.72 and 21.81. Heterosis over mid parent ranged from -2.89 (L770 × PBH-13) to 53.93 (L788 × GJHV-497); over better parent -11.94 (HYPS-152 × L770) to 42.18 (L788 × GJHV-497) and over standard check -4.02 (L788 × GTHV-13/32) to 49.96 (PBH-13 × GJHV-497). The hybrids *viz.*, PBH-13 × GJHV-497, GSHV-177 × GTHV-13/32 and SCS-1207 × GJHV-497 were identified as the best heterotic combinations over mid parent, over better parent and over standard check. These results are in agreement with the research findings of Patel *et al.* (2012) [9], Sekhar *et al* (2012) [12], Kumar *et al*. (2013) [6], Abdul *et al*. (2016) [2], Reecha *et al*. (2016) [11] and Jayshankar (2017) [5].

The mean values of heterosis for boll weight over mid parent, better parent and standard check were found to be 16.41, 6.69 and 4.09, respectively. Heterosis over mid parent ranged from -8.3 (L788 × HYPS-152) to 48.26 (L1493 × GTHV 13/32), over better parent -17.82 (L788 × GTHV-13/32) to 47.94 (L1493 × GTHV 13/32) and over standard check -5.62 (HYPS-152 × L1493) to 20.95 (SCS-1207 × PBH-13). The crosses exhibited significant positive heterosis over mid parent, better parent and standard check were (HYPS-152 × SCS-1207), (L1493 × SCS-1207), (L1493 × GSHV-177), (L1493 × GTHV-13/32), (SCS-1207 × PBH-13) and (SCS-1207 × GTHV-13/32). The hybrid combinations, SCS-1207 × PBH-13, L1493 × SCS-1207 and HYPS-152 × SCS-1207 were found to be superior as they exhibited significant and positive heterosis over mid parent, better parent and standard check. These finding are in support with the reports of Patel *et al*. (2012) [9], Sekhar *et al*. (2012) [12], Kumar *et al*. (2013) [6], Abdul *et al*. (2016) [2] and Reecha *et al*. (2016) [11].

Heterosis for seed index over mid parent, better parent and standard check ranged from -6.23 (L1493 × PBH-13) to 39.35 (L1493 × SCS-1207), -14.13 (SCS-1207 × L1231) to 30.84 (L1493 × SCS-1207) and 2.85 (SCS-1207 × L1231) to 56.72 (L1493 × SCS-1207) with mean values of 14.67, 8.35 and 18.46, respectively. Crosses *viz*., (L788 × L770), (HYPS-152 × L770), (HYPS-152 × GTHV-13/32), (L770 × GSHV-177), (L770 × GTHV-13/32), (L1493 × SCS-1207) and (L1493 × GSHV-177) crosses exhibited significant positive heterosis over mid parent, better parent and standard check. The crosses *viz*., L1493 × SCS-1207, HYPS-152 × SCS-1207 and HYPS-152 × PBH-13 were identified as best heterotic combinations for seed index. These results are in accordance with the findings of Punitha *et al*. (2012) [10], Sehkar *et al*. (2012), Nassar (2013) [8] and Abdul *et al*. (2016) [2].

Heterosis for ginning outturn over mid parent, better parent and standard check ranged from -14.63 (L770 × L1493) to 10.14 (GJHV-497 × GSHV-177), -15.80 (L770 × L1493) to 4.90 (SCS-1207 × PBH-13) and -5.60 (L770 × L1493) to 13.25 (SCS-1207 × L1231) with mean value of -3.70, -6.58 and 2.83, respectively. The crosses *viz*., (SCS-1207 × L1231) exhibited positive significant heterosis over mid, better parent and standard check. The crosses *viz*., SCS-1207 × L1231, L1493 × GTHV-13/32 and GSHV-177 × L1231 were identified as the best heterotic combinations over mid parent, better parent and standard check for ginning outturn. These results are in accordance with the findings of Sekhar *et al*. (2012) [12], Kumar *et al*. (2013) [6], Srinivas and Bhadru (2015) [13] and Abdul *et al*. (2016) [2].

In the present study based on *per se* performance and significant standard heterosis the crosses, SCS-1207 × GSHV-177, GSHV-177 × L1231 and SCS-1207 × PBH-13 were found to be promising for seed cotton yield plant^{-1}. These hybrids can be utilized for commercial cultivation after thorough checking in more number of environments for further confirmation.

Table 1: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check (SC) for seed cotton yield and fibre quality traits in intra-specific cotton hybrids (*Gossypium hirsutum* L.) during *kharif*, 2017-18

S. No.	Character	Plant height (cm)			Number of bolls plant^{-1}			Boll weight (g)			Seed index (g)		
		MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
1	L788 × HYPS-152	3.04	2.78	19.10**	40.37**	33.33**	17.61	-8.30**	-10.36**	4.17	7.43	3.27	13.68
2	L788 × L770	1.41	-3.10	12.30	7.78	-9.24	5.27	0.87	-15.88**	-2.25	20.74**	15.45*	27.09**
3	L788 × L1493	8.07	-2.71	12.74*	20.56*	14.90	0.63	9.47**	-10.57**	3.93	-1.71	-3.91	5.79
4	L788 × SCS-1207	4.20	2.78	19.10**	19.75**	-0.15	18.68	1.77	-6.91*	8.19*	7.31	2.97	23.34**
5	L788 × PBH-13	2.42	-3.22	26.04**	35.01**	12.44	34.05**	-0.59	-7.39*	7.62*	-2.94	-7.05	11.81

6	L788 × GJHV-497	-0.56	-5.42	21.48**	53.93**	42.18**	33.15**	-1.14	-12.91**	1.20	8.67	2.77	13.14
7	L788 × GSHV-177	-9.55*	-14.51 *	11.27	15.97	-0.32	10.01	5.64	-8.22*	6.66	8.13	1.99	12.28
8	L788 × GTHV-13/32	-1.60	-3.75	16.62**	18.41	15.98	-4.02	0.42	-17.82**	-4.49	18.10*	4.97	15.56
9	L788 × L1231	4.17	-5.19	9.87	12.30	-2.64	5.27	7.22*	-9.74**	4.90	13.29	6.43	17.16*
10	HYPS-152 × L770	6.83	2.33	17.99**	0.04	-11.94	2.14	9.02**	-7.38*	2.81	27.66**	26.94**	28.93**
11	HYPS-152 × L1493	16.71**	5.31**	21.42**	28.72**	28.27*	13.14	2.22	-14.97**	-5.62	8.09	6.25	11.73
12	HYPS-152 × SCS-1207	20.02**	18.67	36.83**	3.93	-9.47	7.60	14.71**	7.16*	18.94*	22.61**	13.28	35.69**
13	HYPS-152 × PBH-13	0.99	-4.80	23.98**	3.58	-9.90	7.42	5.58	0.51	11.56*	22.29**	12.77	35.65**
14	HYPS-152 × GJHV-497	-0.45	-5.55	21.32**	26.19**	22.52*	14.75	3.14	-7.30*	2.89	17.27*	15.28	17.08*
15	HYPS-152 × GSHV-177	6.20	0.14	30.34**	17.73*	5.91	16.89	5.02	-6.94*	3.29	3.49	1.46	3.05
16	HYPS-152 × GTHV13/32	11.45*	8.75	31.77**	32.36**	28.27*	13.14	8.11*	-9.91**	0.00	30.03**	19.82*	21.70**
17	HYPS-152 × L1231	17.40**	7.09	23.48**	17.34*	6.53	15.19	21.37**	4.12	15.57**	10.51	7.89	9.58
18	L770 × L1493	15.78**	8.75**	14.83**	32.40**	16.18	34.76**	31.03**	27.71**	-0.88	11.05	8.55	14.15
19	L770 × SCS-1207	8.82	5.38	18.79**	10.05	8.72	29.22**	16.51**	5.16	1.36	14.72*	5.45	26.31**
20	L770 × PBH-13	2.48	-7.21	20.84**	-2.89	-4.20	14.21	13.76**	0.88	1.20	17.61**	7.90	29.79**
21	L770 × GJHV-497	0.43	-8.50	17.52**	35.38**	22.34**	41.91**	16.04**	8.88*	-3.61	14.12	12.81	13.29
22	L770 × GSHV-177	3.06	-6.67	21.48**	6.91	4.31	21.00*	28.75**	22.66**	5.14	29.83**	27.99**	28.54**
23	L770 × GTHV-13/32	-0.07	-6.49	13.30*	11.15	-4.78	10.46	34.78**	31.64**	2.17	30.91**	21.25*	21.77**
24	L770 × L1231	8.53	3.12	8.89	9.41	5.70	22.61*	23.76**	22.32**	-2.81	13.28	11.21	11.69
25	L1493 × SCS-1207	18.18**	7.72**	21.42**	23.12**	6.92	27.08**	41.48**	24.81**	20.30**	39.35**	30.84**	56.72**
26	L1493 × PBH-13	16.54**	-0.22	29.95**	30.68**	13.34	35.12**	12.36**	-2.56	-2.25	-6.23	-12.12	5.71
27	L1493 × GJHV-497	13.12**	-2.59	25.12**	20.12*	16.22	8.85	27.46**	16.77**	3.37	18.35**	14.39	20.29*
28	L1493 × GSHV-177	8.37	-7.20	20.79**	11.60	0.08	10.46	37.97**	28.28**	9.95**	21.87**	17.47*	23.53**

*, ** Significant at 5% and 1% level, respectively

S. No	Character	Plant height (cm)			Number of bolls $plant^{-1}$			Boll weight (g)			Seed index (g)		
		MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
29	L1493 × GTHV13/32	9.20	-3.59	16.81	26.97**	23.47*	8.13	48.26**	47.94**	9.47*	16.27*	5.46	10.91
30	L1493 × L1231	15.58**	14.18*	8.55**	11.23	0.66	8.85	33.12**	28.28**	1.93	11.83	7.36	12.90
31	SCS-1207 × PBH-13	8.75	1.44	32.11**	8.11	7.95	28.69**	22.97**	20.56**	20.95**	6.86	6.63	28.26**
32	SCS-1207× GJHV-497	6.26	-0.25	28.13**	38.77**	24.06**	47.45**	13.02**	8.41*	4.49	23.21**	12.08	34.25**
33	SCS-12 07×GSHV-177	8.85*	1.56	32.19**	14.46	10.38	31.19**	17.76**	11.24**	7.22	6.80	-3.10	16.07
34	SCS-1207×GTHV13/32	20.76**	16.55**	41.21**	29.96**	10.23	31.01**	26.80**	12.07**	8.03*	28.74**	10.38	32.21**
35	SCS-1207 × L1231	17.33**	8.15	21.90**	15.67*	10.45	31.28**	16.48**	6.24	2.41	-5.00	-14.13*	2.85
36	PBH-13 × GJHV-497	1.92	1.22	31.82**	40.89**	25.79**	49.96**	5.06	-1.12	-0.80	8.36	-1.62	18.33*
37	PBH-13 × GSHV-177	3.96	3.93	35.36**	16.08*	11.77	33.24**	12.94**	4.72	5.06	16.42*	5.43	26.82**
38	PBH-13× GTHV-13/32	6.26	2.55	33.56**	34.51**	13.94	35.84**	15.10**	0.00	0.32	14.03*	-2.40	17.40*
39	PBH-13 × L1231	8.68	-6.00	22.43**	14.15	8.85	29.76**	19.64**	7.20	7.54*	-0.68	-10.40	7.78
40	GJHV-497 × GSHV-177	-0.54	-1.20	28.60**	39.82**	29.23**	42.63**	16.35**	14.51**	1.36	14.50	14.18	12.04
41	GJHV497×GTHV13/32	-4.27	-6.98	19.47**	21.78*	14.69	7.42	25.43**	15.14**	1.93	22.26**	14.46	12.31
42	GJHV-497 × L1231	6.10	-7.68	18.58**	19.75*	11.74	20.82*	14.09**	8.25	-4.17	17.63*	16.81	14.62
43	GSHV177×GTHV13/32	5.91	2.25	33.09**	50.67**	31.82**	45.49**	22.11**	13.76**	-2.49	22.66**	15.14	12.35
44	GSHV-177 × L1231	-0.89	-14.25**	11.61	16.56*	15.38	27.35**	27.79**	23.13**	5.54	11.04	10.58	7.90
45	GTHV-13/32 × L1231	22.07**	8.93**	31.98**	42.32**	25.62**	35.84**	33.26**	28.69**	2.25	19.57*	12.69	9.03
	Mean	7.15	0.14	22.57	21.85	11.72	21.81	16.41	6.69	4.09	14.67	8.35	18.46
	Range Min	-9.55	-14.51	8.55	-2.89	-11.94	-8.30	-17.82	-5.62	-6.23	-14.13	2.85	2.85
	Range Max	22.07	18.67	41.21	53.93	42.18	48.26	47.94	20.95	39.35	30.84	56.72	56.72

Table 2: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check (SC) for seed cotton yield and fibre quality traits in intra-specific cotton hybrids (*Gossypium hirsutum* L.) during *kharif*, 2017-18

S. No.	Character	Ginning outturn (%)			Seed cotton yield $plant^{-1}$ (g)		
		MP	BP	SH	MP	BP	SH
1	L788 × HYPS-152	-4.22	-6.05*	1.68	9.86	9.07	-14.25
2	L788 × L770	-5.58*	-8.96**	2.07	14.24	10.28	-13.30
3	L788 × L1493	-1.75	-3.99	4.70	3.33	2.09	-19.74
4	L788 × SCS-1207	0.61	-1.80	2.22	35.91**	32.01*	10.10
5	L788 × PBH-13	3.76	1.94	6.11*	14.00	-1.63	6.55
6	L788 × GJHV-497	-4.40*	-8.21**	3.82	39.77**	39.56**	10.04
7	L788 × GSHV-177	-9.34**	-10.94**	-3.90	5.96	-7.40	-2.66
8	L788 × GTHV-13/32	-2.95	-6.32**	4.79	15.84	4.55	-17.81
9	L788 × L1231	-1.35	-3.11	4.60	36.49**	36.28**	7.46
10	HYPS-152 × L770	-13.05**	-14.56**	-4.21	30.20*	26.57	-1.92
11	HYPS-152 × L1493	-6.16**	-6.52**	1.94	13.59	13.04	-12.41
12	HYPS-152 × SCS1207	-7.09**	-11.00**	-3.67	55.94**	50.42**	25.45*
13	HYPS-152 × PBH-13	-1.04	-4.60	3.24	7.61	-7.70	-0.03
14	HYPS-152 × GJHV-497	-10.29**	-12.23**	-0.72	18.86	17.84	-7.09
15	HYPS-152 × GSHV177	-3.89	-4.03	3.87	14.68	-0.39	4.71
16	HYPS152×GTHV13/32	-9.41**	-10.88**	-0.31	23.00	11.73	-13.42

17	HYPS-152 × L1231	-10.59**	-10.70**	-3.35	4.03	3.13	-18.67
18	L770 × L1493	-14.63**	-15.80**	-5.60 *	19.56	16.78	-10.39
19	L770 × SCS-1207	-0.04	-5.83*	5.57*	44.72**	35.84**	13.29
20	L770 × PBH-13	-7.96**	-12.75**	-2.18	-4.76	-20.21*	-13.58
21	L770 × GJHV-497	-8.84**	-9.24**	2.66	52.32**	46.83**	15.77
22	L770 × GSHV-177	-4.52*	-6.31**	5.04	46.99**	24.65*	31.02**
23	L770 × GTHV13/32	-8.47**	-8.57**	2.50	1.33	-5.51	-30.87**
24	L770 × L1231	0.47	-1.39	10.56**	33.63**	28.81*	1.57
25	L1493 × SCS-1207	-9.30**	-13.43**	-5.60*	75.49**	68.47**	40.51
26	L1493 × PBH-13	-0.66	-4.58	4.06	22.20*	4.39	13.07
27	L1493 × GJHV-497	-5.36*	-7.05**	5.13	-0.99	-2.32	-22.98*
28	L1493 × GSHV-177	-5.05*	-5.55*	3.00	-6.55	-19.17	-15.03

S. No.	Character		Ginning outturn (%)			Seed cotton yield plant^{-1} (g)		
			MP	BP	SH	MP	BP	SH
29	L1493 × GTHV13/32		1.37	0.10	11.96**	51.54**	38.26**	6.09
30	L1493 × L1231		-7.63**	-8.10**	0.23	24.50*	22.83	-3.15
31	SCS-1207 × PBH-13		5.59*	4.90	5.36	37.83**	21.98*	32.12**
32	SCS-1207× GJHV-497		-8.41**	-14.07**	-2.80	45.61**	41.63**	18.12**
33	SCS-1207×GSHV-177		-4.89*	-8.76**	-1.55	61.88**	45.16**	52.59**
34	SCS-1207×GTHV13/32		0.91	-4.84*	6.44*	93.14**	69.85**	41.66**
35	SCS-1207 × L1231		9.38**	4.87*	13.25**	17.00	13.81	-5.08
36	PBH-13 × GJHV-497		-0.56	-6.13*	6.18*	40.81**	21.66*	31.77**
37	PBH-13 × GSHV-177		1.95	-1.57	6.21*	3.82	2.29	10.79
38	PBH-13× GTHV-13/32		-2.07	-7.07**	3.95	40.38**	11.21	20.45
39	PBH-13 × L1231		4.42	0.79	8.81**	45.36**	25.60**	36.04**
40	GJHV-497 × GSHV-177		10.14**	-12.21**	-0.70	32.61**	16.04	21.98*
41	GJHV497×GTHV13/32		-9.80**	-10.30**	1.46	19.13	7.38	-15.33
42	GJHV-497 × L1231		-5.60**	-7.75**	4.35	17.55	17.55	-7.31
43	GSHV177×GTHV13/32		-4.77*	-6.45**	4.64	54.49**	23.76*	30.09**
44	GSHV-177 × L1231		3.53	3.50	11.74**	60.59**	40.53**	47.72**
45	GTHV-13/32 × L1231		-9.07**	-10.66**	-0.06	37.01**	23.49	-2.62
	Mean		-3.70	-6.58	2.83	29.12	19.13	6.25
	Range	Min	-14.63	-15.80	-6.55	-20.21	-30.87	
		Max	10.14	4.90	93.14	69.85	52.59	

*, ** Significant at 5% and 1% level, respectively

Table 2: The best heterotic combinations identified for yield and yield contributing characters in intra-specific hybrids of cotton (*Gossypium hirsutum* L.) during *kharif*, 2017-18

S. No.	Characters	Cross combinations	*Per se* performance	*sca* effect	Standard heterosis
1.	Plant height (cm)	HYPS152× SCS1207	172.86	12.584*	36.83**
		PBH13×GTHV-13/32	168.73	1.848	33.56**
		GSHV177×GTHV-13/32	168.13	4.568	33.09**
2.	Number of bolls plant^{-1}	PBH-13× GJHV -497	55.93	6.767**	49.96**
		SCS-1207 × GJHV-497	55.00	6.356**	47.45**
		GSHV-177 × GTHV -13/32	54.26	9.862**	45.49**
3.	Boll weight (g)	SCS -1207 × PBH -13	5.02	0.452**	20.95*
		L1493 × SCS-1207	4.99	0.648**	20.30*
		HYPS-152× SCS-1207	4.94	0.287**	18.94*
4.	Seed index (g)	L1493 × SCS-1207	13.36	2.636**	56.72**
		HYPS-152 × SCS-1207	11.57	0.784	35.69**
		HYPS-152 × PBH-13	11.56	1.301**	35.65**
5.	Ginning outturn (%)	SCS-1207 × L1231	35.15	2.901**	13.25**
		L1493 × GTHV-13/32	34.75	-1.672**	11.96**
		GSHV-177 × L1231	34.68	1.741**	11.74**
		SCS-1207 × PBH-13	50.00	1.119	6.38**
		GSHV-177 × L1231	50.00	0.952	6.38**
6	Seed cotton yield plant^{-1} (g)	SCS-1207 × GSHV-177	180.76	25.983**	52.59**
		GSHV-177 × L1231	175.00	38.172**	47.72**
		SCS-1207 × PBH-13	167.81	37.379**	32.12**

* Significant at 5% level
** Significant at 1% level

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