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Studies in combining ability for economic traits in cultivated sesame *(Sesamum indicum* L.)

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Abstract: The 36 hybrids obtained by crossing 12x3 genotypes in line x tester fashion and their parents were evaluated during *rabi* 2003-04 for nine metric traits. Combining ability studies indicated the preponderance of non-additive gene action for all the characters except 100-seed weight and oil content. The genotypes CO 1, TMV 4, and ORM 14 might be utilized as potential parents since they possessed high *per se* with significant *gca* effects for most of the traits under study. Based on *per se* performance, *sca* effects and standard heterosis for yield and yield related components along with maturity, the five hybrids namely, CO 1 x ORM 14, TMV 4 x ORM 17, TMV 5 x ORM 17, Paiyur 1 x ORM 14 and TNAU 2030-35 x ORM 14 were identified as the best cross combinations for further exploitation.

Keywords: sesame, combining ability, gca effects, sca effects, per se performance

Introduction

The success of breeding programme primarily depends upon the judicious choice of parents. Genetic information especially about the nature of combining ability is a pre requisite in fixing the suitable parents for heterosis breeding. Combining ability analysis is very useful for the crop improvement as it helps the plant breeders to identify potential parents either to be used for heterosis breeding or to evolve desirable pure line varieties. Combining ability is the ability of an inbred to transmit its desirable performance to its hybrid progenies. The concept of combining ability was enunciated by Sprague and Tatum (1942). General combining ability (GCA) of parents is a good estimate of additive gene action whereas specific combining ability (SCA) of hybrids is a measure of non-additive gene action. One of the biometrical methods is Line x Tester analysis, which provides valid information on combining ability effects and to understand the nature of gene action involved in the expression of various quantitative traits.

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 sesame *(Sesamum indicum* L.).

Materials and Methods

The parental materials consisted of twelve lines *viz.*, CO 1, TMV 3, TMV 4, TMV 5, TMV 6, Paiyur 1, SVPR 1, VRI 1, Uma, TNAU 2030-35, TNAU 2030-70 and Varasampatty Local 1 (V. Local 1) used as females which were crossed with three testers as male parents *viz.*, ORM 7, ORM 14 and ORM 17 to develop 36 F_1 crosses using line x tester mating design during *kharif 2003-04.* The F_1 crosses along with their parents were raised in a randomized block design with two replication during *rabi* 2003 - 04 at Tamil Nadu Agricultural University, Coimbatore. In each replication, 36 hybrids and 15 parents were raised each in single row of 6 m length with a spacing of 30 x 30cm. Recommended agronomic practices were followed

Table 1. Combining ability variance and proportional contribution of lines, testers and interaction to the total variance for different traits

Sources	df	Mean square								
		Days to 50 per cent flowering	Days to maturity	Plant height	No.of primary branches	No.of capsules per plant	100 seed weight	Oil content	Seed yield per plant^{-1}	Oil yield per plant^{-1}
Lines	11	28.60**	62.68**	618.87**	2.05**	1488.59**	0.0006**	10.80	19.74**	3.25**
Testers	2	7.76	13.79	7.29	4.22**	1878.82**	0.0001	2.42	34.41**	4.59*
Line x Testers	22	6.17**	8.38**	55.80**	0.68**	219.61**	0.0002**	11.25**	2.98**	0.97**
Error	35	1.37	1.06	4.25	0.01	5.11	0.0001	2.71	0.24	0.06
σ^2GCA		0.17	0.41	4.11	0.015	11.66	0.000	-0.02	0.17	0.02
σ^2SCA		2.40	3.66	25.78	0.335	107.25	0.0001	4.27	1.37	0.45
σ^2 GCA/σ^2 SCA		0.07	0.11	0.16	0.05	0.11	0.00	-0.004	0.12	0.04

* Significant at 5% level ** Significant at 1% level

under irrigated condition. Observations were recorded on randomly selected five competitive plants of each genotype of the two replications for days to 50 per cent flowering, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, 100-seed weight, oil content, seed yield per plant and oil yield per plant. The combining ability analysis was carried out following Kempthorne (1957).

Results and Discussion

Analysis of variance for parents, crosses and their interaction showed significant differences among parents and crosses for all the traits studied. This revealed the presence of significant variability in the experimental material. The estimates of combining ability variance (Table 1) showed higher proportion of SCA than GCA for yield contributing characters and indicated that these characters were controlled preponderantly by non-additive gene action except 100-seed weight and oil content. It suggested the use of heterosis breeding for improvement of these characters. The same results were reported by Deepa Sankar and Ananda Kumar (2003) and Mishra and Sikarwar (2001). Ramesh *et al.* (2000) reported higher additive component for 100-seed weight and oil content.

Evaluation of Parents

In any breeding programme, the choice of the correct parents is the secret of the success. Knowledge on general combining ability coupled with *per se* performance of the parents would be of great value in selection of parents for hybridization programme. Based on *per se* performance of the parents, CO 1, TMV 4, TMV 6 and Paiyur 1 recorded significant mean performance for most of the characters.

Table 2. General combining ability effects of parents for different characters

Parents	Days to 50 per cent flowering	Days to maturity	Plant height	No.of primary branches	No.of capsules per plant	100-seed weight	Oil content	Seed yield plant^{-1}	Oil yield plant $^{-1}$
Lines									
CO1	-0.31	1.25**	5.50**	0.75**	15.33**	0.01	0.85	2.72**	1.14**
TMV3	2.36**	2.42 **	11.57**	0.71**	15.43**	0.02**	-0.64	0.98**	0.26*
TMV4	0.53	1.75**	3.24**	0.55**	11.24 **	0.00	-0.18	0.75**	0.26*
TMV5	2.36 **	1.42 **	4.20**	0.36 **	11.08**	0.00	0.04	2.01**	0.74**
TMV6	0.69	-1.08*	4.95**	-0.05	0.74	0.00	1.34	0.54**	0.32**
Paiyur 1	0.86	-1.58**	1.14	-0.25 **	-2.69**	0.00	0.71	0.14	0.12
SVPR1	-1.31 **	-8.08 **	-22.53**	-1.07**	-39.02**	0.01	-1.28	-4.18**	-1.62**
VRI 1	-1.47**	-1.42 **	2.80**	-0.15**	-5.49**	-0.02 **	-2.01 **	-0.16	-0.31 **
Uma	-5.81 **	-2.92 **	-17.03**	-0.94**	-17.86**	-0.01 **	-2.37 **	-2.27**	-1.04**
TNAU 2030-35	1.36**	2.42 **	-4.20**	-0.00	-0.42	-0.01 *	0.46	-0.25	-0.06
TNAU 2030-70	0.36	2.75 **	0.72	-0.20**	0.38	0.00	1.31	-0.42*	-0.04
V. Local 1	0.36	3.08 **	9.64**	0.31**	11.28**	0.01 *	1.76*	0.14	0.22*
Testers									
ORM7	0.61 *	0.88 **	-0.33	-0.43 **	-10.13**	0.00	0.16	-1.38**	-0.50 **
ORM 14	-0.10	-0.46 *	0.64	0.41 **	6.21 **	0.00	0.21	0.73 **	0.32 **
ORM 17	-0.51 *	-0.42	-0.30	0.02	3.92 **	-0.00	-0.37	0.65 **	0.18**
SE (Lines)	0.478	0.420	0.842	0.046	0.923	0.004	0.672	0.201	0.102
SE (Testers)	0.239	0.210	0.421	0.023	0.461	0.002	0.336	0.100	0.051

* Significance at 5% level, ** Significance at 1% level.

Table 3. Estimates of *sca* effects for different characters for promising hybrids

Hybrids	Days to 50 per cent flowering	Days to maturity	Plant height	No.of primary branches	No.of capsules per plant	100-seed weight	Oil content	Seed yield plant^{-1}	Oil yield plant^{-1}
CO 1 x ORM 14	0.93	-2.04 **	8.86 **	-0.08	11.96**	0.00	5.91**	1.65**	1.47**
TMV 3 x ORM 7	0.06	0.46	3.92**	0.10	9.45**	-0.02 *	0.17	1.38**	0.54**
TMV 4 x ORM 17	1.51	-2.58**	13.52**	0.51	14.98**	-0.00	2.87*	1.72 **	1.00**
TMV 5 x ORM 17	0.18	-2.25**	0.25	“	11.65**	0.00	1.20	1.45 **	0.69**
Paiyur 1 x ORM 14	-0.24	0.79	-1.67	0.75"	12.72**	-0.02 *	1.72	1.93**	0.91**
TNAU 2030-35 x ORM 14	0.76	-0.71	-0.94	0.52	8.76	0.01 *	0.85	1.04 **	0.45*
SE	0.828	0.728	1.458	“	“	0.006	1.164	0.348	0.176

Significance at 5% level ; Significance at 1% level

The *gca* is considered as the intrinsic genetic value of the parent for a trait which is due to additive genetic effects and is fixable (Simmonds, 1979). Among the parents (Table 2), CO 1, TMV 3, TMV 4, TMV 5, TMV 6 and ORM 14 recorded significant and positive *gca* effects for yield per plant, oil yield per plant and most other characters.

In conclusion, both *per se* performance and *gca* effects are equally important. The lines CO 1, TMV 4 and ORM 14 could be considered as good combiners for most of yield and yield attributing traits.

Evaluation of Hybrids

The primary criterion used for the evaluation of hybrids is the *per se* performance of the characters of the hybrids. In the present study, eleven hybrids CO 1 x ORM 7, CO 1 x ORM 14, CO 1 x ORM 17, TMV 4 x ORM 17, TMV 5 x ORM 14, TMV 5 x ORM 17, VRI 1 x ORM 14, TMV 6 x ORM 14, TMV 6 x ORM 17, Paiyur 1 x ORM 14, and TNAU 2030-35 x ORM 14 recorded significant and superior *per se* performance for seed yield. The hybrids CO 1 x ORM 14, TMV 4 x ORM 17, TMV 5 x ORM 14, TMV 5 x ORM 17 and Paiyur 1 x ORM 14 were recorded significant and positive *per se* performance for most of the yield attributing characters.

The next criterion for selection of hybrid is *sca* effects (Table 3). The hybrids CO 1 x ORM 14, TMV 3 x ORM 7, TMV 4 x ORM 17, TMV 5 x ORM 17, Paiyur 1 x ORM 14 and TNAU 2030-35 x ORM 14 recorded significant positive *sca* effects for seed yield per plant, oil yield per plant and number of capsules per plant.

Table 4. Selected parents and hybrids based on mean *gca, sca* effects

Characters	*Parents*	*Hybrids*	*sca* effects	*gca* status
Days to 50 per cent flowering	SVPR 1, VRI 1, Uma, ORM 17	CO 1 x ORM 17	-2.65**	L x H
		VRI 1 x ORM 17	-2.49**	H x H
Days to maturity	SVPR1,VRI 1, ORM 14	VRI 1 x ORM 14	-2.88**	H x H
Plant height	CO 1, TMV 3, TMV 4, TMV 5, TMV 6, Varasampatty Local 1	CO 1 x ORM 14	8.86**	H x L
		TMV 4 xORM 17	13.52**	H x L
Number of primary branches per plant	CO 1, TMV 3, TMV 4, TMV 5, Varasampatty Local 1	CO 1 x ORM 7	0.66**	H x L
		TMV 5 xORM 17	0.75**	H x L
Number of capsules per plant	CO 1, TMV 3, TMV 4, TMV 5, Varasampatty Local 1	CO 1 x ORM 14	11.96**	H x L
		TMV 4 xORM 17	14.98**	H x H
		TMV 5 x ORM 17	11.65**	HvH
100-seed weight	TMV 3	Paiyur 1 x ORM 17	0.02**	L x L
Oil content	-	CO 1 x ORM 14	5.91**	L x L
		TNAU 2030-70 x ORM 17	1.43	L x L
Seed yield per plant	CO 1, TMV 3, TMV 4, TMV 5, TMV 6	CO 1 x ORM 14	1.65**	H x H
		TMV 4 xORM 17	1.72**	H x H
		TMV 5 xORM 17	1.45**	H x H
		Paiyur 1 x ORM 14	1.93**	L x H
		TNAU 2030-35 x ORM 14	1.04**	L x H
Oil yield per plant	CO 1, TMV 3, TMV 4, TMV 5, TMV 6, Varasampatty Local 1	CO 1 x ORM 14	1.47**	H x H
		TMV 4 x ORM 17	1.00**	H x H
		Paiyur 1 x ORM 14	0.91**	L x H

Relationship between gca and sca effects

The *per se* performance, *gca* effects of their parents and *sca* effects of hybrids are the basic criteria for selection of any breeding programme (Table 4). Griffing (1956) suggested that the high *gca* effects might be due to additive gene action as well as additive x additive type of epistasis gene action. The promising hybrids for days to maturity, seed yield per plant and oil yield per plant, had at least one of the parents as the desirable combiner. Considering the *sca* effects of days to maturity, the hybrid TMV 4 x ORM 17, CO 1 x ORM 14 and TMV 5 x ORM 17 recorded high *sca* effects, while TNAU 2030-35 x ORM 14 recorded moderate *sca* effects and Paiyur 1 x ORM 14 recorded poor *sca* effect.

By the aforesaid discussion, the crosses namely CO 1 x ORM 14, TMV 4 x ORM 17, TMV 5 x ORM 17, Paiyur 1 x ORM 14 and TNAU 2030-35 x ORM 14 could be utilized for pedigree breeding due to the involvement of at least one good *gca* effect parent and the presence of additive nature for oil yield per plant and seed yield per plant. However, the presence of additive x additive epistatic gene action, the selection should be postponed to later generation.

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