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Combining ability evaluation of intra hirsutm crosses for yield and its components in cotton

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Abstract
In present investigation Line x Tester was designed to carried out evaluation of forty intra hirsutum hybrids, produced through crossing of 5 hirsutum lines (H1300, H1098i, H1117,H1226 and H1236) with 8 hirsutum testers (GN 67-1, HS-2, LH 1960, P 729-37, RS 875, Mahalaxmi, RST-9 and PIL-18), to generate information on general combining ability of the parents and specific combining ability of hybrids in respect of seed cotton yield, its attributing traits viz., boll number, boll weight, morphological traits viz., plant height, number of monopods, number of sympods and for important economic parameters viz.,ginning out turn, seed index and lint index.The 40 F_1intra hirsutum hybrids were sown during Kharif 2015-16 in a randomized block design with three replications at CCS Haryana Agricultural University, Cotton Research Station Sirsa. From the estimates of additive and dominance variance, it is observed that SCA variance was greater than GCA variance for all the characters except boll weight, ginning out turn and lint index, indicating the involvement of both additive and non-additive gene effects with the preponderance of non-additive gene effect for genetic control of these characters. Among all the studied hybrids, cross combinations H1226 x RS 875, H1300 x P 729-37, H1300 x PIL-18, H1300 x HS-2 and H1098i x Mahalaxmi are found to be best specific combiners,while best general combiner are male parents LH 1960 &P 729-37and female parent H1098i.

Keywords: Combining ability, hirsutum, line x tester analysis

Introduction
Cotton (*Gossypium hirsutum* L.), the “King of the fibre plants” plays a major role in India’s economy both in terms of providing employment and earning foreign exchange for the country. In spite of severe competition from synthetic fibres in recent years, it is occupying the foremost position in India, with more than 70% share in the textile industry. In cotton, the main objective is to develop high yielding hybrids with desirable standard of quality. Combining ability analysis has proved very useful tool in the evaluation of parents for their genetic value, in the selection of suitable parents for hybridization and also in the identification of superior specific cross combinations. Sprague and Tatum in 1942 revealed that GCA is primarily due to additive effects of genes, while SCA is a consequence of inter-allelic interactions [1]. With advancement of biometrical genetics, several techniques are now available for identifying desirable parents, but line X tester is most commonly used method for the estimation of combing ability and evaluation of lines or inbred in both self and cross pollinated crops. The present investigation was therefore planned and executed to evaluate general combining ability of parents and specific combining ability of intra hirsutum hybrids in cotton for yield and its associate traits.

Material and methods
Eight hirsutum testers (GN 67-1, HS-2, LH 1960, P 729-37, RS 875, Mahalaxmi, RST-9 and PIL-18), and five hirsutum lines (H1300, H1098i, H1117, H1226 and H1236) were used to produce forty intra hirsutum crosses which were grown at CCS HAU Cotton Research Station Sirsa in randomized block design with 3 replications during *Kharif* season of 2015-16. Observations were recorded in five random plants for yield, its attributing traits viz., boll number, boll weight, morphological traits viz., plant height, number of monopods, number of sympods and important economic parameters viz., ginning out turn, seed index and lint index. Method of analysis for combining ability was based on the model given by Kempthorne (1957) [2].

Result and discussion
The combining ability analysis of variances revealed the presence of both additive and non-additive gene effects as evidenced by highly significant values of mean squares due to lines, testers and line x tester interactions except interaction for lint index which was found

significant (Table 1). These findings were in agreement with the findings of Kumar *et al.* (2013), Rajamani *et al.* (2014), Patel *et al.* (2015), Talpur *et al.* (2016) and Monicashree *et al.* (2017) [3-7].

Genetic components of variance

The perusal of data in Table 2 revealed that ratio of GCA to SCA variance was lesser than unity for yield and its component traits viz., seed cotton yield per plant (0.53), boll number (0.53) boll weight (0.77), morphological traits viz., plant height (0.59), number of monopods (0.71), number of sympods (0.56) andeconomic parameter seed index (0.52) indicating importance of non-additive gene effects in the inheritance of these characters.

On the other hand, σ^2GCA**:**σ^2SCA was greater than one for economic parameters ginning outturn (1.37) and lint index (1.14) indicating the predominance of additive gene effects for these traits. Similar result was reported by Mendez-Natera *et al.* (2012), Baloch *et al.* (2014), Faldu *et al.* (2015) and Usharani *et al.* (2016) [8-11]. In current investigation, as for most of the traits except ginning outturn and lint index, non-additive type of gene effect was present; heterosis breeding appears to be most appropriate breeding method. However in concern with ginning outturn and lint index, we may go for selection method of breeding due to preponderance of additive gene effects for these traits.

General combining ability effects

The general combining ability effects of the parents for all the studied nine characters are presented in Table 4. The perusal of the table revealed that among female parents H1098i was the best combiner for the characters viz., Seed cotton yield per plant, number of bolls per plant, boll weight, dwarfness and number of sympods per plant whereas female parent H1300 was second best combiner, which combined the best for number of monopods per plant, seed index and lint index followed by female parents H1117 which was the best combiners for height and ginning out turn.

Among male parents, LH 1960 was the best general combiner for seed cotton yield, boll weight, number of bolls per plant and number of monopods per plant. The second best combiner for seed cotton yield was P 729-37, which was also found the best combiner for number of monopods per plant and number of bolls per plant followed by RS 875 which was the best combiner for number of bolls per plant and seed cotton yield.

Male parent GN 67-1 was the best combiner for plant height, number of monopods per plant, boll weight, seed index and lint index. For increased plant height GN 67-1 was the best combiner followed by LH 1960. However, for dwarfness PIL-18 was found the best combiner. Male parents LH 1960 and P 729-37 were the best combiners for number of bolls per plant while male parent RST 9 was found to be a best combiner for seed index and lint index followed by male parents PIL-18 and GN 67-1.

Specific combining ability effects

The best specific cross combinations along with their mean performance for different characters have been presented in Table 5. The perusal of this table revealed that for plant height hybrids H1236 x RST 9 and H1300 x P 729-37 respectively exhibited the highest SCA effects. The cross combination H1117 x P 729-37 showed the highest SCA for dwarfness. All these were combinations of good x poor, good x good and good x good respectively indicating additive type of gene action in the expression of this trait which is fixable. For number of monopods, the best specific cross combinations H1117 x HS-2 and H1226 x RS 875 were combinations of good x poor and poor x poor combiners. The cross combinations H1098i x RST 9 and H1236 x LH 1960 recorded the highest SCA effect for number of sympods per plant which were a combination of good x good and good x poor combiners. Hence, SCA effect of these crosses is mainly additive gene action.

For number of bolls per plant cross combinations H1300 x P 729-37and H1226 x RS 875 which showed high SCA effects with a combination of poor x good and good x good combining parents and therefore, which was due to additive effect. The cross combinations H1300 x LH 1960 and H1117 x RST 9 recorded the highest SCA effect for boll weight and having a combination of good general combiners. Hence, SCA effect of these crosses is mainly additive gene action. For seed cotton, yield high SCA effects shown by the crosses namely., H1226 x RS 875 (poor x good), H1300 x P 729-37 (poor x good), H1236 x LH 1960 (poor x good), H1098i × RS 875 (good x good), H1098i × Mahalaxmi (good x poor), H1236 x Mahalaxmi (poor x poor), H1236 x LH 1960 (poor x good) and H1226 x GN 67-1 (poor x poor) were cross combinations of mainly poor combining parents which is due to non-fixable dominance gene effect. These observations are akin to the findings of Srinivas *et al.* (2014), Kencharaddi *et al.* (2015), Sajjad *et al.* (2016) and Memon *et al.* (2017) [12-5].

The cross which registered maximum SCA effect for ginning out turn was H1117 x RST 9 (good x poor) succeeded by H1236 x Mahalaxmi (good x good), H1300 x PIL-18 (good x good), H1098i x GN67-1(poor x good) and H1117 x P 729-37(good x poor). All the crosses were showing additive effects; hence SCA effect of these crosses is due to additive gene effects. For seed index, crosses H1117 x GN 67-1, H1236 x RST 9, H1226 x LH 1960, H1300 x LH 1960 and H1098i x RS 875 exhibited high SCA effects. All these combinations were of poor x good, poor x good, poor x poor, good x poor and good x poor combining parents. High SCA effects for lint index was depicted by hybrid H1226 x LH 1960. This cross was combination of both poor combining parent, that indicating additive variance was important for this character.

Table 1: Analysis of variance for Line x Tester for different characters in upland cotton

Source of variation	Degree of freedom	Plant height (cm)	No. of monopods per plant	No. of sympds per plant	No. of	Source of variation	Degree of freedom	Plant height (cm)	No. of monopods per plant	No. of sympds per plant
Replication	2	70.61	0.16	1.80	17.09	0.04	24.09	0.60	0.23	0.07
Lines	7	264.05**	5.67**	10.32**	673.42**	0.18**	3432.93**	4.32**	1.56**	0.78**
Testers	4	441.59**	5.15**	36.35**	582.08**	0.36**	3560.61**	27.84**	3.32**	0.94**
Lines x Testers	28	113.94**	1.12**	6.57**	156.55**	0.06**	872.83**	2.77**	0.78**	0.21*
Error	78	51.48	0.19	1.96	19.40	0.03	107.58	1.28	0.29	0.12

*Significant at P=0.05, **Significant at P=0.01.

Table 2: Estimates of genetic components of variance for different characters in upland cotton

Traits/Variance	Plant height (cm)	No. of monopods per plant	No. of sympods per plant	No. of	Traits/Variance	Plant height (cm)	No. of monopods per plant	No. of sympods per plant	No. of
COV(HS)	12.25	0.22	0.86	24.16	0.01	134.56	0.68	0.09	0.03
COV (FS)	45.32	0.75	3.26	94.05	0.03	524.21	1.86	0.34	0.10
σ2 GCA	12.25	0.22	0.86	24.16	0.01	134.56	0.68	0.09	0.03
σ2 SCA	20.82	0.31	1.54	45.72	0.01	255.08	0.50	0.16	0.03
σ2 GCA/ σ2 SCA	0.59	0.71	0.56	0.53	0.77	0.53	1.37	0.52	1.14
σ2 Additive (F=1)	24.50	0.44	1.72	48.33	0.02	269.12	1.37	0.17	0.07
σ2 Dominance (F=1)	20.82	0.31	1.54	45.72	0.01	255.08	0.50	0.16	0.03

Table 3: General combining ability effects of parents for different characters in upland cotton.

Male parents	Plant height (cm)	No. of monopods per plant	No. of sympods per plant	No. of bolls per plant	Boll weight (g)	Seed cotton yield per plant (g)	Ginning out turn (%)	Seed index (g)	Lint index (g)
GN 67-1	5.15**	0.44**	-0.13	-6.22**	0.12**	-9.76**	0.03	0.24*	0.16*
HS 2	2.41	-0.63**	0.50	-8.91**	-0.14**	-20.16**	1.09**	-0.06	0.16*
LH 1960	3.70**	0.63**	-0.33	8.66**	0.15**	25.27**	-0.42*	-0.12	-0.14*
P 729-37	0.41	0.53**	-0.41	7.55**	-0.03	17.51**	-0.32	-0.28**	-0.22**
RS 875	-5.29**	-0.24**	1.31**	4.18**	-0.01	5.28**	-0.62**	-0.12	-0.19**
Mahalaxmi	1.82	0.63**	-1.54**	3.24**	-0.14**	-3.48	0.11	-0.46**	-0.28**
RST 9	-1.62	-0.79**	0.26	-4.37**	0.09**	-5.29**	-0.21	0.52**	0.28**
PIL-18	-6.57**	-0.56**	0.34	-4.14**	-0.04	-9.36**	0.33	0.28**	0.24**
SE(d)	1.31	0.08	0.26	0.80	0.03	1.89	0.21	0.10	0.06
Female parents									
H1098i	-6.14**	-0.77**	1.98**	5.82**	0.16**	18.77**	-1.72**	0.26*	-0.14
H1236	3.37	0.06	0.27	-3.02**	-0.13**	-4.99*	0.37	-0.40**	-0.18*
H1117	3.50*	0.27*	-0.46	0.70	0.05	2.11	1.23**	-0.30*	0.04
H1226	-2.82	-0.01	-0.54	3.12**	-0.12**	-1.29	-0.07	-0.05	-0.04
H1300	2.10	0.44**	-1.26**	-6.62**	0.04	-14.56**	0.18	0.49**	0.32**
SE(d)	1.73	0.11	0.34	1.06	0.04	2.51	0.27	0.13	0.09

*Significant at P=0.05, **Significant at P=0.01.

Table 4: Best specific cross combiner for different characters

S. No.	Characters	1st	Mean Performance	2nd	Mean Performance
1	Plant height (cm)	H1236 x RST 9 (8.96*)	158.9	H1300 x P 729-37 (8.48*)	163.9
2	No. of monopods per plant	H1117 x HS-2 (1.08**)	4.13	H1226 x RS 875 (1.03**)	4.20
3	No. of sympods per plant	H1098i x RST 9 (2.41**)	16.2	H1236 x LH 1960 (2.24**)	13.7
4	No. of bolls per plant	H1300 x P 729-37 (17.06**)	59.0	H1226 x RS 875 (9.70**)	57.0
5	Boll weight (g)	H1300 x LH 1960 (0.27**)	3.66	H1117 x RST 9 (0.24**)	3.59
6	Seed cotton yield per plant (g)	H1226 x RS 875 (30.88**)	146.5	H1300 x P 729-37 (30.22**)	144.8
7	Ginning out turn (%)	H1117 x RST 9 (2.10**)	40.7	H1236 x Mahalaxmi (1.44*)	39.5
8	Seed index (g)	H1117 x GN 67-1 (0.94*)	7.70	H1236 x RST 9 (0.79**)	7.73
9	Lint index (g)	H1226 x LH 1960 (0.47**)	4.38	H1236 x GN 67-1 (0.30)	4.37

*Significant at P=0.05, **Significant at P=0.01.

Conclusion

The results signify the importance of non-fixable, non-additive gene effects in studied traits for attaining maximum improvement. Cross combinations H1226 x RS 875, H1300 x P 729-37, H1300 x PIL-18, H1300 x HS-2 and H1098i x Mahalaxmi are found to be best specific combiners, which were cross combinations of mainly poor combining parents. While best general combiners were male parents LH 1960 & P 729-37 and female parent H1098i. A summarized account of the most promising hybrids having high SCA effects for yield and its attributes along with GCA effects of the parents revealed that the best performing parent may not be always produce the best specific combinations for all the characters. The cross combination involving H1300 as female parent recorded significant positive SCA effect for yield contributing characters. Thus, the female parent H1300 can be used for hybrid breeding programme.

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