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Research Note

Heterosis for seed yield and its components in sesame (*Sesamum indicum* L.)

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Abstract
A study was conducted in sesame to assess the extent of heterosis for fifteen quantitative traits including seed yield per plant. Twelve lines and three testers were crossed in a line x tester fashion to develop 48 F_1 hybrids. The analysis of variance revealed highly significant differences among the parents and hybrids for all the characters, indicating the presence of sufficient amount of genetic diversity for all traits studied. Heterosis was worked-out over better parent and standard variety, G.Til-4. The standard heterosis for seed yield per plant ranged from -12.32 to 137.39 %. The crosses NIC-75 x G.Til-10, IC-81564 x G.Til-10, NIC-75 x G.Til-4, AT-238 x G.Til-10 and Borda-1 x G.Til-10 were good heterotic combinations for seed yield per plant, which recorded 137.39, 128.74, 111.34, 100.42 and 90.84 % standard heterosis, respectively. The heterosis for seed yield per plant was associated with the heterosis expressed by its component characters.

Key words
Sesame, heterobeltiosis, standard heterosis

Sesame (*Sesamum indicum* L.) is one of the most ancient and important oilseed crops and its seed contains 50 % oil and 25 % protein. It is sixth most important oil seed crop in India and has 19.01 lakh ha area with 8.10 lakh tones production and productivity of 426 kg/ha. The yield improvement achieved through conventional hybridization followed by selection has been only marginal. Although sesame is largely a self pollinated crop, high level of heterosis for yield and its components has been reported by Fatteh *et al*. (1995), Padmavathi, (1998), Jadhav and Mohrir, (2013). But, the commercial exploitation of this phenomenon is feasible only if the means of producing hybrid seeds economically could be made available. Further, with convincing reports on availability of heterosis and possibility of commercial hybrids, generation of cytoplasmic male sterility system in sesame using the possible wild donors can enable the production of hybrids. The sesame plant has distinct features favourable for hybrid seed production. Heterosis of small amount for individual yield contributing characters may have an additive or synergistic effect on the end product (Sasikumar and Sardana, 1990). Therefore, the present study was undertaken to study the extent of heterosis for quantitative traits in sesame.

The present study on sesame was conducted at Department of Genetics and Plant Breeding, Junagadh Agricultural University, Junagadh, Gujarat. Twelve diverse lines *viz.,* IC-205314, IC-43063, IC-81564, IC-204983, AT-164, AT-238, AT-115, Borda-1, Patan-64, TNAU-12, Keriya-2, NIC-75 and three testers *viz.,* G.Til-3, G.Til-4 and G.Til-10 were crossed in a line x tester design during summer 2012 to produce 36 hybrids. The resulting 36 hybrids along with 15 parents and a check variety, G.Til-4 were evaluated during *kharif* 2012 in a Randomized Block Design with three replications. Each plot with a spacing of 45 x 15 cm^2 consisted of single row of 3 m length. All need based agronomic practices were followed during the crop growth period to raise a good crop. Observations were recorded on randomly selected five plants in each entry for 15 quantitative traits including seed yield per plant for each replication. The mean values were used for the analysis of variance for experimental design. The estimation of heterosis over better parent and standard check was carried-out as per the standard procedure.

Analysis of variance (Table 1) showed highly significant differences among the genotypes for all the characters, indicating the presence of sufficient variability in the experimental material for the traits. Differences amongst the hybrids and parents were also found highly significant for all characters under investigation. The difference between parents and hybrids were significant for all the characters except for days to 50 % flowering, number of branches per plant, number of internodes per plant, oil content and protein content. This indicated that with exception of few traits heterosis could be exploited for most of the traits. Similar results were reported by Thiyagu *et al*. (2007) and Jadhav and Mohrir (2013) for most of the characters except days to 50 % flowering, days to maturity and seeds per capsules.

The details on range of heterobeltiosis and standard heterosis as well as number of hybrids having significant heterosis are presented in Table 2. The extent of heterosis for days to 50 % flowering varied from -12.21 to 20.61% where five crosses exceeded the standard parent in desirable direction. Only two crosses surpassed the standard parent for days to maturity in which heterosis ranged from -8.05 to 13.33 %. These findings are in consonance with Krishnaiah *et al*. (2002). The crosses AT-164 x G.Til-4 and Keriya-2 x G.Til-4 could be exploited for this trait.

The characters contributing towards vegetative growth such as plant height, number of branches per plant and number of internodes per plant exhibited heterosis upto 54.28, 177.27 and 42.12%, respectively. The results are in concurrence with the findings of Jadhav and Mohrir (2013). A desirable degree of vegetative growth is essential for realizing high yield as total dry matter production is one of the components deciding high seed yield in crop plants. Out of 36 crosses, 10, 6 and 2 crosses showed significant positive standard heterosis for the characters length of capsule, width of capsule and number of capsules per leaf axil, in which heterosis ranged from -21.28 to 18.53, -20.26 to 20.87 and -62.50 to 20.59%. Similar results have been reported by Jadhav and Mohrir (2013). A total of 13 hybrids for 1000-seed weight, 18 hybrids for protein content and 23 hybrids for number of capsules per plant showed significant positive standard heterosis. Similar results have been reported for this characters by Fatteh *et al.* (1995) and Jadhav and Mohrir (2013).

The hybrid vigour for seed yield per plant varied from -21.58 to 137.39 %. A total of 24 hybrids registered significant standard heterosis for seed yield per plant. The highest value of heterosis was displayed by the cross NIC-75 x G.Til-10. Heterosis for seed yield has been reported earlier by Sasikumar and Sardana (1990), Padmavathi (1998), Singh *et al.* (2005), Banerjee and Kole, (2010) and Jadhav and Mohrir (2013).

The crosses which showed high heterosis for seed yield per plant also had high heterosis for number of capsules per plant, number of branches per plant, plant height, number of internodes per plant, length of capsule and number of seeds per capsule. The results thus, revealed that the heterosis for seed yield per plant was associated with the heterosis expressed by its component characters (Table 3). Such a situation of combinational heterosis has been reported in sesame by Singh *et al.* (2005), Thiyagu *et al.* (2007), Khan *et al.* (2009) and Banerjee and Kole, (2010). The crosses IC-81564 x G.Til-10 and NIC-75 x G.Til-4 showed desirable heterosis for seed yield per plant along with other traits *viz*., plant height, number of branches per plant, number of internodes per plant, number of capsules per plant and number of seeds per capsule, while AT-238 x G.Til-10 showed desirable heterosis for seed yield per plant along with plant height, number of branches per plant, length of capsule, number of capsules per plant and number of seeds per capsule. Three crosses *viz*., IC-43063 x G.Til-10, IC-205314 x G.Til-10 and IC-204983 x G.Til-10 showed desirable heterosis for seed yield per plant along with plant height, number of branches per plant, number of internodes per plant, number of capsules per plant and number of seeds per capsule. Therefore, these cross combinations *viz*., IC-81564 x G.Til-10, NIC-75 x G.Til-4, AT-238 x G.Til-10, IC-43063 x G.Til-10, IC-205314 x G.Til-10 and IC-204983 x G.Til-10 may be tested in large scale trial to confirm the superiority for heterosis.

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Table 1. Analysis of variance for experiment design for different characters in sesame

Source	d.f	Days to 50% flowering	Days to maturity	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)
Replications	2	1.026	1.379	15.006	1.668	0.096	0.154	0.004	0.001
Genotypes	50	52.873**	57.364**	793.076**	343.233**	4.143**	63.687**	0.252**	0.014**
Parents	14	83.990**	66.041**	743.934**	318.781**	4.463**	51.414**	0.456**	0.017**
Hybrids	35	41.698**	53.810**	785.340**	346.974**	4.133**	70.305**	0.177**	0.012**
P. Vs H.	1	8.358	60.298**	1751.820**	554.612**	0.001	3.875	0.022*	0.046**
Error	100	3.566	4.426	28.496	8.138	0.061	2.362	0.005	0.001

Source	d.f.	Number of capsules per plant	Number of capsules per leaf axil	Number of seeds per capsule	1000-seed weight (g)	Oil content (%)	Protein content (%)	Seed yield per plant (g)
Replications	2	13.362	0.008	0.113	0.006	2.300	0.262	1.097
Genotypes	50	1512.039**	0.908**	105.650**	0.510**	10.411**	15.298**	66.570**
Parents	14	1157.152**	1.375**	147.264**	0.627**	16.364**	12.446**	29.026**
Hybrids	35	1526.734**	0.633**	64.842**	0.459**	8.033*	16.844**	67.680**
P. Vs H.	1	5966.109**	3.974**	951.330**	0.679**	10.298	1.132	553.330**
Error	100	11.648	0.008	15.103	0.005	4.711	0.914	1.756

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

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Table 2. Range of heterobeltiosis (H_1) and standard heterosis (H_2) as well as number of crosses with specific heterotic effects for various traits in sesame

Characters	Range of heterosis (%)						Number of crosses with significant heterosis			
	Heterobeltiosis H_1 (%)			Standard heterosis H_2 (%)			H_1 (%)		H_2 (%)	
							+Ve	-Ve	+Ve	-Ve
Days to 50% flowering	-5.51	to	20.61	-12.21	to	20.61	9	0	6	5
Days to maturity	-1.58	to	13.33	-8.05	to	10.73	17	0	14	2
Plant height (cm)	-30.01	to	18.15	-27.94	to	54.28	8	7	21	4
Height to first capsule (cm)	-39.71	to	112.14	-39.87	to	53.10	22	2	14	12
Number of branches per plant	-57.14	to	31.82	-65.91	to	177.27	5	27	15	7
Number of internodes per plant	-54.58	to	33.10	-54.58	to	42.12	7	20	16	12
Length of capsule (cm)	-21.28	to	18.53	-14.49	to	16.89	6	22	10	14
Width of capsule (cm)	-20.26	to	17.18	-14.96	to	20.87	4	23	6	13
Number of capsule per plant	-42.64	to	45.53	-24.89	to	181.11	10	12	23	2
Number of capsule per leaf axil	-62.50	to	20.59	-55.88	to	20.59	1	24	2	34
Number of seeds per capsule	-18.32	to	30.75	6.73	to	44.35	9	4	28	0
1000-seed weight (g)	-25.54	to	22.32	-27.55	to	19.02	10	19	13	13
Oil content (%)	-10.10	to	5.42	-11.61	to	4.65	0	1	0	2
Protein content (%)	-22.96	to	27.89	-15.06	to	45.02	6	16	18	2
Seed yield per plant (g)	-21.58	to	52.67	-12.32	to	137.39	14	4	24	0

+ve = Positive, -ve = Negative

Table 3. Comparative study of top ten standard heterotic crosses for seed yield per plant along with *per se* performance and their heterotic effects for component characters in sesame

Crosses	Seed yield per plant (g)	Plant height (cm)	Number of branches per plant	Number of internodes per plant	Length of capsule (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	*Per se* seed yield per plant (g)
NIC-75 x G.Til-10	137.39**	54.28**	177.27**	42.12**	1.32	181.11**	15.23	-12.18**	28.25
IC-81564 x G.Til-10	128.74**	46.06**	40.91**	30.40**	3.95	122.69**	30.08**	12.23**	27.22
NIC-75 x G.Til-4	111.34**	48.77**	56.82**	38.46**	9.94**	106.30**	33.11**	0.04	25.15
AT-238 x G.Til-10	100.42**	24.22**	31.82**	8.79	10.06**	91.07**	27.12**	3.60	23.85
Borda-1 x G.Til-10	90.84**	31.58**	77.27**	7.33	-4.43*	134.70**	14.12	-8.42**	22.71
IC-43063 x G.Til-10	87.45**	48.35**	38.64**	39.19**	0.36	120.79**	33.26**	-20.46**	22.31
IC-205314 x G.Til-10	84.62**	36.41**	75.00**	21.61**	-12.81**	130.01**	17.81*	-12.63**	21.97
Keriya-2 x G.Til-10	79.72**	0.76	31.82**	22.34**	-2.63	76.13**	25.28**	1.65	21.39
IC-204983 x G.Til-10	77.51**	28.45**	52.27**	25.27**	-8.98**	80.09**	21.21*	0.18	21.12
Borda-1 x G.Til-4	75.74**	16.77**	9.09	31.50**	0.72	34.26**	21.80*	-8.20**	20.91

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