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DIALLEL ANALYSIS THROUGH GRIFFING'S APPROACH FOR SEED YIELD AND ITS ATTRIBUTING TRAITS IN SESAME (*Sesamum indicum* L.)

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ABSTRACT
Eight sesame (*Sesamum indicum* L.) genotypes were crossed in a half diallel mating fashion. The analysis of variance for combining ability revealed that mean sum of squares due to general combining ability were found highly significant for all the traits. Whereas the specific combining ability effects were found highly significant for all the traits except days to maturity. The ratio (δ^2GCA / δ^2SCA) variance for various traits revealed importance of non-additive type of gene action in the expression of yield and attributes except days to maturity. The significant GCA and SCA variances for all the traits except days to maturity for SCA variance suggesting importance of both additive and non-additive type of gene action in the inheritance of traits. While in case of days to maturity, additive type of gene action is more important than non-additive type. The estimates of general combining ability effects revealed that the parents, SKT 1608 and G.TIL 10 were good general combiners for seed yield per plant. The genotype SKT 1608 was also good general combiner for days to flowering, days to maturity, plant height (cm), number of capsule per plant, 1000 seed weight (g) and harvest index (%).The estimates of *sca* effects revealed that The crosses SKT 1608 × SKT 12-2 and SKT 1608 × G.TIL 2 recorded the highest *sca* effects which were also highest in *per se* performance which involved good × average parents suggest the presence of additive × dominance type of gene interaction.

KEYWORDS: Diallel analysis, Gene action, GCA and SCA

INTRODUCTION

Sesame (*Sesamum indicum* L.; 2n = 2x = 26) globally known as 'sesame', while in India it is commonly known as 'Til' belongs to order Lamiales and family Pedaliaceae. It is one of the oldest and most important traditional oilseed crops of the world. The genus *Sesamum* comprised most of wild species believed to originated in Africa while cultivated type *i.e., S. indicum* originated in India (Bedigian, 2010 and Zohary *et al.,* 2012). Sesame is a short-day plant also may grow in long-day areas and it is normally self-pollinated but depending upon topical conditions and insect population out crossing takes place up to 10-50 per cent at field condition (Pathirana, 1994). Sesame is called as the "Queen of oilseeds". The seeds are chemically composed of about 40-52 per cent oil, 20-27 per cent protein, 6-7 per cent moisture, 16 per cent carbohydrate and 6-8 per cent crude fiber. In India, sesame is one of the most important oil seed crops grown after groundnut, rapeseed and mustard. It is cultivated in an area of 13.98 lakh hectares in India with an annual production of 4.18 lakh tonnes and productivity of 291 kg ha^{-1} (IOPEPC; 2017). In Gujarat an estimated area is 1.09 lakh ha with annual production of 0.78 lakh tonnes and productivity of 723 kg ha^{-1} (IOPEPC; 2017). The success of breeding procedure is determined by the useful gene combinations, organized in the form of good combining lines and isolation of valuable germplasm. Some lines produce outstanding progenies on crossing with others, while others may look equally desirable but may not produce good progenies on crossing. The lines, which perform well in combination, are eventually of great importance to the plant breeders. Hence, investigation of general and specific combining ability would yield very useful information. Accordingly, a good knowledge of gene action involved in the inheritance of quantitative characters of economic importance is required in order to form an efficient breeding plan leading to rapid improvement.

MATERIAL AND METHODS

The experimental material comprised of eight parents (including check G.TIL 4) and their 28 half-diallel crosses. The 8×7 half diallel crosses were made during *kharif*-2017 at Castor-Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar by manual crossing. The seeds of parental lines were maintained through selfing. A set of 36 genotypes comprising of eight parents (including check G.TIL 4) and their 28 F_1 hybrids were sown in Randomized Block Design (RBD) with three replications, during *kharif*-2018. Each entry was sown in 3.0 m length in two rows with 45 × 15 cm spacing. The recommended agronomical practices and plant protection measures were adopted for raising a good crop. The observations were recorded both as visual assessment (days to flowering and days to maturity) and measurement on randomly selected five competitive individual plants (plant height, number of effective branch per plant, number of capsule per plant, capsule length, number of seed per capsule, 1000 seed weight, seed yield per plant, harvest index (%) and oil content (%). The replication wise mean values of each entry for the twelve traits were analyzed using Randomized Block Design (RBD) as suggested by Sukhatme and Amble (1985) as well as The half diallel analysis was performed as per method suggested by Griffing (1956) Model-I and method-2. The replicated mean data were analyzed statistically using the software WINDOSTAT version 8.1.

RESULTS AND DISCUSSION

The analyses of variance for combining ability for twelve traits were presented in Table 1. The results revealed that mean sum of squares due to general combining ability were found highly significant for all the traits. Whereas the specific combining ability effects were found highly significant for all the traits except days to maturity. Significant GCA and SCA variances for all the traits except days to maturity for SCA variance suggesting importance of both additive and non-additive type of gene action in the inheritance of traits. While in case of days to maturity, additive type of gene action is more important than non-additive type. As observed in present study, the predominant role of non-additive gene action in the inheritance of seed yield and contributing traits in sesame was in correspondence with results reported by various workers in different traits for seed yield and attributing traits by seed yield and contributing traits in sesame was in correspondence with results reported by Mothilal and Manoharan (2004), Babu *et al.* (2004), Kumar *et al*. (2004), Prajapati *et al*. (2006), Prajapati (2008), Toprope (2008), Patel (2017), Beniwal *et al.* (2018).In case of days to maturity, predominant role of additive gene action was observed result is in this analogous with results reported by Siddique *et al.* (2003), Babu *et al.* (2004), Prajapati *et al.* (2006), Singh *et al.* (2007), Prajapati (2008) and Vekariya *et al.* (2015).

TABLE 1: Analysis of variance for combining ability of twelve traits in sesame

Sources of variation	d.f.	Days to flowering	Days to maturity	Plant height (cm)	Number of effective branch per plant	Number of capsule per plant	Capsule length (cm)
GCA	7	12.38**	3.82**	200.41**	0.71**	111.67**	0.07**
SCA	28	2.86**	0.71	52.50**	0.22**	65.02**	0.02**
Error	70	0.58	0.53	19.08	0.08	17.71	0.00
δ^2GCA		1.18	0.33	18.13	0.06	9.40	0.01
δ^2SCA		2.28	0.18	33.42	0.13	47.32	0.02
δ^2GCA / δ^2SCA		0.52	1.83	0.54	0.47	0.20	0.35

* P ≤ 0.05, ** P ≤ 0.01

Table 1 conti…

Sources of variation	d.f.	Number of seed per capsule	1000 Seed weight (g)	Seed yield per plant (g)	Harvest index (%)	Oil content (%)
GCA	7	47.96**	0.26**	5.51**	7.96**	10.90**
SCA	28	56.84**	0.11**	5.95**	8.47**	10.78**
Error	70	0.27	0.00	1.02	1.23	0.09
δ^2GCA		4.77	0.03	0.45	0.67	1.08
δ^2SCA		56.57	0.11	4.94	7.25	10.70
δ^2GCA / δ^2SCA		0.08	0.24	0.09	0.09	0.10

* P ≤ 0.05, ** P ≤ 0.01

TABLE 2: General combining ability (*gca*) effects for twelve traits in sesame

Parents	Days to flowering	Days to maturity	Plant height (cm)	Number of effective branch per plant	Number of capsule per plant	Capsule length (cm)
SKT 1602	-0.08	-0.18	-6.51**	-0.31**	-6.85**	0.18**
SKT 1604	0.53*	-0.62**	-0.08	-0.13	-1.49	-0.01
SKT 1607	-0.04	0.08	4.59**	-0.01	0.04	-0.02
SKT 1608	-1.88**	-0.62**	-3.98**	0.06	3.34**	-0.04*
SKT 12-2	1.03**	0.75**	0.69	0.05	-0.54	0.00
G.TIL 2	-0.74**	-0.32	-1.51	-0.02	1.09	-0.06**
G.TIL 4	-0.54*	-0.18	-0.81	-0.23**	0.36	0.06**
G.TIL 10	1.73**	1.08**	7.59**	0.58**	4.04**	-0.11**
S. E. (g_i) ±	0.23	0.22	1.29	0.08	1.24	0.02

* P ≤ 0.05, ** P ≤ 0.01

Table 2 conti…

Parents	Number of seed per capsule	1000 seed weight (g)	Seed yield per plant (g)	Harvest index (%)	Oil content (%)
SKT 1602	0.12	0.24**	-1.27**	-1.13**	-0.12
SKT 1604	2.60**	-0.07**	0.03	-0.31	1.24**
SKT 1607	-0.53**	0.12**	0.33	-0.91**	-1.06**
SKT 1608	-0.70**	0.09**	0.76*	0.91**	-0.82**
SKT 12-2	-3.67**	0.04**	-0.55	-0.78*	1.06**
G.TIL 2	1.94**	-0.08**	0.25	0.77*	1.30**
G.TIL 4	-1.97**	-0.05**	-0.52	0.35	-1.13**
G.TIL 10	2.22**	-0.29**	0.96**	1.10**	-0.47**
S. E. (g_i) ±	0.15	0.01	0.30	0.33	0.09

* P ≤ 0.05, ** P ≤ 0.01

TABLE 3: Classification of parents with respect to general combining ability effects for twelve traits in sesame

Traits	Parents							
	SKT 1602	SKT 1604	SKT 1607	SKT 1608	SKT 12-2	G.TIL 2	G.TIL 4	G.TIL 10
Days to flowering	A	P	A	G*	P	G	G	P
Days to maturity	A	G	A	G	P	A	A	P
Plant height (cm)	G*	A	P	G	A	A	A	P
Number of effective branch per plant	P	A	A	A	A	A	P	G*
Number of capsule per plant	P	A	A	G	A	A	A	G
Capsule length (cm)	G*	A	A	P	A	P	G*	P
Number of seed per capsule	A	G*	P	P	P	G*	P	G*
1000 seed weight (g)	G*	P	G*	G*	G*	P	P	P
Seed yield per plant (g)	P	A	A	G	A	A	A	G
Harvest index (%)	P	A	P	G	P	G	A	G
Oil content (%)	A	G*	P	P	G*	G*	P	P

G = Good general combiner; G* = Very good combiner; A = Average general combiner; P = Poor general combiner

The parents were classified as good, average and poor general combiner for different traits based on estimates of *gca* (Table 2 and Table 3). The *gca* effects of parents explicated that none of the parents consistently good general combiner for all the traits. The parents, SKT 1608 and G.TIL 10 were good general combiners for seed yield per plant. The genotype SKT 1608 was also good general combiner for days to flowering, days to maturity, plant height (cm), number of capsule per plant, 1000 seed weight (g) and harvest index (%). While parent G.TIL 10 was also found good general combiner for number of effective branch per plant, number of capsule per plant, number of seed per capsule and harvest index (%). The parent G.TIL 2 was good general combiner for days to flowering, number of seed per capsule, harvest index (%) and oil content (%). The parent SKT 12-2 was good general combiner for 1000 seed weight (g) and oil content (%). The result showed that the trait might be controlled by additive genes. These four parents were observed to be best combiners due to their good combining ability effects and their ability to transmit traits to their progenies for seed yield along with other yield and quality attributes. Thus four parents could be considered in the future breeding programme to improve a particular trait through transgressive segregation of desirable segregants for seed yield and its component traits. There was a good general corresponding relationship between the *gca* and mean performance of the parental genotypes which indicates that the trait might be controlled by additive genes. It is propound that *per se* performance of the parent could be reliable yardstick for selecting a particular parent for hybridization for seed yield and its attributes.

The best three crosses selected on the basis of *sca* effects for various traits (Table 4). A perusal of data implied that none of the crosses had high-ranking *sca* effects for all the traits. The data revealed that the high ranking *sca* for most of the traits where accompanied by high ranking *per se* performance, which proving predominant role of non-additive gene effects in expression of seed yield and component traits. For seed yield per plant, it seems that hybrid with high *sca* effects analogue, high heterobeltiosis in some of the yield and component traits suggested that *sca* performance might be important criterion for choosing best hybrids. The crosses SKT 1608 × SKT 12-2 and SKT 1608 × G.TIL 2 recorded the highest *sca* effects which were also highest in *per se* performance which involved good × average parents (Table 4) suggest the presence of additive × dominance type of gene interaction. Thus best cross combinations could be obtained by hybridization with at least one parent with high *gca* effect. The hybrid combination with high *per se* performance, high *sca* effects along with at least one parent having high *gca* effects would tend to increase the frequency of favourable alleles. The cross combination involving both parent having high *gca* effects *viz.,* SKT 1608 × SKT 12-2 for 1000 seed weight (g) and SKT 1608 × G.TIL 2 for harvest index (%) are hopeful for choosing of good homozygous lines for amelioration of respective traits.

TABLE 4: The top three ranking parents with respect to mean performance; *gca* effects; F_1 hybrids with respect to mean performance and *sca* effects

Traits	Best performing parents	Best general combiners	Best performing hybrids	Hybrids with high *sca* effects	GCA of parents	*sca* effects
Days	SKT 1608	SKT 1608	SKT 1607 × SKT 1608	G.TIL 2 × G.TIL 10	G × P	-3.55**
to	G.TIL 4	G.TIL 2	SKT 1608 × G.TIL 2	SKT 1607 × SKT 12-2	A × P	-2.55**
flowering	G.TIL 2	G.TIL 4	G.TIL 2 × G.TIL 10	SKT 1602 × G.TIL 10	A × P	-1.88*
Days	SKT 1608	SKT 1604	SKT 1604 × SKT 1607	SKT 1607 × SKT 12-2	A × P	-1.22
to	G.TIL 4	SKT 1608	SKT 1602 × SKT 1604	SKT 1604 × SKT 1607	G × A	-0.86
maturity	SKT 1604	-	SKT 1608 × G.TIL 2	G.TIL 2 × G.TIL 10	A × P	-0.82
Plant	G.TIL 2	SKT 1602	SKT 1602 × SKT 1607	SKT 1602 × SKT 1607	G × P	-14.43**
Height	SKT 1602	SKT 1608	SKT 1602 × SKT 1608	SKT 1607 × G.TIL 10	P × P	-9.86*
(cm)	SKT 1604	-	SKT 1608 × G.TIL 4	SKT 1604 × SKT 1607	A × P	-7.86
Number of effective	G.TIL 10	G.TIL 10	SKT 12-2 × G.TIL 10	SKT 1604 × SKT 1607	A × A	0.81**
branch	G.TIL 2	-	SKT 1602 × G.TIL 10	SKT 1608 × SKT 12-2	A × A	0.56*
per plant	SKT 12-2	-	SKT 1608 × SKT 12-2	SKT 1602 × G.TIL 10	P × G	0.47
Number of	SKT 12-2	G.TIL 10	SKT 1604 × G.TIL 10	SKT 1602 × SKT 1608	P × G	14.14**
capsule	G.TIL 2	SKT 1608	SKT 1604 × SKT 1607	SKT 1604 × SKT 1607	A × A	12.62**
per plant	SKT 1607	-	SKT 1602 × SKT 1608	SKT 1604 × G.TIL 10	A × G	11.61**
Capsule	SKT 1602	SKT 1602	SKT 1602 × SKT 1608	SKT 1608 × SKT 12-2	P × A	0.22**
Length	G.TIL 4	G.TIL 4	SKT 1602 × G.TIL 4	SKT 1607 × G.TIL 4	A × G	0.18**
(cm)	SKT 12-2	-	SKT 1607 × G.TIL 4	SKT 1604 × G.TIL 2	A × P	0.17**
Number of	SKT 1604	SKT 1604	SKT 1602 × G.TIL 2	SKT 1602 × G.TIL 2	A × G	15.58*
seed	G.TIL 10	G.TIL 10	SKT 1604 × SKT 12-2	SKT 1604 × SKT 12-2	G × P	12.57**
per capsule	SKT 1607	G.TIL 2	SKT 1602 × SKT 1608	SKT 1602 × SKT 1608	A × P	11.94*
1000	SKT 1602	SKT 1602	SKT 1608 × SKT 12-2	SKT 1608 × SKT 12-2	G × G	0.59*
seed weight (g)	SKT 12-2	SKT 1607	SKT 1602 × SKT 1604	SKT 1608 × G.TIL 4	G × P	0.48**
	SKT 1604	SKT 1608	SKT 1602 × SKT 1607	SKT 1607 × G.TIL 4	G × P	0.40**
Seed yield	G.TIL 10	G.TIL 10	SKT 1608 × SKT 12-2	SKT 1608 × SKT 12-2	G × A	5.49**
per plant	G.TIL 2	SKT 1608	SKT 1608 × G.TIL 2	SKT 1608 × G.TIL 2	G × A	3.26**
(g)	SKT 1607	-	SKT 1607 × G.TIL 2	SKT 1607 × G.TIL 4	A × A	3.16**
Harvest	G.TIL 4	G.TIL 10	SKT 1608 × G.TIL 2	SKT 1608 × SKT 12-2	G × P	4.44**
Index	SKT 1607	SKT 1608	SKT 1608 × SKT 12-2	SKT 1607 × SKT 1608	P × G	3.85**
(%)	G.TIL 10	G.TIL 2	G.TIL 4 × G.TIL 10	SKT 1608 × G.TIL 2	G × G	3.68**
Oil	SKT 12-2	G.TIL 2	G.TIL 2 × G.TIL 10	G.TIL 2 × G.TIL 10	G × P	4.84**
Content	SKT 1604	SKT 12-2	SKT 12-2 × G.TIL 10	SKT 1604 × SKT 1607	G × P	4.73**
(%)	G.TIL 2	SKT 1604	SKT 1604 × SKT 1607	SKT 12-2 × G.TIL 10	G × P	4.43**

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

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