Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 804-810
Received: 05-05-2017
Accepted: 06-06-2017

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Study of Heterosis in Interspecific Hybrids of Cotton (*Gossypium hirsutum* L. x *Gossypium barbadense* L.)

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Abstract
A line x tester analysis was undertaken to estimates the magnitude of heterosis in interspecific hybrids of cotton (*Gossypium hirsutum* L. x *Gossypium barbadense* L.) for yield and its components characters in 56 entries including (42 hybrids along with 13 parents and 1 standard check hybrid). Analysis of variance indicated the significant difference among the parents and hybrids for all thirteen characters studied which revealed existence of variability among the genotypes. Studies revealed that for seed cotton yield per plant out of 42 cross combinations, 10 hybrids had registered significant positive estimates of heterobeltiosis. The hybrids, GJC 101 x TCB 27 (31.64%) followed by SI 13-31 x ARBB 1302 (29.35%) and GN Cot. 22 x ARBB 1302 (28.83%) had significant value with maximum estimates of heterobeltiosis. Six hybrids had registered significant positive standard heterosis over G. Cot. HB 102, of which, GN Cot. 22 x ARBB 1302 (24.61%) followed by GJC 101 x TCB 27 (22.71%) and AC 738 x ARBB 1302 (20.71%) had significant value with maximum estimates and its attributing characters like total number of bolls per plant, average boll weight, lint yield per plant, seed index and lint index.

Keywords: Cotton, Line x Tester analysis, Heterobeltiosis, Standard heterosis, Seed cotton yield per plant

Introduction
Cotton the king of fibre reside one of the momentous and important cash crop exercising profound influence on economics and social affairs of the world. The word "cotton" derived from the Arabic word "*al qatan*" and popularly known as "White Gold". India is going to be in surge in textile industry ahead of China which has been possible only due to cotton crop, which is the backbone of textile industry. Cotton plays vital role in Indian economy. The *Gossypium* species were domesticated in both the old and new world. It supplies products such as lint, oil, seed meal, hulls and linters. The genus *Gossypium*, a member of the Malvaceae family, consists of 50 species, four of which are generally cultivated species. Out of the four cultivated species, *Gossypium hirsutum* L. and *Gossypium barbadense* L. are tetraploids (2n=4x=52) and are commonly called as new world cottons. Whereas, *Gossypium arboreum* L. and *Gossypium herbaceum* L. are diploids (2n=2x=26) and known as old world cottons. India is the only country, where all four cultivated species of cotton *viz., G. herbaceum, G. arboreum, G. hirsutum* and *G. barbadense* are grown. These four species are referred as cotton. The area under cotton cultivation in the India is about 10.5 million hectare with annual production of 35.1 million bales with productivity 568 kg/ha [1].
India reside pioneer in commercialization of heterosis in cotton. A noticeable heterosis is reported in cotton by many workers. For better exploitation of heterosis in cotton, development of simple and economically variable hybrid seed production technique should be strengthen. Thereafter, number of intraspecific hybrids (*G. hirsutum* L. x *G. hirsutum* L.) and interspecific hybrids (*G. hirsutum* L. x *G. barbadense* L.) having high yield potentiality, big boll size, early in maturity coupled with extra-long staples (ELS) and desirable fibre traits have been released for commercial cultivation. Improvement in yield has been achieved through distant hybridization, particularly through interspecific hybridization.

Materials and methods
The experimental materials comprised of two species of Cotton *Gossypium hirsutum* L. used as females and *Gossypium barbadense* L. as pollen parents. Seven females (ACH 15-01, AC 738, SI 13-31, GJHV 507, GJC 101, GN Cot. 22 and G. Cot. 12) and six males (DB 1301, ARBB 1302, GSB 43, CCB 40, TCB 27 and Suvin) were crossed using line x tester mating design to prepare forty two hybrids at Regional Research Station, Anand Agricultural University, Anand during *kharif* 2015-16. Thus, the experimental material consisted of 56 entries, comprising of seven females and six males and resultant forty two hybrids evaluated

along with a G. Cot. HB 102 (H x B) hybrid as standard check. Single row of 4.5 meter length was assigned to each genotype with 10 plants having 45 cm intra row spacing and 120 cm inter row spacing. All the recommended agronomic and plant protection practices were uniformly applied throughout the crop growth period to raise a good crop.

Five plants were randomly selected from each replication for each genotype and the average value per plot was computed for recording observations on plant height, number of monopodia per plant, number of sympodia per plant, total number of bolls per plant, average boll weight, seed cotton yield per plant, seed index and staple length; whereas, ginning percentage, lint yield per plant and lint index were calculated on formula basis. While, days to 50 per cent flowering was recorded on plot basis and oil content was estimated by NMR (Nuclear Magnetic Resonance) machine. Analysis of variance technique suggested by [6] was followed to test the differences between the genotypes for all the characters under study. Heterosis was estimated in terms of two parameters, *i.e.* heterobeltiosis [3] and standard heterosis [5].

Results and discussion

The analysis of variance revealed that the mean squares due to genotypes were significant for all the characters under study (Table 1). The mean squares due to genotypes were further partitioned into parents, hybrids, parents *vs.* hybrids and check *vs.* hybrids. The parents differed significantly for all the characters except plant height and lint index, hybrids highly significant for all characters. This revealed the existence of considerable genetic variability among the parents and hybrids for all the characters under study. The mean squares due to parents *vs.* hybrids were significant for all the characters except average boll weight, which indicated that the performance of parents was different from that of hybrids, thereby supporting the possibility of heterotic effects for all the traits. The mean squares due to check *vs.* hybrids were significant for majority of the traits *viz.*, day to 50 per cent flowering, plant height, number of monopodia per plant, average boll weight, ginning percentage, oil content and staple length, suggesting presence of heterosis for these traits.

The estimates of heterobeltiosis (HB) varied from -7.61% (GN Cot. 22 x Suvin) to 13.41% (ACH 15-01 x GSB 43) for days to 50 per cent flowering, -10.66% (SI 13-31 x CCB 40) to 29.88% (GJC 101 x DB 1301) for plant height, -23.21% (GN Cot. 22 x Suvin) to 15.38% (G. Cot. 12 x ARBB 1302) for number of monopodia per plant, -19.33% (SI 13-31 x GSB 43) to 35.42% (GN Cot. 22 x ARBB 1302) for number of sympodia per plant, -14.32% (AC 738 x Suvin) to 42.46% (ACH 15-01 x ARBB 1302) for total number of bolls per plant, -33.91% (ACH 15-01 x CCB 40) to 11.80% (SI 13-31 x ARBB 1302) for average boll weight, -28.59% (ACH 15-01 x CCB 40) to 31.64 % (GJC 101 x TCB 27) for seed cotton yield per plant, -37.27% (ACH 15-01 x CCB 40) to 27.04% (SI 13-31 x ARBB 1302) for lint yield per plant, -17.74 % (GJC 101 x Suvin) to 1.98% (G. Cot. 12 x TCB 27) for ginning percentage, -21.88% (SI 13-31 x CCB 40) to 35.04% (GJC 101 x TCB 27) for seed index, -23.53% (GJHV 507 x ARBB 1302) to 33.42% (GJC 101 x TCB 27) for lint index, -31.51% (G. Cot. 12 x CCB 40) to 4.22% (GJC 101 x CCB 40) for oil content and -20.64% (G. Cot. 12 x GSB 43) to 5.45% (AC 738 x Suvin) for staple length (Table 2,3,4,5 and 6). Several hybrids exhibited significant heterobeltiosis in desirable direction for different component characters *i.e.* days to 50 per cent flowering (2), plant height (23), number of monopodia per plant (1), number of sympodia per plant (21), total number of bolls per plant (15), average boll weight (1), seed cotton yield per plant (10), lint yield per plant (6), seed index (12) and lint index (9). While, none of the hybrids registered significantly positive heterobeltiosis for ginning percentage, oil content and staple length. The heterotic response over better parent in cotton was also reported by [2, 7, 8, 9, 10, 11].

Improvement in seed cotton yield is one of the important objectives, so the superiority of hybrids over best cultivated hybrid is essential for increasing its commercial value. The estimates of standard heterosis (SH) ranged from -13.24% (GN Cot. 22 x DB 1301) to 2.94% (GJC 101 x GSB 43) for days to 50 per cent flowering, -13.44% (G. Cot. 12 x TCB 27) to 22.66 % (GN Cot. 22 x DB 1301) for plant height, -25.00% (ACH 15-01 x CCB 40) to 15.38% (G. Cot. 12 x ARBB 1302) for number of monopodia per plant, -32.54% (SI 13-31 x GSB 43) to 12.93% (GJC 101 x CCB 40) for number of sympodia per plant, -19.08% (ACH 15-01 x TCB 27) to 26.59% (ACH 15-01 x ARBB 1302) for total number of bolls per plant, -27.82% (ACH 15-01 x CCB 40) to 10.67% (GN Cot. 22 x ARBB 1302) for average boll weight, -30.75 % (ACH 15-01 x CCB 40) and 24.61% (GN Cot. 22 x ARBB 1302) for seed cotton yield per plant, -34.71% (GJHV 507 x ARBB 1302) and 28.05% (GN Cot. 22 x ARBB 1302) for lint yield per plant,-15.06% (GJC 101 x Suvin) to 2.73% (GN Cot. 22 x ARBB 1302) for ginning percentage, -20.0% (G. Cot. 12 x Suvin) to 21.53% (GJC 101 x TCB 27) for seed index, -26.33% (GJHV 507 x ARBB 1302) to 21.92% (GN Cot. 22 x ARBB 1302) for lint index, -27.14% (G. Cot. 12 x CCB 40) to 11.24% (GJC 101 x CCB 40) for oil content and -17.08% (G. Cot. 12 x GSB 43) to 10.61% (AC 738 x Suvin) for staple length (Table 2,3,4,5 and 6). The promising hybrids based on standard heterosis for staple length were AC 738 x Suvin (10.61%), GJC 101 x Suvin (10.00%) and SI 13-31 x Suvin (9.59%). Out of 42 hybrids, several hybrids exhibited significant standard heterosis in desirable direction for different component characters *i.e.* days to 50 per cent flowering (25), plant height (22), number of monopodia per plant (1), number of sympodia per plant (7), total number of bolls per plant (5), average boll weight (2), seed cotton yield per plant (6), lint yield per plant (5), seed index (8), lint index (2), oil content (1) and staple length (3). While, none of the hybrids registered significantly positive standard heterosis for ginning percentage. As observed in the present investigation, several workers [2, 4, 7, 8, 9, 10, 11] had also reported the considerable degree of standard heterosis for seed cotton yield per plant and its component traits.

Conclusion

Among 42 hybrids tested, six hybrids depicted significant and positive heterosis over check hybrid (G. Cot. HB 102) for seed cotton yield per plant. The promising hybrids based on standard heterosis for seed cotton yield per plant were GN Cot. 22 x ARBB 1302 (24.61%), GJC 101 x TCB 27 (22.71%) and AC 738 x ARBB 1302 (20.71%). These hybrids also depicted significant and positive heterosis over their respective better parent. The high heterotic response in these hybrids was resulted due to positive heterosis for yield contributing characters like average boll weight, total number of bolls per plant, lint yield per plant, seed index and lint index. The heterotic effect for seed cotton yield per plant can be considered as outcome of direct effect of these attributes and indirect effects of other yield contributing attributes like number of monopodia per plant, number of sympodia per plant and plant height. Therefore, heterotic effects for seed

cotton yield per plant could be a result of combinational heterosis.

Table 1: Analysis of variance (mean squares) for yield and its components in cotton

Source	d. f.	DF	PH	NMP	NSP	TNBP	ABW	SCYP
Replication	2	0.97	69.50	0.02	0.17	109.41	0.04	114.75
Genotypes	55	31.24**	1135.12**	0.44**	51.59**	341.43**	0.38**	5014.03**
Parents	12	25.98**	355.62	1.20**	25.30**	253.36**	0.56**	6395.48**
Females	6	36.87**	150.38	0.09	0.86	10.65	0.12**	245.34
Males	5	14.49**	400.93	0.08	15.51**	63.60	0.06*	300.63
Females vs Males	1	18.07**	1360.50*	13.44**	220.96**	2658.34**	5.78**	73770.56**
Hybrids	41	32.37**	743.30**	0.21**	42.43**	197.52**	0.34**	3501.52**
Parents vs Hybrids	1	40.31**	27230.31**	0.47**	764.67**	7630.98**	0.01	54001.25**
Check vs Hybrids	1	32.87**	1127.69*	0.43**	11.15	12.03	0.22**	436.70
Error	110	1.79	215.98	0.046	3.29	50.84	0.02	352.80

Table 1: Analysis of variance (mean squares) for yield and its components in cotton

Source	d. f.	LYP	GP	SI	LI	OC	SL
Replication	2	4.53	0.07	0.15	0.06	0.45	4.82
Genotypes	55	571.49**	8.59**	4.58**	0.99**	4.72**	27.03**
Parents	12	939.64**	18.39**	2.74**	0.34	2.39**	53.28**
Females	6	65.73	3.15	0.38	0.07	1.83**	4.52*
Males	5	39.51	5.91**	2.72**	0.66*	2.07**	1.14
Females vs Males	1	10683.78**	172.15**	17.03**	0.39	7.41**	606.49**
Hybrids	41	397.35**	5.65**	3.94**	1.04**	3.15**	19.43**
Parents vs Hybrids	1	3606.39**	14.69**	57.19**	7.35**	100.70**	30.98**
Check vs Hybrids	1	134.20	6.94*	0.24	0.10	3.07*	16.42**
Error	110	44.31	1.54	0.78	0.22	0.47	1.75

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively, DF= Days to 50 per cent flowering, PH= Plant height (cm), NMP= Number of monopodia per plant, NSP= Number of sympodia per plant, TNBP= Total number of bolls per plant, ABW= Average boll weight (g), SCYP= Seed cotton yield per plant (g), LYP= Lint yield per plant (g), GP= Ginning percentage, SI= Seed index (g), LI= Lint index, OC= Oil content (%), SL= Staple length mm

Table 2: Estimates of heterobeltiosis and standard heterosis for days to 50 per cent flowering, plant height and number of monopodia per plant

Sr. No.	Hybrids	Days to 50 per cent flowering		Plant height		Number of monopodia per plant	
		Heterosis over		Heterosis over		Heterosis over	
		BP	SC	BP	SC	BP	SC
1	ACH 15-01 x DB 1301	2.79	-9.80**	27.96**	22.46**	3.96	0.96
2	ACH 15-01 x ARBB 1302	5.59**	-7.35**	26.53**	21.09**	0	-2.88
3	ACH 15-01 x GSB 43	13.41**	-0.49	24.29**	18.95**	-12.87*	-15.38**
4	ACH 15-01 x CCB 40	12.29**	-1.47	20.00**	14.84*	-22.77**	-25.00**
5	ACH 15-01 x TCB 27	7.82**	-5.39**	22.86**	17.58*	-20.79**	-23.08**
6	ACH 15-01 x Suvin	7.82**	-5.39**	22.65**	17.38*	-20.79**	-23.08**
7	GJHV 507 x DB 1301	9.84**	-1.47	12.01	11.13	-9.80	-11.54*
8	GJHV 507 x ARBB 1302	8.06**	-1.47	11.42	10.55	-11.76*	-13.46**
9	GJHV 507 x GSB 43	10.22**	0.49	5.91	5.08	-7.84	-9.62
10	GJHV 507 x CCB 40	7.53**	-1.96	17.13*	16.21*	-15.69**	-17.31**
11	GJHV 507 x TCB 27	11.29**	1.47	12.60	11.72	-13.73**	-15.38**
12	GJHV 507 x Suvin	9.14**	-0.49	12.60	11.72	-21.57**	-23.08**
13	GJC 101 x DB 1301	6.56**	-4.41**	29.88**	22.27**	-18.18**	-13.46**
14	GJC 101 x ARBB 1302	8.38**	1.47	24.11**	15.63*	-4.55	0.96
15	GJC 101 x GSB 43	9.95**	2.94	17.72*	8.98	-16.36**	-11.54*
16	GJC 101 x CCB 40	3.76*	-5.39**	23.37**	14.45*	-9.09	-3.85
17	GJC 101 x TCB 27	2.09	-4.41**	22.95**	14.06*	-15.45**	-10.58*
18	GJC 101 x Suvin	-0.52	-6.86**	24.47**	15.23*	-13.64**	-8.65
19	AC 738 x DB 1301	2.76	-8.82**	14.98*	19.92**	-18.52**	-15.38**
20	AC 738 x ARBB 1302	1.66	-9.80**	9.74	14.45*	-11.11*	-7.69
21	AC 738 x GSB 43	-0.55	-11.76**	7.12	11.72	-13.89**	-10.58*
22	AC 738 x CCB 40	1.10	-10.29**	5.81	10.35	-10.19*	-6.73
23	AC 738 x TCB 27	0.55	-10.78**	10.86	15.63*	-10.19*	-6.73
24	AC 738 x Suvin	1.10	-10.29**	1.12	5.47	-13.89**	-10.58*
25	SI 13-31 x DB 1301	5.59**	-7.35**	6.19	3.91	-8.16	-13.46**
26	SI 13-31 x ARBB 1302	1.68	-10.78**	17.76*	15.23*	-3.06	-8.65
27	SI 13-31 x GSB 43	3.35	-9.31**	2.00	-0.20	-18.37**	-23.08**
28	SI 13-31 x CCB 40	10.06**	-3.43*	-10.66	-12.58	-13.27*	-18.27**
29	SI 13-31 x TCB 27	2.23	-10.29**	20.56**	17.97*	-12.24*	-17.31**
30	SI 13-31 x Suvin	1.12	-11.27**	14.17	11.72	-9.18	-14.42**
31	GN Cot. 22 x DB 1301	-3.28	-13.24**	26.41**	22.66**	-19.64**	-13.46**
32	GN Cot. 22 x ARBB 1302	-6.15**	-10.29**	24.40**	20.70**	-14.29**	-7.69

33	GN Cot. 22 x GSB 43	-2.54	-5.88**	22.38**	18.75**	-8.93	-1.92
34	GN Cot. 22 x CCB 40	8.60**	-0.98	11.92	8.59	-10.71*	-3.85
35	GN Cot. 22 x TCB 27	-1.54	-5.88**	25.20**	21.48**	-19.64**	-13.46**
36	GN Cot. 22 x Suvin	-7.61**	-10.78**	19.16**	15.63*	-23.21**	-17.31**
37	G. Cot. 12 x DB 1301	12.57**	0.98	19.29*	12.30	-3.85	-3.85
38	G. Cot. 12 x ARBB 1302	7.18**	2.45	10.06	2.54	15.38**	15.38**
39	G. Cot. 12 x GSB 43	5.05**	1.96	-5.30	-12.70	-13.46**	-13.46**
40	G. Cot. 12 x CCB 40	10.22**	0.49	16.00*	7.62	-8.65	-8.65
41	G. Cot. 12 x TCB 27	2.05	-2.45	-6.69	-13.44	-7.69	-7.69
42	G. Cot. 12 x Suvin	3.52*	0.98	3.81	-4.30	-10.58*	-10.58*
Ra-nge	Min	-7.61	-13.24	-10.66	-13.44	-23.21	-25.00
	Max	13.41	2.94	29.88	22.66	15.38	15.38
S. E.±		1.096	1.096	12.09	12.09	0.176	0.176
No. of significant crosses		25	25	23	22	29	26
Positive		23	0	23	22	1	1
Negative		2	25	0	0	28	25

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively. BP: Better parent and SC: Standard check

Table 3: Estimates of heterobeltiosis and standard heterosis for number of sympodia per plant, total number of bolls per plant and average boll weight

Sr. No.	Hybrids	Number of sympodia per plant		Total number of bolls per plant		Average boll weight	
		Heterosis over		Heterosis over		Heterosis over	
		BP	SC	BP	SC	BP	SC
1	ACH 15-01 x DB 1301	33.76**	11.85*	37.21**	21.93*	-18.10**	-10.56**
2	ACH 15-01 x ARBB 1302	31.44**	9.91*	42.46**	26.59**	-18.20**	-10.67**
3	ACH 15-01 x GSB 43	6.44	-10.99*	8.83	-3.29	-24.43**	-17.47**
4	ACH 15-01 x CCB 40	16.24**	-2.80	7.88	-4.13	-33.91**	-27.82**
5	ACH 15-01 x TCB 27	5.67	-11.64*	-8.94	-19.08*	-12.26**	-4.18
6	ACH 15-01 x Suvin	12.37*	-6.03	10.88	-1.47	-26.25**	-19.46**
7	GJHV 507 x DB 1301	-4.08	-18.97**	-0.59	-12.47	-16.50**	-11.61**
8	GJHV 507 x ARBB 1302	6.12	-10.34*	-4.94	-16.30	-18.68**	-13.91**
9	GJHV 507 x GSB 43	15.05**	-2.80	17.96	3.86	-5.34	0.21
10	GJHV 507 x CCB 40	6.38	-10.13*	28.52**	13.15	-25.69**	-21.34**
11	GJHV 507 x TCB 27	17.60**	-0.65	12.56	-0.90	-13.24**	-8.16*
12	GJHV 507 x Suvin	6.63	-9.91*	14.17	0.52	-19.37**	-14.64**
13	GJC 101 x DB 1301	11.60*	-6.68	34.15**	16.40	-29.28**	-23.95**
14	GJC 101 x ARBB 1302	-5.15	-20.69**	-3.27	-16.06	-20.53**	-14.54**
15	GJC 101 x GSB 43	5.93	-11.42*	-3.17	-15.98	-16.15**	-9.83**
16	GJC 101 x CCB 40	35.05**	12.93**	29.16**	12.07	-1.36	6.07
17	GJC 101 x TCB 27	33.76**	11.85*	36.92**	18.80*	-4.09	3.14
18	GJC 101 x Suvin	25.00**	4.53	27.68**	10.78	0	7.53*
19	AC 738 x DB 1301	10.16	-3.02	17.16	11.35	-12.55**	-11.09**
20	AC 738 x ARBB 1302	27.29**	12.07*	27.02**	20.72*	-1.85	-0.21
21	AC 738 x GSB 43	24.11**	9.27	12.75	7.17	1.44	3.14
22	AC 738 x CCB 40	0.12	-11.85*	13.02	7.42	0.41	2.09
23	AC 738 x TCB 27	26.81**	11.64*	26.46**	20.19*	-1.85	-0.21
24	AC 738 x Suvin	-1.35	-13.15**	-14.32	-18.57*	3.29	5.02
25	SI 13-31 x DB 1301	13.14*	-5.39	12.38	2.86	7.46	0.94
26	SI 13-31 x ARBB 1302	18.30**	-1.08	15.58	5.78	11.80**	5.02
27	SI 13-31 x GSB 43	-19.33**	-32.54**	20.16*	9.97	-20.49**	-25.31**
28	SI 13-31 x CCB 40	-18.56**	-31.90**	-8.66	-16.40	2.00	-4.18
29	SI 13-31 x TCB 27	0.52	-15.95**	24.99*	14.40	-22.27**	-26.99**
30	SI 13-31 x Suvin	1.29	-15.30**	-3.35	-11.54	2.90	-3.35
31	GN Cot. 22 x DB 1301	29.69**	7.33	17.22	5.04	-1.36	6.59
32	GN Cot. 22 x ARBB 1302	35.42**	12.07*	26.12**	13.02	2.42	10.67**
33	GN Cot. 22 x GSB 43	11.46*	-7.76	2.94	-7.76	-18.88**	-12.34**
34	GN Cot. 22 x CCB 40	6.51	-11.85*	6.46	-4.60	-19.07**	-12.55**
35	GN Cot. 22 x TCB 27	21.61**	0.65	9.87	-1.55	-10.36**	-3.14
36	GN Cot. 22 x Suvin	16.67**	-3.45	29.10**	15.69	-12.10**	-5.02
37	G. Cot. 12 x DB 1301	5.84	-10.13*	1.87	-5.64	-12.01**	-15.69**
38	G. Cot. 12 x ARBB 1302	7.36	-8.84	9.06	1.03	-13.32**	-16.95**
39	G. Cot. 12 x GSB 43	11.68*	-5.17	6.57	-1.28	-7.21	-11.09**
40	G. Cot. 12 x CCB 40	-17.01**	-29.53**	22.35*	13.34	-23.14**	-26.36**
41	G. Cot. 12 x TCB 27	-10.91	-24.35**	10.21	2.08	-7.64*	-11.51**
42	G. Cot. 12 x Suvin	0.51	-14.66**	21.31*	12.37	-17.25**	-20.71**
Ra-nge	Min	-19.33	-32.54	-14.32	-19.08	-33.91	-27.82
	Max	35.42	12.93	42.46	26.59	11.80	10.67
S. E.±		1.489	1.489	5.85	5.85	0.116	0.116
No. of significant crosses		24	26	15	7	27	26

Positive	21	7	15	5	1	2
Negative	3	19	0	2	26	24

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively. BP: Better parent and SC: Standard check

Table 4: Estimates of heterobeltiosis and standard heterosis for seed cotton yield per plant and lint yield per plant

Sr. No.	Hybrids	Seed cotton yield per plant		Lint yield per plant	
		Heterosis over		Heterosis over	
		BP	SC	BP	SC
1	ACH 15-01 x DB 1301	13.17	9.75	2.30	7.63
2	ACH 15-01 x ARBB 1302	16.68*	13.16	6.68	12.23
3	ACH 15-01 x GSB 43	-17.68*	-20.17**	-28.76**	-25.05**
4	ACH 15-01 x CCB 40	-28.59**	-30.75**	-37.27**	-34.00**
5	ACH 15-01 x TCB 27	-20.17**	-22.58**	-30.55**	-26.93**
6	ACH 15-01 x Suvin	-18.21*	-20.68**	-32.75**	-29.25**
7	GJHV 507 x DB 1301	-16.87*	-22.68**	-21.51*	-24.66**
8	GJHV 507 x ARBB 1302	-23.10**	-28.47**	-31.98**	-34.71**
9	GJHV 507 x GSB 43	12.45	4.60	-0.18	-4.19
10	GJHV 507 x CCB 40	-4.25	-10.94	-18.30*	-21.59**
11	GJHV 507 x TCB 27	-2.80	-9.59	-13.38	-16.86*
12	GJHV 507 x Suvin	-7.71	-14.15	-20.12*	-23.33**
13	GJC 101 x DB 1301	-4.87	-11.32	-9.42	-13.07
14	GJC 101 x ARBB 1302	-23.22**	-28.43**	-29.46**	-32.30**
15	GJC 101 x GSB 43	-19.12*	-24.61**	-25.90**	-28.88**
16	GJC 101 x CCB 40	27.43**	18.78*	22.89**	17.95*
17	GJC 101 x TCB 27	31.64**	22.71**	21.63*	16.74*
18	GJC 101 x Suvin	28.64**	19.91**	6.05	1.78
19	AC 738 x DB 1301	2.06	-1.35	-6.58	-5.67
20	AC 738 x ARBB 1302	24.89**	20.71**	16.37*	17.50*
21	AC 738 x GSB 43	14.44	10.61	8.26	9.31
22	AC 738 x CCB 40	13.54	9.75	6.38	7.41
23	AC 738 x TCB 27	24.03**	19.88**	16.38*	17.51*
24	AC 738 x Suvin	-12.18	-15.12*	-21.11*	-20.34*
25	SI 13-31 x DB 1301	20.48*	3.51	17.18	3.07
26	SI 13-31 x ARBB 1302	29.35**	11.13	27.04**	11.74
27	SI 13-31 x GSB 43	-4.79	-18.21*	-10.86	-21.59**
28	SI 13-31 x CCB 40	-6.85	-19.97**	-9.74	-20.61*
29	SI 13-31 x TCB 27	-2.28	-16.05*	-6.90	-18.11*
30	SI 13-31 x Suvin	-0.49	-14.51	-10.68	-21.43**
31	GN Cot. 22 x DB 1301	15.73*	11.93	10.41	12.31
32	GN Cot. 22 x ARBB 1302	28.83**	24.61**	25.88**	28.05**
33	GN Cot. 22 x GSB 43	-16.96*	-19.68**	-30.38**	-29.18**
34	GN Cot. 22 x CCB 40	-13.67	-16.50*	-20.65*	-19.29*
35	GN Cot. 22 x TCB 27	-1.96	-5.18	-13.34	-11.85
36	GN Cot. 22 x Suvin	13.50	9.78	-3.73	-2.08
37	G. Cot. 12 x DB 1301	-9.93	-20.33**	-8.95	-21.51**
38	G. Cot. 12 x ARBB 1302	-5.64	-16.53*	-7.26	-20.05*
39	G. Cot. 12 x GSB 43	-1.35	-12.74	-2.47	-15.92
40	G. Cot. 12 x CCB 40	-5.75	-16.63*	-17.65	-29.00**
41	G. Cot. 12 x TCB 27	1.71	-10.04	3.83	-10.49
42	G. Cot. 12 x Suvin	0.62	-11.00	1.88	-12.17
Ra-nge	Min	-28.59	-30.75	-37.27	-34.71
	Max	31.64	24.61	27.04	28.05
S. E.±		15.40	15.40	5.45	5.45
No. of significant crosses		19	23	19	26
Positive		10	6	6	5
Negative		9	17	13	21

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively. BP: Better parent and SC: Standard check

Table 5: Estimates of heterobeltiosis and standard heterosis for ginning percentage and seed index

Sr. No.	Hybrids	Ginning percentage		Seed index	
		Heterosis over		Heterosis over	
		BP	SC	BP	SC
1	ACH 15-01 x DB 1301	-9.35**	-1.73	34.80**	12.33
2	ACH 15-01 x ARBB 1302	-8.49**	-0.79	0	3.33
3	ACH 15-01 x GSB 43	-13.48**	-6.20	9.68	13.33
4	ACH 15-01 x CCB 40	-12.28**	-4.91	-9.38	-3.33
5	ACH 15-01 x TCB 27	-13.13**	-5.82	11.11	0

6	ACH 15-01 x Suvin	-17.66**	-10.74**	11.11	0
7	GJHV 507 x DB 1301	-5.71	-2.59	24.00**	3.33
8	GJHV 507 x ARBB 1302	-11.39**	-8.46**	-19.35**	-16.67*
9	GJHV 507 x GSB 43	-11.95**	-9.04**	6.45	10.00
10	GJHV 507 x CCB 40	-14.90**	-12.09**	-12.50	-6.67
11	GJHV 507 x TCB 27	-11.06**	-8.12*	18.52*	6.67
12	GJHV 507 x Suvin	-13.43**	-10.57**	18.52*	6.67
13	GJC 101 x DB 1301	-4.87	-1.77	8.00	-10.00
14	GJC 101 x ARBB 1302	-8.30**	-5.31	0	3.33
15	GJC 101 x GSB 43	-8.31**	-5.32	3.23	6.67
16	GJC 101 x CCB 40	-3.86	-0.72	8.88	16.13*
17	GJC 101 x TCB 27	-7.84*	-4.84	35.04**	21.53**
18	GJC 101 x Suvin	-17.74**	-15.06**	30.44**	17.40*
19	AC 738 x DB 1301	-8.73**	-4.85	20.00*	0
20	AC 738 x ARBB 1302	-6.80*	-2.83	13.10	16.87*
21	AC 738 x GSB 43	-5.11	-1.08	11.23	14.93*
22	AC 738 x CCB 40	-5.95	-1.95	12.50	20.00**
23	AC 738 x TCB 27	-5.82	-1.81	29.63**	16.67*
24	AC 738 x Suvin	-9.66**	-5.81	-7.41	-16.67*
25	SI 13-31 x DB 1301	-3.19	-0.82	24.00**	3.33
26	SI 13-31 x ARBB 1302	-1.90	0.51	6.45	10.00
27	SI 13-31 x GSB 43	-6.73*	-4.44	0	3.33
28	SI 13-31 x CCB 40	-2.91	-0.53	-21.88**	-16.67*
29	SI 13-31 x TCB 27	-4.69	-2.35	0	-10.00
30	SI 13-31 x Suvin	-10.32**	-8.12*	7.41	-3.33
31	GN Cot. 22 x DB 1301	-4.51	0.34	32.00**	10.00
32	GN Cot. 22 x ARBB 1302	-2.23	2.73	12.77	16.53*
33	GN Cot. 22 x GSB 43	-15.92**	-11.65**	-9.68	-6.67
34	GN Cot. 22 x CCB 40	-7.67*	-2.98	-9.38	-3.33
35	GN Cot. 22 x TCB 27	-11.73**	-7.24*	11.11	0
36	GN Cot. 22 x Suvin	-15.05**	-10.73**	25.78**	13.20
37	G. Cot. 12 x DB 1301	0.87	-1.52	18.52*	6.67
38	G. Cot. 12 x ARBB 1302	-1.83	-4.16	3.23	6.67
39	G. Cot. 12 x GSB 43	-1.10	-3.44	-19.35**	-16.67*
40	G. Cot. 12 x CCB 40	-12.72**	-14.79**	0	6.67
41	G. Cot. 12 x TCB 27	1.98	-0.44	-7.41	-16.67*
42	G. Cot. 12 x Suvin	1.16	-1.24	-11.11	-20.00**
Ra-nge	Min	-17.74	-15.06	-21.88	-20.00
	Max	1.98	2.73	35.04	21.53
S. E.±		1.02	1.02	0.72	0.72
No. of significant crosses		25	12	15	14
Positive		0	0	12	8
Negative		25	12	3	6

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively. BP: Better parent and SC: Standard check

Table 6: Estimates of heterobeltiosis and standard heterosis for lint index, oil content and staple length

Sr. No.	Hybrids	Lint index		Oil content		Staple length	
		Heterosis over		Heterosis over		Heterosis over	
		BP	SC	BP	SC	BP	SC
1	ACH 15-01 x DB 1301	17.11	9.78	-20.20**	-10.28**	-2.83	-2.04
2	ACH 15-01 x ARBB 1302	6.01	2.26	-10.49**	0.64	-4.35	-3.47
3	ACH 15-01 x GSB 43	10.24	3.34	-25.72**	-16.48**	-12.11**	-8.16*
4	ACH 15-01 x CCB 40	-5.08	-9.83	-22.06**	-12.37**	1.61	2.86
5	ACH 15-01 x TCB 27	-2.06	-8.13	-9.48**	1.76	-10.83**	-7.55*
6	ACH 15-01 x Suvin	-9.35	-15.03	-21.31**	-11.53**	-18.09**	-14.08**
7	GJHV 507 x DB 1301	13.89	-0.28	-23.79**	-16.2**	-2.63	-1.84
8	GJHV 507 x ARBB 1302	-23.53**	-26.33**	-11.19**	-2.34	-16.68**	-15.92**
9	GJHV 507 x GSB 43	10.38	-3.34	-21.01**	-11.53**	-8.01*	-3.88
10	GJHV 507 x CCB 40	-18.36*	-22.44**	-22.48**	-14.76**	-6.05	-4.90
11	GJHV 507 x TCB 27	8.33	-5.10	-14.02**	-5.45	-11.42**	-8.16*
12	GJHV 507 x Suvin	3.92	-8.94	-15.57**	-7.16	-2.72	2.04
13	GJC 101 x DB 1301	3.28	-12.15	-17.12**	-11.53**	0.61	1.43
14	GJC 101 x ARBB 1302	-0.89	-4.44	-11.98**	-6.05	-17.29**	-16.53**
15	GJC 101 x GSB 43	16.58	-0.82	-18.27**	-8.47*	-9.18**	-5.10
16	GJC 101 x CCB 40	20.95*	14.84	4.22	11.24**	-17.34**	-16.33**
17	GJC 101 x TCB 27	33.42**	13.47	-17.22**	-11.64**	-4.33	-0.82
18	GJC 101 x Suvin	9.84	-6.63	-9.55**	-3.46	4.86	10.00**
19	AC 738 x DB 1301	5.59	-6.45	-17.93**	-6.77	-7.89*	-7.14*
20	AC 738 x ARBB 1302	16.69	12.56	-12.31**	-0.39	-9.81**	-8.98**

21	AC 738 x GSB 43	27.82**	13.24	-10.57**	1.59	-16.21**	-12.45**
22	AC 738 x CCB 40	22.68**	16.58*	-16.06**	-4.65	-6.65*	-5.51
23	AC 738 x TCB 27	28.55**	13.89	-15.59**	-4.12	-12.01**	-8.78**
24	AC 738 x Suvin	-13.09	-23.00**	-14.22**	-2.56	5.45	10.61**
25	SI 13-31 x DB 1301	22.90*	2.12	-8.73*	-4.12	-1.21	-0.41
26	SI 13-31 x ARBB 1302	15.22	11.08	-0.70	4.31	-5.36	-4.49
27	SI 13-31 x GSB 43	16.45	-3.24	-11.49**	-0.87	-20.12**	-16.53**
28	SI 13-31 x CCB 40	-12.86	-17.22*	-4.83	1.25	-15.73**	-14.69**
29	SI 13-31 x TCB 27	5.51	-12.39	-10.01**	-5.47	-4.13	-0.61
30	SI 13-31 x Suvin	3.58	-13.94	-11.24**	-6.76	4.47	9.59**
31	GN Cot. 22 x DB 1301	27.65**	10.45	-22.8**	-13.48**	-1.62	-0.82
32	GN Cot. 22 x ARBB 1302	26.43**	21.92**	-17.63**	-7.69*	-8.39*	-7.55*
33	GN Cot. 22 x GSB 43	-9.52	-21.77**	-18.44**	-8.60*	-18.89**	-15.24**
34	GN Cot. 22 x CCB 40	-2.99	-7.84	-8.28*	2.79	-17.74**	-16.73**
35	GN Cot. 22 x TCB 27	4.39	-9.69	-25.26**	-16.25**	-11.81**	-8.57**
36	GN Cot. 22 x Suvin	11.51	-3.63	-17.33**	-7.36	-15.95**	-11.84**
37	G. Cot. 12 x DB 1301	20.02*	4.42	-11.38**	-11.57**	-17.00**	-16.33**
38	G. Cot. 12 x ARBB 1302	4.12	0.43	-4.09	-5.51	-15.67**	-14.90**
39	G. Cot. 12 x GSB 43	-8.56	-20.49*	-18.90**	-9.18*	-20.64**	-17.08**
40	G. Cot. 12 x CCB 40	-10.36	-14.84	-31.51**	-27.14**	-15.52**	-14.49**
41	G. Cot. 12 x TCB 27	-4.69	-17.08*	-9.80*	-9.45*	-19.69**	-16.73**
42	G. Cot. 12 x Suvin	-9.47	-21.33**	-14.58**	-15.85**	-16.34**	-12.24**
Ra-nge	Min	-23.53	-26.33	-31.51	-27.14	-20.64	-17.08
	Max	33.42	21.92	4.22	11.24	5.45	10.61
S. E.±		0.38	0.38	0.56	0.56	1.08	1.08
No. of significant crosses		11	10	38	20	27	27
Positive		9	2	0	1	0	3
Negative		2	8	38	19	27	24

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively. BP: Better parent and SC: Standard check

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