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Gene Action And Combining Ability For Yield And Its Components In Sesame

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ABSTRACT

Combining ability was carried out through line x tester analysis for yield and yield attributing traits in sesame. The predominance of *sca* variance for all the traits suggested that dominant and epistatic gene actions were important for controlling these traits. Significant differences among line x tester for plant height, number of capsules per plant, number of seeds per capsule and seed yield per plant indicating the magnitude of non additive variance. The lines, Chandana and JCS-596 were recorded highly significant *gca* effect for seed yield and contributing characters *viz*., number of capsules per plant, number of seeds per capsule and 1000 seed weight. Among the testers, KMR-74 and Swetha showed high *gca* effect for number of capsules per plant and seed yield per plant. The crosses NIC-8392 x Swetha, Malabaricum x KMR-74, Chandana x Swetha, Rajeswari x KMR-24, JCS-596 x KMR-74, G.Til-3 x KMR-24 and RT-127 x KMR-74 exhibited significant *sca* effect for seed yield per plant. In addition to grain yield per plant, crosses such as RT-127 x KMR-74, NIC-8392 x Swetha and Chandana x Swetha also had significant and positive *sca* effect for different traits such as number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight. It was concluded that both additive and non additive gene actions were important in controlling various characters. The best combiners, Chandana, JCS-596, KMR-74 and Swetha could be utilized as parents in future breeding programmes. The crosses NIC-8392 x Swetha, Malabaricum x KMR-74, Chandana x Swetha, Rajeswari x KMR-24 and JCS-596 x KMR-74 could be used for exploitation of heterosis for seed yield and its components.

Key words : Combining ability, Gene action, Line x tester, Sesame.

Sesame (*Sesamum indicum* L.) is one of the important ancient oilseed crops cultivated in India. The sesame seed contains 50-60% oil which is of superior quality and stability mainly due to the presence of antioxidants (Namiki, 1995). Average productivity of sesame in India is only 453 kg/ha which is far below the average productivity in China (1127 kg/ha) and Egypt (1211 kg/ha). The poor productivity levels can be overcome by commercial exploitation of heterosis and reshuffling of genes inorder to get better recombinants or transgressive segregants by hybridization of suitable parents. Selection of parents in the hybridization programme is very important for getting the desirable recombinants for selection and to serve as parents in hybrid development. Combining ability analysis has been utilized to know the nature and magnitude of gene action controlling the inheritance of traits and leads to identification of parents with good general combining ability effects and the cross combinations with high specific combining ability effects. This in turn helps in choosing the parents to include in a hybridization programme. Successful breeding programme depends on the variability present in the genotypes and understanding of the gene action and genetic architecture of traits related to yield. Sesame is plant breeders' choice crop because of its great variability (Janick and Whipkey, 2002) and simple inheritance for several useful traits. In the present investigation an attempt was made to evaluate ten parents (seven lines and three testers) and 21 hybrids through line x tester analysis inorder to identify the best parents and cross combinations with good general and specific combining abilities for seed yield and its component traits.

MATERIAL AND METHODS

The experimental material for this study consists of seven lines *viz*., RT-127, G.Til-3, NIC-

Table 1. Anova of combining ability variances for line x tester analysis in sesame.

Source	d.f	Plant height	No. of branches per plant	No. of capsules per plant	Capsule length	No. of seeds per capsule	1000 seed weight	Seed yield per plant
Replications	2	41.49	0.66	7.25	0.01	44.91	0.17	0.05
Treatments	30	500.26**	1.80**	2875.41**	0.12	267.50**	0.26	172.65**
Parents	9	341.58**	1.01	2056.91**	0.21	195.02**	0.15	129.98**
Crosses	20	551.67**	1.87*	3053.95**	0.07	251.07**	0.25	156.79**
Crosses *vs* parents	1	900.35**	7.52**	6670.84**	0.37	1248.52**	1.52	873.73**
Lines	6	1163.62**	2.20	2977.38**	0.08	264.27**	0.16	184.63**
Testers	2	799.35**	1.66	3215.41**	0.01	68.04*8	0.11	175.39**
Line x Tester	12	204.41**	1.65	3065.33**	0.07	274.97**	0.32	139.78**
Error	60	16.13	0.33	24.81	0.01	9.78	0.01	0.45
$\sigma^2 g$		9.04	0.01	-0.29	-0.01	-0.62	-0.02	0.44
$\sigma^2 s$		62.75	0.44	101.50	0.02	88.39	0.10	46.44
$\sigma^2 g : \sigma^2 s$		0.14	0.02	-0.003	-0.50	-0.01	-0.10	0.01

* significant at 5% level, ** significant at 1% level

8392, JCS-596, Rajeswari, Chandana and Malabaricum and three testers *viz.*, KMR-24, KMR-74 and Swetha. The seven lines and three testers were crossed in line x tester design during *Rabi 2010* which results in 21 hybrids. The resulting 21 hybrids were evaluated along with their 10 parents and were sown during *Kharif* 2011 in rows with a spacing of 30 cm between rows and 20 cm between plants. The trial was conducted in randomized block design with three replications. Five plants were randomly selected in each replication for recording quantitative traits. Sowing was done manually in optimum moisture condition in furrows by placing two to three seeds per hill. Thinning was done after 20 days of sowing to maintain proper plant stand. Standard agronomic package of practices and suitable plant protection measures were taken to raise a healthy crop. Observations were recorded on quantitative traits such as plant height (cm), number of branches per plant, number of capsules per plant, capsule length (cm), number of seeds per capsule, 1000 seed weight (g) and seed yield per plant (g). The analysis of variance for combining ability was done based on the method developed by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance of combining ability revealed significance among treatments, parents, crosses, crosses *vs* parents, lines, testers and line x tester (Table1). Significance differences for parents and crosses observed for the traits plant height, number of capsules per plant, number of seeds per capsule and seed yield per plant. The significant variances due to crosses *vs* parents indicated prevalence of heterosis for all the characters except capsule length and 1000 seed weight. The significance of mean sum of squares of lines and testers indicated prevalence of additive variance for traits like plant height, number of capsules per plant, number of seeds per capsule and seed yield. Highly significant differences among line x tester for plant height, number of capsules per plant, number of seeds per capsule and seed yield per plant indicating the dominance or non additive variance was important for majority of the traits.

The estimates of GCA and SCA variances are useful to infer the type of gene action and relative importance of the character in breeding programme. The estimates of combining ability variances showed higher values of *sca* variances for all the seven traits studied. The higher estimates of dominance variances as compared to additive variances for all the traits were probably due to preponderance of non-additive gene action suggesting the scope for improvement of these traits through heterosis breeding. Predominance of non-additive genetic component for seed yield per plant, plant height, number of branches per plant, number of capsules per plant and capsule length was reported by Krishnadoss *et al*., 1987; Mishra and Yadav, 1996; Padmavathi, 1999 and Kar *et al*., 2002.

Dhillon (1975) reported that combining ability of parents gives useful information on the choice of parents in terms of expected performance of the hybrids and their progenies. Singh and Nanda (1976) opined that it was logical to select atleast one parent with high *gca* effect. The correlation of parental means with *gca* effects (Table 2) were non-significant for all the traits suggesting that *per se* performance can not be an effective tool for selecting parents for hybridization programme and the combining ability estimates must be a primary criterion for parental choice. The lack of relationship between parental per se performance and *gca* effects could be possibly due to predominance of non-allelic interaction in governing these traits. However, when additive gene effects are primarily important, a good degree of association between per se performance and *gca* effects likely to be observed (Sharma and Chauhan, 1985).

Among the lines studied, Chandana recorded highly significant *gca* effect for seed yield and contributing characters such as number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight. Another line JCS 596 is a good combiner for yield contributing traits viz., number of branches per plant, number of capsules per plant, number of seeds per capsule and seed yield per plant. The line Malabaricum was showed significant *gca* effect for number of branches per plant, number of capsules per plant and 1000 seed weight. Among the testers, KMR-74 showed high *gca* effect for number of capsules per plant, number of seeds per capsule, 1000 seed weight and seed yield per plant. Swetha performed better for number of capsules per plant and seed yield per plant. Considering the *gca* effects of parents Chandana and JCS-596 among the lines and KMR-74 and Swetha among tester were found to be good combiners.

Table 2. Mean and general combining ability (gca) effects of parents for different traits in sesame.

Parents	Plant height		No. of branches per plant		No. of capsules per plant		Capsule length		No. of seeds per capsule		1000 seed weight		Seed yield per plant	
	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca	Mean	gca
Lines														
RT-127	71.02	-23.55 **	2.78	-0.58 **	89.00	-27.28 **	2.03	-0.06 *	70.67	-2.10 *	3.03	-0.10 **	17.19	-4.23 **
GTil-3	103.16	-4.33 **	3.22	-0.32	95.00	-9.78 **	2.77	-0.08 **	68.33	-2.65 *	3.02	-0.12 **	17.59	-4.94 **
NIC 8392	80.79	2.03	3.67	-0.30	128.89	-10.50 **	2.53	-0.14 **	57.33	-5.76 **	2.70	-0.08 *	23.84	0.20
JCS-596	86.61	7.16 **	3.67	0.60 **	150.00	18.60 **	2.63	0.03	64.67	5.90 **	3.20	-0.12 **	28.43	3.47 **
Rajeswari	92.69	8.92 **	2.67	-0.30	89.00	-5.75 **	2.77	0.04	70.67	-1.76	3.00	0.06	22.15	-2.85 **
Chandana	85.81	8.02 **	3.44	0.27	93.22	23.62 **	2.57	0.11 **	72.67	9.24 **	2.67	0.22 **	20.62	7.76 **
Malabaricum	73.97	1.75	3.44	0.64 **	74.44	16.11 **	2.37	0.11 **	51.00	-2.87 **	2.47	0.12 **	10.77	0.58 *
Testers														
KMR-24	76.33	-6.51 **	3.67	-0.37 **	59.33	-14.27 **	2.63	-0.03	56.00	-1.33	2.70	0.01	6.83	-3.34 **
KMR-74	81.65	0.76	4.67	0.14	90.67	6.53 **	2.40	0.02	53.33	2.05 **	2.70	0.07 **	11.33	1.69 **
Swetha	67.57	5.75 **	2.89	0.23	80.56	7.74 **	3.03	0.01	68.00	-0.71	3.00	-0.08 **	19.03	1.65 **

* significant at 5% level, ** significant at 1% level

Table 3. Specific combining ability effects for different traits in sesame.

Crosses	Plant height	No. of branches per plant	No. of capsules per plant	Capsule length	No. of seeds per capsule	1000 seed weight	Seed yield per plant
RT-127 x KMR-24	1.00	0.31	-6.01 *	-0.12 *	-4.00 *	-0.25 **	0.74
RT-127 x KMR-74	-0.36	-0.20	11.36 **	0.10 *	3.95 *	0.15 **	1.13 **
RT-127 x Swetha	-0.64	-0.12	-5.36	0.01	0.05	0.10	-1.87 **
G.Til-3 x KMR-24	4.81 *	-0.11	14.16 **	0.01	0.22	0.01	3.23 **
G.Til-3 x KMR-74	3.57	0.04	-11.30 **	-0.11 *	-0.83	0.01	-1.90 **
G.Til-3 x Swetha	-8.37 **	0.07	-2.86	0.10 *	0.60	-0.01	-1.32 **
NIC 8392 x KMR-24	-1.20	-0.30	-18.95 **	-0.00	-13.33 **	-0.27 **	-4.44 **
NIC 8392 x KMR-74	-3.26	-0.75 *	-33.92 **	-0.12 *	-6.05 **	-0.20 **	-7.92 **
NIC 8392 x Swetha	4.47	1.05 **	52.87 **	0.12 *	19.38 **	0.48 **	12.36 **
JCS 596 x KMR-24	-3.83	-0.26	-6.88 *	-0.07	-1.67	-0.03	-3.32 **
JCS 596 x KMR-74	4.47	-0.21	1.98	0.05	4.62 *	-0.05	4.19 **
JCS 596 x Swetha	-0.64	0.47	4.90	0.02	-2.95	0.08	-0.87 *
Rajeswari x KMR-24	-7.37 **	0.70 *	22.90 **	0.15 **	6.67 **	0.49 **	4.85 **
Rajeswari x KMR-74	-7.32 **	0.02	13.99 **	0.04	4.95 **	-0.10 *	0.33
Rajeswari x Swetha	14.69 **	-0.73 *	-36.89 **	-0.19 **	-11.62 **	-0.39 **	-5.19 **
Chandana x KMR-24	-2.64	0.05	-14.15 **	-0.15 **	4.00 *	0.09	-1.10 **
Chandana x KMR-74	-1.55	-0.32	-19.26 **	-0.03	-7.71 **	-0.24 **	-4.84 **
Chandana x Swetha	4.18	0.27	33.41 **	0.18 **	3.71 *	0.14 **	5.94 **
Malabaricum x KMR-24	9.24 **	-0.41	8.94 **	0.18 **	8.11 **	-0.04	0.04
Malabaricum x KMR-74	4.45	1.41 **	37.14 **	0.07	1.06	0.43 **	9.01 **
Malabaricum x Swetha	-13.69 **	-1.01 **	-46.08 **	-0.25 **	-9.17 **	-0.39 **	-9.05 **

* significant at 5% level, ** significant at 1% level

Specific combining ability is considered to be the best criterion for the selection of superior hybrids. High *sca* effects results mostly from the dominance and interaction effects existed between the hybridizing parents. In the present study, significant *sca* effect was exhibited by seven crosses viz., NIC-8392 x Swetha, Malabaricum x KMR-74, Chandana x Swetha, Rajeswari x KMR-24, JCS-596 x KMR-74, G.Til-3 x KMR-24 and RT-127 x KMR-74 for seed yield per plant (Table-3). Most of the crosses having significant *sca* effects recorded higher per se performance. The cross combinations having significant *sca* effects but failed to record high per se performance resulted from low x low combinations between parents of *gca* effects. The present findings also indicates that crosses having significant *sca* effect recorded the highest per se performance, where either of the parents involved in the combination having high *gca* effect. In addition to grain yield per plant crosses such as RT-127 x KMR-74, NIC-8392 x Swetha and Chandana x Swetha also had significant and positive *sca* effect for different traits such as number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight. The cross Malabaricum x KMR-74 was found to be good for number of branches per plant, number of capsules per plant and 1000 seed weight. For capsule length the crosses, Chandana x Swetha and Malabaricum x KMR-74 were registered as good specific combiner. Maximum 1000 seed weight was recorded in Rajeswari x KMR-24 followed by NIC 8392 x Swetha. These findings favour the establishment of a hybridization programme.

From this study, it is evident that both additive and non additive gene actions are important in controlling various characters. The best combiners, Chandana, NIC 8392, KMR-74 and Swetha could be utilized in future breeding programmes. The crosses NIC-8392 x Swetha, Malabaricum x KMR-74, Chandana x Swetha, Rajeswari x KMR-24 and JCS-596 x KMR-74 could be used for exploitation of heterosis for seed yield and its components. The cross NIC-8392 x Swetha was found to be the best specific combiners for seed yield per plant, number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight.

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