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Research Article

Combining ability studies through Line x Tester analysis in sesame (*Sesamum indicum* L.)

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Abstract
An attempt was made to study the general and specific combining ability in sesame (*Sesamum indicum* L.) through L X T analysis with four lines and eleven testers. Nine characters *viz.*, days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight, seed yield per plant and oil content were studied. Based on the general combining ability effects of parents and *per se* performance, the genotypes SVPR 1, RT 127, TKG 22, TKG 306, TMV 5 have considerable potential and can be utilized for developing cultivars, with high yield and oil content by using appropriate breeding strategy. Based on *sca* effects, the hybrids CO 1 x Shekar, CO 1 x RT 127, CO 1 x TKG 22, SVPR 1 x VRI SV 1, VRI SV 2 x TMV 6, VRI SV 2 x TKG 306 and TMV7 x TMV 4 were adjudged as better hybrids for yield and yield component traits and hence recommended for yield improvement

Key words
Sesame, General combining ability, Specific combining ability

Introduction

Sesame (*Sesamum indicum* L.) is an ancient and important oilseed crop. It is described as 'Queen of Oilseeds' because of its high oil content and excellent qualities of seed oil and meal. The crop is cultivated in almost all parts of the country as a sole or mixed crop. In India, sesame is grown in an area of 1.70 million hectares with the production of 0.748 million tonnes. The productivity is 439 kg per hectare (State of Indian Agriculture, 2012-13). China is the world's largest consumer and 70% of the world's sesame crop is grown in Asia followed by Africa having a gross share of 26% in the world (Niti Pathak *et al*., 2014). Inspite of intensive efforts to increase the productivity of sesame, the production remained static during the past decades. The production of high yielding cultivars by restructuring the genetic architecture is utmost importance to increase the productivity and gain economic returns. The success of any crop breeding programme depends upon the choice of the parents. A thorough knowledge of the gene action involved in yield and components of yield is essential for selecting the parents. Line x Tester analysis (Kempthorne, 1957) helps to find out the general and specific combining ability effects of different yield attributes and also the gene action involved.

Materials and methods

The present investigation was carried out at Vanavarayar Institute of Agriculture, Pollachi, Tamil Nadu during the year 2014 – 15. The experimental material consisted of four lines and 11 testers, *viz.*, CO 1, TMV 7, VRI SV 2, SVPR 1 as lines, Paiyur 1, TMV 3, TMV 4, TMV 5, TMV 6, VRI SV 1, TKG 22, Shekar, TC 289, RT 127 and TKG 306 as testers. The parental seeds were obtained from various sources through Tamil Nadu Agricultural University, Coimbatore. Using these parents, 44 hybrid combinations were obtained by crossing them in Line x Tester mating design.

The experiment was laid out with 15 parents and 44 F_1s in randomized block design with two replications. A single row of 3m length was allotted to each genotype for each replication with spacing of 30 cm between successive rows and 30 cm between plants within the row. The recommended agronomic practices and plant protection measures were uniformly followed in the experiment. Observations were recorded for the nine biometric traits *viz.*, days to 50 per cent flowering, days to maturity, Plant height, Number of branches per plant, Number of capsules per plant, Number of seeds per capsule, 1000-seed weight, seed yield per plant and oil content. The analysis of variance for combining ability was done based on the method developed by Kempthorne (1957).

Result and discussion

The analysis of variance showed highly significant differences among the genotypes for all the characters studied, indicating the presence of sufficient variability in the experimental material (Table 1). The lines and testers differed significantly among themselves for all the nine characters. The line x tester interaction was significant for all the characters except days to 50 per cent flowering. Evaluation of parents based on *per se* performance and *gca* effects separately might lead to contradiction in selection of promising parents, since *per se* performance of the parents was not always associated with high *gca* effects (Singh and Hari Singh, 1985). Knowledge on general

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combining ability coupled with *per se* performance would result in the identification of parents with good reservoir of superior genes. The results of the present study revealed that, the line SVPR 1 gave desirable *per se* performance and *gca* effects for days to maturity, plant height and seed yield per plant. The tester RT 127 for days to 50 per cent flowering, days to maturity, plant height and number of seeds per capsule; Shekar for days to 50 per cent flowering, days to maturity and plant height; TKG 22 for days to 50 per cent flowering and 1000 seed weight; TKG 306 for number of seeds per capsule and oil content and TMV 5 for number of capsules per plant and oil content. Vavdiya *et al*. (2014) reported that, the parents which are good general combiners for more number of characters are considered as the potential parents, and should be preferred in breeding programme in order to combine more number of characters, by involving fewer numbers of parents in a crossing programme.

The Specific Combining Ability (SCA) was used to designate those effects in certain combinations which significantly depart from what would be expected on the basis of average performance of the lines involved. The *sca* effect is an important criterion for the evaluation of hybrids (Table 3). Among the hybrids, CO 1 x Shekar showed positive and significant *sca* effects for days to maturity, number of branches per plant, number of capsules per plant and seed yield per plant. CO 1 x RT 127 showed significant and positive *sca* effects for four traits *viz*., plant height, number of branches per plant, number of capsules per plant and seed yield per plant.

For the trait plant height, 1000-seed weight and oil content, CO 1 x TKG 22 showed significant and positive *sca* effects. The hybrid, SVPR 1 x VRI SV 1 expressed significant and desirable *sca* effects for days to 50 per cent flowering and seed yield per plant. VRI SV 2 x TMV 6 showed significant *sca* effects for days to maturity and oil content. For number of capsules per plant and seed yield per plant, the hybrids VRI SV 2 x TKG 306 and TMV 7 x TMV 4 showed significant and positive *sca* effects. Similar results were reported by Ranjith Rajaram and Senthil Kumar (2011). Based on *sca* effects, the hybrids CO 1 x Shekar, CO 1 x RT 127, CO 1 x TKG 22, SVPR 1 x VRI SV 1, VRI SV 2 x TMV 6, VRI SV 2 x TKG 306 and TMV 7 x TMV 4 were adjudged as better hybrids.

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Table 1. Analysis of variance for combining ability for seed yield and its components in sesame

Source of variation	df	Days to 50 % flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsules / plant	No. of seeds / capsule	1000-seed weight	Seed yield / plant	Oil content
Replication	1	1.63	2.90	6.62	0.01	0.02	6.54	0.00	21.31	0.0002
Crosses	43	6.99**	24.09**	1029.15**	22.95**	14755.99**	39.79**	0.36**	367.88**	21.97**
Lines	3	15.89**	222.90**	6756.11**	79.70**	5329.23**	29.33**	1.14**	41.37**	0.25**
Testers	10	15.28**	15.12**	1089.16**	16.62**	21329.08**	63.42**	0.66**	660.49**	37.42**
Line x Tester interaction	30	3.33	7.20**	436.45**	19.39**	13507.64**	32.96**	0.19**	302.99**	18.99**
Error	43	2.72	1.88	10.02	0.05	2.79	6.17	0.001	5.56	0.001
GCA	14	0.08	0.38	13.42	0.08	28.28	0.15	0.004	1.47	0.06
SCA	43	0.30	1.53	213.21	9.66	6752.42	13.39	0.09	148.71	9.49
GCA/SCA		0.27	0.25	0.06	0.01	0.004	0.01	0.04	0.01	0.01

* Significant at P = 0.05 ** Significant at P = 0.01 df- Degrees of freedom

Table 2. General combining ability effects of parents for seed yield and its components in sesame

S. No.	Genotypes	Days to 50 % flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsules / plant	No. of seeds / capsule	1000- seed weight	Seed yield per plant	Oil content
1.	CO-1	1.16**	4.09**	25.64**	-1.00**	0.64	-1.55**	0.33**	0.91	0.02**
2.	TMV-7	-0.16	-0.64*	-3.12**	-0.32**	18.53**	0.45	-0.16**	-1.82**	0.15**
3.	VRI-SV-2	-0.11	0.18	-10.94**	2.77**	0.39	-0.09	-0.14**	-0.28	-0.07**
4.	SVPR-1	-0.89*	-3.64**	-11.59**	-1.45**	-19.56**	1.18*	-0.03**	1.19*	-0.09**
5.	Paiyur-1	2.06**	-1.00*	20.18**	-1.21**	-65.50**	-3.91**	-0.15**	-13.42**	3.05**
6.	TMV-3	-0.57	-0.88	0.29	-0.56**	-10.36**	-2.66**	-0.11**	-4.28**	-1.32**
7.	TMV-4	0.18	-1.38**	-16.60**	1.90**	-6.99**	-3.66**	-0.07**	-3.61**	1.92**
8.	TMV-5	0.06	1.50**	7.55**	-0.38**	12.67**	0.84	0.04**	-0.57	1.07**
9.	TMV-6	0.81	1.88**	-0.85	-0.00	-62.80**	-1.66	-0.10**	-6.10**	0.67**
10.	VRI-SV-1	1.68**	0.50	12.78**	1.20**	-25.57**	0.41	0.40**	0.12	-1.01**
11.	TKG-22	-1.44*	-1.25*	3.30*	1.87**	100.61**	-0.66	0.59**	17.31**	-1.27**
12.	Shekar	-1.44*	-1.00*	-12.61**	-0.55**	-8.99**	1.59	-0.48**	-0.51	-5.11**
13.	TC-289	0.18	1.88**	2.98	1.21**	78.31**	3.34**	-0.12**	16.15**	1.08**
14.	RT-127	-2.44**	-1.38**	-16.69**	-2.86**	-28.68**	3.59**	-0.12**	-3.80**	0.19**
15.	TKG-306	0.93	1.13*	-0.34	-0.62**	17.30**	3.59**	0.11**	-1.28	0.73**
	SE (Lines)	0.50	0.41	0.95	0.07	0.50	0.74	0.01	0.71	0.01
	CD (5%)	1.00	0.83	1.92	0.15	1.01	1.51	0.02	1.43	0.02
	SE (Testers)	0.83	0.69	1.58	0.12	0.84	1.24	0.01	1.18	0.01
	CD (5%)	1.66	1.38	3.18	0.24	1.68	2.50	0.03	2.37	0.03

* Significant at P = 0.05 ** Significant at P = 0.01

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Table 3. Specific combining ability effects of hybrids for seed yield and its components in sesame

S. No.	Genotypes	Days to 50 % flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsules / plant	No. of seeds / capsule	1000-seed weight	Seed yield / plant	Oil content
1.	CO 1 x Paiyur 1	-0.28	1.41	-12.82**	-0.83**	-66.45**	0.55	-0.06**	2.81	-1.42**
2.	CO 1 x TMV 3	-2.16	1.28	-15.04**	0.82**	66.08**	1.30	-0.34**	1.46	-4.43**
3.	CO 1 x TMV 4	-0.41	-1.22	1.10	-0.82**	-23.60**	0.70	0.19**	0.78	-0.13**
4.	CO 1 x TMV 5	1.72	2.41*	-2.02	1.34**	14.33**	1.80	-0.18**	5.15**	-0.71**
5.	CO 1 x TMV 6	-0.03	0.53	-5.21*	-3.01**	0.13	0.30	0.12**	4.31**	1.33**
6.	CO 1 x VRI SV 1	0.59	-2.09*	-18.08**	-5.91**	-170.87**	-3.95*	-0.19**	-24.68**	-3.71**
7.	CO 1 x TKG 22	1.72	0.66	11.95**	-2.89**	-60.38**	-0.70	0.68**	-15.52**	3.22**
8.	CO 1 x Shekar	-1.78	-2.09*	6.00*	3.50**	144.12**	0.05	-0.34**	16.95**	-0.98**
9.	CO 1 x TC 289	1.59	-1.97*	-1.58	2.75**	-22.15**	1.30	0.54**	5.00**	2.13**
10.	CO 1 x RT 127	-0.28	0.78	35.55**	4.46**	170.09**	-2.95	-0.12**	13.75**	-0.14**
11.	CO 1 x TKG 306	-0.66	0.28	0.15	0.59**	-51.29**	3.05	-0.31**	-10.00**	4.82**
12.	TMV 7 x Paiyur 1	-0.97	-0.36	4.39	0.48**	44.94**	-5.45**	-0.11**	-10.47**	0.32**
13.	TMV 7 x TMV 3	0.16	-1.49	-10.59**	-0.17	-5.52**	-0.70	0.11**	-5.12**	4.52**
14.	TMV 7 x TMV 4	0.41	1.51	9.71**	1.70**	91.66**	-0.70	0.11**	-5.12**	4.52**
15.	TMV 7 x TMV 5	-0.97	0.64	9.41**	1.65**	62.16**	-0.20	0.20**	12.02**	-3.43**
16.	TMV 7 x TMV 6	-0.22	-1.24	2.77	-0.56**	-45.23**	-0.70	-0.23**	-4.99**	-4.57**
17.	TMV 7 x VRI SV 1	-0.09	2.64**	6.90**	-0.61**	41.42**	4.05*	0.06**	8.09**	0.28**
18.	TMV 7 x TKG 22	-0.97	-1.11	-12.17**	-1.60**	-4.88**	-1.70	-0.19**	-4.30*	0.74**
19.	TMV 7 x Shekar	1.53	1.14	5.91*	2.84**	-41.98**	3.05	0.19**	-1.53	-0.04**
20.	TMV 7 x TC 289	-0.09	2.26*	-18.10**	-1.88**	-95.48**	-7.70**	-0.43**	-13.95**	0.37**
21.	TMV 7 x RT 127	0.03	-2.99**	-10.78**	0.23	-60.48**	7.05**	0.28**	-0.64	2.32**
22.	TMV 7 x TKG 306	1.16	-0.99	12.55**	-2.09**	13.39**	3.05	-0.10**	4.37*	2.53**
23.	VRI SV 2 x Paiyur 1	0.99	0.32	-14.22**	1.40**	-5.20**	3.09	0.25**	2.00	1.05**
24.	VRI SV 2 x TMV 3	1.11	-0.31	-3.33	1.07**	-21.86**	-2.16	-0.08**	4.72**	-0.61**
25.	VRI SV 2 x TMV 4	0.86	-1.31	-2.17	-0.71**	-80.32**	-2.16	-0.26**	-19.64**	1.34**
26.	VRI SV-2 x TMV 5	-0.01	-1.18	-5.07*	-2.43**	-13.54**	-5.66**	-0.15**	-3.78**	3.39**
27.	VRI SV 2 x TMV 6	-0.76	-3.56**	0.97	-0.50**	7.15**	1.84	0.10**	-4.61**	3.00**
28.	VRI SV 2 x VRI SV 1	1.86	0.82	3.98	7.99**	68.72**	0.59	0.16**	3.92*	2.78**
29.	VRI SV 2 x TKG 22	-1.51	0.57	6.34**	-0.36*	38.33**	7.84**	-0.12**	11.02**	-5.31**
30.	VRI SV 2 x Shekar	0.49	0.82	3.94	-4.61**	-68.62**	-2.41	0.46**	-5.74**	0.96**
31.	VRI SV 2 x TC 289	-1.14	0.94	10.88**	-1.69**	-3.26**	2.84	-0.31**	-2.60	1.67**
32.	VRI SV 2 x RT 127	-0.01	2.19**	3.75	-2.95**	-44.33**	-4.41*	0.01	-7.09**	-1.80**
33.	VRI SV-2 x TKG 306	-1.89	0.69	-5.07*	2.81**	122.94**	0.59	-0.05**	21.80**	-6.46**
34.	SVPR 1 x Paiyur 1	0.26	-1.36	22.65**	-1.05**	26.70**	1.80	-0.08**	5.66**	0.05**
35.	SVPR 1 x TMV 3	0.89	0.51	28.96**	-1.72**	-38.69**	1.57	0.31**	-1.06	0.51**

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S. No.	Genotypes	Days to 50 % flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsules / plant	No. of seeds / capsule	1000-seed weight	Seed yield / plant	Oil content
36.	SVPR 1 x TMV 4	-0.86	1.01	-8.64**	-0.17	12.25**	3.57*	-0.15**	2.34	1.83**
37.	SVPR 1 x TMV 5	-0.74	-1.86	-2.32	-0.55**	-62.95**	4.07*	0.13**	-13.40**	0.75**
38.	SVPR 1 x TMV 6	1.01	4.26**	1.46	4.07**	37.95**	-1.43	-0.00	5.29**	0.25**
39.	SVPR 1 x VRI SV 1	-2.36*	-1.36	7.20**	-1.47**	60.73**	-0.68	-0.02	12.67**	0.65**
40.	SVPR 1 x TKG 22	0.76	-0.11	-6.12**	4.85**	26.94**	-5.43**	-0.36**	8.80**	1.35**
41.	SVPR 1 x Shekar	-0.24	0.14	-15.84**	-1.73**	-33.52**	-0.68	-0.31**	-9.67**	0.06**
42.	SVPR 1 x TC 289	-0.36	-1.24	8.80**	0.82**	120.89**	3.57*	0.19**	11.55**	-4.17**
43.	SVPR 1 x RT 127	0.26	0.01	-28.52**	-1.74**	-65.28**	0.32	-0.17**	-6.02**	-0.39**
44.	SVPR 1 x TKG 306	1.39	0.01	-7.63**	-1.31**	-85.03**	-6.68**	0.47**	-16.17**	-0.89**
	SE	1.65	1.37	3.17	0.24	1.67	2.48	0.03	2.36	0.03
	CD (5%)	3.32	2.76	6.36	0.48	3.36	4.99	0.06	4.74	0.05

* Significant at P = 0.05 ** Significant at P = 0.01