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Combining ability studies for yield and its attributes in sesame

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Abstract : Combining ability effects were estimated in line x tester crossing programme for ten characters involving 7 lines and 5 testers in sesame (*Seasamum indicum L.)*. Higher magnitude of *sca* effects indicated the preponderance of non-additive gene action control on all the traits. Among the lines VS 350, VS9101 and Tapi were evaluated as good general combiners for seed yield and its components. Tester TMV 3 was found to be a good male donor for plant height, number of capsules per plant and seed yield per plant. Among hybrids VS9101 x TMV4 was the most promising one as it had high *sca* effects and *per se* performance for seed yield per plant, number of capsules per plant and length / breadth ratio. An attempt of multiple crosses with the use of all the above good general combiners would lead to obtain transgressive segregants for grain yield in advanced generations. *(Key Words : Combining ability, Sesamum, Line x Tester, Gene action).*

The knowledge on nature and magnitude of gene action determines the selection of parents which, when crossed will result in heterotic hybrids or higher proportions of transgressive segregants. Combining ability analysis study provides this information and is frequently used by the plant breeders as a tool to evaluate newly developed cultures for their parental usefulness and to assess the gene action involved in various characters so as to design an appropriate and efficient plant breeding method. The present investigation was undertaken to get the information on the nature of combining ability operative in the inheritance of grain yield and its related traits in sesamum (*Sesamum indicum* L.) through line x tester mating design involving 7 lines and 5 testers of sesame.

Materials and Methods

The experimental materials comprised of seven pure lines of sesame *viz.*, Padma, Tapi, VS 350, VS 9101, WO 33, WO 38 and EO 63 used as females which were crossed with five male parents *viz.*, TMV 3, TMV 5, CO 1, TMV 4 and TMV 6 to develop 35 F_1 crosses using line x tester mating design during *rabi* 1995-96. The F_1 crosses along with their parents were raised in a randomized block design with three replications during *rabi* 1996-97 at Oilseeds Research Station, Tamil Nadu Agricultural University, Tindivanam, Tamil Nadu.

In each replication each entry was sown in a two row plot of 4m length with a distance of 40 cm and 15 cm between rows and plants respectively. All the normal agronomic practices were followed to obtain a healthy crop.

Observations were recorded on five randomly selected competitive plants in each entry and in each replication for days to flowering, plant height, number of branches per plant, relative height to first capsule, number of capsules per plant, days to maturity, number of seeds per capsule, L / B ratio, 100 seed weight and seed yield per plant. The combining ability analysis was carried out following Kempthorne (1957).

Results and Discussion

Analysis of variance (Table 1) indicated that the hybrids, lines (females), testers (males) and line x testers differed significantly for all the characters except hybrids, lines, testers and line x testers for days to maturity and 100 seed weight and testers for length and breadth ratio. The specific combining ability variance was greater than that of general combining ability variance for all the traits studied. Hence the relative estimates of GCA and SCA variances indicated that the variances due to *sca* effect were predominant for all the characters and inturn it indicated the preponderance of non-additive gene action on all the traits. The characters controlled by non-additive gene action hold promise for the exploitation of heterosis for evolving hybrids in sesamum. The importance of non-additive gene action for seed yield and seed components was also reported earlier (Anandakumar and Sree Rangasamy, 1987; Chaudhari *et al.* 1997; Krishnadoss *et al.* 1987 and Rathinaswamy and Jagathesan, 1984).

The estimate of *gca* effects (Table 2a) revealed that none of the parents registered good general combining ability for all the traits studied. However among the lines the parent VS 350 was a good general combiner for number of branches per plant, number of capsules per plant and single plant yield (Table 2).

Table 1. Analysis of variance for combining ability for different characters in sesamum

Sources	df	days to floweing	Plant height (cm)	No. of branches / plant	Relative height to first capsule	No. of capsules / plant	Days to maturity	No. of seeds / plant	L/B ratio	100 seed weight (g)	Seed yield/ plant (g)
Replications	2	3.61**	1.12	0.02	0.16	12.17	13.39**	20.83	0.08	0.002	0.06
Parents	11	4/47**	288.52**	2.34**	52.15**	623.22**	3.09**	29.86**	0.08*	0.01	9.15**
Prents vs Hybrids/crosses	1	0.38	5135.7**	43.71**	115.72**	135.32**	0.02	2.63	0.05	0.07*	90.40**
Hybrids	34	3.38**	475.20**	2.27**	57.88**	278.8**	0.86	55.80**	0.15**	0.01	13.18**
Lines	6	6.64**	1650.2**	5.19**	160.93**	360.62**	1.65	57.05**	0.22**	0.01	27.71**
Testers	4	3.95**	244.89**	0.36**	44.68**	290.5**	1.60	96.24**	0.09	0.003	8.89**
Lines x Testers	24	2.46**	219.83**	1.85**	34.31**	206.41**	0.71	48.75**	0.14**	0.01	10.26**
Error 0.18	68	0.56	22.06	0.06	0.06	3.36	9.51	0.90	10.00	0.04*	0.01
σ^2 GCA		0.16	40.43	0.05	3.81	12.18	0.02	1.55	0.01	-0.05	0.44
σ^2 SCA		0.63	65.92	0.60	10.32	65.63	-0.06	12.92	0.03	0.01	3.36
σ^2 GCA / σ^2 SCA		0.25	0.61	0.09	0.37	0.19	-0.33	0.12	0.33	0.50	0.13

* Significant at 5% level

** Significant at 1% level

Table 2. Mean performance for different characters in sesamum

	LINES							TESTERS				
Characters	Padma	Tabi	VS 350	VS 9101	WO 33	WO 38	EO 63	TMV 3	TMV 5	CO 1	TMV 4	TMV 6
Days to flowering	37.3	34.8	36.9	35.8	36.9	33.3	37.3	38.5	37.4	34.63	37.7	36.5
Plant height	75.0	62.9	60.4	57.9	73.5	56.5	58.6	80.3	83.3	76.0	77.8	76.5
No. of branches/ plant	5.5	4.1	5.3	4.6	4.1	3.2	3.6	4.6	5.5	5.8	6.0	5.0
Relative height to first capsule	23.8	26.3	28.1	21.4	22.9	23.6	20.3	30.2	27.8	28.2	29.4	34.7
No. of capsules / plant	71.1	41.2	54.2	25.1	37.1	34.6	50.9	6.1	63.4	49.9	62.1	65.6
Days to maturity	81.9	79.6	80.6	79.8	81.4	79.7	80.7	82.4	81.7	79.7	81.9	81.5
No. of seeds / capsules	71.3	67.6	63.2	63.7	65.2	61.2	64.5	61.2	62.1	63.0	64.9	69.1
L / B ratio	1.6	1.2	1.3	1.3	1.6	1.7	1.4	1.4	1.3	1.3	1.3	1.3
100 seed weight (g)	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.4	0.5	0.4
Yield (g)	6.3	5.4	5.6	3.5	4.7	5.4	4.5	3.6	8.9	6.5	7.2	8.6

Table 2a. Estimates of *gca* effects for different characters in sesamum

	LINES							TESTERS				
Characters	Padma	Tabi	VS 350	VS 9101	WO 33	WO 38	EO 63	TMV 3	TMV 5	CO 1	TMV 4	TMV 6
Days to flowering	1.18**	-0.36	-0.23	-0.05	0.37*	-0.97**	0.07	-0.02	-0.70**	0.01	0.38*	0.34
Plant height	-	4.48**	5.48**	5.96**	-	-	15.13**	2.48*	-5.14**	-1.80	2.87**	1.60
No. of branches/plant	11.66**	-	-	-	7.47**	12.26**	-	-	-	-	-	-
Relative height to first capsule	-3.30**	1.97**	3.35**	1.03	-	-.478**	3.41**	0.67	0.21	1.15**	-2.54**	0.51
No. of capsules /plant	-4.24**	-1.19	9.67**	5.92**	0.96	-2.93**	-8.18**	5.26**	1.96**	-2.86**	0.44	-3.93**
Days to maturity	0.58*	-0.04	-0.05	0.20	-0.10	-0.52	-0.16	0.01	-0.30	0.02	0.20	0.06
No. of seeds / capsules	-0.51	2.76**	1.46	0.33	-1.18	-3.39**	0.17	0.05	-0.15	-2.55**	3.30**	-0.95
L / B ratio	0.01	0.03	-0.26**	-0.13**	0.03	0.03	0.03	-0.11	0.02	-0.01	-0.01	0.01
100 seed weight (g)	0.02	-0.02	0.01	0.04	0.04	0.01	-0.04	-0.02	0.01	-0.01	-0.01	0.01
Yield (g)	-0.74**	-0.21	2.22**	1.42**	-0.07	-1.46**	-1.18**	0.65**	0.35	-1.04**	0.18	-0.15
SE				0.15						0.13		
CD 5%				0.41						0.36		
1%				0.55						0.47		

* Significant at 5% level

** Significant at 1% level

Table 3. Crosses showing favourable *sca* effects for single plant yield and other traits

Sl. No.	Crosses	*sca* effects for yield	Mean yield (g)	Other traits* for which cross showed desirable *sca* effects
1	VS 9101 x TMV 4	3.38	12.70	5(14.6), 8(0.34)
2	VS 350 x CO 1	2.68	11.57	-
3	Tapi x TMV 6	2.15	9.50	4(3.2)
4	EO 63 x TMV 6	2.11	8.50	5(8.87)
5	WO 38 x CO 1	1.80	7.00	3(0.44), 5(7.05), 7(7.0)
6	Tapi x TMV 3	1.68	9.83	-
7	WO 33 x TMV 5	1.61	9.60	2(6.34), 5(6.1)
8	VS 350 x TMV 5	1.45	11.73	3(059), 5(10.0), 8(0.29), 9(0.08)
9	WO 33 x TMV 6	1.31	8.80	2(19.0), 3(2.02)
10	Padma x TMV 5	1.21	8.53	3(0.33), 5(9.4)
11	Padma x TMV 4	0.98	8.13	4(4.0)

* 2-Plant height, 3-No. of branches per plant, 4-Relative height to first capsule, 5-No. of capsules per plant, 7-No. of seeds per capsule, 8-L/B ratio, 9-100 seed weight.

Table 4. Top three crosses recording high *sca* effects *per se* performance and *gca* effect of parents for seed yield and its components.

Character	Crosses	*sca* effects	Mean	*gca* effects
Yield per plant (g)	VS 9101 x TMV.4	3.38	12.70	H x L
	VS 350 x CO.1	2.68	11.57	H x L
	Tapi x TMV.6	2.15	9.50	L x L
Plant height	WO 33 x TMV.6	19.00	96.87	L x L
	Padma x TMV.4	13.69	88.63	L x H
	VS 9101 x CO.1	9.17	97.07	H x L
No. of branches per plant	VS 9101 x TMV 6	2.02	3.47	H x L
	VS 9101 x TMV 3	1.15	4.97	H x L
	VS 350 x TMV 3	0.92	5.33	H x L
Relative height to first capsule	Tapi x CO.1	8.05	39.63	H x H
	WO 33 x TMV 3	4.88	32.33	L x L
	EO 63 x TMV 4	0.92	34.13	H x L
No. of capsules per plant	VS 9101 x TMV 4	14.62	73.87	H x L
	VS 350 x TMV 5	9.96	73.87	H x H
	Padma x TMV 5	9.40	60.90	L x H
No. of seeds per capsule	WO 38 x CO 1	7.01	66.13	L x L
	VS 350 x TMV 6	6.02	71.60	L x L
	WO 33 x TMV 3	5.44	69.37	L x L
L/B ratio	VS 9101 x TMV 3	0.34	1.87	L x L
	Padma x TMV 3	0.30	1.55	L x L
	VS 350 x TMV 3	0.30	0.31	L x L
100 seed weight	VS 350 x TMV 5	0.09	0.40	L x L
	WO 33 x TMV 4	0.09	0.38	L x L
	WO 38 x TMV 3	0.09	0.39	L x L

Similarly, VS 9101 was found to be the best combiner for number of branches per plant, number of capsules per plant and yield per plant, where as the parent Tapi was found to be a good general combiner for number of seeds per plant. Among testers, TMV 3 emerged as a good general combiner for number of capsules per plant and seed yield per plant. The tester TMV 5 had significant *gca* effects for days to flowering, plant height, number of branches per plant and number of capsules per plant. The parent CO 1 was found to be a good general combiner for number of branches per plant and TMV 4 for number of capsules per plant and relative height to first capsule.

These parents may thus be used in the hybridization programme to get transgressive segregants in early generations. As non of the parent was found to be good general combiner for all the traits, there is need to attempt multiple crosses for component breeding for improvement of yield. Parents VS 350, VS 9101 and TMV 3 should be given importance in the choice of parents because of their good *sca* for yield. Multiple crosses followed by intermating among the desirable selected plants in later segregating generations may also be of much use for simultaneous improvement of grain yield (Patil *et al.* 1995).

The estimates of specific combining ability effects revealed that none of the crosses were found to be superior for all the traits under study. However the significant and positive *sca* effect for seed yield per plant was exhibited by 11 crosses (Table3) *viz.* VS 1901 x TMV 4, VS 350 x CO1, Tapi x TMV 6, EO 63 x TMV 6, WO 38 x CO1, Tapi x TMV 3, WO 33 x TMV 5, VS 350 x TMV 5, WO 33 x TMV 6, Padma x TMV 5 and Padma x TMV 4 in ascending order of magnitude. These crosses except VS 350 x CO 1 and Tapi x TMV 3 recorded significant and desirable positive *sca* effects for one or more yield components. For example the cross VS 9101 x TMV 4 showed high *sca* effects and *per se* performance for seed yield per plant, number of capsules per plant and length / breadth ratio. It also exhibited high *per se* performance for seed yield per plant, number of capsules per plant and length/breadth ratio of capsule involving high x low, high x low and low x low general combiners respectively (Table4). And hence there was no association between *sca* effect and *per se* performance of the crosses. The same results were reported earlier in wheat by Rajaram and Maheswari (1996).

All the superior specific combiners (Table4) involved high x high, high x low and low x low general combiners. It shows that the desirable *sca* effect of any cross combination need not necessarily depend on the level of *gca* effects of the parents involved. It indicated the role of additive and non additive gene action for the characters studied, and also signify the importance of both the types of gene action for improvement in seed yield by following an appropriate method of recurrent selection.

As a conclusion, it was observed that the parents VS 350, VS 9101 and TMV 3 were the good general combiners and these parents can be used advantageously in the crossing programme of practical plant breeding like pedigree breeding etc., for the development of superior sesamum varieties. Based on the mean performance and *sca* effects three hybrids VS 9101 x TMV 4, VS 350 x CO 1 and Tapi x TMV 6 were found to be the best hybrid combinations for grain yield and other contributing traits and these hybrids can be utilised for heterotic breeding for exploitation of heterosis and it is possible to select a genotype in the subsequent generation.

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