Original Research Article

Study on heterosis for grain yield and component characters in Sesame (*Sesamum indicum* L.)

Abstract

A study on the extent of relative heterosis, heterobeltiosis and standard heterosis was performed in eight cross combinations for important yield attributing traits in sesame. The analysis showed significant differences between the genotypes for all the characters studied. The hybrids showed Relative/ Mid parental heterosis ranging from 2.02 to 26.05; heterobeltiosis from -4.55 to 15.85 and standard heterosis from -11.27 to 15.85 for grain yield /ha. For the yield contributing traits like no. of capsules/plant and no. of branches / plant, the relative heterosis varied from 8.51 to 70.79 and from 15.11 to 96.95; heterobeltiosis ranged from -9.95 to 60.0 and from 5.48 to 63.29 and standard heterosis differed from -8.05 to 60.0 and from -2.53 and 63.29 respectively. Mid Parental Heterosis (RH) was found to be positive and significant for the characters no. of branches/plant, no. of capsules / plant, grain yield (kg/ha) in all the hybrid combinations except VRI (Sv) 2 / Prachi. Based on heterobeltiosis, the hybrids TMV 7 / E 8, TMV 7 / DSS 9, TMV 7 / DS 5, VRI 2 / DS 5 could be selected since they showed significance for important yield contributing characters *viz*., no. of branches / plant, no. of capsules /plant and grain yield. With regards to the Standard heterosis for grain yield characters like no. of branches/plant, no. of capsules/plant and grain yield/ha the hybrids *viz*., TMV 7 / E 8, TMV 7 / DS 5 and TMV 7 / DSS 9 showed positive and significant heterosis. Considering all the three types of heterosis, the hybrids TMV 7 / E 8, TMV 7 / DS 5 and TMV 7 / DSS 9 may be selected for yield enhancement in Sesame.

Key words: Relative Heterosis, Heterobeltiosis, Standard Heterosis, Sesame, Yield.

Introduction

Sesame is described as the “Queen of oilseeds” due to its high oil content (38-54%), protein (18-25%), calcium, phosphorus, oxalic acid and excellent qualities of seed oil and meal (Prasad, 2002). *Sesamum* oil has long shelf life due to the presence of lignans (sesamin, sesamolin and sesaminol), which have remarkable antioxidant function (Gauthaman and Saleem, 2009). Whole sesame seeds are rich source of mammalian lignin precursors (sesamin, sesamolin

UNDER PEER REVIEW

and sesaminol) and have been suggested to have potential anticancer effects (Coulman *et al*., 2005). Sesame oil, is also used as a solvent, oleaginous vehicle for drugs, skin softener, and used in the manufacture of margarine and soap (Morris, 2002). It is resistant to drought, short in maturity duration and suitable for wide range of cropping systems. Sesame seed is an important source of edible oil and is also widely used as a spice because of its ease of extraction and its great stability. In India sesame occupies a place of prominence among oilseeds.

The annual area put under Sesame in India is about 2.3million hectares (13.1 % per cent of the world hectarage) and the total production is nearly 81lakh tonnes (Agricultural Statistics at a glance,2021). India ranks third in sesame production and second in area after Sudan in the world with productivity of 502 kg/ha (https://aicrp.icar.gov.in/sesame/about-us/). Though the progress achieved in sesame in terms of cultivated area and production is quite high, its productivity in India is the lowest when compared to the world average. The major constraints identified for most of the countries including India are, instability in yield, lack of wider adaptability, drought, non synchronous maturity *etc*. There are few studies on the genetics of sesame as well as on the improvement of genetic variation and root system. In-depth research on sesame is still necessary to further increase the yield and quality of sesame and to improve the related traits of sesame (Wei *et al*., 2022). Heterosis breeding is a potential technique to improve yields in sesame (Nayak *et al*., 2017). Hybrid vigor in sesamum even a small magnitude for individual component, have additive or synergistic effects on end product (Sasikumar and Sardana, 1990). The magnitude of heterosis provides a basis for genetic diversity and a guide to the choice of parents for developing superior F_1 hybrids, so as to exploit hybrid vigour and/or for building better gene pools to be employed in population improvement (Jatothu *et al.,* 2013). Besides, heterotic crosses may be amenable for selection of high yielding transgressive segregants in F_2 and follow up selfing generations (Tripathy *et. al.,* 2016). Hence the present investigation was undertaken to study the extent of heterosis present in select sesame hybrids developed for yield enhancement.

Materials and Methods

The present investigation is carried out in the Research farm at Oilseeds Research Station, Tindivanam during Summer, 2020. The experimental material included eight hybrids evolved by crossing two female and 4 male parents in line x tester fashion. The female parents taken for the

UNDER PEER REVIEW

study were the high yielding varieties developed by TNAU *viz*., TMV (Sv) 7 and VRI (Sv) 2 while the male parents were E8, DSS 9, DS 5 and Prachi which showed good general combining ability with the female parents selected from the All India Coordinated Reseach trials. The crosses were performed in L x T fashion during Rabi and Summer, 2019 giving suitable isolation distance. The resultant eight hybrids along with the 6 parents were raised in a Randomized Block Design replicated thrice in plot size of 4 x 3 m. All the package of practices was followed to raise a good crop. Observations on days to 50% flowering (days), plant height (cm), No. of branches/plant (No.) and No. of capsules/plant (No.) were recorded in 10 plants selected at random per replication in each cross and parent. The plot yield (kg/plot) of the hybrids and the parents recorded in each replication was converted to per hectare yield (kg/ha). The mean of characters were utilized for L x T statistical analysis as per Kempthorne (1957). For working of standard heterosis, the cosmopolitan high yielding variety released by TNAU in 2009 *viz*., TMV (Sv) 7 was utilized.

Results and Discussion

The analysis of variance for different characters showed significant differences between the genotypes for all the characters studied (Table 1). The heterosis observed over the Mid parent (Relative heterosis), better parent (heterobeltiosis) and standard parent (standard heterosis) was tabulated in Table 2.

Relative/Mid parental heterosis ranged from -1.59 (VRI (Sv) 2 / Prachi) to 14.92 (VRI (Sv) 2 / DSS 9) in days to 50% flowering; from -5.49 (TMV 7 / Prachi) to 17.43 (VRI (Sv) 2 / Prachi) in plant height; 15.11 (VRI (Sv) 2 / Prachi) to 96.95 (TMV 7 / DSS 9) in no. of branches / plant; 8.51 (VRI (Sv) 2 / Prachi) to 70.79 (TMV 7 / E8) in no. of capsules/plant and from 2.02 (VRI (Sv) 2 / Prachi) to 26.05 (TMV 7 / E8) in grain yield. Heterobeltiosis ranged between -4.12 (VRI (Sv) 2 / Prachi) and 7.22 (VRI (Sv) 2 / DSS 9) for days to 50% flowering, -5.47 (TMV 7 / Prachi) and 17.43 (VRI (Sv) 2 / Prachi) for plant height, 5.48 (VRI (Sv) 2 / DSS 9) and 63.29 (TMV 7 / DSS 9) for No. of branches/plant, -9.95 (VRI (Sv) 2 / Prachi) and 60.0 (TMV 7 / E8) for no. of capsules/plant and between -4.55 (VRI (Sv) 2 / Prachi) and 15.85 (TMV 7 / E8) in grain yield / ha. Wide range of relative heterosis and heterobeltiosis also existed in the study conducted by Rajput *et al.* 2017 for yield, no. of capsules /plant, no. of branches and no. of seeds/capsule.

UNDER PEER REVIEW

Standard heterosis varied between -6.06 (VRI (Sv) 2 / Prachi) and 6.06 (TMV 7 / DSS 9) in days to 50% flowering, -5.49 (TMV 7 / Prachi and VRI (Sv) 2 / DSS 9) and 6.11 (TMV 7 / E 8) in plant height, -2.53 (VRI (Sv) 2 / DSS 9) and 63.29 (TMV 7 / DSS 9) in no. of branches / plant, -8.05 (VRI (Sv) 2 / Prachi) and 60.0 (TMV 7 / E 8) in no. of capsules / plant and between -11.27 (VRI (Sv) 2 / Prachi) and 15.85 (TMV 7 / E 8) in yield / ha. Significant standard heterosis has been reported for days to 50% flowering, plant height, no. of branches/plant, no. of capsules/plant and grain yield by Virani *et. al.* 2017 and Shekawat *et al.* 2014.

Earliness is preferred for varieties and hybrids in general in sesame. Hence for the character days to 50% flowering alone negative heterosis is considered and for all other characters positive heterosis is considered for selection of hybrids. For days to 50% flowering none of the hybrids showed negatively significant heterosis in all the three forms *viz*., Relative heterosis, heterobeltiosis and standard heterosis. Hence, none of the hybrids can be selected for days to 50% flowering with negative heterotic values.

In the present study, positively significant heterosis is exhibited in several hybrids for yield attributing characters. Mid Parental Heterosis (RH) was found to be positive and significant for the characters no. of branches/plant, no. of capsules / plant, grain yield (kg/ha) in all the hybrid combinations except VRI (Sv) 2 / Prachi. For plant height, all hybrids except TMV (Sv) 7 / Prachi and TMV (Sv) 7 /DS 5 showed significant relative heterosis. Significant positive relative heterosis was noticed in eleven out of forty five crosses for no. of primary and secondary branches/ plant, no. of capsules/plant, no. of seeds/ capsule and single plant yield in the study conducted by Meenakumari and Ganesamurthy (2017). This indicates that the cross combinations were heterotic for the yield characters and shows good scope for utilization as commercial hybrids as well as in varietal improvement.

Heterobeltiosis / better parental heterosis was positive and significant for the character plant height in hybrids TMV 7 / E8, VRI 2 / DSS 9, VRI 2 / DS 5 and VRI 2 / Prachi; for no. of branches / plant and grain yield in cross combinations *viz*., TMV 7 / E8, TMV 7 / DSS 9, TMV 7 / DS 5, VRI 2 / E 8 and VRI 2 / DS 5 while hybrids TMV 7 / E 8, TMV 7 / DSS 9, TMV 7 / DS 5 and VRI 2 / DS 5 showed positive and significant heterobeltiosis for no. of capsules / plant. Better parental heterosis is considered for selection of hybrids in many cases as this may benefit for yield improvement if the cross combination is for improvement of specific characters.

UNDER PEER REVIEW

Monpara and Pawar (2016) also reported significant and positive heterobeltiosis in eight cross combinations for yield attributing traits like primary branches/plant, capsules/plant, seeds/capsule, seed yield and harvest index in sesame.

Accordingly the hybrids TMV 7 / E 8, TMV 7 / DSS 9, TMV 7 / DS 5, VRI 2 / DS 5 could be selected since they showed significant heterobeltiosis for important yield contributing characters *viz*., no. of branches / plant, no. of capsules /plant and grain yield.

Standard heterosis is generally considered for varietal improvement as this is economically useful to the farmers and the commercial success of the new variety depends on the yield advantage of this variety over the ruling variety. Kadambavana sundaram (1980) suggested that heterotic expression over standard variety should be given due importance for exploitation of commercial hybrid. Considering the standard heterosis for plant height, only one hybrid TMV 7 / E 8 could be adjudged as the best hybrid showing significant heterosis. For grain yield characters like no. of branches/plant, no. of capsules/plant and grain yield/ha the hybrids *viz*., TMV 7 / E 8, TMV 7 / DS 5 and TMV 7 / DSS 9 are showing significant heterosis compared to other hybrids and hence can be utilized for exploitation of commercial heterosis. Saravanan and Nadarajan (2002) reported high Standard heterosis for no. of primary branches/plant, no. of capsules/plant, 1000 seed weight and single plant yield in sesame. High standard heterosis has been recorded in five cross combination over the standard parent by Chaudhari *et. al.* 2017.

Considering all the three types of heterosis, the cross combination VRI (Sv) 2 / Prachi is found to exhibit lowest values of relative heterosis, heterobeltiosis and Standard heterosis for economically important characters *viz*., no. of capsules/plant and grain yield/ha while the cross combination TMV 7 / E 8 exhibited highest relative heterosis, heterobeltiosis and Standard heterosis for the characters *viz*., no. of capsules/plant and grain yield/ha among the eight hybrids studied. Similarly the hybrids *viz*., TMV 7 / DSS 9 and TMV 7 / DS 5 also showed significant relative heterosis, heterobeltiosis and standard heterosis for no. of branches/plant, no. of capsules/plant and grain yield/ha. Sushila *et. al*., 2020 reported significant positive average heterosis in six crosses, heterobeltiosis in five crosses and standard heterosis in seven and also concluded highly and positive significant values for all three kinds of heterosis in two crosses, RT-351×TKG-22 andRT-54 × TKG-22.

UNDER PEER REVIEW

Conclusions

The highly heterotic combinations are expected to through better transgressive segregants in the future generations and considered to be of high value than the low heterotic combinations. Hence considering all the three type of heterosis, the hybrids TMV 7 / E 8, TMV 7 / DS 5 and TMV 7 / DSS 9 were adjudged to be good for enhancement of grain yield and its attributing characters in Sesame.

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UNDER PEER REVIEW

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UNDER PEER REVIEW

Table 1. Analysis of Variance for yield parameters in Sesame

Sl. No.	Source	df	Mean Squares				
			Days to 50% flowering	Plant Height (cm)	No. of Branches/plant	No. of Capsules/plant	Yield (kg/ha)
1.	Genotypes	13	10.53*	405.41*	5.95*	703.24*	23514.13*
2.	Replication	2	1.45	6.88	0.02	3.24	280.27
3.	Error	26	1.84	23.69	0.20	27.45	902.70

Table 2. Relative heterosis, Heterobeltiosis and Standard heterosis for yield parameters in Sesame

Genotypes/ Hybrids	Days to 50% flowering	Plant Height (cm)	No. of Branches/plant							No. of Capsules/plant			Yield (kg/ha)		
	RH	HB	SH	RH	HB	SH	RH	HB	SH	RH	HB	SH	RH	HB	SH
TMV (Sv) 7 / E8	1.59	-3.03	-3.03	7.87 **	6.11 *	6.11 *	45.34 **	43.04 **	43.04 **	70.79 **	60.00 **	60.00 **	26.05 **	15.85 **	15.85 **
TMV (Sv) 7 / DSS 9	14.75	6.06	6.06	14.03 **	5.46	5.46	96.95 **	63.29 **	63.29 **	42.77 **	24.74 **	24.74 **	17.99 **	7.39 *	7.39

UNDER PEER REVIEW

	**														*
TMV (Sv) 7 / DS 5	1.54	0.00	0.00	-2.30	-2.30	-2.30	50.39 **	22.78 **	22.78 **	22.83 **	18.95 **	18.95 **	19.85 **	11.62 **	11.62 **
TMV (Sv) 7 / Prachi	6.81 *	3.03	3.03	-5.49	-5.49	-5.49	17.24 *	7.59	7.59	16.98*	-2.11	-2.11	11.28 **	0.70	0.70
VRI (Sv) 2 / E8	5.88	2.06	0.00	9.23 **	0.83	-2.46	19.06 **	16.34 *	12.66	21.61 **	12.84	-2.11	14.74 **	9.09 *	1.41
VRI (Sv) 2 / DSS 9	14.92 **	7.22 *	5.05	6.69 *	6.69 *	-5.49	23.20 **	5.48	-2.53	10.54	-4.28	-2.26	2.21	-3.79	-10.56 **
VRI (Sv) 2 / DS 5	1.55	1.03	-1.01	9.40 **	9.01 **	-1.95	39.84 **	17.81 *	8.86	36.29 **	30.67 **	33.42 **	13.56 **	9.47 **	1.76
VRI (Sv) 2 / Prachi	-1.59	-4.12	-6.06	17.43 **	17.43 **	4.87	15.11 *	9.59	1.27	8.51	-9.95	-8.05	2.02	-4.55	-11.27 **

UNDER PEER REVIEW