Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 1339-1344
Received: 13-05-2019
Accepted: 15-06-2019

Dela GJ
M.Sc. (Agri.) Student, Department of Genetics & Plant Breeding, College of Agriculture, JAU, Junagadh, Gujarat, India

Sharma LK
Assistant Research Scientist, Pulses Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Delvadiya IR
Ph.D. (Agri.) Student, Department of Genetics & Plant Breeding, College of Agriculture, JAU, Junagadh, Gujarat, India

Correspondence
Dela GJ
M.Sc. (Agri.) Student, Department of Genetics & Plant Breeding, College of Agriculture, JAU, Junagadh, Gujarat, India

Combining ability analysis for seed yield per plant and its components in sesame (*Sesamum indicum* L.)

Dela GJ, Sharma LK and Delvadiya IR

Abstract
Combining ability for seed yield and its component traits in sesame (*Sesamum indicum* L.) was studied using diallel mating design involved 37 test entries comprising of 28 hybrids developed from eight diverse parental lines and one standard check (G.TIL 4). The analysis of variance for combining ability revealed that mean square due to GCA and SCA were significant for all the characters except width of capsule for GCA indicated that both type of gene effects played a vital role in the inheritance of all these traits. The magnitude of GCA and SCA variances revealed that the SCA variances were higher than their respective GCA variances for all the characters which confirmed the preponderance of non-additive gene action for all the traits. The estimate of GCA effects indicated that the parents AT 377 and G.TIL 4 were found good general combiners for plant height, number of branches per plant, number of internodes per plant, length of capsule, number of capsules per plant, number of seeds per capsule, 1000-seed weight and seed yield per plant commonly. For the characters related to earliness viz., days to 50% flowering, AT 396 was found good combiner. The cross combinations viz., AT 377 x AT 396, AT 347 x G.TIL 4 and AT 376 x AT 377 were found to be good specific cross combination for seed yield per plant accompanied by high to moderate heterotic response.

Keywords: Combining ability, GCA, SCA, gene action

Introduction
Sesamum indicum L. is known as sesame, til, gingelly, simsim, gergelim, etc. Sesame (*Sesamum indicum* L.) is a member of the order tubiflorae and family pedaliaceae which consists of 16 genera and about 36 species. It is self- pollinated annual diploid (2n=26) herb. Seed is the economical part which contains oil and protein. Although it originated in Africa, it spread early through West Asia to India, China and Japan which became secondary distribution centers themselves (Weiss, 1983) [32]. Sesame seeds are rich source of linoleic acid, vitamin E, A, B_1 and B_2; minerals including Ca and P. Sesame cake is nutritious feed for dairy cattle and it can also be used as fertilizer (Ashri, 1998) [1]. Combining ability describes the breeding value of its parental lines to produce hybrids. Combining ability analysis helps in the identification of its parents with high GCA and its parental combinations with high SCA. Based on combining ability analysis of different characters, higher SCA values refer to dominant gene effects and higher GCA effects indicate a greater role of additive gene effects controlling the characters.

Materials and Methods
The experimental material used in a study consisted of 37 test entries comprised of 28 hybrids developed from eight diverse parental lines and one standard check (G.TIL 4). The genotypes were AT 345, AT 347, AT 376, AT 377, AT 396, AT 404, G.TIL 3, G.TIL 4 and seeds of genotypes used as parents were planted at Sagdividi Farm, Department of Seed Science and Technology, Junagadh Agricultural University, Junagadh, during *kharif*- 2017. The crosses were made in 8 x 8 diallel fashion without reciprocals, to obtain sufficient seeds of the 28 F_1 hybrids and an experimental material was evaluated during summer-2018 at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh. Five plants from each plot were randomly selected for recording the observations on the following traits *viz.*, days to 50% flowering, plant height (cm), height to first capsule (cm), number of branches per plant, number of internodes per plant, length of capsule (cm), width of capsule (cm), number of capsules per plant, number of seeds per capsule, 1000- seed weight (g) and seed yield per plant (g). The analysis of variance for combining ability was computed according to the model (method-2 and model-1) given by Griffings (1956a) [7].

Results and Discussion

The analysis of variance for combining ability for different characters (Table 1) revealed that mean squares due to general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the characters except width of capsule for GCA. This indicated that both additive and non-additive type of gene effects imparting a vital role in the inheritance of all the traits under the study. The magnitude of GCA and SCA variances revealed that the SCA variances were higher than their respective GCA variances for all the characters. The GCA and SCA ratio (σ^2GCA/σ^2SCA) was less than unity for all the traits (Table 1). This indicated that non-additive components play relatively greater role in the inheritance of most of these traits. The predominance of non-additive gene action for seed yield and its component traits were also reported by Patel (1993) [19], Durga *et al*. (1994) [4], Kumar and Sivasamy (1995) [12], Swain *et al.* (2001) [29], Kar *et al*. (2002b) [11], Mothilal *et al*. (2003) [17], Babu *et al*. (2004) [2], Gawade *et al*. (2007) [6], El-Shakhess and Khalifa (2007) [5], Sumathi and Muralidharan (2008) [28], Kumar and Vivekanandan (2009) [13], Bangar *et al.* (2009) [3], Shekhat *et al.* (2009) [26], Prajapati *et al.* (2010b) [21], Mandal *et al.* (2010) [15], Sakhiya (2013) [25], Shekhawat *et al.* (2014) [27] and Pawar and Monpara (2016) [20].

The summary of general combining ability effects of the parents (Table 2) revealed that none of the parents was found to be good general combiner for all the characters. An overall appraisal of GCA effect revealed that parents, G.TIL 4 and AT 377 were good general combiners for seed yield per plant and some of its components, whereas AT 396, AT 404 and G.TIL 3 were poor combiners for seed yield per plant. Thus, G.TIL 4 and AT 377 were good general combiner for seed yield and its components, which may be utilized in crossing programme to generate high genetic variability for effective selection to develop high yielding varieties of sesame. In general, it was observed that the parents having high *per se* performance for various characters also exhibited high general combining ability effects for respective characters. Such relationship will help in identifying good general combiners based on *per se* performance alone while selecting the parents for hybridization programme. Thus, if a character is unidirectionally controlled by set of alleles and additive effects are important, the choice of parents on the basis of *per se* performance may be more effective. Similar finding has also been reported by Pushpa *et al.* (2002) [22], Shekhat *et al.* (2009) [26], Sakhiya (2013) [25], Shekhawat *et al*. (2014) [27], Joshi *et al.* (2015) [10], Mungala *et al.* (2017) [18], Rajput *et al*. (2017) [23] and Virani *et al*. (2018) [30]. High general combining ability effects mostly contribute additive gene effects or additive x additive interaction effects (Griffing, 1956a and 1956b) [7, 8] and represent fixable portion of genetic variation. In view of this, G.TIL 4 and AT 377 offer the best possibilities of exploitation for the development of improved lines with enhanced yielding ability in sesame (Table 2).

For days to 50% flowering, AT 396 (-2.50) exhibited significant and negative GCA effects and hence, it was registered as good general combiner for earliness in flowering, which is desirable in sesame (Table 2). Out of 28 crosses, six crosses exhibited significant and negative SCA effects for early flowering. The highest significant and negative SCA effect was observed in cross AT 345 x G.TIL 4 (-5.26) followed by AT 345 x AT 396 (-4.56) and AT 377 x G.TIL 4 (-4.13) (Table 3).

For plant height, Significant and positive GCA effects were observed in two parents *viz*., G.TIL 4 (7.44) and AT 377 (5.00). Thus, they were registered as good general combiners for this trait (Table 2). The magnitude of SCA effects in hybrids varied from -32.14 (AT 345 x AT 404) to 18.39 (AT 377 x AT 404). Out of 28 crosses, 12 hybrids exhibited significant and desirable (positive) SCA effects for this trait. The cross AT 377 x AT 404 (18.39) ranked first by AT 347 x G.TIL 4 (16.07) for this trait (Table 3).

For height to first capsule, Estimates of GCA effects revealed that three parents *viz.*, AT 347 (-4.73), AT 404 (-1.64) and AT 376 (-1.62) were considered as good general combiners for height to first capsule as they had exerted significant and negative GCA effects (Table 2). The spectrum of variation for SCA effects in hybrids was from -9.69 (AT 345 x G.TIL 3) to 10.14 (AT 376 x AT 377). Out of 28 crosses, 6 crosses showed significant and negative SCA effects in desirable direction for height to first capsule. The cross AT 345 x G.TIL 3 (-9.69) ranked first trailed by AT 345 x G.TIL 4 (-6.16) for this trait (Table 3).

For number of branches per plant, Two parental lines *viz*., AT 377 (0.28) and G.TIL 4 (0.19) showed highly significant and positive GCA effects thus were considered as good general combiners for number of branches per plant (Table 2). The range of SCA effects in hybrids varied from -0.69 (AT 396 x G.TIL 4) to 0.68 (AT 347 x G.TIL 4). Out of 28 crosses, 4 cross combinations showed significant and positive SCA effects for number of branches per plant with highest SCA effects in AT 347 x G.TIL 4 (0.68) followed by AT 345 x G.TIL 3 (0.43) (Table 3).

For number of internodes per plant, The GCA effects were significant and positive for the parents *viz.,* G.TIL 4 (2.26) and AT 377 (1.01) thus it indicated good general combining ability effects (Table 2). Estimates of SCA effects for number of internodes per plant revealed that 20 crosses displayed significant SCA effects, out of which nine hybrids were in positive direction. Some of the best combinations were AT 377 x AT 396 (4.42), AT 347 x G.TIL 4 (4.31) and AT 404 x G.TIL 3 (4.27) (Table 3).

For length of capsule, Two parental lines *viz.,* AT 377 (0.18) and G.TIL 4 (0.16) were found to be good general combiners as they had significant and positive GCA effects for this trait (Table 2). For capsule length, 15 hybrids showed significant SCA effects. Among these, 7 hybrids depicted positive and significant SCA estimates in desirable direction, thus they were good specific combinations. Some of the good specific combinations were AT 376 x AT 404 (0.40), AT 396 x G.TIL 3 (0.32) and AT 377 x AT 396 (0.30) (Table 3).

For width of capsule, Out of 8 parental lines, none of parents exhibited significant and positive GCA effects thus it indicated that none of parents were good general combiners (Table 2). The spectrum of variation for SCA effects in hybrids was from -0.06 (AT 347 x AT 404 and G.TIL 3 x G.TIL 4) to 0.05 (AT 404 x G.TIL 4). Four out of 28 crosses showed significant and positive SCA effects for width of capsule (Table 3).

For number of capsules per plant, Highly significant positive GCA effects were exhibited by two parents *viz*., G.TIL 4 (7.54) and AT 377 (6.30) thus they were considered as good general combiners (Table 2). Out of 28 crosses, 5 crosses exhibited significant and positive SCA effects. The highest, significant and positive SCA effect was observed in cross AT 347 x G.TIL 4 (13.14) followed by AT 377 x AT 396 (12.98) and AT 347 x G.TIL 3 (11.77) (Table 3).

For number of seeds per capsules, The parents *viz.*, AT 377 (4.86) and G.TIL 4 (3.90) exhibited significant and positive GCA effects, hence they were considered as good general combiners for number of seeds per capsule (Table 2). The spectrum of variation for SCA effects in hybrids ranged from -12.10 (AT 345 x AT 347) to 13.46 (AT 376 x AT 404). Out of 28 crosses, thirteen hybrids exhibited significant and positive SCA effects, therefore, they were considered as good specific combinations for number of seeds per capsule. Some of the good specific combinations were AT 376 x AT 404 (13.46), AT 345 x G.TIL 4 (7.83) and AT 377 x AT 396 (7.31) (Table 3).

For 1000-seed weight, Estimates of GCA effects revealed that two parents *viz.,* AT 377 (0.10) and G.TIL 4 (0.07) were considered as good general combiners for number of seed per capsule as they had exerted significant and positive GCA effects (Table 2). The estimates of SCA effects in hybrids ranged from -0.58 (AT 345 x AT 347) to 0.46 (AT 376 x AT 396). Among 28 crosses, 5 hybrids were identified as good specific combinations by exhibiting significant and positive SCA effects for 1000-seed weight (Table 3).

For seed yield per plant, Two parents *viz.,* G.TIL 4 (0.99) and AT 377 (0.65) had significant and positive GCA effects and hence, they were considered as good general combiners for seed yield per plant (Table 2). Significant SCA effects were exhibited by 11 hybrids, of which, 5 hybrids possessed positive SCA effects, hence they were good specific combinations for higher seed yield per plant. The hybrids AT 377 x AT 396 (2.48) was the best specific combination followed by AT 347 x G.TIL 4 (1.98) and AT 376 x AT 377 (1.67) (Table 3).

The estimate of SCA effects revealed (Table 3) that none of the crosses was consistently superior for all the characters. The highest yielding hybrid was AT 347 x G.TIL 4 and AT 377 x AT 396 had registered highest SCA effect for seed yield per plant (Table 3). The high SCA effect for this components were also accompanied by high heterobeltiosis as well as good *per se* performance. This could be due to poor x good general combiner parents. This indicated the presence of epistatic gene action and such deviation could be attributed to the genetic diversity in the form of heterozygous loci. Such combination could be utilized for intermating segregants in F_2 or F_3 generation and simultaneous selection for desirable plant type.

In the present study, such cross combinations for seed yield were AT 377 x AT 396 (good x poor), AT 377 x AT 404 (good x poor), AT 377 x G.TIL 3 (good x poor), AT 396 x G.TIL 4 (poor x good), AT 404 x G.TIL 4 (poor x good) and G.TIL 3 x G.TIL 4 (poor x good) (Table 3). These crosses may be expected to yield transgressive and stable performing segregants possessing enhance yielding ability. Only one cross combinations *viz.,* AT 377 x G.TIL 4, involving both high combining parents (good x good) offer still better possibilities of exploitation as these are expected to yield stable segregants in the advance generations and thus, need further exploitation in the breeding programme. The crosses *viz,* AT 347 x G.TIL 3, AT 347 x G.TIL 4, AT 376 x AT 377, AT 376 x AT 404 and AT 377 x AT 396 which recorded significant SCA effect for seed yield, resulted from poor x poor or good x good or good x poor combiners (Table 3). This indicated the inconsistent expression of SCA effect in specific crosses irrespective of GCA effect of the parents. Similar results have been reported by Hadiya *et al*. (2009) [9], Kumar and Kanan (2010) [14], Prajapati *et al.* (2010b) [21], Sakhiya (2013) [25], Shekhawat *et al.* (2014) [27], Meenakumari *et al*. (2015) [16], Reddy *et al*. (2015) [24], Pawar and Monpara (2016) [20], Walter *et al*. (2016) [31] and Virani *et al*. (2018) [30]. This suggested that information on GCA effects should be supplemented by SCA effects and hybrid performance of cross combinations to predict the transgressive type possibly made available in segregating generations. If crosses showing high SCA effects involve at least one parent possessing good GCA effects and high mean value, they could be exploited for practical breeding. Therefore, it is suggested that the selection of parents for furter breeding programme should be based on GCA effects and due consideration should be given to mean value of the cross combinations while selecting crosses for specific combining ability effects.

Table 1: Analysis of variance for combining ability for diallel analysis in sesame

Source of variation	df	Days to 50% flowering	Plant height(cm)	Height to first capsule (cm)	No. of branches per plant	No. of internodes per plant
GCA	7	18.79**	256.57**	78.65**	0.28**	15.20**
SCA	28	13.63**	167.73**	31.28**	0.13**	8.35**
Error	70	1.64	6.44	2.67	0.04	0.58
σ^2GCA		1.71	25.01	7.60	0.02	1.46
σ^2SCA		11.99	161.29	28.61	0.08	7.76
σ^2GCA/σ^2SCA		0.14	0.15	0.26	0.27	0.19

Source of variation	df	Length of capsule (cm)	Width of capsule (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Seed yield per plant (g)
GCA	7	0.14**	0.0005	211.97**	92.19**	0.043**	3.04**
SCA	28	0.07**	0.0010*	67.71**	65.52**	0.060**	1.38**
Error	70	0.01	0.0005	7.14	3.08	0.009	0.20
σ^2GCA		0.01	0.0001	20.48	8.91	0.003	0.28
σ^2SCA		0.06	0.0005	60.58	62.44	0.050	1.18
σ^2GCA/σ^2SCA		0.20	0.0133	0.34	0.14	0.065	0.24

*,** Significant at 5% and 1% levels, respectively

Table 2: Estimates of general combining ability effects for different characters in sesame

Parents	Days to 50% flowering	Plant height(cm)	Height to first capsule (cm)	No. of branches per plant	No. of internodes per plant
AT 345	2.10**	-1.32	-0.17	-0.06	0.10
AT 347	-0.73	-4.45**	-4.73**	0.01	0.10
AT 376	-0.50	-4.48**	-1.62**	0.01	-1.18**
AT 377	0.63	5.00**	1.09*	0.28**	1.01**
AT 396	-2.50**	1.29	-0.15	-0.09	-0.90**

AT 404	1.13**	-6.73**	-1.64**	-0.25**	-1.50**
G.TIL 3	0.01	3.25	3.49**	-0.09	0.10
G.TIL 4	-0.13	7.44**	3.74**	0.19**	2.26**
SE (gi)	0.38	0.75	0.48	0.06	0.22
SE (gi-gj)	0.57	1.13	0.73	0.09	0.34

Parents	Length of capsule (cm)	Width of capsule (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Seed yield per plant (g)
AT 345	-0.02	0.012	-0.15	-3.16**	-0.02	-0.03
AT 347	-0.02	0.006	-0.47	0.30	0.02	-0.16
AT 376	0.01	0.006	-1.54	0.69	0.01	-0.10
AT 377	0.18**	-0.006	6.30**	4.86**	0.10**	0.65**
AT 396	-0.09**	-0.004	-3.86**	-2.6**	-0.05	-0.34**
AT 404	-0.17**	0.001	-5.27**	-2.45**	-0.09**	-0.66**
G.TIL 3	-0.03	-0.003	-2.55**	-1.54**	-0.04	-0.35**
G.TIL 4	0.16**	-0.011	7.54**	3.90**	0.07*	0.99**
SE (gi)	0.02	0.006	0.79	0.52	0.03	0.13
SE (gi-gj)	0.03	0.010	1.19	0.78	0.04	0.20

*,** Significant at 5% and 1% levels, respectively

Table 3: Estimates of specific combining ability effects for different characters in sesame

S. No.	Hybrids	Days to 50% flowering	Plant height(cm)	Height to first capsule (cm)	No. of branches per plant	No. of internodes per plant	Length of capsule (cm)
1	AT 345 X AT 347	-1.66	-6.98**	-1.42	-0.67**	-3.61**	-0.41**
2	AT 345 X AT 376	-1.23	2.90	7.14**	-0.13	-3.93**	-0.27**
3	AT 345 X AT 377	-3.36**	1.94	-0.22	0.19	1.15	0.12
4	AT 345 X AT 396	-4.56**	-5.90*	-3.00*	-0.37	-2.54**	-0.35**
5	AT 345 X AT 404	-1.53	-32.14**	4.63**	-0.21	-0.67	-0.21**
6	AT 345 X G.TIL 3	-0.06	0.95	-9.69**	0.43*	-0.61	0.05
7	AT 345 X G.TIL 4	-5.26**	-5.07*	-6.16**	0.08	1.57*	0.14*
8	AT 347 X AT 376	-2.06	0.14	-1.07	-0.01	1.81**	0.01
9	AT 347 X AT 377	-3.53**	7.51**	4.68**	-0.01	2.35**	0.19**
10	AT 347 X AT 396	-1.40	-10.38**	-2.85	-0.18	-1.47*	-0.18*
11	AT 347 X AT 404	1.30	-9.75**	-3.37*	-0.01	-2.06**	-0.03
12	AT 347 X G.TIL 3	-0.56	11.38**	5.88**	0.36	3.99**	0.28**
13	AT 347 X G.TIL 4	8.90**	16.07**	5.64**	0.68**	4.31**	0.23**
14	AT 376 X AT 377	2.57*	7.23**	10.14**	0.33	2.63**	0.13
15	AT 376 X AT 396	1.04	5.03*	5.42**	0.10	1.21	0.13
16	AT 376 X AT 404	-0.93	-3.59	-4.49**	0.40*	-0.71	0.40**
17	AT 376 X G.TIL 3	-2.80*	5.84*	2.74	0.24	-1.19	0.07
18	AT 376 X G.TIL 4	4.00**	5.23*	2.84	-0.25	-3.21**	-0.09
19	AT 377 X AT 396	-1.43	8.84**	3.55*	0.42*	4.42**	0.30**
20	AT 377 X AT 404	6.27**	18.39**	-1.11	-0.01	-1.51*	-0.07
21	AT 377 X G.TIL 3	1.40	-2.34	-4.44**	0.16	-2.25**	0.10
22	AT 377 X G.TIL 4	-4.13**	3.66	-0.62	0.01	-2.07**	-0.01
23	AT 396 X AT 404	2.07	-0.37	-1.77	0.09	-1.66*	-0.23**
24	AT 396 X G.TIL 3	-1.80	12.35**	3.07*	0.13	0.46	0.32**
25	AT 396 X G.TIL 4	0.67	3.35	3.53*	-0.69**	-4.03**	-0.44**
26	AT 404 X G.TIL 3	0.57	12.55**	3.68*	0.16	4.27**	0.13
27	AT 404 X G.TIL 4	0.70	-1.75	5.85**	0.01	1.11	0.07
28	G.TIL 3 X G.TIL 4	-0.83	5.01*	2.83	-0.29	2.17**	-0.16*
	SE(Sij)	1.16	2.30	1.48	0.19	0.69	0.07
	SE(Sij-Sik)	1.72	3.40	2.19	0.29	1.02	0.11
	SE(Sij-Skl)	1.62	3.21	2.07	0.27	0.97	0.09

S. No.	Hybrids	Width of capsule (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Seed yield per plant (g)
1	AT 345 X AT 347	-0.04*	-12.09**	-12.10**	-0.58**	-1.49**
2	AT 345 X AT 376	-0.02	-4.28	-8.70**	-0.24**	-0.73
3	AT 345 X AT 377	0.01	3.14	-1.06	-0.06	-0.15
4	AT 345 X AT 396	0.01	-5.56*	-5.80**	-0.02	-1.21**
5	AT 345 X AT 404	-0.04*	-2.02	-5.55**	0.04	-0.84*
6	AT 345 X G.TIL 3	-0.02	1.39	-1.46	0.01	0.39
7	AT 345 X G.TIL 4	0.03	-3.24	7.83**	0.06	-0.23
8	AT 347 X AT 376	0.01	2.76	3.04	0.03	0.01
9	AT 347 X AT 377	0.01	0.39	6.94**	0.40**	-0.11
10	AT 347 X AT 396	-0.02	-5.32*	2.34	0.09	-0.60
11	AT 347 X AT 404	-0.06**	-0.18	3.66*	0.15	-0.18
12	AT 347 X G.TIL 3	0.02	11.77**	6.61**	0.14	0.83*

13	AT 347 X G.TIL 4	0.04*	13.14**	4.64**	0.22*	1.98**
14	AT 376 X AT 377	-0.01	4.40	5.22**	-0.15	1.67**
15	AT 376 X AT 396	0.01	-0.24	5.41**	0.46**	0.12
16	AT 376 X AT 404	-0.02	7.03**	13.46**	0.13	1.03*
17	AT 376 X G.TIL 3	0.01	0.71	2.95	0.06	0.10
18	AT 376 X G.TIL 4	0.01	1.55	0.51	0.23*	-0.98*
19	AT 377 X AT 396	0.04*	12.98**	7.31**	-0.02	2.48**
20	AT 377 X AT 404	0.04*	1.92	2.50	0.02	-0.07
21	AT 377 X G.TIL 3	-0.04*	4.27	5.78**	0.34**	0.19
22	AT 377 X G.TIL 4	-0.04*	-1.16	3.34*	0.17	-0.54
23	AT 396 X AT 404	-0.03	-1.78	-7.38**	-0.22*	-0.61
24	AT 396 X G.TIL 3	-0.01	11.50**	5.51**	0.07	0.73
25	AT 396 X G.TIL 4	-0.04*	-17.33**	-8.80**	-0.34**	-1.90**
26	AT 404 X G.TIL 3	0.02	-0.76	6.70**	0.03	0.60
27	AT 404 X G.TIL 4	0.05*	4.41	1.79	-0.01	-0.27
28	G.TIL 3 X G.TIL 4	-0.06**	-9.51**	-5.52**	-0.22*	-0.97*
	SE(Sij)	0.02	2.42	1.59	0.09	0.40
	SE(Sij-Sik)	0.03	3.59	2.36	0.13	0.59
	SE(Sij-Skl)	0.03	3.38	2.22	0.13	0.56

*,** significant at 5% and 1% levels, respectively

Conclusion

From the above study we concluded that estimate of GCA effect indicated that the parents AT 377 and G.TIL 4 were found to be the good general combiners for seed yield and some of the yield attributing characters. For the characters related to earliness *viz.*, days to 50% flowering, AT 396 was found to be good combiner. The cross combinations *viz*., AT 377 x AT 396, AT 347 x G.TIL 4, AT 376 x AT 377, AT 376 x AT 404 and AT 347 x G.TIL 3 were found to be good specific cross combination for seed yield per plant. Crosses showing high SCA effects for seed yield also depicted high SCA effects for important yield attributes, accompanied by high to moderate heterotic response. Crosses with high SCA effect in seed yield per plant were in combinations of good x good or good x poor or poor x poor general combiners.

References

1. Ashri A. Sesame breeding. Pl. Breed. Rev. 1998; 16:179-228.
2. Babu DR, Kumar PVR, Rani CVD, Reddy AV. Studies on combining ability for yield and yield components in sesame (*Sesamum indicum* L.). J Oilseeds Res. 2004; 21(2): 260-262.
3. Bangar ND, Gawade SA, Meher BB. Combining ability analysis for yield and yield components in sesame. J of Maharashtra Agril. Uni. 2009; 35(1):52-56.
4. Durga KK, Raghunatham G, Ranganatha ARG, Sharma PS. Studies on the combining ability for morpho-physiological, reproductive and yield attributes in sesame (*Sesamum indicum* L.). Int. J Trop. Agric. 1994; 12(3-4): 248-254.
5. El-Shakhess SAM, Khalifa MMA. Combining ability and heterosis for yield, yield components, charcoal-rot and *Fusarium* wilt disease in sesame (*Sesamum indicum* L.). Egyptian J Plant Breed. 2007; 11(1): 351-371.
6. Gawade SA, Banger ND, Patil CM, Nikam AS. Combining ability analysis for yield and its components in sesame (*Sesamum indicum* L.). Res. Crops. 2007; 8(2):492-495.
7. Griffing B. Concept of general and specific combining ability in relation to diallel crossing system. Australian J Bio. Sci., 1956a; 9:463-493.
8. Griffing B. A general treatment of the use of diallel cross in quantitative inheritance. Heredity. 1956b; 10:31-50.
9. Hadiya AM, Chovatiya VP, Kulkarni GU, Mehta DR. Combining ability analysis for grain yield and its attributes in sesame (*Sesamum indicum* L.). Nat. J Pl. Imrov. 2009; 11(1): 20-25.
10. Joshi HK, Patel SR, Pathak AR, Patel RK. Combining ability analysis for yield and yield components in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2015; 6(2): 454- 458.
11. Kar UC, Swain D, Mahapatra JR. Line x tester analysis in sesame (*Sesamum indicum* L.). Madras Agric. J. 2002b; 99(1-3):9-13.
12. Kumar CRA, Sivasamy N. Combining ability analysis in sesame (*Sesamum indicum* L.). Ann. Agric. Res. 1995; 16(4): 468-472.
13. Kumar KB, Vivekanandan P. Studies on combining ability effects in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2009; 1(1):33-36.
14. Kumar SP, Kanan B. Studies on general and specific combining ability in sesame (*Sesamum indicum* L.) Electronic J Plant Breed. 2010; 1(6):1405-1408.
15. Mandal RK, Suman SJ, Ram S. Combining ability analysis for yield and its contributing characters in sesame (*Sesamum indicum* L.). Environ. Ecol. 2010; 28(4A):2562-2567.
16. Meenakumari B, Manivannan N, Ganesamurthy K. Combining ability analysis in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2015; 6(3):700-708.
17. Mothilal A, Varman PV, Ganesan KN. Combining ability in sesame (*Sesamum indicum* L.). J Ecobio. 2003; 15(2):113-119.
18. Mungala RA, Bhatiya VJ, Movaliya HM, Savaliya PG, Virani MB. Study of combining ability for seed yield and its component in sesame (*Sesamum indicum* L.). Int. J Pure App. Biosci. 2017; 5(4):775-785.
19. Patel NA. Heterosis and combining ability analysis in sesame (*Sesamum indicum* L.). M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardarkrushinagar, 1993.
20. Pawar AK, Monpara BA. Breeding for components of earliness and seed yield in sesame. Plant Gene and Trait. 2016; 7(1):1-7.
21. Prajapati NN, Patel CG, Patel KM, Prajapati KP. Combining ability for seed yield and its components in sesame (*Sesamum indicum* L.). Int. J Plant Sci. 2010b; 5(1):180-183.

22. Pushpa R, Kumar PS, Ganesan J. Studies on combining ability through diallel analysis in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsl. 2002; 17: 22-25.
23. Rajput SD, Harer PN, Kute NS. Combining ability analysis for yield and its component traits in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2017; 8(4):1307-1309.
24. Reddy VA, Parimala K, Rao PVR. Exploitation of hybrid vigour in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2015; 6(1):125-129.
25. Sakhiya SV. Diallel analysis in sesame (*Sesamum indicum* L.). M.Sc. (Agri.) thesis submitted to Junagadh Agricultural University, Junagadh, 2013.
26. Shekhat HG, Vachhani JH, Dhaduk LK. Combining ability studies in sesame (*Sesamum indicum* L.). Nat. J Pl. Improv. 2009; 11(1):51-55.
27. Shekhawat NR, Macwana SS, Choudhary R, Patel BR. Line x tester analysis in sesame (*Sesamum indicum* L.). The Bioscan. 2014; 9(4):1657-1660.
28. Sumathi P, Muralidharan V. Study of gene action and heterosis in monostem/shybranching genotypes in sesame (*Sesamum indicum* L.). Indian J Genet. 2008; 68(3):269-274.
29. Swain D, Mahapatra JR, Kar UC. Nature of gene action for yield and yield components in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsl. 2001; 16:36-38.
30. Virani MB, Vachhani JH, Kachhadia VH, Chavadhari RM, Sharma S. Combining ability for seed yield and its components in sesame (*Sesamum indicum* L.). Electronic J Plant Breed. 2018; 9(1):107-115.
31. Walter OA, Patrick R, Paul G, Patrick O. Combining ability and gene action in sesame (*Sesamum indicum* L.) elite genotypes by diallel mating design. J Plant Breed. Crop Sci. 2016; 8(11):250-256.
32. Weiss EA. Oilseed Crops, Longman, New York, 1983.