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Combining ability studies for yield and yield contributing characters in cotton (*Gossypium hirsutum* L.)

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ABSTRACT : The present investigation was undertaken by adopting half diallel analysis involving 6 diverse parents for combining ability analysis at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The analysis of variance for combining ability revealed that variances due to sca were larger than gca for all the characters indicating predominance of non additive gene action. The parents RHCr 0606, RHBB 9718 and HAP 22-4 were good general combiners for seed cotton yield. The hybrids RHC 577/3-3 x RHCr 0606 and RHRIH 13-1 x RHC 577/3-3 had significant sca effect for seed cotton yield and important yield components.

Key words: Combining ability, cotton, gene action, half diallel, yield

Cotton occupies a special place among the cash crops as it endows with a large farming community. Traditional varieties and hybrids reflect low potential in rainfed area. Though the area of the Maharashtra state is highest under cotton in India, the productivity is the lowest that is 310 kg/ha due to low potential of traditional varieties and hybrids being cultivated under erratic rainfall in rainfed conditions. For increase in the lint productivity, exploitation of hybrid vigour is the only alternative. Combining ability is a powerful tool for choosing appropriate parental lines to produce superior hybrids. Combining ability studies also elucidate the nature and magnitude of gene action involved in the inheritance of seed cotton yield and its related characters, which will be useful to follow the segregating material. In this context, combining ability effects provides sound basis for parental selection. Hence, the present investigation was undertaken by adopting half diallel analysis involving six diverse parents to know the magnitude of general combining ability and specific combining ability effect of different genotypes.

The experiment material consisted of 15 F_1's developed by half diallel fashion involving six cotton genotypes *viz.,* AKH 7, RHRIH 13-1, HAP 22-4, RHC 577/3-3, RHBB 9718 and RHCr 0606. The total 21 genotypes *i.e.* 15 F_1's and six parents were raised in randomized block design with 3 replications during *kharif,* 2011-2012 at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The crop was planted at 90 x 90 cm spacing. Observations were recorded on 5 randomly selected competitive plants from each of the 3 replications for 9 characters namely, days to 50 per cent flowering (DAS), plant height (cm), sympodia and bolls/plant, boll weight (g), seed cotton yield (kg/ha), ginning outturn (%), lint index and seed index and mean was taken for further analysis. The data of 21 genotypes were subjected to half diallel analysis (Method II, model I).

In combining ability studies, parents should be selected with utmost care to have successful hybridization programme. The selection should be based on their variability and combining ability.

The analysis of variance revealed highly significant differences among the genotypes for all the characters under study and sufficient genetic variability among experimental material. Further, mean sum squares due to hybrids and parents were also highly significant for all the characters except for days to 50 per cent flowering, boll weight and GOT in case of parents. The significant mean square due to parents *v/s* hybrids also revealed presence of heterosis for the almost all the characters except days to 50 per cent flowering and boll weight (Table 1).

The mean squares for general combining ability as well as specific combining ability were significant for all the characters except sca for boll weight, indicated that both additive and non additive gene action played important role for the inheritance of these traits. The ratio of á^{2}gca/ á^{2}sca was less than unity indicating predominance of non additive and dominant type of gene action for all the characters studied. These results are in agreement with the observations of Patel *et al.,* (2005).

A summarized account of the parent with significant gca effects along with crosses showing significant sca effects for various characters are presented in Table 2. The gca effects of parents are presented in Table 2. The parent RHCr 0606 (91.74) was the best combiner for seed cotton yield followed by RHBB 9718 (82.00) and HAP 22-4 (79.54). The genotype AKH 7 was found to be good combiner for days to 50 per cent flowering (-0.13) and ginning per cent (0.71). Good combing ability for bolls/plant (0.94), boll weight (0.19) and ginning per cent (0.34) was observed with the parent RHRIH 13-1. Besides seed cotton yield, HAP 22-4 was also found to be good combiner for bolls/plant (1.51) and seed index (0.26). Considering earliness the genotype RHC 577/3-3 (-0.13) was the only parent found to be good combiner for flowering. RHBB 9718 was good combiner for plant height (5.20), seed cotton yield (82.0) and ginning per cent (0.39). RHCr 0606 followed by RHBB 9718 and HAP 22-4, were the parents having significant gca effects for seed cotton yield which may have resulted from combined effects of the components *viz.,* plant height (7.77), bolls/plant (2.33), lint index (0.32) and seed index (0.80) indicating their joint importance in determining yield. Similar results were obtained by Preetha and Ravindran (2008) and Patil *et al.*, (2011). Amongst all, none of the parent was found to be good combiner for sympodia/plant.

Out of 15 crosses, only 7 crosses showed significant sca effects for seed cotton yield. The best cross combination for seed cotton yield was RHC 577/3-3 x RHCr 0606 (739.01) followed by RHRIH 13-1 x RHC 577/3-3 (461.50). The best combination for days to 50 per cent flowering was AKH 7 x RHC 577/3-3 (-0.45). The cross AKH 7 x HAP 22-4 (11.17) and RHC 577/3-3 x RHCr 0606 (11.03) were found to be best combiners for plant height followed by AKH 7 x RHBB 9718 (9.92). Positive and significant sca effects were observed with the crosses RHC 577/3-3x RHBB 9718 (2.55), AKH 7x HAP 22-4 (2.32), RHC 577/3-3x RHCr 0606 (2.15), AKH 7x RHCr 0606 (2.14) and HAP 22-4x RHC 577/3-3 (2.00) for sympodia/plant though their parents had average to poor combining ability. Out of 5 crosses which showed significant positive sca effects 4 were in combinations of poor x average and one with the combination of average x poor, indicating a limited utility of parental gca effects in identifying crosses with high sca effects for sympodia/plant. Almost similar results were reported by Manickam and Gururajan (2004) and Patil *et al.,* (2011) for seed cotton yield. The cross AKH 7 x HAP 22-4 (7.49) showed significant sca effects for bolls/plant

Table 1. Analysis of variance for mean squares for seed cotton yield ,yield contributing characters

Source of variations	df	Days to 50 per cent flowering	Plant height (cm)	Sympodia / plant	Bolls / plant	Boll weight (g)	SCY (kg/ha)	GOT (%)	Lint index	Seed index
Replications	2	0.63	37.53	2.12	33.01	0.19	92931.90	0.56	0.17	0.21
Treatments	20	0.65**	507.24**	9.38**	95.75**	0.47*	659182.30**	4.03**	0.75**	3.03**
Parents	5	0.001	343.35**	8.76**	103.38**	0.36	81728.80*	0.43	0.95**	3.43**
Hybrids	14	0.92**	509.88**	6.16*	53.13**	0.52**	323044.37**	5.06**	0.60**	2.27**
Parents *v/s* hybrids	1	0.10	1289.60**	51.17**	654.23**	0.17	8252380.86**	7.56**	1.78**	11.71**
Error	40	0.60	60.46	3.17	20.85	0.23	39617.26	0.56	0.12	0.23
gca	5	0.19**	324.91**	2.41	37.22**	0.19*	139539.25**	2.48**	0.36**	2.01**
sca	15	0.23**	117.13**	3.36*	30.15**	0.14	246456.83**	0.96**	0.21**	0.68**
error	40	0.02	20.15	1.06	6.95	0.07	13205.75	0.19	0.04	0.08
δ^2 gca		0.021	38.09	0.16	3.78	0.015	15791.69	0.29	0.04	0.24
δ^2 sca		0.20	96.98	2.30	23.12	0.06	233251.07	0.78	0.17	0.60
δ^2 A		0.04	76.19	0.34	7.56	0.03	31583.37	0.57	0.08	0.48
δ^2 D		0.20	96.98	2.30	23.12	0.06	233251.07	0.78	0.17	0.60
δgca/äsca		0.10	0.39	0.07	0.16	0.22	0.07	0.37	0.23	0.40

*, ** Significant at 5 and 1 per cent level of significance

followed by RHC 577/3-3 x RHCr 0606 (7.25). Only one cross RHRIH 13-1 x RHCr 0606 (0.80), AKH 7x RHRIH 13-1 (0.77) and HAP 22-4 x RHBB-9718 (-0.53) each was found significant for boll weight, ginning per cent and seed index respectively. Four crosses *viz.,* AKH 7 x RHRIH 13-1 (0.80), RHRIH-13-1 x RHCr 0606 (0.56), AKH 7 x RHC 577/3-3 (0.54) and HAP 22-4 x RHCr-0606 (0.40) were observed for significant sca for the lint index.

The crosses showing high sca effects for seed cotton yield also showed high sca effects for plant height, sympodia/plant and bolls/plant. Thus it was evident that a good cross combination is not necessarily the result of good x good combination of parents, rather it might occur from poor x average, average x poor, poor x good as well. High sca effects due to good x good combiners reflects additive x additive type of gene interaction and superiority while those involving good x poor or poor x average combiners indicated the interaction of additive x dominance or dominance x additive, respectively. Almost similar results were reported by Patil *et al.*, (2011).

The cross HAP 22-4x RHC 577/3-3 for seed cotton yield involving parents with poor x good gca effects indicates the interaction of dominance x additive variance, while the cross RHC 577/3-3x RHCr 0606 involving parents with good x good gca effects resulted into high sca effects which could throw transgressive segregants. It involved additive x additive type of interaction which could be easily fixed and is highly desirable. These results are in conflagration with the findings of Nimbalkar *et al.,* (2004) and Patil *et al.*, (2011).

Considering the above condition the best cross combination was RHC 577/3-3x RHCr 0606 which could be used for further exploitation.

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Table 2. Best parents, best general combiners best heterotic cross and best specific combiners in seed cotton yield and its component characters in *hirsutum* cotton

Characters	Best general combiners	Crosses with significant sca effect	Parent combination
Seed cotton yield	RHCr 0606 (91.74)	RHC 577/3-3 x RHCr 0606 (739.01)	P x G
	RHBB 9718 (82.00)	RHRIH 13-1 x RHC 577/3-3 (461.50)	P x A
	HAP 22-4 (79.54)	HAP 22-4 x RHCr 0606 (419.63)	P x G
		RHRIH 13-1 x RHBB 9718 (398.38)	P x G
		AKH 7 x HAP 22-4 (369.01)	G x A
		HAP 22-4 x RHC 577/3-3 (292.35)	G x G
		RHRIH 13-1 x RHCr 0606 (226.69)	A x G
Days to 50 per cent flowering	AKH 7 (-0.13)	AKH 7 x RHC 577/3-3 (-0.45)	G x A
	RHC 577/3-3 (-0.13)		
Plant height	RHCr 0606 (7.76)	AKH 7 x HAP 22-4 (11.17)	P x A
	RHBB 9718 (5.19)	RHC 577/3-3 x RHCr 0606 (11.03)	P x A
		AKH 7 x RHBB 9718 (9.92)	P x G
		HAP 22-4 x RHC 577/3-3 (9.30)	P x G
		AKH 7 x RHCr 0606 (8.46)	A x P
		AKH 7 x RHRIH 13-1 (8.25)	P x G
Sympodia / plant	—	RHC 577/3-3 x RHBB 9718 (2.55)	P x A
		AKH 7x HAP 22-4 (2.32)	P x A
		RHC 577/3-3x RHCr 0606 (2.15)	A x P
		AKH 7x RHCr 0606 (2.14)	P x A
		HAP 22-4x RHC 577/3-3 (2.00)	P x A
Bolls / plant	RHCr 0606 (2.33)	AKH 7 x HAP 22-4 (7.49)	P x G
	HAP 22-4 (1.51)	RHC 577/3-3 x RHCr 0606 (7.25)	P x G
	RHRIH 13-1 (0.94)	RHC 577/3-3 x RHBB 9718 (5.93)	G x P
		AKH 7 x RHCr 0606 (5.67)	P x A
		HAP 22-4 x RHC 577/3-3 (5.63)	P x G
Boll weight	RHRIH 13-1 (0.18)	RHRIH 13-1 x RHCr 0606 (0.80)	G x A
Ginning per cent	AKH 7 (0.71)	AKH 7x RHRIH 13-1 (0.77)	G x G
	RHBB 9718 (0.39)		
	RHRIH 13-1 (0.34)		
Lint index	RHCr 0606 (0.33)	AKH 7 x RHRIH 13-1 (0.80)	P x A
		RHRIH 13-1 x RHCr 0606 (0.56)	P x P
		AKH 7 x RHC 577/3-3 (0.54)	A x G
		HAP 22-4 x RHCr 0606 (0.40)	P x G
Seed index	RHCr 0606 (0.80)	HAP 22-4 x RHBB 9718 (-0.53)	G x G
	HAP 22-4 (0.26)		

(G-good, P-poor, A-average)

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