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Line x tester analysis in sesame *(Sesamum indicum* L.)

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Abstract: Line x tester analysis (14 x 3) of combining ability revealed preponderance of non-additive gene action for seed yield and its components. Guj. Til 1, Sel. 73, Sel. 33, Sel. 123 and Uma were good general combiners for seed yield and yield contributing characters. Non-significant correlation was observed between parental per se performance and gca effects. A good degree of association was observed between F_1 performance and sca effects. Hybrids of superior combinations involved mostly parents of high x high or high x low, combining ability effects. Sel. 33 x Uma, Guj. Til 1 x TC 25, Sel. 84 x Sel. 185 and Sel. 73 x Uma which showed significant sca effects and heterosis for seed yield, branches/ plant, capsules on main stem and capsules/ plant can be considered as best combinations for exploitation of hybrid vigour. *(Key words: Combining ability, Heterosis, Line x tester, Sesame).*

The average productivity of sesame *(Sesamum indicum* L.) in India is almost stagnant during last few years and not impressive as compared to other sesame growing countries of the world. This yield plateau and poor productivity can be overcome by commercial exploitation of heterosis and reshuffling of genes in order to get better recombinants or transgressive segregants, by hybridization of suitable parents. The combining ability finds out the good general combiners for yield and its components, promising cross combinations, nature and magnitude of gene action governing the expression of yield and yield components which in turn helps in identification of proper breeding methodology. The present investigation was undertaken for evaluation of combining ability and heterosis for yield and yield components in sesame.

Materials and Methods

The materials were comprised of 14 lines (female parents), three testers (male parents) of sesame with diverse genetic base (Table 2) and, their 42 cross combinations recovered through a line-tester (14 x 3) mating design. The 42 F_1s and 17 parental lines were grown in three rows, with 3 meter row length, in a randomized block design with three replications and a spacing of (45 x 10) cm^2 at the Central Research Station, O.U.A.T., Bhubaneswar during summer, 1999. Observations were recorded on 10 randomly selected competitive plants for 11 quantitative characters namely plant height, height upto first capsule, branches per plant, nodes on main stem, capsules on main stem, capsules/plant, capsule length, capsule breadth, seeds/capsule, 1000-seed weight and seed yield/plant. Heterosis over mid-parent and better parent was calculated as per the standard procedure. Combining ability analysis was done as per the method given by Kempthrone (1957).

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all characters studied indicating sufficient genetic variability among the genotypes. The analysis of variance for combining ability (Table 1) revealed significant differences in the variances due to lines, testers, hybrids and line x testers for all the traits, except height upto first capsule, for which mean square due to testers was non-significant.

The higher estimates of dominance variances as compared to additive variances for all the traits, except 1000-seed weight (Table 1), was probably due to predominance of non-additive gene action suggesting the scope of improvement of these traits through heterosis breeding. For 1000-seed weight, both additive and non-additive components of genetic variance were in equal proportion. Predominance of non-additive genetic component for seed yield, plant height, branches/ plant, capsules/plant, capsule length, 1000-seed weight was also reported earlier (Krishnadoss *et al.* 1987; Mishra and Yadav, 1996 and Padmavati, 1999)

The gca effects of parents (Table 2) suggested that Guj. Til 1, Sel. 33, Sel. 84, Sel. 73, Sel.123

Table 1. Analysis of variance for combining ability in sesame

Source	d.f.	Mean sum of square										
		Plant height (cm)	Height upto first capsule (cm)	Branches /plant	Nodes on main stem	Capsules on main stem	Capsules/ plant	Capsule length (mm)	Capsule breadth (mm)	Seeds/ Capsules	1000-seed weight (g)	Seed yield/ plant (g)
Hybrids	41	506.54**	138.14**	1.22**	106.52**	57.66**	864.24**	3.76**	0.92**	50.69**	0.13**	42.01**
Lines	13	609.33**	248.33**	0.93**	135.71**	72.16**	652.08**	4.17**	0.34**	53.35**	0.08**	44.45**
Testers	2	979.75**	21.87	4.01 **	134.78**	133.98**	1875.58**	5.67**	0.71 **	20.54**	0.88**	82.80**
Line X tester	26	418.75**	91.98**	1.15**	89.75**	44.55**	859.52**	3.41**	1.23**	51.69**	0.10**	37.65**
Error	82	43.72	22.85	0.13	20.01	10.61	33.30	0.66	0.13	4.61	0.01	0.83
σ^2_{gca}	-	14.74	1.69	0.05	1.78	2.29	14.56	0.06	-0.03	-0.58	0.015	1.02
σ^2_{sca}	-	125.01	- 23.04	0.34	23.25	11.31	286.41	0.92	0.37	15.69	0.03	12.27
σ^2_A	-	29.47	3.38	0.10	3.57	4.59	29.12	0.12	-0.06	-1.16	0.03	2.04
σ^2_D	-	125.01	23.04	0.34	23.25	11.31	286.41	0.92	0.37	15.69	0.03	12.27

*, ** Significant at 5 and 1 per cent levels, respectively.
σ^2_A = Additive variance; σ^2_D = Dominance variance.

and Uma are good general combiners for seed yield. The good general combiners for seed yield were also found to be good general combiners for different yield components, e.g. high gca effects were exhibited for five characters in Guj. Til1 (branches/plant, capsules on main stem, capsules/plant, seeds/capsule and 1000-seed weight) and Sel.33 (plant height, capsules on main stem, capsules/ plant, capsule length and seeds/ capsule), while Sel. 84, Sel.73 and Sel.123 showed high gca effects for four (plant height, nodes on main stem, capsules/plant and seeds/capsule), three (plant height, branches/plant and capsules/plant) and one (branches/plant) yield components, respectively. Among the testers, Uma was found to be good general combiners for branches/plant, nodes on main stem, capsules/plant and seeds/ capsule along- with the seed yield. This direct relationship between gca effects of seed yield with that of yield components was probably due to close association between seed yield and yield components.

The correlation of parental means with gca effects (Table 4) were non-significant for all the traits, except capsule length, suggesting that per se performance can not be an effective tool for selecting parents for hybridization programme and the combing ability estimates must be a primary criterion for parental choice. The lack of relationship between parental per se performance and gca effects could be possibly due to predominance of non-allelic interaction in governing these traits. However, when additive gene effects are primarily important a good degree of association between *per se* performance and gca effects likely to be observed (Sharma and Chauhan, 1985).

The sca effects of different characters were wide in range with highly significant values in most of the crosses. The five top cross combinations selected on the basis of *per se* performance for six characters, their sca effects, heterosis estimates and gca effects are presented in Table 3. In general, crosses with high performance or highly significant heterosis also exhibited highly significant sca effects for most of the characters. This direct relationship between sca effect and F_1 performance was further confirmed from the

Table 2. Estimates of general combining ability effects of parents

Parents	Plant height (cm)	Height upto first capsule (cm)	Branches /plant	Nodes on main stem	Capsules on main stem	Capsules/ plant	Capsule length (mm)	Capsule breadth (mm)	Seeds/ Capsules	1000-seed weight (g)	Seed yield/ plant (g)
Lines											
Phule Til 1	7.46**	-2.45	-0.39**	2.11	0.42	-6.73**	0.89**	-0.01	-0.03	0.09**	-1.88**
Guj. Til 1	1.59	0.00	0.53**	-0.21	4.92**	14.99**	-0.07	0.00	1.82**	0.08**	3.98**
Sel. 84	4.51 *	7.04**	-0.16**	3.64**	1.39	3.11 *	-0.14	-0.03	1.69**	-0.01	3.20**
Sel. 6-1	-1.17	-6.22**	-0.26**	-0.23	-2.02**	-4.15**	-0.41	-0.13	-3.41 *	-0.06*	-1.08**
Sel. 20	-15.70**	-10.83**	0.04**	-2.23	-2.83*'	-7.96**	0.57**	0.26**	2.78**	0.21 **	-2.05**
Sel. 15	-3.07	-1.27	0.08**	3.45**	1.42	-4.75**	1.21 **	0.07	4.49**	0.09**	-1.06**
Sel. 73	11.31 **	8.11 **	0.38**	-1.35	0.09	4.57**	-0.15	-0.24*	0.31	0.01	1.21 **
Sel. 58	-6.14**	0.51	-0.52**	-1.67	-5.15**	-1 3.23**	-1.49**	0.32**	-2.28**	-0.08**	-3.05**
Sel. 33	12.91 **	6.36**	-0.22**	1.15	4.82**	18.67**	0.81 **	-0.03	1.60**	-0.08**	3.59**
Vinayak	-7.50**	-1.58	0.53**	-1.25	-2.04*	-1.60	-0.17	0.16	0.63	0.05.	-0.08
Krishna	-8.57**	-3.70**	0.17**	-8.88**	-2.77**	-1.37	-0.35	-0.24*	-0.32	-0.101*	-1.63**
OMT 26	8.41 **	3.50**	-0.14**	8.40**	0.58	-2.03	-0.38	0.23*	-2.56**	-0.06*	-0.86**
Sel. 23	-0.77	-2.04	-0.14**	-1.28	1.38	1.50	-0.13	-0.04	-4.00**	-0.03	-0.82**
Sel. 123	-3.27	2.57*	0.1 1 **	-1.67	-0.21	2.00	-0.20	-0.32**	-0.71	1-0. 1 2**	0.52**
S.E. (lines)	0.51	0.47	1.79	1.30	0.10	1.21	1.25	1.56	0.22	0.10	0.58
Testers											
TC 25	-5.51	-0.76	-0.28**	-0.98*	-2.04*	-6.96**	0.30**	0.14**	-0.22	0. 1 7**	-1.46**
Sel. 185	3.52**	0.68	-0.05	-1.09*	0.73	0.59	-0.41	-0.12**	-0.56*	-0.07**	0.11
Uma	1.98**	0.07	0.33**	2.07**	1.30	6.37**	0.11	-0.01	0.78**	-0.10**	1.34**
S.E.(testers)	0.20	0.18	0.70	0.51	0.04	0.48	0.35	0.61	0.09	0.04	0.23

*, ** Significant at 5 and 1 per cent levels, respectively

highly significant correlation coefficients of sca effects with F_1 *per se* performance and relative heterosis (Table 4) which indicated that sca effects can be a suitable index to determine the performance of a cross for exploitation of heterosis.

The five best combinations selected on the basis of *per se* performance for each character had parents of mostly high x high or high x low or medium x high combing ability effects (Table 3). The promising crosses resulted from the combination of high x low gca parents could be possibly due to complementary action of divergent genes in the hybrids and additive type of gene interaction. Heteoritic hybrids found in case of high x high gca parental combinations and with significant sca effects were probably due to accumulation of additive genes in hybrid from both the parents and additive x additive type of gene interaction. The crosses involving high x low gca parents may yield transgressive segregants in later generations, if the allelic genetic systems are present in good combinations and epistatic effects present in the cross act uni-directionally to maximize the expression of the character under selection. The possibility of recovering transgressive segregants would be enhanced through bi-parental mating design as it may release concealed variability and change linkage equilibrium by breaking linkages. The crosses having high x high gca parents

Table 3. Five top ranking cross combinations selected on the basis of *per se* performance for seed yield and five major yield components along with respective sca effect of hybrid and gca of parents

Character		Cross	F_1 mean	Heterosis (%)		sca effect	gca effects
				RH	H		
1.	Seed yield Plant (g)	Sel. 33 x Uma	20.36	236.67**	232.31	6.35**	H x H
		Guj. Til 1 x TC 25	18.79	295.51	218.16**	7.18**	H x L
		Sel. 84 x Sel. 185	16.08	210.00**	198.47**	3.69**	H x L
		Sel. 73 x Uma	15.45	167.38**	158.79**	3.82**	H x H
		Sel. 84 x Uma	15.21	177.55**	154.74**	1.58**	H x M
2.	Branches/Plant	Guj. Til 1 x Uma	4.00	224.32**	160.87**	1.10**	H x H
		Sel. 33 x Uma	3.17	126.19**	106.52**	1.01**	H x H
		Sel. 123 x Uma	2.87	43.33**	16.22	0.38**	H x H
		Sel. 73 x Uma	2.83	31.78**	2.41	0.08	H x H
		Vinayak x Uma	2.83	117.95**	84.78**	-0.06	H x H
3.	Capsules/plant	Sel. 33 x Uma	121.27	207.39*	191.51 **	40.61	H x H
		Guj. Til 1 x TC 25	90.07	220.90**	214.19**	26.41	H x L
		Sel. 84 x Sel. 185	85.60	177.32**	172.90**	26.28**	H x M
		Sel. 73 x Uma	76.47	102.83**	83.81 **	9.91	H x H
		Sel. 123 x Uma	72.40	102.80**	74.04**	8.41	M x H
4.	Capsule length (mm)	Phule Til. 1 x TC 25	29.53	3.75	1.96	1.46**	H x H
		Sel. 20 x Uma	28.53	13.60**	11.90**	0.98**	H x M
		Sel. 33 x Sel. 185	28.53	15.68**	1.30	1.25**	H x L
		Sel. 15 x TC 25	28.40	11.52**	-1.96	0.01	H x H
		Sel. 15 x Uma	28.20	18.82**	10.59**	0.00	H x M
5.	Seeds/ Capsule	Sel. 20 x Uma	79.43	24.37**	19.39**	6.43**	H x H
		Krishna x Uma	77.70	22.39**	16.79**	7.79**	M x H
		Sel. 15 x Uma	77.20	4.00*	-5.78**	2.48**	H x H
		Sel. 84 x Uma	74.73	11.82**	11.32**	2.82**	H x H
		Sel. 33 x Sel. 185	74.33	4.45**	-1.68	3.85**	H x L
6.	1000-seed weight (g)	Phule Til 1 x TC 25	3.52	10.68**	4.22	0.22**	H x H
		Sel. 15 x TC 25	3.47	5.76**	2.80	0.17**	H x H
		Guj. Til 1 x TC 25	3.46	5.63**	2.52	0.17**	M x H
		Vinayak x TC 25	3.41	9.27**	1.15	0.15**	M x H
		Sel. 73 x TC 25	3.38	8.43**	0.19	0. 16**	L x H

*, **Significant at 5 and 1 per cent levels, respectively. RH = Relative heterosis ; H = Heterobeltiosis.

Table 4. Correlation coefficients among combining ability effects, mean and relative heterosis

Correlation between	Plant height	Height upto first capsule	Branches/ plant	Nodes on main stem	Capsules on main stem	Capsules/ plant	Capsule length	Capsul breadth	Seeds/ Capsule	1000 seed weight	Seed yield/ plant
Parental mean vs. *gca* effects	0.33	0.25	-0.01	0.48	0.24	0.40	0.60*	0.02	0.19	0.27	0.32
Hybrid mean vs. *sca* effects	0.72**	0.65**	0.77**	0.73**	0.70	0.81**	0.76**	0.92**	0.80**	0.69**	0.75**
Relative heterosis vs. *sca* effects	0.72**	0.60**	0.71	0.70**	0.68**	0.85**	0.43	0.57**	0.62**	0.76**	0.77**

*, ** - Significant at 5 and 1 per cent levels, respectively

may yield better recombinants by following simple pedigree method.

As both additive and non-additive genetic components are important, bi-parental mating followed by recurrent selection may hasten the genetic improvement of yield and yield components. As the seed yield and its components were governed by non-additive gene action, there is a greater scope of exploitation of hybrid vigour for yield and its components. The potential crosses such as Sel. 33 x Uma, Guj Til 1 x TC 25, Sel.84 x Sel.185 and Sel.73 x Uma exhibited high heterosis for seed yield and other yield components like branches/plant, capsules on main stem and capsules/plant. Hence these crosses could be used for commercial exploitation of heterosis in sesame.

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