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Combining ability and gene action for yield and yield components in sesame (*Sesamum indicum* L.)

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ABSTRACT

Combining ability for seed yield, yield components and oil content was studied in a 9 x 9 half diallel cross of sesame. Combining ability analysis revealed presence of both additive and non-additive gene actions for majority of the traits. The estimates of general combining ability effect suggested that parents GT 4 and AT 319 were good general combiners for seed yield per plant and its related attributes. The specific combining ability effect revealed AT 308 x SKT 12-2, GT 10 x GT 4 and AT 311 x SKT 12-2 as best specific combiners for seed yield per plant.

Key words : Sesame, combining ability, gca effect, sca effect

Sesame (*Sesamum indicum* L.) is one of the most important ancient and traditional oilseed crop and its seed contains 50 per cent oil and 25 per cent protein. It is sixth most important oilseed crop in India and cultivated in 18.6 lakh hectares area with 6.3 lakh tones production and productivity of 341 kg/ha. The yield improvement achieved through conventional hybridization followed by selection has been only marginal. Selection of parents in the hybridization programme is very important for getting the desirable recombinants for selection and to serve as parents for hybrids. Hence, the present investigation was undertaken to assess the nature of gene action involved in inheritance of yield and its contributing characters and to identify the best general combiners.

MATERIALS AND METHODS

The experimental materials comprised of 9 parents (*viz.*, AT 324, AT 311, AT 316, AT 314, AT 319, AT 308, GT 10, GT 4, SKT 12-2), their 36 hybrids produced through half diallel and one standard check *viz.*, GT 2. The experiment was laid out in a Randomized Block Design with 3 replications at Main Castor-Mustard Research Station, S. D. Agricultural University, Sardarkrushinagar during kharif-2014, with inter and intra-row spacing 45 and 15 cm, respectively. The observations were recorded on five competitive plants randomly selected from each genotype in each replication for days to flowering, days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, number of seeds per capsule, seed yield per plant (gm), 1000 seed weight (gm), harvest index (%), oil content (%) and chlorophyll content.

The replication wise mean values of each genotype for various characters were subjected to statistical analysis as per the procedure of Randomized Block Design as suggested by Panse and Sukhatme (1985). Mean value of 46 entries (parents and hybrids) were entered in computer and combining ability analysis was carried out according to the procedure given by Griffing (1956a) as per Method II and Model I .The combining ability analysis was carried out as per the method suggested by Griffing (1956 a & b) Method-II, Model-1 which assumes that variety and block effects are constant. The chlorophyll content was measured at flowering stage of selected plant by using SPAD 502 meter (Minolta, 1989).

RESULTS AND DISCUSSION

The analysis of variance for combining ability for all the characters presented in Table1 revealed that the mean squares due to GCA as well as SCA were significant for all the characters except chlorophyll

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Table 1 Analysis of variance for combining ability for various characters in sesame

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of capsules per plant	No. of seeds per capsule	Seed yield per plant (g)	1000 seed weight (g)	Harvest Index (%)	Oil content (%)	Chlorophyll content
GCA	8	3.35**	18.81**	163.48**	8.59**	1207.87**	90.16**	6.87**	0.23**	25.76**	178.04**	9.99
SCA	36	0.82**	2.04*	181.81**	0.80**	271.26**	37.32**	2.71**	0.09**	44.70**	29.95**	3.09
Error	88	0.29	0.95	31.63	0.06	50.57	4.39	0.50	0.02	4.31	0.54	0.76
σ^2gca		0.28	1.62	11.99	0.78	105.21	7.80	0.58	0.02	1.95	16.14	0.84
σ^2sca		0.53	1.09	150.19	0.74	220.68	32.93	2.21	0.07	40.40	29.41	2.33
σ^2gca/ σ^2sca		0.53	1.49	0.08	1.04	0.48	0.24	0.26	0.27	0.05	0.55	0.36

* $P \leq 0.05$, ** $P \leq 0.01$.

Table 2 Estimates of general combining ability effect of parents for various characters

Sr. No.	Parents	Days to flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of capsules per plant	No. of seeds per capsule	Seed yield per plant (g)	1000 seed weight (g)	Harvest Index (%)	Oil content (%)	Chlorophyll content
1	AT 324	0.51*	1.50**	2.64	-0.20*	-3.28	-1.29*	-1.10**	-0.20**	0.16	-9.51**	-1.75**
2	AT 311	-0.31*	0.83*	-4.47*	-1.00*	-4.11*	0.89	-1.29**	0.10*	0.50	-1.62**	-1.20**
3	AT 316	1.15**	1.53**	5.84**	2.05**	22.90**	-2.74**	0.31	-0.23**	0.88	2.09**	0.46
4	AT 314	-0.22	-0.68*	1.61	-0.19*	0.56	0.68	0.80**	0.04	0.92	1.64**	1.24**
5	AT 319	-0.01	0.95**	3.77*	0.33**	9.20**	-5.04**	0.91**	0.09*	-0.38	2.07**	0.21
6	AT 308	-0.19	-0.08	-3.36*	-0.07	-6.38*	0.63	0.56*	0.10*	1.11	0.33	-0.11
7	GT 10	0.21	-0.35	0.60	-0.73**	-7.76**	4.84**	0.20	0.08*	-1.16	4.85**	-0.08
8	GT 4	-0.58*	-2.02**	-5.24*	0.28**	0.692	2.41**	0.07	0.15**	1.46*	0.92**	0.29
9	SKT 12-2	-0.55*	-1.68**	-1.39	-0.49**	-11.83**	-0.37	-0.45*	-0.14**	-3.47**	-0.77**	0.94**
	S.E. (gi)	0.15	0.28	1.60	0.07	2.02	0.60	0.20	0.04	0.59	0.21	0.25

* $P \leq 0.05$, ** $P \leq 0.01$.

content indicating the importance of both additive and non-additive gene action in the inheritance of characters studied.

The ratio of GCA to SCA variance for various characters indicated that additive type of gene action was important in expression of days to maturity and number of branches per plant as the variance ratio was more than unity, whereas non-additive type of gene action was predominant in the expression of days to flowering, plant height, number of capsules per plant, number of seeds per capsule, seed yield per plant, 1000 seed weight, harvest index, oil content and chlorophyll content as the ratio of GCA to SCA variance was less than unity. Results are in agreement with the studies of Mishra and Yadav (1996), Kar *et al.* (2001), Sankar and Kumar (2003), Mothilal and Manoharan (2004), Shekhat *et al.* (2007), Misra *et al.* (2008), Raghunaiah *et al.* (2008), Parameshwarappa *et al.* (2010), Kumar *et al.* (2012) and Sarvaliya *et al.* (2013). The presence of predominantly large amount of non-additive gene action would necessitate the maintenance of heterozygosity in the population. Breeding methods such as biparental mating followed by reciprocal recurrent selection may increase frequency of genetic recombination and hasten the rate of genetic improvement.

The highest significant positive heterobeltiosis was recorded by the cross AT 308 × SKT 12-2 (67.90%) followed by AT 311 × SKT 12-2 (53.58%) and GT 10 × GT 4 (47.95%) for seed yield per plant. The GT 10 × GT 4 was the best hybrid for seed yield per plant, which registered significantly higher standard heterosis (43.75%) which is followed by AT 308 × SKT 12-2 (40.44%) than the check GT 2.

Nature and magnitude of combining ability effect helps in identifying superior parents and their utilization in further breeding programme. The close examination of GCA effect of the parents revealed that, none of the parents was found to be consistently good general combiner simultaneously for all the characters (Table 2). The parent GT 4 and SKT 12-2 were considered as good general combiners for earliness.

The parent GT 4 was good combiner for days to flowering, days to maturity, plant height, number of branches per plant, number of seeds per capsule, 1000-seed weight, harvest index and oil content. The parents, AT 319, AT 314 and AT308 were good general combiners for seed yield per plant. Among these, AT 319 was found to be best general combiner for seed yield per plant, and good general combiner for yield attributing characters i.e number of branches per plant, number of capsules per plant, 1000-seed weight and oil content. Therefore, parents, GT 4 and AT 319 can be considered as a good source of favourable genes for increasing seed yield along with other yield attributes and oil content and it would be worthwhile to use above parental lines in the hybridization programme. Vavdiya *et al.* (2013) also reported similar results in sesame.

The parents GT 10 and AT 316 were found to be good general combiners for oil content. Similarly, AT 314 and SKT 12-2 were found good general combiners for chlorophyll content. The results are similar to report of Saravanan and Nandarajan (2003).

The potentiality of a parent in hybridization may be assessed by it's *per se* performance and GCA effect. For the present study, top ranking parents for *per se* performance and GCA effect for different traits are presented in Table 3. The results revealed that the most of the characters had relatively high degree of correspondence between *per se* performance and GCA effect. This can be ascribed to the predominant role of additive and additive x additive type of gene action for the inheritance of these traits.

Three best crosses with significant SCA effects for various traits along with per se performance involved in the crosses are listed in Table 3. The crosses AT 324 × GT 10 and AT 316 × AT 308 showed significant negative SCA effect for days to flowering and day to maturity, these crosses can be used to isolate early flowering as well as maturity segregants in later generations. The best combinations AT 308 × SKT 12-2 and GT 10 × GT 4 expressed maximum SCA effect along with high per se performance, heterosis over better parent and check variety GT 2 for seed yield per plant as well as its contributing traits *viz.*, number of capsules per plant and number of seeds per capsules. The cross AT 311 × SKT 12-2 had significant SCA effect for seed yield per plant, number of branches per plant, number of seeds per capsules and chlorophyll content.

The cross AT 324 × AT 311 exhibited significant SCA effect for oil content and number of branches per plant and number of capsules per plant. The crosses which exhibited significant desirable SCA effect were AT 311

Table 3 Three top ranking parents with respect to per se performance and GCA effect; three top ranking hybrids with respect to per se performance and SCA effect and heterosis over better parent and check variety GT 2

Characters	Best performing parents	Best general combiners	Best performing hybrids	Hybrids with high SCA effects	SCA effects	Heterosis over	
						BP	SC- GT 2
Days to flowering	AT 311	GT 4	AT 316 x GT 4	AT 324 x GT 10	-1.46*	-	-0.91
	AT 308	SKT 12-2	AT 316 x AT 308	AT 316 x AT 308	-1.46*	-5.45*	-5.45*
	SKT 12-2	AT 311	AT 308 x SKT 12-2	AT 316 x AT 314	-1.25*	-3.70	-5.45*
Days to maturity	GT 4	GT 4	GT 4 x SKT 12-2	AT 324 x GT 10	-2.75*	-2.14	-
	SKT 12-2	SKT 12-2	AT 316 x GT 4	GT 10 x SKT 12-2	-2.56*	-	-0.75
	AT 314	AT 314	AT 316 x AT 308	AT 316 x AT 308	-2.35*	-1.12	-1.49
Plant height (cm)	AT 324	GT 4	AT 311 x SKT 12-2	GT 10 x SKT 12-2	-9.17	-	-
	GT 4	AT 311	AT 319 x GT 4	AT 316 x AT 314	-6.91	-	-
	AT 311	AT 308	AT 311 x AT 319	AT 314 x GT 4	-6.66	-	-
No. of branches per plant	AT 316	AT 316	GT 10 x GT 4	AT 324 x AT 311	2.24**	97.44**	57.14**
	AT 319	AT 319	GT 10 x AT 314	AT 311 x SKT 12-2	1.53**	47.62**	26.53*
	GT 4	GT 4	GT 10 x AT 316	GT 10 x AT 308	1.39**	-	108.16**
No. of capsules per plant	AT 316	AT 316	GT 10 x AT 316	GT 10 x AT 316	42.74**	72.87**	96.25**
	GT 4	AT 319	GT 10 x GT 4	AT 324 x AT 311	32.86**	67.48**	42.93**
	AT 319	GT 4	GT 10 x AT 319	GT 10 x AT 319	22.41*	41.43**	60.56**
No. of seeds per capsule	GT 10	GT 10	AT 308 x SKT 12-2	AT 311 x SKT 12-2	13.43**	19.86**	27.28**
	GT 4	GT 4	AT 311 x SKT 12-2	AT 308 x SKT 12-2	13.35**	9.47**	32.77**
	AT 314	AT 311	AT 319 x AT 308	GT 10 x AT 319	10.10**	12.29**	18.82**
Seed yield per plant (g)	AT 314	AT 319	GT 10 x GT 4	AT 308 x SKT 12-2	3.08**	67.90**	40.44**
	AT 308	AT 314	AT 308 x SKT 12-2	GT 10 x GT 4	2.75**	47.95**	43.75**
	AT 319	AT 308	AT 314 x GT 4	AT 311 x SKT 12-2	2.44**	53.38**	17.54
1000 seed weight (g)	GT 4	GT 4	AT 311 x AT 316	AT 311 x AT 316	0.83**	19.33**	29.21**
	AT 308	AT 311	AT 311 x AT 319	AT 324 x AT 316	0.55**	13.92*	12.94*
	AT 311	AT 308	AT 319 x SKT 12-2	AT 319 x SKT 12-2	0.50**	4.59	14.84**
Harvest Index (%)	AT 324	GT 4	GT 10 x AT 319	GT 10 x AT 319	13.33**	45.38**	36.54**
	AT 314	AT 308	AT 319 x GT 4	AT 311 x AT 314	8.55**	6.64	20.05**
	AT 311	AT 314	AT 324 x AT 319	GT 10 x SKT 12-2	8.37**	23.51**	12.86
Oil content (%)	GT 4	GT 10	AT 316 x AT 308	AT 324 x AT 311	8.70**	13.50**	-
	GT 10	AT 316	AT 308 x GT 4	AT 314 x AT 319	7.15**	18.04**	22.37**
	AT 314	AT 319	AT 314 x AT 319	GT 10 x AT 319	6.00**	22.84**	19.91**
Chlorophyll content	AT 314	AT 314	AT 314 x AT 319	AT 314 x AT 319	4.51**	28.69**	22.57**
	GT 4	SKT 12-2	GT 10 x AT 316	GT 4 x SKT 12-2	2.53*	14.21	16.82*
	AT 316	AT 316	GT 4 x SKT 12-2	AT 311 x SKT 12-2	2.33*	20.73*	5.60

* $P \leq 0.05$, ** $P \leq 0.01$; G = Good, A = Average, P = Poor.

× AT 316 for 1000 seed weight and GT 10 × AT 319 for harvest index, whereas cross AT 314 × AT 319 for chlorophyll content. The cross combination GT 10 × AT 316 exhibited significant SCA effect for number of capsules per plant.

In the present study, crosses which exhibited high SCA effects for yield per plant and other characters involved at least one good general combiner, indicated additive x dominance type of gene interaction, which could produce desirable transgressive segregates in subsequent generations.

CONCLUSION

Combining ability analysis revealed presence of both additive and non-additive gene actions for majority of the traits. The estimates of general combining ability effect suggested that parents GT 4 and AT 319 were good general combiners for seed yield per plant and its related attributes. The specific combining ability effect revealed AT 308 x SKT 12-2, GT 10 x GT 4 and AT 311 x SKT 12-2 as best specific combiners for seed yield per plant.

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