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Studies on reciprocal differences and gene actions through diallel analysis in sesame (*Sesamum indicum* L.)

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A combining ability analysis was carried out in a 7 x 7 diallel mating system for nine quantitative characters in sesame. The results revealed that the variance due to gca, sca and rca were highly significant, denoting the importance of both additive as well as non additive genetic components for yield and yield contributing characters. The magnitude of the gca variance was higher than the sca variance. The magnitude of the latter, when compared to the variance due to the reciprocal effect, was highly significant and higher for the characters, number of capsules per plant, number of seeds per capsule, while the magnitude of the rca variance was highly significant and higher than the sca variance for the characters days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, 1000 seed weight and seed yield per plant. This indicated the presence of reciprocal effects for these characters as both additive and non-additive genetic components are involved for yield and yield contributing traits. The additive genetic variances could be improved in the future by a simple selection, whereas no fixable genetic variances can be improved by following biparental mating of the F_2 generation.

Key words : Combining ability, Dialled analysis, GCA, SCA, RCA

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INTRODUCTION

Sesame is the most traditional and important oil yielding crop grown in India. A careful choice of parents in breeding programmes is important particularly if the aim is to improve quantitative characters like yield and its components. The concept of a combining ability analysis gives precise estimates of the nature and magnitude of gene actions involved in the inheritance of quantitative characters, which facilitate the identification of parents with good general combining ability effects and crosses with good specific combining ability effects. It is also useful for selecting the most suitable breeding method. Therefore, the present study was undertaken to study the nature of gene action and maternal effects present in the inheritance of the quantitative characters.

RESEARCH METHODOLOGY

The experimental material comprised seven genotypes *viz.*, JCT-7, DSS-9, CO-1, RT-54, Dhauri Local, Gowry-173, MT-75which were crossed in an 7 x 7 diallel mating design including reciprocals during *Rabi*, 2010. The resulting 42 cross combinations along with parents were grown in a Randomized Block Design with two replications at the Plant Breeding Farm, College of Agriculture, University of Agricultural Sciences, Raichur during the summer of 2011. A spacing of 45 cm between rows and 15 cm between plants was given and 20 plants were maintained in each cross. Observations were recorded on nine biometrical traits *viz.,* days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, number of seeds per capsule, 1000 seed weight, seed yield per plant and seed oil content. A fertilizer schedule of 40:25:25 kg of NPK per hectare was followed along with the recommended cultural operations and plant protection measures. The diallel analysis was carried out according to the statistical genetic model described by Griffing (1956) as Method I and Model I and assuming a fixed effects statistical model (Model I). The statistical analysis was carried out with INDOSTAT programme. The combining ability analysis was done based on the method developed by Griffing (1956).

RESEARCH FINDINGS AND ANALYSIS

The analysis of variance for their combining ability, as presented in Table 1, indicated the existence of significant differences for the general combining ability, specific combining ability and reciprocal effects between the hybrids for all the characters. The magnitude of the gca variance was higher than the sca variance for all the character except number of capsule per plant, number of seeds per capsule and oil content. The general combining ability variances were found to be highly significant and higher than the specific combining ability for the characters, days to maturity, plant height, number of branches per plant, capsule length, 1000 seed weight, seed yield per plant indicating the predominant role of the additive gene action in the inheritance of these characters. Similar results were also reported by Shinde *et al*. (1991), Rajavindran *et al*. (2000) and Devasena *et al*. (2001).

For the productive nodes per plant, number of capsule per plant, number of seeds per capsule and oil content the sca variance was higher than the gca variance, indicating the predominance of non-additive gene action in their inheritance, this higher magnitude of the sca effects than the gca effects for these characters was also reported by Thiyagarajan and Ramanathan (1995) and Ragiba and Reddy (2000) in their studies.

The magnitude of the sca variance when compared to the variance due to the reciprocal effect was highly significant and higher for the characters, number of branches per plant, number of seeds per capsule and seed oil content suggesting the predominant role of sca effects. Similar results were reported by Fatteh *et al*. (1982) and Sharma and Chauhan (1985).

The magnitude of the rca variance was highly significant and higher than the sca variance for the characters, days to maturity, plant height, number of capsules per plant, caps length, 1000 seed weight, seed yield per plant. Thus indicating the presence of reciprocal effects for these characters. This may be due to the influence of the maternal effect or cytoplasmic influence which could be well ascertained in the later segregating generations. This higher magnitude of the rca effect than the sca effect for these character was also noticed by Dora and Kamala (1986), Brindha and Shivasubramanian (1992) and Krishna Devi *et al*. (2002).

Reciprocal effects :

The estimates of the reciprocal effects of 21 reciprocal crosses for 9 characters are presented in Table 2. Highly significant negative reciprocal effects were recorded in six reciprocal crosses for days to maturity. The reciprocal cross Gowri -173 x JCT-7 registered the highest (-9.62) and the crosses MT-75 x JCT-7, DSS-9 x JCT-7 showed the lowest (-1.13) significant reciprocal effect. The reciprocal crosses Gowri -173 x JCT-7, Gowri -173 x RT-54, Dhauri Local x JCT-7 for days to maturity were found to be promising. These reciprocal effects were also previously reported by Sharma and Chauhan (1985) and Brindha and Sivasubramanian (1992).

Highly significant positive reciprocal effects were recorded in seven reciprocal crosses for plant height. The highest value for the reciprocal effect (9.00) was exhibited by the reciprocal Gowri-173 x CO-1, and the lowest (3.50) by RT-54 x CO-1, CO-1 x DSS-9 for plant height. The reciprocal crosses Gowri-173 x CO-1, Gowri-173 x JCT-7, RT-54 DSS-9 were found to be promising for plant height. Similar results for these characters have been reported by Fatteh *et al*. (1982) and Sharma and Chauhan (1985).

Six reciprocals exhibited a highly significant positive reciprocal effect for number of branches per plant. The cross MT-75 x RT-54 showed the highest (0.82) and the MT-75 x Dhauri Local, the lowest (0.29) significantly positive reciprocal effects for number of branches. MT-75 x RT -54, Dhauri Local x RT-54, Dhauri Local x DSS-9 exhibited the highest reciprocal effect for number of branches per plant. Similar results for both characters have been reported by Fatteh *et al*. (1982), and Sharma and Chauhan (1985).

Four reciprocals showed a highly significant positive reciprocal effect for number of capsules per plant. Among these, the reciprocal Dhauri Local x DSS-9 exhibited the highest (13.5) and the combination of MT-75 x RT-54 showed the lowest (2.50) values. The reciprocal crosses Dhauri Local x DSS-9, MT-75 x DSS-9 showed highly significant positive reciprocal effects for number of capsule per plant. Four reciprocals registered highly significant positive reciprocal effects for length of capsules. Reciprocal cross MT-75 x Dhauri Local showed the highest (0.14) and crosses CO-1 x JCT-7 exhibited the lowest (0.15) significant values for this character. The reciprocal crosses MT-75 x Dhauri Local, Dhauri Local x DSS-

Table 1: Analysis of variance for combining ability for 15 characters in an 7 x 7 complete diallel set in sesame

Source of variation	d. f.	Mean sum of squares								
		Days to maturity	Plant height (m)	No. of branches/ plant	No. of capsules/ plant	Capsule length	No. of seeds/ capsule	1000 S.W (g)	Seed yield/ plant (g)	Seed oil content (%)
GCA	6	121.47**	215.3**	1.49**	68.0**	0.12**	33.2**	0.40**	7.891**	7.25**
SCA	21	38.50**	40.1**	0.69**	81.33**	0.07**	58.42**	0.12**	5.64**	9.98**
Reciprocal	21	62.40**	50.88**	0.55**	90.27**	0.10**	49.3**	0.20**	6.447**	3.04**
Error	48	2.198	2.58	0.02	0.95	0.007	1.25	0.01	0.194	0.1

* and ** indicate significance of values at P=0.05 and P=0.01, respectively.

Table 2: Estimates of reciprocal effects in sesame

Crosses	Days to maturity	Plant height (m)	No.of branches/ plant	No.of capsules/plant	Capsule length	No.of seeds/ capsule	1000 S.W. (g)	Seed yield/ plant (g)	Seed oil content (%)
DSS-9 x JCT-7	-1.13	-2.25	-0.23	-3.50**	0.00	7.00**	0.70**	1.92**	2.17**
CO-1 x JCT-7	-6.25**	0.00	-0.13**	-10**	0.14*	-7.50**	-0.06	-2.42**	0.33
CO-1x DSS-9	-8.5**	3.50**	0.25	-1.00	0.22**	3.50	0.03	0.37	1.14**
RT-54 x JCT-7	5.62**	3.75**	-0.68	-6.5**	0.23**	-4.50**	-0.67**	-3.00**	0.34
RT-54 x DSS-9	1.88	-2.50	-1.16**	-11**	-0.31	-8.50**	-0.15	-4.12**	-2.13**
RT-54 x CO-1	-2.88	3.50**	0.50**	0.25	-0.45*	7.50**	-0.25*	0.40	0.60
DhauriLocal x JCT-7	-8.75**	5.50**	-0.30	-5.75*	0.13	2.25	0.18*	0.05	-1.77**
DhauriLocal x DSS-9	3.50	-7.00**	0.65**	12.5**	0.37**	5.00**	0.03	3.50**	0.53
Dhauri Local x CO-1	4.50	1.25	-0.26	6.00**	0.10	4.50**	-0.37	0.53**	1.11**
Dhauri Local x RT-54	5.56**	-3.25	0.80**	-5.50	-0.23	-1.00	0.10	-0.60	-0.67
Gowri-173 x JCT-7	-9.62**	8.50**	-0.12	-4.75	0.02	-4.75	0.12	-0.77**	0.15
Gowri-173 x DSS-9	1.75	4.75**	-0.15**	0.50	0.02	-2.50	0.14*	0.06	0.66**
Gowri-173 x CO-1	-2.62	9.00**	-0.20	-7.5**	-0.21**	4.5**	0.09*	-0.45**	0.44
Gowri-173 xRT-54	-9.24**	-4.00**	-0.47**	-12.5**	-0.15	-1.00	-0.51**	-2.72**	-0.64**
Gowri-173xDhauri Local	-0.37	1.25	-0.70	0.00	-0.33**	8.00**	-0.03	0.98**	0.60
MT-75 x JCT-7	-1.13	1.00	-0.80	0.75	0.10	-0.50	0.21**	0.58**	-0.41
MT-75 x DSS-9	5.5**	-2.50**	0.45**	11.7**	-0.01	-5.75**	-0.05	1.12**	2.87**
MT-75 x CO-1	-6.12**	-6.00**	0.18	-5.75**	-0.05	-1.50	-0.72	-2.77**	-0.40**
MT-75 x RT-54	-2.88	-11.5**	0.82**	2.5*	-0.05	-4.75**	-0.04	-0.31**	-0.08
MT-75x Dhauri Local	3.25	-4.75**	0.29**	1.25	0.46**	-1.00	0.03	0.17*	-0.58**
MT-75x Gowri-173	8.51**	1.25	-0.02	1.00	0.12	-5.25**	-0.14	-0.55	-2.32**
S.E. (rij)	0.91	0.99	0.09	0.60	0.05	0.69	0.09	0.27	0.06
S.E. (rij-rKL)	1.48	1.61	0.142	0.98	0.088	1.12	0.138	0.44	0.06

* and ** indicate significance of values at P=0.05 and P=0.01, respectively

9 and RT-54 x JCT-7 appeared to be highly significant with positive reciprocal effects for length of capsules. Similar results for both characters were found by Brindha and Sivasubramanian (1992).

Highly significant positive reciprocal effects were recorded in six reciprocal crosses recorded significant positive reciprocal effects for number of seeds per capsule. Among these, Gowri-173 x Dhauri Local possessed the highest (8.00) and Dhauri Local x CO-1 had the lowest (0.30) positive significant values for this character. The crosses Gowri-173 x Dhauri Local, RT-54 x CO-1 and DSS-9 x JCT-7 showed highly significant positive reciprocal effects for number of seeds per capsule in a decreasing order in magnitude and had highly significant positive reciprocal effects. Five reciprocal crosses for 1000-seed weight registered highly significant positive reciprocal effects. The reciprocal DSS-9 x JCT-7 showed the highest (0.70) and Gowri-173 x CO-1 the lowest (0.09) positive significant values for 1000 seed weight. The reciprocal crosses DSS-9 x JCT-7, MT-75 x JCT-7 had highly significant positive reciprocal effects for that character. These results were also achieved by Brindha and Sivasubramanan (1992).

Seven reciprocal crosses recorded highly significant positive reciprocal effects and two crosses recorded significant positive reciprocal effects for seed yield per plant. The reciprocal cross Dhauri Local x DSS-9 had the highest (3.50) and the lowest value (0.17) was exhibited by the reciprocal cross MT-75 x Dhauri Local for seed yield per plant. The crosses Dhauri Local x DSS-9, DSS-9 x JCT-7 and MT-75 x DSS-9 ranked in a decreasing order in magnitude for yield per plant and had highly significant positive reciprocal effects. Similar results for these traits have been reported by Dora and Kamala (1987).

Five reciprocal crosses exhibited highly significant positive reciprocal effects for oil content. Among these reciprocals MT-75 x DSS-9 had the highest (2.87) and Gowri-173 x DSS-9 the lowest (0.66) significant values for this character, whereas the reciprocal crosses MT-75 x DSS-9, DSS-9 x JCT-7 and CO-1 x JCT-7 showed highly significant positive reciprocal effects for oil percentage, agreeing with the results reported by Brindha and Sivasubramanian (1992).

Reciprocal effects were observed for all the characters, so that the significance of reciprocal effects for all the characters exhibited the presence of a maternal effect which may be due to the influence of maternal effects or cytoplasmic influence, which would be ascertained in the later segregating generations. Considering the importance of both additive and non-additive gene actions for yield and its components, genetic improvement could be achieved by a population breeding approach in the form of biparental mating in early generation segregating populations followed by intensive selection in future generations.

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