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STUDY OF COMBINING ABILITY AND GENE ACTION FOR YIELD AND YIELD COMPONENT CHARACTERS IN INTERSPECIFIC HYBRIDS OF COTTON (*Gossypium hirsutum* L. x *Gossypium barbadense* L.)

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ABSTRACT

Present investigation was carried out to find out the combining ability of parents and identification of potential hybrids for improving seed cotton yield. To fulfil this objective, 42 interspecific hybrids were developed in line x tester analysis comprises of 7 lines of *Gossypium hirsutum* L. and 6 testers of *Gossypium barbadense* L. The variance ratio (σ^2gca/σ^2sca) indicated the preponderance of non-additive genetic variance and greater magnitude of variance due to specific combining ability for all the characters except for days to 50 per cent flowering and plant height. Based on estimates of general combining ability effects four parents *viz*., AC 738, GN Cot. 22, GJC 101 and ARBB 1302 were found good general combiners for yield and its contributing traits suggesting exploitation of heterosis breeding for development of hybrids. The estimates of sca effects revealed that none of the hybrid was consistently significantly superior for all the traits. Only 13 hybrids had registered significant positive sca effects for seed cotton yield per plant. The best three hybrid combinations on the basis of significant and positive sca effects for seed cotton yield were GJHV 507 x GSB 43 (49.12), GJC 101 x CCB 40 (47.37) and GJC 101 x Suvin (43.63) and these crossed further evaluated for development of new hybrid.

INTRODUCTION

Cotton (Gossypium spp.) the king of fibre popularly called "White Gold", reside one of the momentous and important cash crop exercising profound influence on economics and social affairs of the world. It plays vital role in Indian economy. The genus Gossypium, a member of the Malvaceae family, consists of 50 species, four species are cultivated in the world. 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 species were cultivated. The area under cotton cultivation in the India is about 10.5 million hectare with annual production of 35.1 million bales (1 bale = 170kg) with productivity 568 kg/ha (Anon., 2016). Recent emphasis in cotton breeding is on the simultaneous improvement of yield and fibre quality traits to meet the demand of cotton producers and the textile industry (Coyle and Smith, 1997). Pima cotton or Egyptian cotton, *Gossypium barbadense* is known for its better fibre properties being cultivated in less than 2 per cent area of total cotton cultivation area in the world (Chen *et al*., 2007). In India, long and extra long staple cotton have heavy demand in textile industry and it is widely grown in Tamil Nadu, Andhra Pradesh and Karnataka. Heterosis breeding is one of the important tools to meet the increased demand of lint. The initial step in a sound heterosis breeding programme is to identify desired parents having good combining ability. Certain parents combine well, whereas, others which appears equally good but produce poor progenies in combinations. Eventually, the lines, which produced good progenies on crossing has immense value for the plant breeder. In a crop improvement programme, much of the success depends upon isolation of valuable gene combinations as determined in the form of lines with high combining ability. This necessitates the study of combining ability effects of crosses for the selection of superior parents and hybrids. Many researchers like, Kaliyaperumal *et al*. (2010), Nidagundi *et al*. (2011), Mendez Natera *et al*. (2012), Sahu *et al*. (2013), Dube *et al*. (2014), Linghe and Pettigre (2015), Pushpum *et al*. (2015), Seema *et al*. (2016) have reported combining ability and gene action on yield and yield contributing traits of cotton. Several research on cotton revealed combining ability assists in gathering strong genetic information (Martani, 1964; Ahuja and Tuteja, 2000). For combining ability study, many mating designs available but Line x Tester analysis given by Kempthrone (1957) is widely used design . The Line x Tester analysis is one of the most simplest and efficient methods of evaluating large number of inbreds/parents for their combining ability. This design provide information on potential parents (GCA), their combination (SCA) along with gene action involved in the inheritance of seed cotton yield and its related characters, which will be helpful in identification of desired segregants from segregating material. Therefore, the present investigation was carried out with an objective of finding out the general and specific combining ability effects for seed cotton yield and its attributing characters and selection of appropriate parents and crosses for the investigated traits.

MATERIALS AND METHODS

Thirteen diverse accessions/released varieties were used as parents for generating experimental materials. The experimental material consist of seven females parents belongs to *G. hirsutum* (ACH 15-01, AC 738, SI 13-31, GJHV 507, GJC 101, GN Cot. 22 and G. Cot. 12) and six males form *G. barbadense*. (DB 1301, ARBB 1302, GSB 43, CCB 40, TCB 27 and Suvin) were crossed in line x tester mating design to produced forty two hybrids at Regional Research Station, Anand Agricultural University, Anand during kharif 2015-16. Crosses were developed by conventional hand emasculation and pollination method developed by Dock and Moll (1934). The experimental material consists of 56 entries, comprising of thirteen parents and forty two hybrids and one standard check (G.Cot. Hy 102) evaluated in Randomized Block Design in kharif 2016-17. Each entry sown in single row of 4.5 meter length with 10 plants having 45 × 120 cm row spacing with three replications. 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 plant 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 as per formula developed by Sikka and Joshi (1960). While, days to 50 per cent flowering was recorded on plot basis and oil content was estimated by NMR (Nuclear Magnetic Resonance) machine of Bruker. Analysis of variance technique suggested by Panse and Sukhatme (1978) was followed to test the differences between the genotypes for all the characters under study. The variation among the hybrids was partitioned further into sources attributed to general combining ability (gca) and specific combining ability (sca) components in accordance with the procedure suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability for 13 characters (Table 1) revealed that significant differences among crosses for all the characters under study indicating present considerable genetic diversity or the variation present in the hybrids for all the characters studied. Analysis of variance for combining ability revealed that mean sum of squares due to females (lines) were significant for days to 50 per cent flowering, plant height, number of monopodia per plant and number of sympodia per plant. Whereas mean sum of squares for males (testers), it was significant for number of monopodia per plant, ginning percentage and staple length. Significance of mean

Table 1: Analysis of variance (mean square) for combining ability and estimates of components of variance for different characters in cotton

Source of Variation	d. f.	DF	PH	NMP	NSP	TNBP	ABW	SCYP	LYP	GP	SI	LI	OC	SL
Replication	2	0.77	99.11	0.02	3.72	152.85	0.04	377.9	30.46	1.82	0.35	0.22	1.02	5.13
Female	6	149.14**	2655.23**	0.38*	95.75*	74.82	0.73	5544.92	625.47	6.73	5.45	1.35	6.07	31.32
Male	5	19.15	741.38	0.43*	34.21	61.93	0.11	1508.15	305.8	13.59*	0.88	1.43	3.18	37.87*
Hybrids	30	11.22**	361.24	0.14**	33.14**	244.66**	0.30**	3425.06**	366.99**	4.11**	4.15**	0.91**	2.56**	13.97**
σ^2 gca		3.74	68.57	0.01	1.63	-9.04	0.01	5.2	5.06	0.31	-0.05	0.02	0.11	1.06
σ^2 sca		3.17	33.73	0.03	10.03	61.77	0.09	1008.83	105.94	0.92	1.11	0.23	0.71	4.04
σ^2 gca/ σ^2 sca		1.18	2.03	0.39	0.16	-0.15	0.06	0.01	0.05	0.34	-0.05	0.11	0.15	0.26
Error	82	1.7	260.04	0.04	3.05	59.35	0.02	398.56	49.18	1.37	0.82	0.23	0.43	1.87

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

Table 2: Estimates of general combining ability (gca) effects of parents for yield and its components in cotton

Parents	DF	PH	NMP	NSP	TNBP	ABW	SCYP	LYP	GP	SI	LI	OC	SL
Females													
ACH 15-01	-0.04	12.33**	-0.13**	1.45**	0.22	-0.20**	-12.41**	-3.72**	-0.06	0.14	0.05	-0.16	0.60*
GJHV 507	2.96**	-0.73	-0.14**	-0.77*	-3.36*	-0.09**	-15.85**	-7.01**	-1.16**	-0.23	-0.33**	-0.38**	0.59*
GJC 101	1.46**	6.16*	0.11**	1.46**	0.82	0.11**	11.19**	2.61	-0.21	0.63**	0.22*	0.29*	0.88**
AC 738	-3.65**	2.44	0.05	2.21**	3.26*	0.27**	27.57**	9.59**	0.57**	0.58**	0.39**	0.61**	0.61*
SI 13-31	-2.60**	-9.36**	-0.17**	-3.32**	-1.47	-0.01	-6.48	-0.59	0.70**	-0.51**	-0.08	0.74**	0.89**
GN Cot. 22	-1.98**	11.05**	0.05	1.80**	0.15	0.19**	13.92**	4.34**	-0.03	0.21	0.1	-0.21	-0.94**
G. Cot. 12	3.85**	-21.88**	0.22**	-2.83**	0.37	-0.27**	-17.94**	-5.23**	0.18	-0.84**	-0.35**	-0.90**	-2.63**
S. E ±	0.25	3.08	0.04	0.33	1.47	0.03	3.81	1.34	0.22	0.17	0.09	0.12	0.26
CD @ 5%	0.49	6.04	0.078	0.64	2.88	0.058	7.46	2.62	0.43	0.33	0.17	0.235	0.51
Range Min.	-3.65	-21.88	-0.17	-3.32	-3.36	-0.27	-17.94	-7.01	-1.16	-0.84	-0.35	-0.9	-2.63
Max.	3.85	12.33	0.22	2.21	3.26	0.27	27.57	9.59	0.7	0.63	0.39	0.74	0.89
Males													
DB 1301	-0.94**	8.33**	0.04	0.85**	1.68	-0.02	3.18	2.82*	0.95**	0.08	0.24**	-0.52**	1.10**
ARBB 1302	-0.13	4.81	0.27**	1.65**	1.24	0.09**	11.07**	5.11**	0.71**	0.29	0.30**	0.67**	-0.99**
GSB 43	1.21**	-7.28**	-0.04	-0.76*	-2.71*	-0.05**	-11.53**	-4.12**	-0.33	0.07	-0.04	-0.1	-1.29**
CCB 40	1.11**	-5.11	-0.03	-1.81**	-0.07	-0.11**	-7.41*	-2.57*	-0.19	-0.1	-0.09	0.11	-0.89**
TCB 27	-0.32	1.11	-0.08**	0.69*	1.16	0.04*	6.04	2.06	0.15	-0.02	0.02	-0.04	-0.02
Suvin	-0.94**	-1.86	-0.15**	-0.61*	-1.3	0.05*	-1.34	-3.30**	-1.29**	-0.32*	-0.43**	-0.12	2.09**
S. E ±	0.23	2.81	0.03	0.3	1.34	0.02	3.48	1.22	0.2	0.16	0.08	0.11	0.24
CD @ 5%	0.45	5.5	0.058	0.588	2.62	0.039	6.82	2.39	0.39	0.31	0.156	0.215	0.47
Range Min.	-0.94	-7.28	-0.15	-1.81	-2.71	-0.11	-11.53	-4.12	-1.29	-0.32	-0.43	-0.52	-1.29
Max.	1.21	8.33	0.27	1.65	1.68	0.09	11.07	5.11	0.95	0.29	0.3	0.67	2.09

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively

DF = Days to 50 per cent flowering;LYP = Lint yield per plant;PH = Plant height ;GP = Ginning percentage;NMP = Number of monopodia per plant;SI = Seed index;NSP = Number of monopodia per plant;LI = Lint index ;TNBP = Total umber of bolls per plant OC = Oil content ;ABW = Average boll weight;SL = Staple length ;SCYP = Seed cotton yield per plant

Table 3: Classification of parents with respect to general combining ability (gca) effect for various traits in cotton

Parents	DF	PH	NMP	NSP	TNBP	ABW	SCYP	LYP	GP	SI	LI	OC	SL
Females													
ACH 15-01	A	G	P	G	A	P	P	P	A	A	A	A	G
GJHV 507	P	A	P	P	P	P	P	P	P	A	P	P	G
GJC 101	P	G	G	G	A	G	G	A	A	G	G	G	G
AC 738	G	A	A	G	G	G	G	G	G	G	G	G	G
SI 13-31	G	P	P	P	A	A	A	A	G	P	A	G	G
GN Cot. 22	G	G	A	G	A	G	G	G	A	A	A	A	P
G. Cot. 12	P	P	G	P	A	P	P	P	A	P	P	P	P
Males													
DB 1301	G	G	A	G	A	A	A	G	G	A	G	P	G
ARBB 1302	A	A	G	G	A	G	G	G	G	A	G	G	P
GSB 43	P	P	A	P	P	P	P	P	A	A	A	A	P
CCB 40	P	A	A	P	A	P	P	P	A	A	A	A	P
TCB 27	A	A	P	G	A	G	A	A	A	A	A	A	A
Suvin	G	A	P	P	A	G	A	P	P	P	P	A	G

Where, G = Good combiner parent having significant gca effect in desired direction; A = Average combiner parent having either positive or negative but non-significant gca effects ; P = Poor combiner parent having significant gca effect in undesired direction
DF = Days to 50 per cent flowering ; LYP = Lint yield per plant ;PH = Plant height ;GP = Ginning percentage;NMP = Number of monopodia per plant;SI = Seed index ;NSP = Number of sympodia per plant;LI = Lint index ;TNBP = Total number of bolls per plant;OC = Oil content ;ABW = Average boll weight ;SL = Staple length ;SCYP = Seed cotton yield per plant

sum of square indicated the presence of sufficient amount of wide genetic diversity or variation among the parents used in hybridization. The mean squares due to female x male interaction were highly significant for all the characters except for plant height; indicated that lines x testers interaction variance contributed largely for total genetic variance and both lines and testers interacted differently in cross combinations except for plant height. Analysis of variance for combining ability revealed that both gca and sca variances were important for inheritance of various traits studied. A perusal of variance ratio (σ^2 gca/σ^2 sca) suggested the reponderance of non-additive genetic variance and greater magnitude of sca variance for all the characters except for days to 50 per cent flowering and plant height indicating preponderance of non-additive gene action in the expression of these characters, this indicates the scope for exploitation of hybrid for the above traits. Predominance of non-additive gene action for cotton yield and its components was also reported by Abro *et al*. (2009), Khan *et al*. (2009), Patel *et al*. (2009), Patel *et al*. (2012), Deosarkar *et al*. (2014), Dubey *et al*.(2014) Patel *et al*. (2014), Dave *et al*. (2015), Sawarkar *et al*. (2015), Reddy *et al*. (2016) and Lanjewar *et al*. (2017).

General combining ability

Ability of line to be used as parent in crossing for commercial hybrid may be determined by the combining ability effects along with mean value. The combining ability of the parents may be considered as reliable guide for prediction of yield potential of a hybrid. Based on estimates of general combining ability effects for various characters are presented in Table 2. It was observed that among the parents, four parents *viz*., AC 738, GN Cot. 22, GJC 101 and ARBB 1302 were found good general combiners for yield and its contributing traits. Therefore, they were noted as good source of favourable genes for increasing seed cotton yield through various yield contributing characters. These parents having a significant gca effects would be useful in crosses and subject them to selection in segregating generations to identify desirable seggregants having a high yield and quality traits. The parents, AC 738, SI 13-31, GN Cot. 22, DB 1301 and Suvin were good general combiners for days to 50 per cent flowering. Whereas, for plant height, parents ACH 15-01, GN Cot. 22, DB 1301 and GJC 101 were good general combiners. The parents ARBB 1302, G. Cot. 12 and GJC 101 were good general combiners for number of monopodia per plant. The parents AC 738, GN Cot. 22, ARBB 1302, GJC 101, ACH 15-01, DB 1301 and TCB 27 were good general combiners for number of sympodia per plant. The parent AC 738 was good general combiner for total number of bolls per plant. While for average boll weight, parents AC 738, GN Cot. 22, GJC 101, ARBB 1302, Suvin and TCB 27 were good general combiners. With respect to seed cotton yield per plant, the parents, AC 738, GN Cot. 22, GJC 101 and ARBB 1302 were considered as good general combiners. In case of lint yield per plant, parents, AC 738, ARBB 1302, GN Cot. 22 and DB 1301 were observed as good general combiners. The parents DB 1301, ARBB 1302, SI 13-31 and AC 738 were observed as good general combiners for ginning percentage. The parents GJC 101 and AC 738 were observed as good general combiners for seed index. In case of lint index, parents, AC 738, ARBB 1302, DB 1301 and GJC 101 were observed as good general combiners. The parents SI 13-31, ARBB 1302, AC 738 and GJC 101 were observed as good general combiners for oil content. While, Suvin, DB 1301, SI 13-31, GJC 101, AC 738, ACH 15-01 and GJHV 507 were found good general combiners for staple length (Table 2). This results are in agreement with the findings of Panhwar *et al*. (2008), Abro *et al*. (2009), Khan *et al*. (2009), Kaliyaperumal *et al*. (2010), Nidagundi *et al*. (2011), Mendez-Natera *et al*. (2012), Patel *et al*. (2012), Sahu *et al*. (2013), Linghe and Pettigre (2015), Pushpum *et al*. (2015) and Seema *et al*. (2016) as they reported different parents with good general combiners for seed cotton yield and yield contributing characters. In general, it was evident from the (Table 3) that the parents which were good general combiners for seed cotton yield per plant *viz*., AC 738, GN Cot. 22, GJC 101 and ARBB 1302 were also good combiners for other yield contributing characters like as number of bolls per plant, average boll weight, lint yield per plant. So, use of these parental lines would be more rewarding for increasing yield in cotton. It was further noted that involvement of these parents had resulted into

Table 4: Estimates of specific combining ability (sca) effects of hybrids for yield and its components in cotton

Hybrids	DF	PH	NMP	NSP	TNBP	ABW	SCYP	LYP	GP	SI	LI	OC	SL
ACH 15-01 x DB 1301	-2.34**	-1.95	0.51**	3.32**	10.48**	0.16**	41.64**	12.70**	0.1	0.72	0.36	0.2	0
ACH 15-01 x ARBB 1302	-1.48**	-0.76	0.15	1.92**	13.98**	0.05	40.81**	13.44**	0.64	-0.38	-0.06	0.60*	1.62**
ACH 15-01 x GSB 43	1.85**	7.67	0.02	-2.14**	-1.7	-0.02	-5.64	-1.92	-0.04	0.83*	0.33	-1.14**	0.39
ACH 15-01 x CCB 40	1.28*	-1.5	-0.33**	1.44	-4.9	-0.30**	-31.70**	-9.37**	0.23	-0.66	-0.23	-0.74**	3.59**
ACH 15-01 x TCB 27	0.04	-3.05	-0.21**	-3.79**	-15.95**	0.30**	-28.21**	-9.34**	-0.4	-0.4	-0.26	1.47**	-0.68
ACH 15-01 x Suvin	0.66	-0.42	-0.14	-0.76	-1.92	-0.19**	-16.9*	-5.51	-0.52	-0.11	-0.13	-0.39	-4.92**
GJHV 507 x DB 1301	0.33	-8.22	0.09	-3.99**	-8.54**	0.02	-22.12**	-5.31	0.92	0.19	0.27	-0.45	0.08
GJHV 507 x ARBB 1302	-0.48	-5.7	-0.21**	-2.12**	-10.62**	-0.17**	-42.02**	-14.23**	-0.7	-2.01**	-1.01**	0.39	-2.44**
GJHV 507 x GSB 43	-0.48	-2.94	0.23**	2.62**	6.58*	0.43**	49.12**	15.13**	0.15	0.87*	0.4	-0.19	1.80**
GJHV 507 x CCB 40	-2.06**	13.89*	-0.05	1.4	10.04**	-0.20**	12.8	2.13	-0.97	-0.62	-0.44*	-0.87**	1.07
GJHV 507 x TCB 27	1.71**	0	0.07	1.83*	-0.42	0.06	2.15	0.6	-0.03	0.63	0.26	0.64*	-0.87
GJHV 507 x Suvin	0.99	2.97	-0.13	0.27	2.96	-0.14*	0.07	1.69	0.63	0.93*	0.53*	0.47	0.35
GJC 101 x DB 1301	-0.17	3.89	-0.23**	-2.42**	6.25	-0.57**	-25.62**	-7.28*	0.24	-2.00**	-0.84**	-0.43	0.85
GJC 101 x ARBB 1302	3.02**	-3.92	0.04	-7.56**	-14.64**	-0.39**	-68.99**	-22.27**	-0.65	-0.87*	-0.54*	-0.82**	-2.93**
GJC 101 x GSB 43	2.68**	-3.16	-0.09	-2.28**	-10.64**	-0.09	-38.44**	-10.78**	0.39	-0.32	-0.04	-0.41	1.12
GJC 101 x CCB 40	-2.89**	4	0.17*	6.30**	5.15	0.47**	47.37**	18.57**	1.71**	0.80*	0.75**	2.27**	-2.95**
GJC 101 x TCB 27	-0.79	-2.88	-0.01	3.46**	8.34*	0.22**	42.05**	13.14**	0.07	1.26**	0.58**	-0.94**	1.25*
GJC 101 x Suvin	-1.84**	2.08	0.12	2.50**	5.53	0.36**	43.63**	8.63**	-1.75**	1.14**	0.09	0.34	2.66**
AC 738 x DB 1301	1.94**	3.61	-0.24**	-2.03**	0.49	-0.33**	-21.35*	-9.39**	-1.52**	-0.95*	-0.75**	-0.05	-1.68**
AC 738 x ARBB 1302	0.46	-2.2	-0.20*	1.83*	7.09*	-0.09	16.49	3.6	-0.64	0.53	0.07	-0.31	-0.19
AC 738 x GSB 43	-2.21**	5.23	0.01	3.37**	2.13	0.16**	18.17*	7.43*	0.96	0.56	0.44*	0.74**	-1.02
AC 738 x CCB 40	-1.11*	0.72	0.13	-2.11**	-0.34	0.18**	12.24	4.64	0.54	1.24**	0.65**	-0.38	0.85
AC 738 x TCB 27	-0.02	3.5	0.18*	2.65**	6.82*	-0.04	19.80*	6.67*	0.25	0.83*	0.42*	-0.16	-1.09
AC 738 x Suvin	0.94	-10.87	0.12	-3.71**	-16.19**	0.12*	-45.36**	-12.94**	0.41	-2.21**	-0.85**	0.16	3.13**
SI 13-31 x DB 1301	1.88**	-11.92	0.05	2.75**	-0.36	0.34**	22.78**	6.56*	-0.38	0.47	0.12	0.2	0.24
SI 13-31 x ARBB 1302	-1.26*	10.93	-0.02	3.29**	2.01	0.35**	30.68**	9.99**	0.29	0.93*	0.48*	0.25	1
SI 13-31 x GSB 43	-1.60**	-3.3	-0.21**	-4.04**	8.71**	-0.47**	-7.51	-2.77	-0.25	0.48	0.15	0.25	-2.63**
SI 13-31 x CCB 40	2.50**	-26.61**	-0.05	-2.79**	-11.26**	0.26**	-15.3	-3.66	0.85	-1.34**	-0.45*	0.36	-2.43**
SI 13-31 x TCB 27	-0.74	19.30**	0.03	-0.36	7.74*	-0.62**	-20.61*	-6.64*	-0.06	-0.75	-0.33	-0.48	1.30*

Table 4:

Hybrids	DF	PH	NMP	NSP	TNBP	ABW	SCYP	LYP	GP	SI	LI	OC	SL
SI 13-31 x Suvin	-0.79	11.6	0.20*	1.14	-6.84*	0.13*	-10.03	-3.48	-0.46	0.21	0.04	-0.58*	2.52**
GN Cot. 22 x DB 1301	-2.73**	-0.33	-0.17*	1.58*	-0.54	0.32**	19.84*	7.72**	0.72	0.42	0.33	-0.22	1.94**
GN Cot. 22 x ARBB 1302	-1.54**	-0.14	-0.20*	2.24**	5.14	0.33**	38.21**	15.81**	1.73**	0.87*	0.80**	-0.56*	1.83**
GN Cot. 22 x GSB 43	0.13	8.62	0.31**	-1.48*	-4.56	-0.25**	-30.98**	-12.71**	-1.81**	-1.24**	-0.90**	0.07	-0.38
GN Cot. 22 x CCB 40	3.56**	-10.89	0.23**	-1.70*	-5.13	-0.21**	-28.50**	-7.73**	0.81	-0.73	-0.19	1.53**	-1.27*
GN Cot. 22 x TCB 27	1.65**	4.89	-0.05	-0.34	-4.35	-0.06	-18.48*	-7.45*	-0.89	-0.47	-0.39	-1.11**	0.53
GN Cot. 22 x Suvin	-1.06	-2.14	-0.12	-0.3	9.43**	-0.12*	19.90*	4.35	-0.56	1.15**	0.34	0.28	-2.65**
G. Cot. 12 x DB 1301	1.10*	14.93*	0	0.8	-7.78*	0.06	-15.17	-5.01	-0.08	1.14**	0.50*	0.75**	-1.44*
G. Cot. 12 x ARBB 1302	1.29*	1.79	0.43**	0.4	-2.96	-0.09	-15.2	-6.34*	-0.67	0.93*	0.25	0.45	1.12
G. Cot. 12 x GSB 43	-0.37	-12.12	-0.26**	3.94**	-0.53	0.24**	15.28	5.61	0.59	-1.18**	-0.38	0.67*	0.71
G. Cot. 12 x CCB 40	-1.28*	20.38**	-0.1	-2.54**	6.43	-0.19**	3.09	-4.56	-3.16**	1.32**	-0.07	-2.16**	1.15*
G. Cot. 12 x TCB 27	-1.85**	-21.77**	-0.02	-3.45**	-2.19	0.13*	3.31	3.03	1.07*	-1.09**	-0.28	0.57*	-0.45
G. Cot. 12 x Suvin	1.10*	-3.21	-0.05	0.86	7.02*	-0.16**	8.69	7.27*	2.25**	-1.12**	-0.03	-0.28	-1.09
S. E ±	0.56	6.88	0.08	0.74	3.29	0.06	8.51	2.99	0.5	0.39	0.21	0.28	0.58
CD @ 5%	1.09	13.48	0.156	1.45	6.44	0.117	16.67	5.86	0.98	0.76	0.41	0.54	1.13
Range Min.	-2.89	-26.61	-0.33	-7.56	-16.19	-0.62	-68.99	-22.27	-3.16	-2.21	-1.01	-2.16	-4.92
Max.	3.56	20.38	0.51	6.3	13.98	0.47	49.12	18.57	2.25	1.32	0.8	2.27	3.59
No. of significant crosses	26	6	18	31	20	32	27	26	8	24	17	18	21
Positive	13	4	8	15	11	17	13	13	4	14	9	9	11
Negative	13	2	10	16	9	15	14	13	4	10	8	9	10

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively.

DF = Days to 50 per cent flowering; LYP = Lint yield per plant; PH = Plant height; GP = Ginning percentage; NMP = Number of monopodia per plant; SI = Seed index; NSP = Number of sympodia per plant; LI = Lint index; TNBP = Total number of bolls per plant; OC = Oil content; ABW = Average boll weight; SL = Staple length; SCYP = Seed cotton yield per plant

hybrids expressing useful heterosis for various traits for majority of cases.

Specific combining ability

The estimates of sca effects (Table 4) revealed that none of the hybrid was consistently significantly superior for all the traits. Out of 42 hybrids evaluated, 13 hybrids had registered significant and positive sca effects for seed cotton yield per plant, lint yield per plant, four for plant height and ginning percentage, nine for lint index and oil content, eleven for total number of bolls per plant and stepal length, fifteen for sympodia per plant, seventeen for boll weight, fourteen for seed index. Whereas, sixteen and thirteen hybrids registered significant and negative for monopodia per plant, days to flowering, respectively. This results are in agreement with the findings of Nidagundi *et al*. (2011), Mendez-Natera *et al*. (2012), Sahu *et al*. (2013), Dubey *et al*.(2014), Linghe and pettigre (2015) and Pushpum *et al*. (2015) and Seema *et al*. (2016). The best three hybrid combinations on the basis of significant and positive sca effects for seed yield per plant were GJHV 507 x GSB 43 (49.12), GJC 101 x CCB 40 (47.37) and GJC 101 x Suvin (43.63). Among three best hybrids based on significant and positive sca effect the hybrid GJHV 507 x GSB 43 had significant and positive sca effect for several yield attributing characters like total number of bolls per plant, average boll weight, lint yield per plant, seed index, number of monopodia per plant, number of sympodia per plant and staple length. While hybrid GJC 101 x CCB 40 had possessed significant and positive sca effect for average boll weight, lint yield per plant, ginning percentage, seed index, lint index, number of monopodia per plant, number of sympodia per plant, oil content and days to 50 per cent flowering. While hybrid GJC 101 x Suvin had possessed significant and positive sca effect for average boll weight, lint yield per plant, ginning percentage, seed index, number of sympodia per plant, days to 50 per cent flowering and staple length. This appeared appropriate as yield being a complex character depends on a number of its component traits. If these crosses were further evaluated, there is good scope for identifying intraspecific hybrids with desirable cross combinations of seed cotton yield and its component characters having superior fibre quality. Significant positive sca effects for seed cotton yield and its component traits have also been reported by Patel *et al*. (2009), Patel *et al*. (2012), Deosarkar *et al*. (2014), Patel *et al*. (2014), Dave *et al*. (2015) and Reddy *et al*. (2016).

The highest significant sca effects in desired direction for various characters was exhibited by different hybrids viz., GJC 101 x CCB 40 (-2.89) for days to 50 per cent flowering, G. Cot. 12 x CCB 40 (20.38) for plant height, ACH 15-01 x DB 1301 (0.51) for number of monopodia per plant, GJC 101 x CCB 40 (6.30) for number of sympodia per plant, ACH 15-01 x ARBB 1302 (13.98) for total number of bolls per plant, GJC 101 x CCB 40 (0.47) for average boll weight, GJC 101 x CCB 40 (18.57) for lint yield per plant, G. Cot. 12 x Suvin (2.25) for ginning percentage, G. Cot. 12 x CCB 40 (1.32) for seed index, GN Cot. 22 x ARBB 1302 (0.80) for lint index, GJC 101 x CCB 40 (2.27) for oil content and ACH 15-01 x CCB 40 (3.59) for staple length.

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