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Studies on general and specific combining ability in sesame (*Sesamum indicum* L.)

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Abstract

A Line × Tester analysis in sesame (*Sesamum indicum* L.) was carried out with four lines and six testers to estimate the combining ability effects and heterosis for thirteen characters *viz*., days to first flower, days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, width of capsule, number of seeds per capsule, 1000 seed weight, shattering percent, oil content and seed yield per plant. Based on the general combining ability effects, RT-54 among lines and SSD-22 among testers and for oil content among lines RT-54 and among testers AT-255 were found to be good general combiners for seed yield per plant. The cross combination GT-3 X AT-255 exhibited the maximum positive and significant sca for seed yield per plant and the cross RT-54 X MT-10-8-2 showed maximum positive significant sca effect for oil content and hence recommended for heterosis breeding, whereas the hybrid GT-3 X AT-255 exhibited high test weight and hence it is recommended for breeding bold seeded type. Similarly the hybrid PRAGATI X AT-255 recorded desirable sca for earliness.

Keywords: sesame, line, tester, yield, heterosis

Introduction

Sesame (*Sesamum indicum* L.) is commonly known as *gingelly, til, benniseed, simsim*. It is probably the most ancient oilseed known and used by man and its domestication is lost in the mists of antiquity. Although originated in Africa, It is cultivated mainly in the tropical and subtropical regions of Asia, Africa and Southern America. And also it spread early through West Asia to India, China and Japan which themselves became secondary distribution center. Worldwide it is grown on an area of 75.4 lakh hectares with a production of 33.4 lakh tonnes with a productivity of 518 kg/ha and having high productivity in the Egypt is 1315 kg/ha. India is the largest producer of sesame in the world. It also ranks first in the world in terms of sesame-growing area (24%). In India sesame is cultivated on an area of 19.01 lakh hectare with a productivity of 426 kg/ha and 8.10 lakh tonnes production (Anonymous, 2014) [3]. It is widely cultivated in the states of Uttar Pradesh, Rajasthan, Orissa, Andhra Pradesh, Telangana State, Tamil Nadu, Karnataka, West Bengal, Bihar and Assam. In Maharashtra area under this crop is 0.52 lakh hectare, with 0.08 lakh metric tonnes production and average productivity 160 kg/ha in kharif (Anonymous, 2014) [3]. A further increase in sesame productivity per unit area and unit time needs intensive research in genetics and plant breeding. Studies on heterosis breeding in sesame are of paramount importance to achieve the goal. In the present investigation, attempts have been made to evaluate ten parents (four lines, Eight testers) and 32 hybrids through Line × Tester analysis to bring out the best parents and cross combinations with good general and specific combining abilities for seed yield and its contributing traits.

Material and Methods

The present investigation on sesame was conducted at Plant Breeding Farm, Oil Seeds Research Station Latur. The experimental materials for this study consisted of four lines and eight testers *viz*., L1-PRAGATI, L2-GT-3, L3-AT-2. L4-RT-54,T1-MT-10-8-2, T2 –AT-207, T3-SSD-9, T4-MT-10-8-1, T5-JLS-301-24, T6 –SSD-11, T7 –SSD-22 and T8 –AT-255. The four lines and eight testers were crossed in a Line X Tester mating design resulting in thirty two hybrids. Thirty two hybrids and their twelve parents were sown in rows with spacing of 45 cm between rows and 20 cm between plants in a row during August-October, 2016. Our earlier studies (Ghule, *et. al*., 2017) [5] reported details about methodology adapted for generation of for generation of hybrids.

In each cross, 20 plants were maintained. The experiment was conducted in randomized block design with two replications. Border rows were grown all around the experimental block. A fertilizer schedule of 30:60:30 kgs of NPK per hectare was followed along with the recommended cultural operations and plant protection measures. Observations were recorded on thirteen traits *viz*., days to first flower, days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, width of capsule, number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant. The analysis of variance for combining ability was done based on the method developed by Kempthorne (1957) [6].

Results and Discussion

The analysis of variance showed significant differences among the genotypes (Table1), for all thirteen traits *viz*., days to first flower, days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, capsule length, width of capsule, number of seeds per capsule, 1000 seed weight, shattering percent, oil content and seed yield per plant. (Table1.). Significant differences between lines were observed for days to 50% flowering, no. of capsule/plant, no. of seed/capsule and oil content and among testers for days to first flower, days to 50% flowering, plant height, no. of branches/ plant, no. of capsule/plant, no. of seed/ capsule, and oil content. The L x T interaction effect was significant for days to first flower, days to 50 per cent flowering, number of branches per plant, and oil content.

Dhillon (1975) [4] 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 at least one parent with high gca effects (Table2). In the present investigation among the lines SSD-22 was the best general combiner for oil content. The other female RT-54 exhibited desirable and significant gca for seed yield and expressed positive significant gca effects for the traits *viz*., plant height no. of branches/plant, no. of capsules/plant, and width of capsule.

Among the female parents RT-54 showed significant positive gca effects for oil content and also for no. of seeds/ capsule. The parent SSD-11 was the best general combiner for plant height, no. of branches /plant, no. of capsules/plant, length of capsule, width of capsule, 1000 seed weight and seed yield/plant. Another tester GT-3 was the best general combiner for no. of seeds/capsule and negatively significant for the days to first flower, days to 50% flowering and days to maturity which indicated that this parent is suitable for earliness breeding. The tester SSD-22 was best general combiner for the character no. of seed/capsule and the parent MT-10-8-1 for gca exhibited positive significant character.

The specific combining ability is the deviation from the performance predicted on the basis of general combining ability (Allard, 1960) [1]. The sca effect is an important criterion for the evaluation of hybrids (Table3). The cross GT-3 X AT-255 exhibited significantly high sca effects for the characters *viz*., plant height and seed yield per plant. The cross RT-54 X AT-207 showed highest significant sca for number of capsules per plant, and width of capsule RT-54 X MT-10-8-1 showed maximum positive and significant sca effects for the trait no. of seeds/capsule. GT-3 X AT-255 showed positive and significant sca effects for the traits length of capsule and 1000 seed weight and the four crosses RT-54 X MT-10-8-2 and RT-54 X AT-

255 showed positive significant sca for oil content. Earlier Vara Prasad and Shivani reported few significant sca effects in few promising crosses in maize. Based on sca effects, the hybrids GT-3 X AT-255 and RT-54 X MT-10-8-1 produced significant positive heterosis and desirable sca effects for most of the traits studied indicating good potential for exploitation of their hybrid vigour commercially.

Table 1: Analysis of variance for combining ability for different eleven characters including parents in sesame

Sources of Variation	d.f.	Days to 50% flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsule / plant	Length of capsule	Width of capsule	No. of seed / capsule	1000 Seed weight	Seed yield / plant	Oil content
Replications (MSS)	1	2.227	3.681	131.932	0.013	315.631	0.008	0.00029	6.944	0.075	0.076	3.131
Treatments (MSS)	43	10.472**	5.650*	459.752**	2.403**	361.667**	0.091**	0.00398**	104.491**	0.231**	0.647**	8.140**
Parents(MSS)	11	9.920**	4.041	439.576**	2.474**	109.674	0.058*	0.00042	37.060	0.109**	0.336	1.530
Lines(MSS)	3	15.458**	1.791	218.759*	1.938**	3.553	0.102**	0.00050	12.144	0.193**	0.048	2.261
Testers(MSS)	7	8.535*	2.142	583.201**	3.053**	103.213	0.038	0.00033	40.018	0.075*	0.502	1.432
Lines v/s Testers (MSS)	1	3.000	24.083**	96.64523	0.02521	473.260*	0.067	0.00083	91.107	0.090	0.038	0.020
Parents v/s Crosses (MSS)	1	5.833	37.386**	0.34008	0.509*	503.745*	0.227**	0.00967**	9.344	1.844**	1.653*	37.867**
Crosses(MSS)	31	10.818**	5.197	481.732**	2.439**	446.500**	0.098**	0.00506**	131.487**	0.222**	0.725**	9.527**
Error (MSS)	43	2.785	3.100	62.758	0.123	105.450	0.022	0.00127	23.211	0.029	0.241	3.096

*and ** indicated significance at 5and 1 percent level, respectively

Table 2: Estimates of general combining ability (GCA) of parents in sesame

Parents	Days to 50% flowering	Days to maturity	Plant height	No. of branches / plant	No. of capsule / plant	Length of capsule	Width of capsule	No. of seed / capsule	1000 Seed weight	Seed yield / plant	Oil content
Lines											
PRAGATI	-0.391	0.109	-4.523 *	-0.163	-8.605 **	-0.048	-0.039 **	1.694	-0.245 **	-0.254 *	-1.269 **
GT-3	-0.953 *	0.609	-1.012	-0.088	1.885	0.067	0.029 **	5.665**	0.183 **	0.336 *	0.119
AT-231	0.797	0.609	-2.678	0.150	-1.043	0.012	-0.011	-5.548 **	-0.198 **	-0.297 *	-1.425 **
RT-54	0.547	-1.328 **	8.212**	0.100	7.763**	-0.031	0.021 *	-1.811	0.260 **	0.215	2.575 **
Testers											
MT-10-8-2	-0.953	0.797	-5.820 *	-0.625 **	-11.733 **	-0.202 **	-0.036 **	-6.568 **	0.058	-0.495 **	0.331
AT-207	0.797	0.672	0.971	-0.338 *	6.650	0.078	0.029 *	2.064	0.218 **	0.051	0.406
SSD-9	-1.328 *	0.172	8.005**	1.050 **	3.975	0.057	0.014	-4.980 **	-0.060	-0.180	0.256
MT-10-8-1	-0.328	0.172	-5.538	-1.250 **	-5.907	0.151 **	-0.026	10.980**	0.056	0.119	0.131
JLS-301-24	-1.203	0.422	3.779	0.925 **	1.463	-0.043	0.017	-0.641	-0.059	0.101	-0.581
SSD-11	1.547 *	-0.578	-1.151	0.700 **	8.188*	-0.040	0.011	5.899**	-0.142 *	0.043	-0.494
AT-255	1.922 *	-0.703	6.501*	0.238	3.814	0.267 **	-0.008	1.133	0.081	0.355 *	-1.056
SSD-22	-0.453	-0.953	-6.748 *	-0.700 **	-6.450	-0.269 **	-0.002	-7.886 **	-0.152 *	0.005	1.006

*and ** indicated significance at 5and 1 percent level, respectively

Table 3: Estimates of specific combining ability (SCA) for 10 characters in sesame

Sr. No.	Characters	Days to 50% flowering	Day to maturity	Plant height	No. of branches / plant	No. of capsule / plant	Length of capsule	Width of capsule	No. of seed / capsule	1000 Seed weight	Seed yield / plant	Oil content
1	PRAGATI X MT-10-8-2	2.891 *	1.516	9.325	-0.162	15.656 *	0.110	-0.007	1.256	0.207	0.677	0.181
2	PRAGATI X AT-207	-2.359	-1.859	-22.076 **	-0.600*	-19.383 *	-0.130	-0.037	3.475	-0.068	-0.345	-0.644
3	PRAGATI X SSD-9	1.766	-0.859	-8.750	-1.288**	-7.308	0.332 **	0.018	-7.081 *	-0.024	-0.048	-0.644
4	PRAGATI X MT-10-8-1	1.766	0.141	5.633	0.263	-5.625	-0.302 **	-0.017	1.934	0.060	0.043	0.681
5	PRAGATI X JLS-301-24	-0.859	2.391	-1.784	-0.163	-5.395	-0.098	0.046	0.030	0.360 **	-0.420	-0.156
6	PRAGATI X SSD-11	-0.109	0.891	-14.454 *	-0.188	-1.120	0.059	0.012	0.105	-0.208	0.039	-0.794
7	PRAGATI X AT-255	-2.484 *	-0.484	18.949 **	1.925**	21.958 **	0.002	0.011	2.256	-0.305 *	0.137	1.719
8	PRAGATI X SSD-22	-0.609	-1.734	13.158 *	0.213	1.217	0.028	-0.026	-1.975	-0.023	-0.083	-0.344
9	GT-3 X MT-10-8-2	-0.047	-0.984	-6.006	0.313	-6.783	-0.184	0.019	-5.215	-0.145	-0.028	-1.806
10	GT-3X AT-207	-0.797	-0.859	-0.387	-1.125 **	11.828	0.171	0.004	2.929	0.400 **	0.470	0.969
11	GT-3X SSD-9	-0.172	2.141	-10.156	-0.213	-7.047	-0.213	-0.021	-0.202	-0.176	-0.398	-0.431
12	GT-3 X MT-10-8-1	-0.672	0.641	-11.038	-0.413	-0.195	0.153	-0.006	-3.553	-0.213	-0.612	-0.256
13	GT-3 X JLS-301-24	-0.797	-1.109	29.121 **	1.063 **	0.515	0.127	-0.028	-0.991	-0.203	0.390	-1.244
14	GT-3 X SSD-11	-2.047	-1.109	9.776	0.238	2.490	0.015	0.033	1.869	-0.010	-0.006	0.369
15	GT-3 X AT-255	2.578 *	1.516	-6.407	0.600 *	15.664 *	-0.053	0.057 *	3.285	0.497 **	0.962 **	1.081
16	GT-3 X SSD-22	1.953	-0.234	-4.903	-0.463	-16.472 *	-0.017	-0.059 *	1.879	-0.150	-0.778 *	1.319
17	AT-231 X MT-10-8-2	-0.797	0.516	4.415	-0.125	-2.760	-0.080	-0.036	-1.652	-0.055	-0.796 *	-1.412
18	AT-231 X AT-207	0.953	0.641	2.209	0.688 **	8.806	-0.020	0.059 *	1.517	-0.155	0.453	-0.938
19	AT-231 X SSD-9	-2.922 *	0.141	3.205	1.500 **	15.931 *	-0.053	-0.006	2.161	0.164	0.199	0.412
20	AT-231 X MT-10-8-1	-0.422	0.641	-21.893 **	0.050	-14.787	0.158	-0.056 *	-1.349	-0.277 *	-0.290	1.438
21	AT-231 X JLS-301-24	-2.047	-1.609	-3.059	-0.475	13.343	-0.128	0.032	1.177	-0.127	0.118	-0.950
22	AT-231 X SSD-11	2.203	-1.109	12.146 *	0.000	1.818	-0.151	-0.012	-0.168	0.250 *	0.407	0.913
23	AT-231 X AT-255	2.828 *	-0.984	0.679	-1.638 **	-18.008 *	0.197	-0.018	-4.152	0.058	-0.251	0.625

24	AT-231 X SSD-22	0.203	1.766	2.298	0.000	-4.344	0.078	0.036	2.467	0.140	0.159	-0.088
25	RT-54 X MT-10-8-2	-0.797	-1.047	-7.734	-0.025	-6.112	0.153	0.023	5.611	-0.008	0.147	3.037 *
26	RT-54 X AT-207	-2.047	2.078	20.254 **	1.038**	-1.251	-0.022	-0.027	-7.921 *	-0.178	-0.579	0.613
27	RT-54 X SSD-9	2.203	-1.422	15.701 **	0.000	-1.576	-0.065	0.008	5.123	0.036	0.247	0.663
28	RT-54 X MT-10-8-1	1.328	-1.422	27.298 **	0.100	20.607 **	-0.009	0.078 **	2.968	0.430 **	0.859 *	-1.862
29	RT-54 X JLS-301-24	-0.672	0.328	-24.278 **	-0.425	-8.463	0.100	-0.049	-0.216	-0.030	-0.089	2.350
30	RT-54 X SSD-11	3.703 **	1.328	-7.468	-0.050	-3.188	0.077	-0.033	-1.806	-0.033	-0.440	-0.487
31	RT-54 X AT-255	-0.047	-0.047	-13.221 *	-0.888**	-19.615 *	-0.145	-0.049	-1.389	-0.250 *	-0.848 *	-3.425 **
32	RT-54 X SSD-22	-2.922 *	0.203	-10.552	0.250	19.599 *	-0.089	0.049	-2.371	0.032	0.702	-0.887
	SE (±)	1.1801	1.2451	5.6017	0.248	7.2612	0.1069	0.0252	3.4068	0.1212	0.3478	1.2442

*and ** indicated significance at 5and 1 percent level, respectively

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