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Heterosis and Inbreeding Depression Studies in Sesame (*Sesamum indium* L.)

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ABSTRACT

Ten F_1s, F_2s along with their parents of sesame were evaluated for nine characters *viz.,* days to 50% flowering, days to maturity, plant height, number of primary branches/plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant to estimate heterosis and inbreeding depression during *rabi* 2012 - 13 at Agricultural Research Station, Yallamanchili, Andhra Pradesh. Negative and desirable heterosis for plant height and days to maturity was observed in the crosses YLM 89 x YLM 100 and YLM 90 x YLM 100. While seed yield per plant showed positive significant heterosis in the crosses YLM 89 x YLM 100 and YLM 90 x YLM 100 while the crosses, YLM 95 x YLM 100 and YLM 93 x YLM 100 showed the least inbreeding depression for seed yield per plant, oil content indicating their usefulness in isolating the transgressive segregants for these traits. The yield contributing traits of remaining crosses showed varied levels of inbreeding depression.

Key words: *Heterosis, inbreeding depression and sesame*

Sesame (*Sesamum indicum* L.) commonly known as gingelly, is a member of the order *Tubiflorae* and family *Pedaliaceae*. Sesame oil quality is excellent with 50-53% of oil and 20-26% of protein, antioxidant called sesamol, vitamin E and amino acid methionine. Sesame is cultivated in an area of about 1.94 million hectares in India with a production of about 0.58 million tones (Ministry of Agriculture, 2013-14). In Andhra Pradesh it occupies an area of 0.09 million hectares with a production of about 0.2 million tonnes. The average productivity of sesame in Andhra Pradesh (222.2 kg/ha) is far less as compared to the Indian average of 303 kg/ha (Ministry of Agriculture, 2013-14) indicating the urgent need to enhance the productivity by evolving high yielding varieties.

In India, oil and yield productivity of sesame are low and the slow progress in improvement programmes is due to the arbitrary choice of parents and inadequate information about the nature of gene action in governing the traits. A thorough knowledge on genetic parameters along with the heterosis and inbreeding depression upon hybridization will provide the required basis for selecting systematic breeding strategy to improve yield/ oil potential of the genotypes. The magnitude of heterosis provides a basis for genetic diversity and acts as a guide in choosing desirable lines and cross combinations. Keeping this in view, the present investigation was planned with the objective to identify the cross combinations with desirable traits for their further exploitation.

MATERIAL AND METHODS

The present investigation was carried out with seven parents (Five females and two males), ten F_1s, 10 F_2s for heterosis and inbreeding depression for the traits *viz.,* days to 50% flowering, days to maturity, plant height, primary branches/ plant, capsules per plant, number of seeds per capsule, 1000 seed weight, oil content and seed yield per plant during *rabi* 2012-13 in randomized block design with three replications at Agricultural Research Station, Yelamanchili, Andhra Pradesh. The parents and F_1s were grown in single rows of 2 m length while, the F_2s were grown in 5 rows of 2 m length. The intra and inter row spacing was 10 cm x 20 cm. Recommended package of practices were followed to raise a good crop. The mean values were used for the statistical analysis. The data was

analysed statistically to compute the average heterosis, heterobeltiosis and inbreeding depression by using the following formulae.

$$\text{Relative heterosis} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

Where,

$$\overline{MP} = \frac{\overline{P_1} - \overline{P_2}}{2}$$

$$\text{Heterobeltiosis} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

Where,

$\overline{F_1}$ = Mean value of F_1

$\overline{MP}$ = Mean value of mid parent

$\overline{BP}$ = Mean value of better parent

$\overline{P_1}$ = Mean of first parent

$\overline{P_2}$ = Mean of second parent

$$\text{Inbreeding depression} = \frac{\overline{F_1} - \overline{F_2}}{\overline{F_1}} \times 100$$

$\overline{F_2}$ = Mean of F_2 progenies of the respective F_1

RESULTS AND DISCUSSION

The magnitude of heterosis in F_1s help to assess the ability of the genotypes to transmit the desirable characters to the F_1s upon hybridization. This facilitates in identification of genotypes that exhibit high amount of exploitable heterosis. In the present investigation, heterosis of F_1s over mid parent (relative heterosis) and better parent (heterobeltiosis) and its component characters were estimated using ten F_1s and by using the F_2 data inbreeding depression was calculated. The estimates of heterosis and inbreeding depression for seed yield and yield components for ten cross combinations are presented in Tables 1, 2 and 3.

Days to 50% flowering

Heterosis over better parent for this character ranged from -6.78 (YLM 89 x YLM 100) to -2.43 (YLM 96 x YLM 92) while relative heterosis ranged from -6.78 (YLM 89 x YLM 100) to -1.01 (YLM 96 x YLM 92). Inbreeding depression values varied from -4.94 (YLM 96 x YLM 100) to -0.11 (YLM 93 x YLM 100). Negative heterosis is a desirable feature for this character as it indicates the earliness of a genotype. The significant and maximum negative heterosis over mid parent and better parent was observed in the cross, YLM 89 x YLM 100 (-6.7 8; -.6.78). Similar results of significant negative heterosis over mid parent and better parent for this trait were reported by Sankar and Kumar (2001), Prajapati *et al.* (2006) and Gaikwad *et al.* (2009). The significant negative heterosis over mid parent and better parent coupled with negative inbreeding depression was observed in the crosses YLM 93 x YLM 92 (-4.63; -3.03; -2.04), YLM 89 x YLM 100 (-6.78, -6.78, -2.48), YLM 90 x YLM 100 (-6.66, -5.83, -4.78) and YLM 95 x YLM 100 (-5.40, -5.19, -3.32) indicating the presence of non additive gene action in the expression of this character which is desirable. Negative heterosis along with negative inbreeding depression was also reported by Sodani and Bhatnagar (1990).

Days to maturity

Negative heterosis for days to maturity is a desirable trait. The heterosis over better parent ranged from -4.31 (YLM 89 x YLM 100) to 2.55 (YLM 95 x YLM 100). The range of average heterosis varied from -3.89 (YLM 89 x YLM 100) to 3.21 (YLM 95 x YLM 100). Inbreeding depression values ranged from -2.46 (YLM 89 x YLM 92) to 1.76 (YLM 96 x YLM 92). Significant negative heterosis over better parent and mid parent was recorded by the crosses, YLM 89 x YLM 100 (-4.31, -3.89) and YLM 90 x YLM 100 (-3.40, -2.78) while the crosses, YLM 93 x YLM 92 (-1.73*) and YLM 95 x YLM 92 (-3.40), recorded significant negative heterosis over better parent. The cross, YLM 95 x YLM 100, recorded significant positive heterosis over better parent and mid parent (2.55 & 3.21). The inbreeding depression values were the lowest in the crosses YLM 89 x YLM 92 and YLM 93 x YLM 92 indicating these are useful for the isolation of short duration varieties. These results are in conformity with the results of Sasi Kumar and Sardana (1990). Negative heterosis and

negative inbreeding depression for this trait was also reported by Singh *et al.* (2007), Thiyagu *et al.* (2007) and Gaikwad *et al.* (2009).

Plant height (cm)

The trait, plant height, showed the heterosis over better parent in the range of -8.15 (YLM 90 x YLM 92) to 1.67 (YLM 89 x YLM 100) whereas average heterosis ranged from -7.71 (YLM 90 x YLM 92) to 2.98 (YLM 95 x YLM 100). The range of inbreeding depression was -2.22 (YLM 95 x YLM 92) to 0.23 (YLM 96 x YLM 92). The crosses, YLM 89 x YLM 92 (-5.56, -4.56), YLM 90 x YLM 92 (-8.15, -7.71) and YLM 95 x YLM 92 (-7.08,-4.68) recorded significant negative heterosis over better parent and mid parent, respectively. The inbreeding depression was the lowest in the crosses YLM 95 x YLM 92 and YLM 96 x YLM 100 indicating their usefulness in isolation of short statured lines in further generations. Similar results for significant negative heterosis over mid parent were reported by Padmavathi (1998) and Gaikwad *et al.* (2009). However significant positive heterosis for this character over better parent was also reported by Senthil Kumar *et al.* (2003) and Senthil Kumar and Ganeshan (2004) and Shekhat *et al.* (2008).

The crosses, YLM 89 x YLM 92, YLM 90 x YLM 92 and YLM 95 x YLM 92, recorded significant negative heterosis along with negative inbreeding depression indicating the usefulness of these cross combinations in generating dwarf genotypes.

Number of primary branches per plant

The range of heterobeltiosis was -46.15 (YLM 89 x YLM 100) to -27.47 (YLM 96 x YLM 92), average heterosis was -46.00 (YLM 89 x YLM 100) to -27.27 (YLM 96 x YLM 92) and inbreeding depression was zero (YLM 93 x YLM 100) to 9.24 (YLM 90 x YLM 100). All the crosses exhibited significant negative heterosis over better parent and mid parent along with positive inbreeding depression for this trait. The crosses, YLM 90 x YLM 100 and YLM 93 x YLM 100 manifested low levels of inbreeding depression indicating their use in further generations in isolating the highly heterotic lines for this trait. Similar results for significant negative heterosis over better parent were reported by Saravanan and Nadarajan (2002).

Number of capsules per plant

The range of heterobeltiosis and average heterosis were 4.06 and 5.67 (YLM 93 x YLM 92) to 28.11 and 28.14 (YLM 89 x YLM 100), respectively. The cross, YLM 95 x YLM 100, recorded the lowest inbreeding depression (-1.49) while the cross, YLM96 x YLM 100, recorded the maximum value (6.23) for inbreeding depression. All the crosses recorded significant positive heterosis over better parent except YLM 90 x YLM 92 and average heterosis coupled with positive inbreeding depression (except YLM 95 x YLM 100). The crosses, YLM 95 x YLM 100, YLM 93 x YLM 92 and YLM 89 x YLM 92, showed low levels of inbreeding depression indicating the isolation of heterotic types in further generations. Significant positive heterosis over better parent was also recorded by Senthil Kumar *et al.* (2003), Senthil Kumar and Ganesan (2004) and Shekhat *et al.* (2008).

Number of seeds per capsule

Heterobeltiosis ranged from 0.75 (YLM 89 x YLM 100) to -6.56 (YLM 96 x YLM 100) while average heterosis recorded -5.57 (YLM 93 x YLM 92) to 1.81 (YLM 89 x YLM 100). The range of inbreeding depression for this trait was -2.68 (YLM 96 x YLM 92) to 4.65 (YLM 89 x YLM 100). The cross, YLM 89 x YLM 100, recorded positive non significant heterosis over better parent and mid parent along with positive inbreeding depression. The crosses, YLM 96 x YLM 92, YLM 90 x YLM 92, YLM 90 x YLM 00 and YLM 96 x YLM 100, showed low levels of inbreeding depression indicating the isolation of heterotic types in further generations. These results over both mid and better parent were in conformity with the results of Prajapati *et al.* (2006).

1000 seed weight (g)

The cross, YLM 99 x YLM 92, recorded significant heterosis over better parent and mid parent (-14.77, -8.79). While the cross, YLM 89 x YLM 100, recorded the maximum heterosis over better parent and mid parent (-5.79, 2.44). The range of inbreeding depression was -3.77 (YLM 90 x YLM 100) to 3.30 (YLM 96 X YLM 92). The cross, YLM 89 x YLM 100, recorded positive average heterosis coupled with positive inbreeding depression. The crosses, YLM 90 x YLM 100, YLM 89 x YLM 100 and YLM 89 x YLM 92, showed low levels of inbreeding depression indicating the isolation of heterotic types in further generations. Similar results for positive heterosis was also reported by Prajapati *et al.* (2006)

Table 1. Heterobeltiosis, average heterosis and inbreeding depression for ten crosses for days to 50% flowering, days to maturity and plant height in sesame.

S.No	Crosses	Days to 50% flowering			Days to maturity			Plant Height		
		Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression
1.	YLM 89 x YLM 92	-3.16	-2.72	-3.00	-1.08	-1.08	-2.46	-5.56**	-4.56*	-1.14
2.	YLM 90 x YLM 92	-4.00	-2.70	-1.67	-2.55	-1.50	-0.06	-8.15**	-7.71**	-1.12
3.	YLM 93 x YLM 92	-4.63**	-3.03*	-2.04	-1.73*	-1.31	-1.97	-2.75	-2.13	-0.23
4.	YLM 95 x YLM 92	-2.70	-2.04	-1.66	-3.40*	-2.36	-0.87	-7.08*	-4.68*	-2.22
5.	YLM 96 x YLM 92	-2.43	-1.01	-0.68	1.06	2.25	1.76	-1.74	-1.11	0.23
6.	YLM 89 x YLM 100	-6.78**	-6.78**	-2.48	-4.31**	-3.89**	-0.61	1.67	2.08	-0.11
7.	YLM 90 x YLM 100	-6.66**	-5.83**	-4.78	-3.40**	-2.78**	-1.19	-2.39	-1.28	-0.85
8.	YLM 93 x YLM 100	-3.75	-2.57	-0.11	1.72	2.60*	-0.01	-1.84	-0.58	-1.41
9.	YLM 95 x YLM 100	-5.40*	-5.19*	-3.32	2.55*	3.21**	0.01	1.03	2.98	-0.19
10.	YLM 96 x YLM 100	-4.21	-3.24	-4.94	0.21	0.96	-1.29	-1.56	-0.28	-1.67

* and ** represents 5% and 1% level of significance, respectively.

Table 2. Heterobeltiosis, average heterosis and inbreeding depression for ten crosses for primary branches per plant, capsules per plant and seeds per capsule in sesame.

S.No	Crosses	No. of primary branches per plant			No. of Capsules per plant			No. of Seeds per capsule		
		Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression
1.	YLM 89 x YLM 92	-42.30**	-42.14**	0.95	7.16*	10.36**	0.75	-4.42	-3.54	0.62
2.	YLM 90 x YLM 92	-43.98**	-43.68**	1.46	4.99	7.41*	3.56	-4.99**	-4.59**	0.06
3.	YLM 93 x YLM 92	-45.90**	-45.60**	2.02	4.06	5.67*	0.46	-5.95*	-5.57*	0.47
4.	YLM 95 x YLM 92	-28.02**	-27.82**	3.81	6.63*	7.40*	4.76	-0.62	-0.28	1.61
5.	YLM 96 x YLM 92	-27.47**	-27.27**	0.75	15.68**	15.71**	4.08	-2.69	-1.98	-2.68
6.	YLM 89 x YLM 100	-46.15**	-46.00**	0.00	28.11**	28.14**	6.02	0.75	1.81	4.65
7.	YLM 90 x YLM 100	-34.97**	-34.61**	9.24	23.69**	24.57**	3.03	-3.72	-2.23	0.08
8.	YLM 93 x YLM 100	-42.62**	-42.30**	0.00	9.96**	11.58**	3.10	-0.48	1.07	3.62
9.	YLM 95 x YLM 100	-37.91**	-37.74**	6.19	7.21**	11.23**	-1.49	-2.44	-0.85	2.81
10.	YLM 96 x YLM 100	-40.65**	-40.49**	3.24	14.92**	18.36**	6.23	-6.56*	-4.04	0.49

* and ** represents 5% and 1% level of significance, respectively.

Table 3. Heterobeltiosis, average heterosis and inbreeding depression for ten crosses for 1000 seed weight, oil content and seeds yield per plant in sesame.

S.No	Crosses	1000 Seed weight			Oil Content			Seed Yield per plant		
		Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression	Hetero beltiosis	Average Heterosis	Inbreeding Depression
1.	YLM 89 x YLM 92	-14.53**	-7.01**	0.96	-7.52**	-5.15*	4.29	1.50	6.61	5.68
2.	YLM 90 x YLM 92	-14.77**	-8.79**	1.52	-3.51	-2.43	3.40	-6.52	-3.06	6.40
3.	YLM 93 x YLM 92	-11.93**	-6.11**	2.14	-7.58**	-5.18*	-0.11	-5.09	-3.13	1.42
4.	YLM 95 x YLM 92	-11.34**	-4.82**	2.13	-7.84**	-6.78**	5.70	1.88	2.57	5.29
5.	YLM 96 x YLM 92	-10.63**	-4.60**	3.30	-8.09**	-6.42*	5.25	10.88**	12.40**	4.27
6.	YLM 89 x YLM 100	-5.79	2.44	0.37	-7.62**	-5.88**	4.13	5.16	16.68**	4.73
7.	YLM 90 x YLM 100	-8.99**	-2.65	-3.77	-7.72**	-7.32**	3.54	9.06*	19.58**	5.57
8.	YLM 93 x YLM 100	-9.46**	-3.53	1.96	-9.61**	-7.87**	-0.69	-7.10*	0.33	6.64
9.	YLM 95 x YLM 100	-8.87**	-2.22	2.07	-8.07**	-7.64**	-5.29	-5.28	-0.27	-0.02
10.	YLM 96 x YLM 100	-8.04**	-1.89	2.70	-8.69**	-7.66**	-0.60	-3.90	3.13	5.52

* and ** represents 5% and 1% level of significance, respectively.

Oil content (%)

The lowest values for heterosis over better parent and mid parent were recorded by the cross, YLM 93 x YLM 100 (-9.61, -7.87) while the cross, YLM 90 x YLM 92, recorded the highest values over the better parent and mid parent (-3.51 and -2.43). The inbreeding depression values ranged from -5.29 (YLM 95 x YLM 100) to 5.70 (YLM 95 x YLM 92). All the crosses recorded significant negative heterosis over better parent and mid parent coupled with positive inbreeding depression (except YLM 93 x YLM 92, YLM 93 x YLM 100, YLM 95 x YLM 100, YLM 96 x YLM 100). The crosses, YLM 96 x YLM 100, YLM 93 x YLM 100 and YLM 93 x YLM 92, manifested the low levels of inbreeding depression indicating the isolation of heterotic types in further generations. However, contradictory results for positive heterosis over both the mid and better parents were reported by Prajapati *et al.* (2006).

Seed yield per plant (g)

The range of heterosis over better parent for seed yield per plant was -6.52 (YLM 90 x YLM 92) to 10.88 (YLM 96 xYLM 92) while the average heterosis range was -3.13 (YLM 90 x YLM 92) to 19.58 (YLM 90 x YLM 100). The range of inbreeding depression varied from -0.02 (YLM 95 x YLM 100) to 6.64 (YLM 93 x YLM 100). The crosses, YLM 96 x YLM 92 and YLM 90 x YLM 100, recorded significant positive heterosis over better parent and mid parent coupled with positive inbreeding depression. The crosses, YLM 93 x YLM 100 and YLM 93 x YLM 92, exhibited low levels of inbreeding depression indicating the isolation of heterotic types in further generations. Similar results for significant positive heterosis over better parent and mid parent were also reported by Prajapati *et al.* (2006) and Gaikwad *et al.* (2009).

Desirable heterosis for plant height and days to maturity (negative), seed yield per plant (positive) was recorded in the crosses YLM 89 x YLM 100 and YLM 90 x YLM 100 while the crosses, YLM 95 x YLM 100 and YLM 93 x YLM 100 showed the least inbreeding depression for seed yield per plant and oil content indicating their usefulness in isolating desirable transgressive segregants for these traits.

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