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Research Article

Combining ability analysis for yield and yield components in sesame (*Sesamum indicum* L.) genotypes

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Abstract

Combining ability was estimated among nine parents for yield and its contributing traits in sesame. Both *per se* performance and *gca* effects were considered for judging the genotypes as best parent. The genotypes TMV 6, TMV (Sv) 7, TVS 0603 and ORM 21 recorded significant *gca* effect for single plant yield, number of capsules per plant, branches per plant, dry matter production. Hence these genotypes were categorized as good combiners. The cross TMV 3 x ORM 21 registered significant *sca* effect for single plant yield, dry matter production, plant height and branches per plant. While TMV6 x ORM 21 exhibited significant *sca* effect for single plant yield, dry matter production, plant height and branches per plant. The former cross involved parents with good combining ability. Hence, pedigree breeding method could be adopted to isolate desirable recombinants. However, the latter cross involved parents with poor combining ability. Hence, biparental mating followed by selection is recommended for the identification of desirable recombinants.

Key words

General combining ability, Sesame, pedigree breeding, *gca* and *sca*

Introduction

Sesame (*Sesame indicum* L) is one of the important indigenous oilseed crop and cultivated in India for its excellent cooking, medicinal, cosmetic and nutritional quantities of oil. India is the largest producer and exporter of the sesame in the world. The genus Sesmum which belongs to the family Pedaliaceae. It is rich source of oil (50%), Protein (24%), carbohydrates (15%) and sesame oil primarily contributes oleic, linoleic, palmitic and stearic acid. India is the world leader with the largest area, maximum production and highest export of sesame seed with the foreign earnings of Rs. 2000 crores (Ranganatha *et al*., 2012). The increase in productivity through hybrid breeding has not been adequate. Choice of desirable parent for hybridization is the crucial step of any crop breeding programme. Hence, the present investigation is made to ascertain the nature of gene action governing yield and its component traits in sesame. Combining ability is an efficient tool which helps in the identification of desirable parent. The selected good combiner could be later utilized in the crossing programme to bring out desirable combination of genes, which in turn helps to formulate suitable breeding strategy to develop high yielding genotypes with desirable agronomic traits.

Materials and Methods

The experimental materials of this study comprised of nine genotypes which included six lines (TMV 3, TMV 4, TMV 6, TMV (Sv) 7, TVS 0603, VRI 1) and three testers (ORM 7, ORM 14, ORM 21). The six lines were crossed with three testes in line x tester mating fashion and the resultant F1 hybrids were raised along with the parents during *Rabi* 2012-2013 in a randomized block design with two replications in the Oilseeds Research Station, Tindivanam, Tamil Nadu. The hybrids and parents were raised in 3 meter length row. The spacing adopted was 30 x 10 cm. Recommended package of practices were followed throughout the cropping period. Biometrical observation was recorded for days to 50% flowering, plant height, branches per plant, number of capsules per plant, dry matter production, harvest index, days to maturity and single plant yield. The data was analysed statistically as per the method suggested by Kempthorne (1957).

Results and discussion

The mean square due to lines and tester were highly significant for all the traits indicating the diverse nature of parents studied (Table 1). Due to the diverse nature of lines and testers, the crosses between them are also found to be significant for all the traits. Significant nature of line x tester interaction indicated the importance of specific combining ability. The variance due to *sca* was greater than the *gca* for all the traits which indicated the preponderance of non-additive gene action in expression of these traits. This was in the agreement with the findings of Manivannan and Genesan (2001), Mishra and Sikarwar (2001), Kumar and Ganesan (2002), Mothilal *et al.* (2003), Vidhyavathi *et al.* (2005), Solanki and Singh (2006), Sharmila and Ganesh (2008), Bharathi

Kumar and Vivekanandan (2009) and Yamanura *et al.* (2009) and Joshi *et al* (2015).

per se performance of parents:The first criteria for selection of desirable parent its *per se* performance for the trait of interest. Among the nine parents evaluated in the present study, the line parent TMV 6 recorded significantly superior *per se* performance of plant height, number of capsules per plant, dry matter production and single plant yield (Table 2). The tester parent, ORM 7 exhibited significantly higher *per se* performance for branches per plant and dry matter production. The line parent VRI 1 recorded significantly high *per se* performance for cluster per plant. Hence these genotypes can be used as parents to improve the respective traits.

gca effects of parents: In certain cases, high *per se* performing parents may not transmit their superior traits to their offspring. Hence general combining ability effect is considered as the second criteria for selection of superior parents. Table 3 illustrates *gca* effects of parents for various traits studied. The line, TMV 3 recorded significant *gca* effect for single plant yield, dry matter production, number of capsules per plant and plant height. For number of capsules per plant, four lines viz., TMV 6, TMV (Sv) 7, TVS 0603 and ORM 21 were adjudged as good combiners.

Per se performance of crosses:Perusal of the *per se* performance of 18 crosses revealed that the cross TMV 3 x ORM 7 registered significantly higher *per se* performance for single plant yield, dry matter production, number of capsules per plant (Table 4). Among crosses, TMV 6 x ORM 21 recorded significant *per se* performance for single plant yield, branches per plant, number of capsules per plant and dry matter production. However the crosses, TVS 0603 x ORM 14, TVS 0603 x ORM 21 exhibited superior *per se* performance for branches per plant and number of capsules per plant.

sca effects of crosses:In contrast to the *gca* effect being attributed to additive geometric effects, *sca* effects denote dominance and epistatic effects that are not fixable components of genetic variation. The cross TMV 3 x ORM 7 registered significant *sca* effect for single plant yield, dry matter production, branches per plant (Table 5). Appreciably their *per se* performance for single plant yield, dry matter production was also significantly higher. In this cross, the parents involved were also good general combiners for the aforesaid traits. Hence this cross could be exploited through pedigree breeding which may throw superior performing segregants in the later generations. The cross TMV 6 x ORM 21 exhibited significant *sca* effects for single plant yield, dry matter production, number of capsules per plant and branches per plant. This cross involved parents of poor combiners indicating operation of non additive gene action in controlling these traits. Hence, biparental mating followed by selection might be worthwhile for fostering greater recombination in this cross (Francier and Ramalingam, 1999).

From the foregoing discussion, it can be concluded that the parent TMV 6, TMV (Sv) 7, TVS 0603 and ORM 21 could be extensively used in the hybridization programme as these genotypes possessed good combiners for single plant yield, dry matter production, number of capsules per plant, branches per plant. The crosses, TMV 3 x ORM 21, TMV 6 x ORM 31 involved parents of good combining ability. Hence, pedigree method of breeding could be effectively executed to identify desirable recombinants. However, the cross TMV 6 x ORM 21 involved parents with poor combining ability. Therefore, for this cross, biparental mating followed by selection may be recommended for developing genotypes with desirable attributes.

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Table 1. Analysis of variance for combining ability

	Days to 50% flowering	Plant height	Branches per plant	Capsules per plant	Dry matter production	Harvest index	Days to maturity	Single plant yield
Lines	2.87**	250.43**	2.23**	192.4	296.64	0.49	2.87**	31.41
Testers	3.00**	170.32**	4.0**	560.2	75.36	1.35	3.00**	6.50
Line x tester	0.47	67.88**	0.63**	188.5*	243.89**	0.99	0.47	26.64**
Gca	0.0451	2.96	0.04	2.02	-.0.19	-0.005	0.05	-.0.04
Sca	-0.1169	33.94	1.03	150.3	79.7	0.05	-0.12	9.85
gca/ sca	-0.386	0.087	0.039	0.013	-0.002	-0.100	-0.417	-0.004
Error	2.07	0.001	0.0001	1.11	7.72	0.87	2.07	2.07

*, ** Significance at P=0.05 and P= 0.01 level respectively

Table 2. Mean performance of parents for different characters

	Days to 50% flowering	Plant height	Branches per plant	Capsules per plant	Dry matter production	Harvest index	Days to maturity	Single plant yield
Lines								
TMV 3	36	110.3*	5.0	38.0*	53.5*	24.8	86.0	17.7
TMV 4	35	107.7*	5.3	48.0*	42.5	24.7	85.0	14.0
TMV 6	35	114.0*	5.3	41.0*	59.5*	25.5	85.0	20.3**
TMV (Sv) 7	36	101.3	4.0	41.0*	48.5	25.6	86.0	16.7
TVS 0603	33	115.3*	4.0	61.0*	34.0	24.9	83.0	11.3
VRI 1	32	111.7*	4.7	33.0	30.0	24.9	82.0	10.0
Testers								
ORM 7	35	96.3	6.08	17.5	54.0*	24.6	85.0	15.0
ORM 14	36	97.3	4.0	23.0	48.5	25.6	86.0	17.7
ORM 21	37	88.3	3.3	23.5	28.0	25.1	87.0	16.2
Mean	35	104.6	4.67	36.3	44.3	25.0	85.0	14.6
Sed	1.49	0.001	0.37	0.79	3.42	0.94	1.49	1.49
CD (5%)	3.44	0.002	0.89	1.12	7.90	2.16	3.41	3.44

*, ** Significance at P=0.05 and P= 0.01 level respectively

Table 3. General combining ability effects of parent for different characters

	Days to 50% flowering	Plant height	Branches per plant	Capsules per plant	Dry matter production	Harvest index	Days to maturity	Single plant yield
Lines								
TMV 3	-0.50	0.36**	0.58**	-3.28**	11.11**	0.16	-0.50	3.71**
TMV 4	-0.83	-2.41**	-0.48**	-8.44**	-8.56**	0.49	-0.83	2.49**
TMV 6	-0.50	8.49**	0.75**	3.22**	-2.56*	-0.19	-0.50	-0.96
TMV (Sv) 7	0.50	2.26**	-0.18**	2.39**	-4.39**	-0.29	0.50	-1.62**
TVS 0603	0.83	2.26**	-0.82**	7.72**	4.94**	-0.04	0.83	1.61*
VRI 1	0.50	-10.97**	0.15**	-1.61**	-0.56	-0.14	0.50	-0.26
Se (*gi*)	0.59	0.001	0.0014	0.43	1.13	0.38	0.59	0.59
Testers								
ORM 7	0.001	-1.08**	-0.67**	-6.36*	-1.81*	0.39	0.0001	0.34
ORM 14	0.50	-4.19**	0.33**	-0.86*	-1.06	-0.21	0.50	-0.59
ORM 21	-0.50	3.11**	0.33**	7.22*	2.86*	-0.18	-0.50	0.84
Se (*gj*)	0.42	0.0001	0.0024	0.30	0.80	0.27	0.42	0.42

*, ** Significance at P=0.05 and P= 0.01 level respectively

Table 4. Mean performance of crosses for different characters

Crosses	Days to 50% flowering	Plant height	Branches per plant	Capsules per plant	Dry matter production	Harvest index	Days to maturity	Single plant yield
TMV 3 x ORM 7	34	121.3	6.0*	73.5	42.0	26.3	84.0	15.0
TMV 3 x ORM 14	35	110.3	6.3*	55.5	51.0*	23.9	85.0	16.0
TMV 3 x ORM 21	35	119.7	5.3	75.5*	62.0*	24.7	85.0	20.3*
TMV 4 x ORM 7	34	110.3	4.0	53.5	23.0	26.7	84.0	12.0
TMV 4 x ORM 14	35	113.7	4.7	65.0	21.5	24.5	85.0	7.0
TMV 4 x ORM 21	34	119.0	5.7	70.5	41.5	24.8	84.0	13.7
TMV 6 x ORM 7	35	120.7	4.7	55.5	37.0	24.5	85.0	12.0
TMV 6 x ORM 14	35	120.3	6.7*	76.5*	25.5	24.6	85.0	8.3
TMV 6 x ORM 21	34	134.7	6.7*	92.0*	51.5*	24.8	84.0	7.0
TMV (Sv) 7 x ORM 7	36	121.0	4.3	73.0	38.5	24.3	86.0	12.3
TMV (Sv) 7 x ORM 14	36	111.0	5.7	80.5	48.5*	24.8	86.0	16.0
TMV (Sv) 7 x ORM 21	35	125.0	5.3	68.0	21.5	24.5	85.0	7.0
TVS 0603 x ORM 7	36	128.0	3.7	73.0	36.5	24.7	86.0	12.0
TVS 0603 x ORM 14	37	117.0	5.0	82.5*	52.5*	24.8	87.0	17.3*
TVS 0603 x ORM 21	35	111.0	4.7	82.0*	47.5*	24.8	85.0	15.7
VRI 1 x ORM 7	36	105.0	5.0	62.0	45.5*	24.8	86.0	15.0
VRI 1 x ORM 14	36	103.0	5.3	63.5	38.0	25.0	86.0	12.7
VRI 1 x ORM 21	35	109.0	6.0*	84.0*	36.5	24.2	85.0	11.7
Mean	35.17	106.7	5.28	71.44	40.5	24.5	85.2	13.39
Sed	1.45	-	0.33	1.09	1.46	1.08	1.46	1.46
CD(5%)	3.07	-	0.69	2.30	3.07	2.29	3.07	3.07

*, ** Significance at P=0.05 and P= 0.01 level respectively

Table 5. Specific combining ability effects of crosses for different characters

Crosses	Days to 50% flowering	Plant height	Branches per plant	Capsules per plant	Dry matter production	Harvest index	Days to maturity	Single plant yield
TMV 3 x ORM 7	-0.67	3.12**	0.80**	11.69	-7.86**	0.95	-0.67	-1.36
TMV 3 x ORM 14	-0.17	-2.61**	0.10**	-11.81	0.39	-0.86	-0.17	-0.59
TMV 3 x ORM 21	0.83	-0.51**	-0.90**	0.11	7.47**	-0.09	0.83	2.36*
TMV 4 x ORM 7	-0.33	-5.11**	-0.13**	-3.14	2.81	0.96	-0.33	1.44
TMV 4 x ORM 14	0.17	3.56**	-0.43**	2.86	-9.44**	-0.59	0.17	-3.39**
TMV 4 x ORM 21	0.17	1.56**	0.57**	0.29	6.64**	-0.77	0.17	1.96
TMV 6 x ORM 7	0.33	-5.61**	-0.67**	-12.81	0.81	-0.55	0.33	-0.09
TMV 6 x ORM 14	-0.17	-0.34**	0.33**	2.69	-11.44**	0.19	-0.17	-3.63**
TMV 6 x ORM 21	-0.17	6.36**	0.33**	10.11	10.64**	0.36	-0.17	3.72**
TMV (Sv) 7 x ORM 7	0.33	0.92**	-0.13**	5.53	4.14	-0.65	0.33	0.87
TMV (Sv) 7 x ORM 14	-0.17	-3.81**	0.27**	7.53	13.39**	0.49	-0.17	4.74**
TMV (Sv) 7 x ORM 21	-0.17	2.89**	-0.13**	-13.06	17.53**	0.16	-0.17	-5.61**
TVS 0603 x ORM 7	0.01	8.22**	-0.10**	0.19	-7.19**	-0.45	0.01	-2.66*
TVS 0603 x ORM 14	0.50	2.19**	0.20**	4.19	8.06**	0.24	0.50	2.81*
TVS 0603 x ORM 21	-0.50	-10.41**	-0.10**	-4.39	-0.86**	0.21	-0.50	-0.14
VRI 1 x ORM 7	0.33	-1.54**	0.23**	-1.47	7.30	-0.25	0.33	2.21*
VRI 1 x ORM 14	-0.17	1.42**	-0.47**	-5.47	-0.94	0.54	-0.17	0.07
VRI 1 x ORM 21	-0.17	0.12**	0.23**	6.94	-6.36**	-0.29	-0.17	-2.28
SE (*gij*)	1.02	0.0001	0.0024	0.75	1.96	0.66	1.02	1.02

*, ** Significance at P=0.05 and P= 0.01 level respectively