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GENETIC STUDIES FOR THE EXPLOITATION OF HETEROSIS IN SESAME (*Sesamum indicum* L.)

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SUMMARY

Heterosis breeding is a potential technique to improve yields in sesame. Twenty-four diverse sesame genotypes were used as male parents and highly adoptable 3 local varieties were used as female parents. Thirty-eight hybrids were produced during rabi, 2013 and were evaluated along with parents and 3 checks during summer, 2014 in Randomized Block Design at Regional Agricultural Research Station, Polasa, Jagtial, India. The data was recorded for 8 biometrical traits viz., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, capsule length and number of seeds per capsule, 1000-seed weight and seed yield per plant. In this study, highly significant differences were recorded among sesame hybrids for all the traits studied. Further, 2 hybrids Swethathil x VS 07-023 and Swethathil x JL SEL 05-3 had recorded highest standard heterosis of 13.40% and 10.70% respectively. The same hybrids recorded statistically significant superior seed yield per plant ie., 28.7 g and 28.0 g respectively. These potential crosses can be utilized for further breeding program to develop potential purelines.

Key words: Heterosis, heterobeltiosis, standard heterosis, *Sesamum indicum* L., yield and yield components, phenotypic and genotypic coefficients of variation

Key findings: Highly significant differences were recorded among 38 sesame hybrids for a wide range of traits: flowering, maturity, plant height, number of primary branches per plant, number of capsules per plant, capsule length and number of seeds per capsule, 1000-seed weight and seed yield per plant. Two hybrids Swetha x VS 07-023 and Swetha x JL SEL 05-3 recorded highest standard heterosis (13.4% and 10.7% respectively).

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INTRODUCTION

Sesame is highly nutritive, having medicinal value with high oil (38-54%) and protein content (18-25%). The present sesame varieties under cultivation have limited yield potential as most of the varieties evolved and released for cultivation are selections from local or closely related populations. In addition they lack resistance to biotic and abiotic stresses during the crop growth period, all these major causes attributed to low productivity potential of

cultivars grown in India. Although sesame is largely self-pollinated (20-30% cross pollination is through honeybees), high levels of heterosis have been reported for certain hybrid combinations from various countries. Success of hybrids is observed in several crops *viz.,* cotton, maize, sorghum and even in oil seed crops like sunflower and castor. Generally high levels of heterosis will be obtained when the parents of hybrids were from very divergent origins. Heterobeltiosis has been reported by Murthy (1975), Brar and Ahuja (1979), Murty (1979), Mazzani *et al.* (1981), Osman and Yermanos (1982), Yermanos (1984), Sharma (1985), Osman (1989), Zhan *et. al.* (1990), Reddy and Haripriya (1993), Tu (1993) and Quijada and Layrisse (1995). Based on the earlier reports of high heterosis in sesame, National crossing program for development of hybrid sesame was initiated in collaboration with Directorate of Oil seeds Research, Rajendranagar, Hyderabad, during 2013-14 with the objective of development and identification of superior experimental hybrids.

MATERIALS AND METHODS

The experiment was conducted during summer of 2013-14 at the Regional Agricultural Research Station, Polasa, Jagtial, Karimnagar district of Telangana state in India. To develop high yielding hybrids, about 24 sesame genotypes with diverse origin have been used as male parents and crossed to highly adoptable local varieties viz., Rajeshwari, JCS1020 and Swetha. Parents were sown during late *kharif,* 2013 and crosses were attempted by emasculating female parents (Rajeshwari, JCS1020 and Swetha) and pollinating with 24 male parental lines. All 61 entries, which include parents and hybrids, were evaluated at Regional Agricultural Research Station, Polasa, Jagtial in Randomized Block Design during *summer*, 2014. Three genotypes, TKG 22 (national check), Pragathi (zonal check) and Swetha (local check) were used as checks in the experiment. Each entry (61 entries) was sown in one row of 2 m length in 2 replications with a spacing of 30 cm between the rows and 10 cm between the plants. Twenty plants were maintained for each hybrid and parent in each replication. Recommended cultural practices were followed uniformly to all the hybrids. Observations were recorded in 10 randomly selected plants in each replication. The data recorded for 8 biometrical traits *viz*., days to 50% flowering, plant height, number of primary branches per plant, number of capsules per plant, capsule length and number of seeds per capsule, 1000-seed weight (g) and seed yield per plant (g).

Data analysis

Phenotypic and genotypic coefficients of variation were estimated according to the method suggested by Burton and de Vane (1953).

Seed yield was recorded in each entry and Heterosis over mid-parent, Heterobeltiosis over better parent and Standard heterosis over national check, zonal check and local check were calculated for seed yield per plant following Singh and Chaudhary (1979) (Table 1).

RESULTS

Variance components and coefficients of variation

Estimates of phenotypic (PCV) and genotypic (GCV) coefficients of variation are given in Table 2.

Table 1. Seed yield per plant (Singh and Chaudhary, 1979).

1. Heterosis (MP)	Mid parental value	= ((F1-MP)/MP) x 100
2. Heterobeltiosis (BP)	Better parental value	= ((F1-BP)/BP) x 100
3. Standard Heterosis	Swetha(LC)	= ((F1-LC)/LC) x 100
	TKG 22(NC)	= ((F1-NC)/NC) x 100
	Pragathi(ZC)	= ((F1-ZC)/ZC) x 100

Table 2. Estimates of range, mean, phenotypic and genotypic coefficients of variation of sesame hybrids evaluated during summer, 2014, RARS, Polasa, Jagtial.

Trait	Range	Mean	SE	PCV (%)	GCV (%)
Days to flowering	39.20 - 62.43	46.66	7.23	54.4	41.1
Plant height (cm)	38.6 - 145.06	68.52	5.57	63.5	48.4
Number of capsules per plant	73.28–162.53	111.21	2.59	62.9	44.1
Capsule length (cm)	2.36 - 3.43	2.86	1.44	42.4	34.2
Number of seeds per capsule	46.56 - 86.73	61.86	2.46	65.7	49.9
Number of branches per plant	2.30 - 6.83	5.6	0.76	51.6	49.0
1000 seed weight (g)	2.61 - 3.19	2.93	0.69	29.5	23.0
Seed yield per plant (g)	16.0 – 28.7	22.80	0.62	69.5	62.6

The genotypic coefficient of variation was ranged from 23.0% for 1000-seed weight to 62.6% for seed yield per plant. Similarly, the range for phenotypic coefficient of variation was from 29.5% for 1000-seed weight to 69.5% for seed yield per plant. In this study, the GCV values were lower than that of PCV values. The difference between PCV and GCV was medium for capsule length, number of branches per plant, 1000-seed weight (g) and seed yield per plant and high for all the eight characters namely days to flowering, plant height, number of capsules per plant, number of seeds per capsule.

Heterosis

For seed yield per plant (Table 3), 30 crosses exhibited positive heterosis, whereas 8 crosses showed negative heterosis over mid parent. Cross JCS 1020 x AT 213 (52%) followed by Swetha x US 07-023 (39%) exhibited highest heterosis values.

Heterobeltiosis

Twenty-one crosses exhibited positive heterosis, and 17 crosses showed negative heterosis over better parent. Crosses JCS 1020 x AT 213 (46.2%) and JCS 1020 x TKG-22 (27.6%) exhibited highest values.

Standard Heterosis

Twenty-two crosses exhibited positive heterosis, whereas 16 crosses showed negative heterosis over national check, TKG 22. Cross Swetha x VS 07-023 (32.8%) and Swetha x JL SEL 05-3 (29.6%) exhibited highest values. Similarly, 35 crosses exhibited positive heterosis, whereas 3 crosses showed negative heterosis over zonal check Pragathi. Cross Swetha x VS 07-023 (57.6%) and Swetha x JL SEL 05-3 (53.8%) exhibited highest values. While, 10 crosses exhibited positive heterosis and 28 crosses showed negative heterosis over local check Swetha. Cross Swetha x VS 07-023 (13.4%) and Swetha x JL SEL 05-3 (10.7%) exhibited highest values.

Overall, 10 crosses produced higher seed yield per plant compared to the checks during summer, 2014. Out of these, Swetha x VS 07-023 (Figure 1) had maximum seed yield per plant (28.7 g) and heterosis values of 39% and 13.4% over mid and better parent, 32.8%, 57.6% and 13.4% over standard national (TKG 22), zonal (Pragathi) and local (Swetha) checks respectively. Further, this was followed by the cross, Swetha x JL SEL 05-3 (Figure 2) had maximum seed yield per plant (28.0 g) and heterosis values of 35.6% and 10.7% over mid and better parent, 29.6%, 53.8% and 10.7% over national (TKG 22), zonal (Pragathi) and local (Swetha) checks respectively. Similarly, among top 10 crosses, Swetha x Madhavi (27.9 g), Rajeswari x JCS 1020 (27.6 g), Rajeswari x AT 213 (27.2 g), Rajeswari x MT 10-81 (27.0 g), Rajeswari x LT 8 (26.5 g), JCS 1020 x AT 213 (26.0 g), Rajeswari x Nanabhanadra (25.5 g) and Rajeswari x JL SEL 05-3 (25.5 g) recorded the highest seed yield over high yielding check (local) Swetha (25.3 g).

Table 3. Evaluation of Sesame Hybrids with seed yield per plant (g) for Heterosis (MP), Heterobeltiosis (BP) and Standard heterosis (SC) during summer, 2014, RARS, Jagtial.

Pedigree	Seed yield/plant (g)			Heterosis	Heterobeltiosis	Standard heterosis		
	Hybrid	Parent 1 (F)	Parent 2 (M)			TKG 22 (NC)	Pragathi (ZC)	Swetha (LC)
Rajeshwari x JCS 1020	27.6	23.2	19.6	29.0	19.0	27.7	51.6	9.1
RajeshwarixNanabhanadra	25.5	23.2	20.5	16.7	9.9	18.0	40.1	0.8
Rajeshwari x AT 213	27.2	23.2	21.2	22.5	17.2	25.9	49.4	7.5
Rajeshwari x LT 8	26.5	23.2	18	28.6	14.2	22.6	45.6	4.7
Rajeshwari x HAVERI	22.0	23.2	17.5	8.1	-5.2	1.8	20.8	-13.0
Rajeshwari x CST 2008-2	22.0	23.2	18.5	5.5	-5.2	1.8	20.8	-13.0
Rajeshwari x JL SEL 05-3	25.5	23.2	16	30.1	9.9	18.0	40.1	0.8
Rajeswhari x Nes.selection	24.5	23.2	14	31.7	5.6	13.4	34.6	-3.0
Rajeshwari x TKG 87	21.5	23.2	16.5	8.3	-7.3	-0.4	18.1	-15.0
Rajeshwari x Prachi	20.0	23.2	16	2.0	-13.8	-7.4	9.8	-20.9
Rajeshwari x MT 10-81	27.0	23.2	20	34.3	25.0	25.0	48.3	6.7
Rajeshwari x DS-30	24.5	23.2	18	18.9	5.6	13.4	34.6	-3.2
Rajeshwari x YLM-17	19.0	23.2	12	8.0	-18.1	-12.0	4.4	-24.9
Rajeshwari x TKG-22	21.0	23.2	21.6	1.9	-9.5	-2.7	15.3	-17.0
Rajeshwari x VS 07-023	24.5	23.2	16	25.0	5.6	13.4	34.6	-3.2
Rajeshwari x JLS 408-2	24.0	23.2	15	25.7	3.4	11.1	31.8	-5.1
Rajeshwari x RT 125	22.0	23.2	14	18.3	-5.2	1.8	20.8	-13.0
Rajeshwari x Nirmala	21.0	23.2	16.5	5.8	-9.5	-2.7	15.3	-17.0
Rajeshwari x Madhavi	20.5	23.2	16.5	3.3	-11.6	-5.0	12.6	-19.0
Rajeshwari x Chandana	20.4	23.2	19.6	-4.7	-12.1	-5.5	12.0	-19.4
JCS 1020xNanaBhanadra	23.3	19.6	20.5	16.2	13.7	7.8	28.0	-7.9
JCS 1020 x AT 213	26.0	19.6	21.2	52.0	46.2	20.3	42.8	2.8
JCS 1020 x HAVERI	24.8	19.6	17.5	33.7	26.5	14.8	36.2	-2.0
JCS 1020 x CST 2008-2	19.5	19.6	18.5	2.4	-0.5	-9.7	7.1	-22.9
JCS 1020 x JL SEL 05-3	17.0	19.6	16	-4.5	-13.3	-21.3	-6.5	-32.8
JCS 1020 x Nes.selection	18.6	19.6	14	10.7	-5.1	-13.8	2.2	-26.5
JCS 1020 x MT 10-81	21.3	19.6	20	7.6	6.5	-1.3	17.0	-15.8
JCS 1020 x DS-30	23.0	19.6	18	22.3	17.3	6.4	26.3	-9.1
JCS 1020 x TKG-22	25.0	19.6	21.6	33.0	27.6	15.7	37.3	-1.2
JCS 1020 x VS 07-023	24.0	19.6	16	34.8	22.4	11.1	31.8	-5.1
JCS 1020 x JLS 408-2	16.5	19.6	15	-4.6	-15.8	-23.6	-9.3	-34.8
JCS 1020 x DS 10	21.3	19.6	13.5	28.7	8.7	-1.3	17.0	-15.8
Swetha x LT 8	18.6	25.3	18	-14.1	-26.5	-13.8	2.2	-26.5
Swetha x JL SEL 05-3	28.0	25.3	16	35.6	10.7	29.6	53.8	10.7
Swetha x YLM-17	16.0	25.3	12	-14.2	-36.8	-25.9	-12.0	-36.8
Swetha x VS 07-023	28.7	25.3	16	39.0	13.4	32.8	57.6	13.4
Swetha x Madhavi	27.9	25.3	16.5	38.3	14.2	29.1	53.3	10.3
Swetha x CST 2008-2	21.0	25.3	18.5	-4.1	-17.0	-2.7	15.3	-17.0

Figure 1 & 2. Superior hybrids in evaluation of sesame hybrids with seed yield per plant (g) for Heterosis (MP), Heterobeltiosis (BP) and Standard heterosis (SC) during summer, 2014, RARS, Jagtial, India.

Cross 1: Swetha x VS 07-023

Cross 2: Swetha x JL SEL 05-3

DISCUSSION

To achieve higher yields in sesame, exploitation of heterosis is the most practical and achievable option. 38 hybrids were developed by using 24 male lines and 3 adoptable in *rabi,* 2013 as part of National crossing program on hybrid sesame development was initiated during 2013-14 in collaboration with Directorate of Oilseeds Research, Rajendranagar, Hyderabad, India. All the 38 hybrids and 23 parental lines were evaluated during summer, 2014. In this study, both genotypic and phenotypic coefficients of variance, heterosis, heterobeltiosis and standard heterosis were estimated.

The GCV values were lower than that of PCV, indicating that the environment had an important role in the expression of these characters. Generally, quantitative characters or agronomic traits are highly influenced by environment. Similarly, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) values greater than 20% are regarded as high, whereas values less than 10% are considered to be low and values between 10 and 20% to be medium (Deshmukh *et al*.,1986). Based on this delineation, all the 8 characters had high genotypic (GCV) and phenotypic (PCV) coefficients of variation. This finding indicates that, selection may be effective based on these characters and their phenotypic expression would be a good indication of genetic potential. There is large scope for selection based on these characters and the diversity in genotypes provides huge potential for future breeding program. Similar finding was reported by Sumathi and Muralidharan (2010) for number of primary branches per plant and seed yield. Arameshwarappa *et al*. (2009) reported similar results considering number of capsules per plant, number of primary branches per plant and number of seeds per capsule, where high PCV and GCV values were recorded except for number of capsules/plant that had medium GCV. Solanki and Gupta (2003) and Saravanan and Nandarajan (2003) recorded the highest coefficient of variation for number of capsules per plant and branches per plant. Furthermore, Vasline *et al*. (2000) also reported that high coefficient of variation for number of capsules per plant.

Medium to high difference between PCV and GCV was recorded for all the 8 characters. Higher difference between PCV and GCV shows high influence of the environment on the characters whereas low difference shows

low influence of the environment on the characters. Similar results were also by Arameshwarappa *et al*. (2009).

In heterosis breeding, choice of suitable parents is an important criteria in the exploitation of hybrid vigour. Therefore, heterosis (mid parent), heterobeltiosis (better parent) and standard heterosis (standard checks) were estimated. Sesame is highly localized, adoptability of varieties and hybrids is highly variable. Compared to heterosis and heterobeltiosis, standard heterosisis reliable criteria due to performance of the hybrid will be superior over best check/popular variety.

Among 38 hybrids, 22, 35 and 10 hybrids recorded positive standard heterosisfor seed yield per plant over checks, TKG 22, Pragathi and Swetha respectively. Out of all these, Swetha x VS 07 -023 (13.40%) and Swetha x JL SEL 05-3 (10.70%) recorded highest standard heterosis over local checks Swetha. Further, another eight hybrids Swetha x Madhavi (10.30%), Rajeswari x JCS 1020 (9.10%), Rajeswari x AT 213 (7.50%), Rajeswari x MT 10-81 (6.70 %), Rajeswari x LT 8 (4.70 %), JCS 1020 x AT 213 (2.80%), Rajeswari x Nanabhanadra (0.80% g) and Rajeswari x JL SEL 05-3 (0.80%) recorded positive heterosisover standard local check, Swetha.

Therefore, more emphasis should be given to these 10 crosses for development of varieties with high seed yield per plant. The average heterotic effects over mid, better parents and standard checks (TKG 22, Pragathi, Swetha) were also positive with high values of 16.63%, 2.90%, 5.59% and 25.32% respectively. These results are in agreement with the findings of Sankar and Kumar (2001), Kumar *et al.* (2003), Bhyan and Sarma (2003), Singh *et al*. (2005) and Yadav *et al.* (2005) were reported positive heterosis for seed yield in sesame. Therefore it is summarized that, all the parents used in these crosses have the potential to be used in breeding program. However, 2 crosses viz. Swetha x VS 07-023 and Swetha x JL SEL 05-3 could be considered as elite crosses. Keeping these points in view, these 2 crosses seems to have got the potential to be utilized in selection program. Thus, respective parents of these 2 crosses could be utilized in breeding program for developing future commercial hybrids of sesame.

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