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Heterosis study of seed yield and it's attributing traits in sesame (*Sesamum indicum* L.)

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Abstract

By crossing six genotypes in half-diallel pattern, created 15 crosses to inspect heterosis for seed yield and its attributing traits in sesame. Six parents, 15 crosses and one check evaluated in a RBD with three replications at College farm, NAU, Campus-Bharuch during *Kharif*-2022. The performance of genotypes, parents and hybrids were significant for all the traits, but parents *vs* hybrids were found to be significant for all the traits except seed yield per plant, 1000 seed weight, and harvest index. Parent, AT-490 had high *per se* performance while hybrids, AT-305 x AT-490, JND-3 x AT-490, AT-377 x AT-490 and AT-467 x AT-305 had highest, desirable standard heterosis for seed yield per plant (in gram). These hybrids could be exploited in future for hybrid development after testing in large scale trials to confirm their superiority in heterosis.

Keywords: Half-diallel, heterosis, RBD, sesame

Introduction

Sesame (*Sesamum indicum* L., 2n = 26) is one of the oldest oil-seed crop in world. It belongs to order Tubiflorae and family Pedaliaceae. It is basically considered as crop of tropical and sub-tropical regions, but it has also spread to the temperate regions of the world. Africa has been considered to be the primary center of origin of sesame and it spread early through West Asia to India, China and Japan, which became secondary distribution centers Weiss, 1983) [1].

The genus *sesamum* consists so many species among them, *Sesamum indicum* L. is most cultivated (Ashri, 1998) [2]. It is self-pollinated, short duration (70-150 days) crop. Sesame is typically an erect, indeterminate, branched annual having 0.5-2.0 meters height with well-developed root system. Sesame is highly drought tolerant due to well-developed root system but it requires adequate moisture for germination and early growth. It is extensively susceptible to water logging condition and heavy continuous rains at all stages of development (Ashri, 1998) [2]. Sesame is highly sensitive to drought-stress during anthesis which shows devastating effect on the number of capsules per plant, grain yield as well as oil yield and quality. Sesame requires a minimum of 300-400 mm of rainfall per season but it is sensitive to wet condition and has a very low salt tolerance (Carlsson *et al*., 2008) [3].

Sesame known as "Queen of the oil seeds" due to its excellent qualities of the seed, oil and meal. Sesame seed having 50-60 percent oil and 25 percent protein (Pathak *et al*. 2017) [4]. Sesame oil contains saturated fatty acid, unsaturated fatty acids, proteins, and various minor nutrients such as vitamins, minerals, lignans, such as sesamin, sesamol, sesamolin, and tocopherols (Charan *et al*. 2018) [5]. Due to high nutritive value and economical price of sesame oil, it also known as poor man's substitute for ghee. Sesame also use in industrial purpose for manufacturing of soap, pharmaceuticals, paints, lubricants, cosmetics etc. Sesame oil used as an oleaginous vehicle and solvent in injected drugs, cosmetics carrier oil, coating of stored grains to prevent weevil attacks.

Sesame is cultivated in almost all parts of the country during different seasons of the year. In India, sesame is cultivated in 19.01 lakh ha area with a production of 8.10 lakh tones annually and productivity of 426 kg/ha (Anon., 2022) [6]. In Gujarat, sesame is cultivated in 2.46 lakh ha area with a production of 1.16 lakh tones annually and productivity of 471 kg/ha (Anon., 2022) [6].

The study of heterosis can give essential information relating to breeding methodology to be used for varietal improvement. It additionally helps in discarding a large number of crosses in the initial generation itself and selecting only those which having high potential.

Material and Methods

The crossing programme was carried out at College Farm, College of Agriculture, NAU, Campus Bharuch during summer-2022. The fifteen crosses were made using six diverse parents *viz.*, AT-467, JND-3, AT-377, AT-305, AT-490 and AT-338 of sesame in half-diallel fashion. A complete set of 22 entries comprising of six parental genotypes, their 15 hybrids and one standard check variety (G. Til-6) were evaluated in RBD with three replications during *Kharif*-2022. Each entry was grown in a single row plot of 1.5 m length with 45 x 10 cm spacing. All the cultural and recommended packages of practices were performed. Five plants out of fifteen were randomly selected and tagged excluding border plants from each replication and in each treatment to minimize border effects. The twelve observations *viz.*, days to 50% flowering, days to maturity, plant height (cm), branches per plant, capsules per plant, capsule length (mm), seeds per capsule, seed yield per plant (g), 1000 seed weight (g), harvest index (%), oil content (%) and protein content (%) were recorded. The analysis of variance for RBD was performed to test the significance of differences among the genotypes for all the characters advised by Panse and Sukhatme (1978) [7], estimation of heterobeltiosis by Fonseca and Patterson (1968) [8] and standard heterosis by Meredith and Bridge (1972) [9].

Results and Discussion

The analysis of variance (mean sum of square) revealed that the genotype related mean squares were highly significant due to the parents and hybrids related mean squares were displayed significant for all the traits. This verified that all the traits showed significant genetic variability among genotypes, parents and hybrids under this study. Comparison of mean squares resulting from parents *vs*. hybrids was found to be significant for branches per plant, seed yield per plant, 1000 seed weight and harvest index (Table no. 1). This implied that hybrids performed in a different way from parents, which revealed the existence of mean heterosis for approximately all the traits studied. Similar results were noted by Virani *et al.* (2017) [10], Konate *et al.* (2021) [11], Ghule *et al.* (2022) [12], Tavadare *et al.* (2022) [13] and Gadhiya *et al.* (2023) [14] in sesame.

The magnitude of heterobeltosis and standard heterosis was observed for all twelve characters are presented in tables no. 2. The cross JND-3 x AT-305 show negative standard heterosis for days to 50% flowering and days to maturity, while the crosses, AT-467 x AT-490 and AT-377 x AT-305 show negative standard heterosis for days to maturity. Negative values for days to 50% flowering and days to maturity consider as desirable. So, these crosses may be important for earliness. Similar results were noted by Virani *et al.* (2017) [10], Beniwal *et al.* (2018) [15], Disowja *et al.* (2021) [16] and Tavadare *et al.* (2022) [13]. The cross *viz.*, JND-3 x AT-377, AT-377 x AT-305 and AT-305 x AT-490 show significant positive standard heterosis for oil content. Similar findings were reported by Abd-Elsaber *et al.* (2019) [17], Chauhan *et al.* (2019) [18], Daba *et al.* (2019) [19], Ghule *et al.* (2022) [12] and Tavadare *et al.* (2022) [13]. The cross AT-377 x AT-305 show significant positive standard heterosis for protein content. Similar case reported by Azeez and Morakinyo (2014) [20]. In the present study, seed yield per plant showed a wide range of variation in heterotic response over better parent and standard check and it was found that the hybrids, AT-305 x AT-490, JND-3 x AT-490, AT-377 x AT-490 and AT-467 x AT-305 were showing significant, desirable standard heterosis for seed yield per plant. Similar cases were reported by earlier workers like Virani *et al.* (2017) [10], Beniwal *et al.* (2018) [15], Vekariya and Dhaduk (2018) [15], Chauhan *et al.* (2019) [18], Dela and Sharma (2019) [22], Nehra *et al.* (2021) [23], Sandhya *et al.* (2021) [24], Tavadare *et al.* (2022) [13] and Gadhiya *et al.* (2023) [14].

Table 1: Analysis of variance (mean sum of square) for various characters in sesame

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height	Branches per plant	Capsules per plant	Capsules length
Replication	2	2.05	11.49	3.10	0.05	5.77	2.06
Genotypes	20	8.60**	23.22**	174.00**	0.78**	76.11**	9.29**
Parents	5	15.02**	34.48**	337.96**	0.98**	91.87**	10.52**
Hybrids	14	6.75**	20.39**	127.46**	0.73**	74.88**	9.25**
Parents *vs*. Hybrids	1	2.53	6.50	5.63	0.47**	14.41	3.64
Error	40	2.58	6.54	27.34	0.05	23.51	1.47
Total	62	4.50	12.08	73.87	0.29	39.90	4.01`1
Source of Variation	**d.f.**	**Seeds per capsule**	**Seed yield per plant**	**1000 seed weight**	**Harvest index**	**Oil content**	**Protein content**
Replication	2	2.38	1.36	0.07	2.79	0.22	1.69
Genotypes	20	102.31**	14.32**	0.49**	29.34**	29.46**	6.22**
Parents	5	119.32**	6.19**	0.58**	24.16*	35.48**	6.56**
Hybrids	14	103.52**	15.79**	0.42**	31.04**	28.93**	6.39**
Parents *vs*. Hybrids	1	0.35	24.80**	0.92**	3.37**	6.75	2.20
Error	40	26.41	2.36	0.08	6.54	2.68	1.05
Total	62	50.12	5.94	0.21	13.77	11.24	2.74

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

Table 2: The estimates of heterosis over heterobeltiosis and standard heterosis for different characters in sesame

Sr. No	Crosses	Days to 50% flowering		Days to maturity		Plant height		Branches per plant	
		BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)
1	AT-467 x JND-3	-5.11	-0.76	-4.18**	-1.95	-11.06**	-3.41**	-7.26	0.88
2	AT-467 x AT-377	-8.76**	-4.58	-1.90	0.39	-15.17**	-7.88**	10.48*	20.18*
3	AT-467 x AT-305	-6.57**	-2.29	-3.04	-0.78	-7.46**	0.50	7.26	16.67*
4	AT-467 x AT-490	-2.19	2.29	-9.51**	-7.39**	-10.29**	-2.57**	-0.74	17.54*
5	AT-467 x AT-338	-2.90	2.29	-2.99	1.17	-4.53**	3.69**	-14.52**	-7.02
6	JND-3 x AT-377	0.79	-2.29	3.50**	3.50**	-8.28**	-8.99**	9.09	5.26
7	JND-3 x AT-305	-4.76	-8.40**	-1.63	-5.84**	3.94**	3.13**	-10.09	-14.04*
8	JND-3 x AT-490	2.36	-0.76	3.56**	1.95	-6.00**	-4.64**	-8.15	8.77
9	JND-3 x AT-338	-6.52**	-1.53	-4.85**	-0.78	-5.22**	1.51	-9.62	-17.54*
10	AT-377 x AT-305	6.30*	3.05	-5.45**	-5.45**	-1.82	-9.44**	2.73	-0.88
11	AT-377 x AT-490	5.51	2.29	1.17	1.17	3.69**	5.20**	-5.19	12.28*
12	AT-377 x AT-338	-6.52**	-1.53	-1.49	2.72	-3.29**	3.58**	-1.82	-5.26
13	AT-305 x AT-490	4.72	1.53	3.56**	1.95	-1.10	0.34	-2.22	15.79*
14	AT-305 x AT-338	0.00	5.34	-3.36**	0.78	-2.82**	4.08**	-15.60*	-19.30*
15	AT-490 x AT-338	-3.62	1.53	-0.37	3.89**	0.99	8.16**	-11.11*	5.26
	S.E.(d) ±	1.31	1.31	2.14	2.14	4.27	4.27	0.19	0.19

*, ** Significant at 5 percent and 1 percent levels of probability, respectively
BH = Heterobeltiosis and SH = Standard Heterosis

Sr. No	Crosses	Capsules per plant		Capsules length		Seeds per capsule		Seed yield per plant	
		BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)
1	AT-467 x JND-3	-11.60**	-7.91**	-9.44*	-1.09	-9.91**	-3.34	-11.39	-15.67
2	AT-467 x AT-377	-12.87**	-5.34**	-1.97	-3.52	-14.06**	-7.79**	-2.78	-7.48
3	AT-467 x AT-305	-4.82**	-0.84	-1.36	-2.91	-2.92	7.69**	29.12**	22.88*
4	AT-467 x AT-490	-9.08**	2.95	4.92	11.29**	3.30	10.83**	-11.39	1.97
5	AT-467 x AT-338	-13.43**	-9.81**	4.42	8.98*	-14.34**	-8.10**	-0.30	-3.74
6	JND-3 x AT-377	5.77**	14.92**	-14.22**	-6.31	-9.03**	-13.36**	11.39	0.82
7	JND-3 x AT-305	8.76**	5.63**	-7.22*	1.33	-17.15**	-8.10**	21.31	9.81
8	JND-3 x AT-490	-1.68	11.33**	3.22	12.74**	-4.54**	-4.15	15.40	32.80**
9	JND-3 x AT-338	9.15**	4.79	-8.89*	-0.49	6.00**	0.96	0.88	-2.59
10	AT-377 x AT-305	-2.99	5.40**	9.23*	3.40	-15.33**	-6.07**	27.16*	10.98
11	AT-377 x AT-490	0.59	13.91**	2.29	8.50*	-10.58**	-10.22**	7.45	23.65*
12	AT-377 x AT-338	-13.03**	-5.51**	-7.91*	-3.88	1.53	-5.87**	-7.75	-10.92
13	AT-305 x AT-490	1.68	15.14**	4.00	10.32*	7.12**	18.83**	38.95**	59.89**
14	AT-305 x AT-338	6.74**	3.67	-7.33*	-3.28	-4.01	6.48**	14.94	10.98
15	AT-490 x AT-338	-15.32**	-4.11	-0.23	5.83	-2.72	-2.33	-24.82**	-13.49
	S.E.(d) ±	3.95	3.95	0.99	0.99	4.19	4.19	1.25	1.25

*, ** Significant at 5 percent and 1 percent levels of probability, respectively
BH = Heterobeltiosis and SH = Standard Heterosis

Sr. No	Crosses	1000 seed weight		Harvest index		Oil content		Protein content	
		BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)	BH (%)	SH (%)
1	AT-467 x JND-3	-10.46	-2.18	-12.45**	-9.56**	-2.07	-2.15	-6.73	-13.56*
2	AT-467 x AT-377	2.12	-1.20	12.97**	9.63**	-6.28**	0.58	-0.08	-4.16
3	AT-467 x AT-305	-3.72	-21.61*	1.06	10.94**	-6.77**	1.83	-1.44	3.87
4	AT-467 x AT-490	-2.00	-9.21	-3.62	-12.33**	-1.68	-3.23	9.57*	1.54
5	AT-467 x AT-338	15.16*	17.15*	6.88	13.87**	-4.80	-11.11**	-1.61	-8.82*
6	JND-3 x AT-377	-9.29	-0.91	-15.95**	-13.18**	5.50*	13.22**	-0.37	-4.43
7	JND-3 x AT-305	-7.33	1.24	-4.72	4.60	-4.20	4.63	-12.55*	-7.85
8	JND-3 x AT-490	-2.95	6.02	-7.15	-4.08	4.82	4.73	-1.31	-11.16*
9	JND-3 x AT-338	-17.16*	-9.50	-2.64	3.73	2.19	2.10	5.18	-2.96
10	AT-377 x AT-305	14.13	10.41	-6.21	2.96	4.31	13.93**	8.45*	14.28**
11	AT-377 x AT-490	19.68*	15.78*	-7.85	-10.57**	-3.56	3.49	-2.85	-6.81
12	AT-377 x AT-338	-0.86	0.85	12.42**	19.77**	-9.72**	-3.11	-0.88	-4.92
13	AT-305 x AT-490	23.29*	14.22*	-8.48	0.47	-2.36	6.64**	-11.78*	-7.04
14	AT-305 x AT-338	-14.49*	-13.02	-3.10	6.37	-14.78**	-6.92**	-10.77*	-5.97
15	AT-490 x AT-338	-1.73	-0.03	-17.69**	-12.31**	-0.77	-2.34	-4.02	-11.45*
	S.E.(d) ±	0.23	0.23	2.08	2.08	1.31	1.31	0.84	0.84

*, ** Significant at 5 percent and 1 percent levels of probability, respectively
BH = Heterobeltiosis and SH = Standard Heterosis

Conclusion

A marked degree of heterobeltiosis diverse from cross to cross. In order to see whether similar situation exists in sesame or not, a comparison of four most useful standard heterotic crosses for seed yield per plant was made with other yield related traits and found that the hybrid AT-305 x AT-490 ranked first by expressing the highest standard heterosis followed by JND-3 x AT-490, AT-377 x AT-490 and AT-467 x AT-305. They also showing significant and desirable standard heterosis for seed yield per plant also exhibited significant and desirable heterosis for other traits like branches per plant, capsules per plant, capsules length, seeds per capsule, 1000 seeds weight, oil content, plant height, days to 50% flowering and harvest index. Therefore, the selection of these hybrids either on the basis of *per se* performance or on the basis of standard heterosis for sesame improvement would be reliable in future.

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