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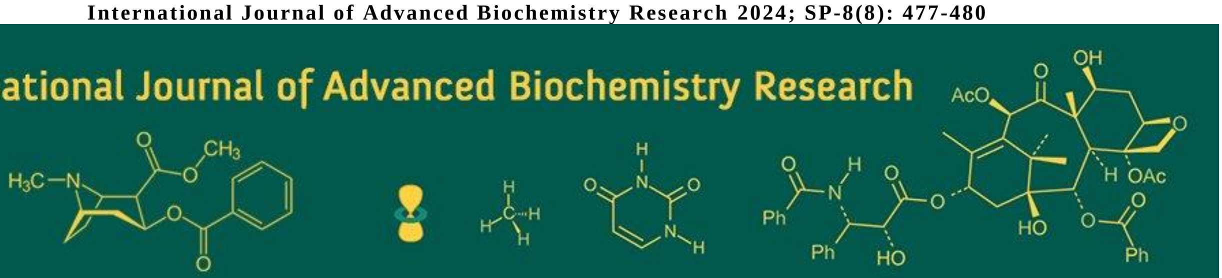

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Combining ability studies for seed yield and its component traits in sesame [*Sesamum indicum* (L.)]

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Abstract

The experimental material consisted of twelve parents and their 32F_1 hybrids through line x tester analysis. An experiment was carried out in randomized complete block design including three replications to asses combining abilities for seed yield and its attributing traits at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during *kharif*-2022. The estimates of σ^2gca were higher than the corresponding σ^2sca for days to maturity only, while in case of remaining characters *viz.,* for days to 50% flowering, plant height (cm), number of branches per plant, height to first capsule, number of capsules per plant, length of capsule (cm), width of capsule (cm), number of seeds per capsules, number of capsules per leaf axil, test weight (g), oil content (%) and seed yield per plant (g), the magnitude of σ^2sca was higher than σ^2gca. This was also confirmed by baker's ratio ($\sigma^2 gsc/\sigma^2 sca$) which was less than unity (<1) for all the traits (except days to maturity) indicated that non-additive gene action was more pronounced than that of additive gene action. The lines N 62-39 and AT 510 and tester AT 338 found to be good general combiner for seed yield per plant and some of its related traits. The perusal of SCA effects revealed that the five cross combinations *viz.,* AT 522 x GT 3, AT 482 x AT 338, AT 377 x GT 1, IC 204528 X AT 338 and DC 4 X AT 338. The cross AT 522 x GT 3 manifested good specific combining ability for seed yield and some of its related traits. Cross combinations with high SCA effects for seed yield per plant were in combinations of good × poor, average × good, average × poor, average × average and *vice versa* general combiners.

Keywords: Line x tester, gene action, general combining ability, specific combining ability, sesame

Introduction

Sesame (*Sesamum indicum* L.) is one of the most ancient and important oilseed crops grown next to groundnut and mustard in India. The oilseed crops play an important role in agriculture and industrial economy of our country. India occupies a very prominent place in the oilseed map of the world as it produces a large variety of oilseed crops and ranks first in respect of total hectarage and production. Sesame can grow well in many ecological regions of tropical and sub-tropical climates, although its cultivation reaches from 40^o N to 40^o S latitude.

The sesame is a self-pollinated crop and the genus *sesamum* belongs to *Pedaliaceae* family. The genus *Sesamum* consists of many species but, only *Sesamum indicum* L. has been recognized as a cultivated species (Ashri, 1998) [1]. According to Kobayashi *et al.* (1990) [6], 36 species have been identified of which 22 species have been found in Africa, five in Asia, seven in both Africa and Asia and one species each in Crete and Brazil. There are three cytogenetic groups of which 2n=26 consist of the cultivated *S. indicum* along with *S. alatum, S. capense, S. schenckii, S. malabaricum*; 2n=32 consist of *S. prostratum, S. laciniatum, S. angolense, S. angustifolium*; while *S. radiatum, S. occidentale, S. schinzianum* belong to 2n=64. Mainly due to the differences in chromosomal numbers across the three cytotaxonomic groups, there is limited cross compatibility among the species. Therefore, it has been difficult to transfer desirable characteristics such as drought tolerance and resistance to diseases and pest, from wild relatives into cultivated sesame (Carlsson *et al.,* 2008) [2].

Materials and Methods

The current investigation on sesame consisted of 32 genotypes, a line x tester set of twelve (8 lines and 4 testers) parents and their 32 crosses. The experiment was laid out in randomized complete block design (RCBD) with three replications at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during *kharif*-2022. Observation were recorded for nine traits of five representative plants in each replication on plant height (cm) (PH), number of branches per plant (NBPP), number of capsules per plant (NCP), Length of capsule (cm) (LC), Width of capsule (cm) (WC), number of seeds per capsule (NSPC), Number of capsules per leaf axil (NCPL), 1000-seed weight (g) (TW) and Seed yield per plant (g) (SYP). Data was analysed according to the model given by Kempthorne (1957) [5] to study combining ability variances and effects.

Results and Discussion

The analysis of variance for combining ability exposed that the partitioning of variance among the crosses showed that mean squares due to lines and testers were found significant for all the characters except variance due to testers for plant height and 1000-seed weight (g) when tested against respective error mean square. In case of lines x testers interaction, the mean squares were also significant for all the characters except days width of capsule (cm) (Table 1). The ratio of σ^2gca / σ^2sca was less than unity for all the characters (Table 2). This indicated that both additive as well as non-additive genetic variances played a vital role in the inheritance of all these traits under studied. The results were in line with the findings of Kumar *et al.* (2012) [7]; Joshi *et al.* (2015) [3]; Priya *et al.* (2016) [8]; Saxena and Bisen, (2017) [9]; Virani *et al.* (2018) [10]; and Dela *et al.* (2019) [4].

Table 1: Analysis of variance (mean squares) for combining ability in line x tester design for seed yield and its contributing traits in sesame

Sources	df	PH	NBPP	NCP	LC	WC	NSPC	NCPL	TW	SYP
Replication	2	30.843	0.387*	0.412	0.016*	0.002	9.361	0.072	0.049	0.593
Lines	7	57.961**	0.268*	182.9**	0.016**	0.002*	17.719*	0.381**	0.307**	1.538**
Testers	3	33.007	0.804**	179.4**	0.027**	0.005**	70.09**	0.189**	0.085	4.608**
Lines x Testers	21	34.565**	0.278**	102.5**	0.009**	0.001	21.88**	0.080**	0.446**	3.611**
Error	62	15.749	0.097	24.099	0.003	0.001	8.858	0.027	0.0452	0.481

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

Table 2: Estimation of components of genetic variance

	PH	NBPP	NCP	LC	WC	NSPC	NCPL	TW	SYP
σ^2l	3.517	0.014	13.240	0.001	0.0001	0.738	0.029	0.021	0.088
σ^2t	0.719	0.029	6.472	0.001	0.0002	2.551*	0.006	0.001	0.172
σ^2gca	1.651**	0.024	8.728	0.001	0.0001	1.947	0.014	0.008	0.144
σ^2lt (σ^2sca)	6.272	0.060**	26.14**	0.002**	0.0002	4.343**	0.017**	0.133**	1.043**
σ^2gca / σ^2sca	0.263	0.400	0.333	0.500	0.500	0.448	0.82	0.060	0.138

The magnitude of gca and sca variances revealed that the sca variances were higher than their respective gca variances for all the traits (Table 2). This was further supported by the potent ratio (σ^2gca/σ^2sca) less than unity confirmed the preponderance of non-additive gene action for characters under studied and suggested the utility of hybrid breeding approach to exploit existing heterosis in sesame genotypes.

Estimation of general combining ability effects (Table 3) revealed that it was difficult to pick up a good combiner for all the characters together as the combining ability effect were not consistent for all the yield attributing characters. the line AT 510 gave desirable gca effect simultaneously for three characters *viz.*, length of capsule (cm), number of capsules per leaf axil and 1000-seed weight (g). Likewise, the line N 62 39 was good general combiner for days to maturity, 1000-seed weight (g) and seed yield per plant (g). Likewise, the line AT 377 was good general combiner for plant height (cm), number of capsules per plant and number of capsules per leaf axil.

Specific combining ability effects facilitates the identification of superior cross combinations for development of promising hybrids. Five cross combinations (Table 4)

Table 3: Estimation of general combining ability effects of parents for seed yield and its contributing traits in sesame

Sr. no.	Parents	Plant height (cm)	Number of branches per plant	Number of capsules per plant	Length of capsule	Width of capsule	Number of seeds per capsule	Days to maturity	Number of capsules per leaf axil	1000-seed weight (g)	Seed yield per plant
Lines											
1	AT-375	0.673	0.048	2.108	-0.028*	-0.014	-1.176	-0.385	0.123**	0.026	-0.029
2	AT-377	2.515*	0.048	8.108**	-0.031*	0.012	-0.126	0.948	0.182**	-0.081	-0.113
3	AT-482	0.781	-0.152	1.178	-0.014	-0.019*	1.624	0.531	-0.098*	-0.181**	-0.728**
4	AT-510	-1.577	0.035	-1.558	0.066**	0.012	1.249	1.198	0.093**	0.146**	0.192
5	AT-522	2.056	-0.219*	-3.858**	0.039*	0.003	1.091	-0.135	0.029	0.001	0.040
6	DC-4	1.4223	0.231*	-2.475	0.020	-0.005	-1.734*	-0.135	-0.229**	0.127*	-0.101
7	N 62-39	-3.410**	-0.069	-2.958	-0.023	0.001	-0.701	-2.385**	-0.271**	0.206**	0.494*
8	IC 204528	-2.460*	0.148	-1.125	-0.029*	0.009	-0.226	0.365	0.170**	-0.244**	0.245
S.E(g_i)		1.145	0.090	1.417	0.018	0.009	0.859	0.786	0.047	0.061	0.200
S.E(g_i-g_j)		1.620	0.127	2.004	0.025	0.013	1.215	1.112	0.067	0.086	0.283
Testers											
1	GT-1	-0.365	-0.035	-1.958	-0.024*	0.013*	-0.734	-0.635	0.043	0.009	-0.451**
2	GT-3	-1.465	-0.194**	-2.383*	0.009	0.014*	-0.143	-1.302*	-0.043	0.073	-0.134
3	GT-10	0.619	0.248**	3.492**	-0.002*	-0.017**	-1.539*	3.198**	0.100**	-0.072*	-0.011
4	AT-338	1.120	-0.019	0.850	0.044**	-0.010	2.416**	-1.260*	-0.100**	-0.010	0.596**
S.E(g_i)		0.810	0.063	1.002	0.012	0.006	0.607	0.556	0.033	0.043	0.141
S.E(g_i-g_j)		1.145	0.090	1.417	0.018	0.009	0.859	0.786	0.047	0.061	0.200

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

Table 4: Estimates of specific combining ability effects of hybrids for seed yield per plant (g) along with its component traits

Sr. No.	Crosses	Plant height	Number of branches per plant	Number of capsules per plant	Length of capsule	Width of capsule	Number of seeds per capsule	Days to maturity	Number of capsules per leaf axil	1000-seed weight (g)	Seed yield per plant
1	AT-375 X GT-1	1.998	-0.065	-2.225	-0.025	-0.005	-1.682	0.719	0.085	-0.168	0.206
2	AT-375 X GT-3	-1.169	-0.040	-3.400	0.029	0.037*	2.993	1.385	-0.010	0.003	-0.095
3	AT-375 X GT-10	2.215	0.319	8.525 **	-0.046	-0.029	0.255	-0.115	-0.159	0.075	0.529
4	AT-375 X AT-338	-3.044	-0.215	-2.900	0.041	-0.003	-1.566	-1.990	0.084	0.090	-0.640
5	AT-377 X GT-1	-2.044	-0.065	2.842	-0.108 *	-0.012	0.534	-2.615	-0.178*	0.048	1.232 **
6	AT-377 X GT-3	1.190	-0.240	-8.933 **	0.092 **	0.034	-0.324	-1.281	0.134	0.045	-1.310 **
7	AT-377 X GT-10	-1.994	0.052	2.325	0.078**	0.028	1.405	2.885	-0.058	0.369 **	0.186
8	AT-377 X AT-338	2.848	0.252	3.767	-0.062*	-0.049 **	-1.616	1.010	0.102	-0.461 **	-0.109
9	AT-482 X GT-1	4.223	-0.131	-5.275	0.101 **	0.019	-0.149	3.135*	-0.194*	-0.086	-0.477
10	AT-482 X GT-3	2.923	0.560 *	13.217 **	-0.045	-0.016	-4.407 **	-5.198**	-0.012	0.172	0.130
11	AT-482 X GT-10	-3.760	-0.281	-4.725	-0.020	-0.005	-1.078	-0.031	0.105	-0.184	-0.886*
12	AT-482 X AT-338	-3.385	-0.148	-3.217	-0.036	0.001	5.634 **	2.094	0.102	0.099	1.233 **
13	AT-510 X GT-1	-3.619	-0.048	-3.492	-0.025	0.005	0.826	-1.531	-0.029	-0.252*	-0.733
14	AT-510 X GT-3	1.881	-0.223	-0.933	-0.011	-0.023	-1.666	0.802	-0.073	0.061	0.776
15	AT-510 X GT-10	5.265 *	0.535 *	5.925*	-0.012	-0.016	-0.303	0.302	-0.089	0.397 **	0.682
16	AT-510 X AT-338	-3.527	-0.265	-1.500	0.048	0.034	1.143	0.427	0.191*	-0.206	-0.726
17	AT-522 X GT-1	3.015	0.135	4.275	0.049	0.017	0.318	-0.865	-0.038	0.143	-0.076
18	AT-522 X GT -3	-4.285	-0.040	6.233*	0.002	-0.024	4.193 *	0.135	-0.162	0.426 **	2.477 **
19	AT-522 X GT-10	-3.835	-0.281	-7.642 **	-0.032	0.004	-0.145	-1.031	0.095	0.111	-0.138
20	AT-522 X AT-338	5.106*	0.185	-2.867	-0.019	0.003	-4.366 *	1.760	0.105	-0.679 **	-2.263 **
21	DC-4 X GT-1	-2.752	-0.248	-0.442	0.034	-0.024	0.543	1.135	0.091	0.463 **	-0.338
22	DC-4 X GT-3	1.081	0.244	1.383	-0.039	0.014	-2.216	1.469	-0.104	-0.682 **	-1.266 *
23	DC-4 X GT-10	0.998	-0.131	-1.492	-0.007	0.012	-1.720	-1.031	0.180*	-0.343 **	0.706
24	DC-4 X AT-338	0.673	0.135	0.550	0.011	-0.002	3.393*	-1.573	-0.167	0.562 **	0.898*
25	N 62-39 X GT-1	-0.052	0.585 *	5.575*	-0.050	0.002	-2.357	0.052	0.292 **	-0.405 **	0.116
26	N 62-39 X GT-3	1.181	-0.190	-4.267	0.024	-0.012	0.784	0.385	0.081	0.009	-0.444
27	N 62-39 X GT-10	-1.035	-0.231	-1.808	0.036	0.015	2.280	0.219	-0.122	-0.045	-0.336
28	N 62-39 X AT-338	-0.094	-0.165	0.500	-0.010	-0.005	-0.707	-0.656	-0.252 **	0.442 **	0.664
29	IC 204528 X GT-1	-0.769	-0.165	-1.258	0.024	-0.002	1.968	-0.031	-0.029	0.257*	0.069
30	IC 204528 X GT-3	-2.802	-0.073	-3.300	-0.053	-0.010	0.643	2.302	0.147	-0.033	-0.269
31	IC 204528 X GT-10	2.148	0.019	-1.108	0.003	-0.009	-0.695	-1.198	0.048	-0.379 **	-0.743
32	IC 204528 X AT-338	1.423	0.219	5.667*	0.026	0.021	-1.916	-1.073	-0.166	0.155	0.943 *
S.E(Sij) ±	2.291	0.180	2.834	0.036	0.019	1.718	1.573	0.095	0.122	0.400	SE(Sij) ±
S.E(Sij-Skl) ±	3.240	0.255	4.008	0.051	0.027	2.430	2.225	0.134	0.173	0.566	SE(Sij-Skl) ±

The estimates of sca effect of the crosses indicated that five hybrids manifested significant and positive sca effect for seed yield per plant. These best five specific combinations were AT 522 x GT 3 followed by AT 482 x AT 338, AT 377 x GT 1,IC 204528 X AT-338 and DC-4 X AT-338. The cross AT 522 x GT 3 was also found good specific combiner for number of capsules per plant, number of seeds per capsule, 1000-seed weight (g) and oil content (%) and also showed high *per se* performance and standard heterosis. Likewise, the cross AT 482 x AT 338 also showed desirable sca effect for number of seeds per capsule, oil content (%) and seed yield per plant (g). The high sca effect observed for seed yield per plant was associated with desirable sca effect manifested by its component characters like number of capsules per plant, number of seeds per capsule and 1000-seed weight (g).

Conclusion

In commenced investigation, both GCA and SCA variances were important for all the characters studied with predominance of SCA variance which delineated substantial scope for sesame crop improvement through hybrid breeding. The parents N 62-39, AT 510 and tester AT 338 were found to be good general combiners for seed yield and its attributing traits. The cross combinations with high sca effects were involved in to good × poor, poor × good, average × average and average × poor general combiners. This reflected the role of additive and non-additive gene actions in the genetic control of traits. Under a circumstance where both additive and non-additive gene effects are important, biparental mattings as well as mating of selected plants in early segregating generations should be attempted in developing potential populations having optimum levels of homozygosity and heterozygosity in sesame.

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