Journal of Tropical Agriculture 51 (1-2) : 84-91, 2013

Evaluation of sesame crosses for heterosis of yield and yield attributing traits

Jawahar lal Jatothu*[1], Kuldeep Singh Dangi[2], S. Sudheer Kumar[1]

*[1]*Department of Genetics and Plant Breeding, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad – 500 030, (Andhra Pradesh), India;* [2]*Directorate of Oilseeds Research, Rajendranagar, Hyderabad-30, India;* [1]*Department of Genetics and Plant Breeding, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad – 500 030, India.*

Received 2 January 2013; Received in revised form 25 October 2013; Accepted on 29 October 2013

Abstract

The extent of standard heterosis of eleven characters of sixty hybrids of sesame developed by crossing 10 lines and 6 testers in line x tester fashion were evaluated during *Rabi*, 2007-08, 2008-09 at College Farm, College of Agriculture, ANGRAU, Hyderabad, India. The analysis of variance (line x tester) revealed significant differences among genotypes for all the characters studied. The line x tester interactions contributed up to 79.55 per cent for capsule length followed by number of seeds per capsule (77.98%), seed yield per plant (77.15%) and number of effective primaries per plant expressed in per cent (75.75%). The highest percentage of average heterosis was observed for seed yield per plant and number of effective primaries per plant. Five crosses *viz.,* PKDS-62 x IS 562 B , SI7818 x SI-3171, KKS-98049 X SI-3171, KKS-98049 x KMR-78, CST 2001-5 x TKG-22 were identified as potential hybrids with high standard heterosis for seed yield over better yielding commercial hybrid check Swetha til. Testing of these hybrids in all India coordinated trials across different states of the country may result in identification of better hybrids in the near future for commercial exploitation.

Keywords: Average heterosis, Standard heterosis, Sesame, Yield attributes

Introduction

Sesame (*Sesamum indicum* L.), is a source of edible oil with high nutritive value and keeping quality. Heterosis is a universal phenomenon which occurs both in self and cross pollinated species. 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. Heterosis for seed yield in sesame is due to simultaneous heterotic effects of more than one component. Hence, it is important to measure the magnitude of heterosis in sesame hybrids with due emphasis on contribution of different morphological traits. To exploit commercially viable heterosis the new crosses are compared with released varieties, so that the crosses with high heterotic potential could be identified.

Hybrid sesame is an optimistic approach for significant improvement in genetic potential for yield and yield attributing traits. For commercial exploitation of heterosis in sesame, the pre-requisites are identification of parents which show good heterosis and development of mechanisms such as male sterility to reduce the cost of hybrid seed.

In the present investigation, heterosis for 60 cross combinations in sesame was estimated over mid parent, better parent and standard checks (Swetha

---

*Author for correspondences: Phone +919160451473; E-mail: <jawaharlaljatoth@gmail.com>.

til and Rajeshwari) for yield and yield components. A high level of heterosis in the desired direction was observed in several hybrids for various characters.

Materials and Methods

Ten elite high yielding sesame genotypes collected from different agro morphological regions of India were used as female parents (IS 1547 A, KKS-98049, PKDS-62, SI-7818, JCS-720, JCS-724, KMR-108, KMR-24, S-0018 and CST 2001-5) and six genotypes as male parents (KMS 5-396, JCS-507, IS 562 B, SI-3171, KMR-78 and TKG-22). The selected parents were crossed in a Line x Tester mating design to generate 60 hybrids. These 60 crosses along with their parents and checks were evaluated in a randomized block design with three replications at College Farm, College of Agriculture, ANGRAU, Hyderabad during *Rabi*, 2007-08, 2008-09 (two season data values were pooled to derive mean values). Each genotype in each replication was sown by dibbling in plots of 4 meters length with a spacing of 30 cm between the rows and 10 cm between the plants. The recommended packages of practices were adopted to raise a healthy crop. Plant protection measures were taken up as and when required. The genotypes were harvested as and when they attained physiological maturity.

Observations were recorded for each genotype on eleven quantitative traits in ten randomly tagged plants. The traits measured were number of days to 50% flowering, numbers of days to maturity, number of effective primaries per plant, plant height (cm), total number of capsules per plant, capsule length (cm), number of seeds per capsule, 1000-seed weight (g), oil content (%), chlorophyll content (SPAD units) and seed yield per plant (g). Line x tester analysis was carried out as per Kempthorne (1957). The heterosis was estimated over the check as per the standard procedure. Mean values per replication for all traits were subjected to analysis of variance according to Panse and Sukhatme (1985) for randomized block design. The estimates of general and specific combining ability and their variances were obtained by using covariance of half sibs and full sibs.

Results and Discussion

The analysis of variance revealed that genotypes exhibited highly significant differences among themselves. The parents exhibited significant differences for all the traits studied. The crosses and parents vs. crosses exhibited highly significant differences for all the traits except days to 50 per cent flowering in parents vs. crosses.

When the effects of crosses was partitioned into lines, testers and line x tester effects, the effect of lines were significant for days to 50 per cent flowering, plant height and capsule length and it was non-significant for days to maturity, number of effective primaries per plant, number of effective capsules per plant, number of seeds per capsule, 1000-seed weight, seed yield per plant, oil content and chlorophyll content, while testers were found to be significant for eight traits excepting for capsule length and oil content. The interaction effects (line x tester) were found to be significant for all the traits under study.

Contribution of parents towards variance

Lines and their interaction with testers contributed more than 70 per cent of total variance for number of effective primaries per plant, number of capsules per plant, capsule length, number of seeds per capsule, seed yield per plant, chlorophyll content and oil content, while for lines, contribution was high for days to 50% flowering, days to maturity, plant height, capsule length and seed yield per plant (Table 1). For days to maturity, contribution of both lines and testers was equally important. Similarly, line x tester interactions contributed up to 79.55 capsule length, followed by number of seeds per capsule (77.98%), seed yield per plant (77.15%) and oil content (73.77%).

Table 1: Proportional contribution of lines, testers and their interactions to total variance

Character	Contribution		
	Line %	Tester %	Line x Tester %
Days to 50 % flowering	36.66	24.81	38.52
Days to maturity	15.61	15.09	69.28
Plant height (cm)	36.72	7.56	55.71
No. of effective primaries/ plant	17.98	6.26	75.75
No. of effective capsules/ plant	23.51	3.81	72.66
Capsule length (cm)	11.64	8.80	79.55
No. of seeds/ capsule	13.85	8.15	77.98
1000-seed weight (g)	26.44	6.29	67.25
Seed yield/plant (g)	16.61	6.23	77.15
Chlorophyll content (SPAD Units)	27.10	2.88	70.01
Oil content (%)	25.83	0.39	73.77

Extent of heterosis

To draw the valid conclusions regarding the extent of heterosis for various characters, the overall means of parents, F_1 and standard checks were computed to obtain average and standard heterosis for all the characters studied and presented in Table 2. The degree of heterosis varied considerably for seed yield per plant and its attributes. The highest percentage of average heterosis was observed for seed yield per plant followed by number of primaries per plant, capsule length and chlorophyll content. Negative heterosis was observed for plant height, number of seeds per capsule, 1000 seed weight and oil content. The observed highest heterosis for seed yield per plant was due to expressions of heterosis in component characters like seed yield per plant (13.41%), number of primaries per plant (12.41%) and number of capsules per plant (7.98%).

Heterosis for maturity and plant height

Positive and negative heterosis was observed for all the growth and yield attributing traits (Table 3). Early maturing hybrids are desirable as they produce

Table 2. Average performance of parents, F_1s, checks and average heterosis for seed yield per plant and other contributing traits in sesame

Character	Average performance			Average H%
	Parents	crosses	Check	
Days to 50 % flowering	39.10	39.27	38.00	0.42
Days to maturity	94.43	94.77	94.00	0.36
Plant height (cm)	126.76	124.73	129.33	-1.59
No. of effective primaries/ plant	6.32	7.11	6.87	12.41
No. of effective capsules/ plant	132.29	142.85	128.83	7.98
Capsule length (cm)	2.41	2.47	2.67	2.22
No. of seeds/ capsule	63.24	62.00	60.40	-1.96
1000-seed weight (g)	2.66	2.55	2.43	-4.2
Seed yield/plant (g)	11.27	12.78	15.26	13.41
Chlorophyll content (SPAD Units)	43.91	47.23	43.00	7.55
Oil content (%)	42.50	41.28	52.30	-2.87

Table 3. Heterosis of promising hybrids for seed yield per plant and its components in sesame

Cross	Days to maturity			Plant height (cm)			No. of effective primaries/ plant			No. ofeffective capsules/plant		
	HB	SH1	SH2	HB	SH1	SH2	HB	SH1	SH2	HB	SH1	SH2
SI-7818 x SI-3171	0.00	0.71	2.16	10.26**	-0.57	-1.25	81.15**	46.61**	70.44 **	38.02**	14.85*	5.90
SI-7818 x KMS 5-396	-1.06	-0.35	1.08	2.34	7.16*	6.42	-11.02**	-4.24	11.33	95.07**	18.65**	9.41
KKS-98049 x SI-3171	0.00	-2.48	-1.08	-6.19	-1.65	-2.33	37.80**	22.03**	41.87 **	19.91**	13.98*	5.10
KKS-98049 x KMR-78	-1.06	-0.71	0.72	-5.01	-0.41	-1.10	20.57**	6.78*	24.14 **	-6.69	-11.30*	-18.21**
CST 2001-5 x JCS-507	2.48	2.48	3.96 **	-1.10	0.00	0.59	3.85	2.97	19.70 **	-14.16*	-14.76*	-21.40**
CST 2001-5 x KMS 5-.396	-0.71	-0.71	0.72	-0.47	4.23	3.51	-27.95**	-22.46**	-9.85	28.18**	-2.30	-9.91
KMR-24 x IS 562 B	-8.08**	-3.19*	-1.80	-2.80	-0.54	-1.23	6.73*	-5.93*	9.36	1.69	-8.72	-15.83**
KMR-24 x TKG-22	4.95**	5.32**	6.83 **	-5.09	-4.85	-5.50	0.00	-24.58**	-12.32	-22.16**	-30.14**	-35.58**
KMR-24 x KMS 5-396	3.91**	3.55**	5.04 **	-5.88	-1.44	-2.12	-27.95**	-22.46**	-9.85	-2.61	-12.59*	-19.40 **
JCS-720 x IS 562 B	-3.37**	1.77	3.24 *	-3.20	-0.95	-0.61	-11.54**	-22.03**	-9.36	10.48	-2.05	-9.68
JCS-720 x TKG-22	5.65**	6.03**	6.83 **	-2.99	-8.79	-9.67 **	-17.28**	-33.05**	-19.21 **	7.87	-8.51	-15.64**
JCS-724 x SI-3171	4.00**	1.42	2.88 *	3.53	3.48	2.76	-29.84**	-43.22**	-33.99 **	4.00**	1.42	-23.43**
S-0018 x IS 562 B	-5.39**	-0.35	1.08	-11.49 **	-7.84 *	-8.47 *	-17.31**	-27.12**	-16.26 *	-5.39**	-0.35	-28.63**
S-0018 x TKG-22	-4.48**	-1.77	-0.36	-27.23 **	-24.23 **	-24.75 **	14.61**	-13.56**	0.49	-4.48**	-1.77	1.23
IS 1547 A x KMS 5-396	1.38	4.26**	5.76 **	-7.26 *	-2.89	-3.30	-3.94	3.39	20.20 **	35.73**	4.63	-3.52
PKDS-62 x IS 562 B	-5.65**	0.71	2.16	2.39	4.77	4.04	82.69**	61.02**	87.19 **	33.90**	22.22**	12.70*

Cross	No. of seeds/ capsule			1000-seed weight (g)			Seed yield/plant (g)			Oil content (%)		
	HB	SH1	SH2	HB	SH1	SH2	HB	SH1	SH2	HB	SH1	SH2
SI-7818 x SI-3171	3.36	8.49	25.87 **	4.75	6.50	7.18	58.11**	17.90**	38.04 **	6.91**	-1.28*	2.99**
SI-7818 x KMS 5-396	-2.91	12.47*	30.48 **	13.30**	18.54**	19.29 **	36.48**	1.77	19.16 **	-10.81**	-18.94**	-15.44**
KKS-98049 x SI-3171	6.88	-2.21	13.45 *	-5.33	2.22	2.87	30.38**	14.35*	33.88 **	-14.23**	-20.79**	-17.37**
KKS-98049 x KMR-78	5.50	20.63**	39.96 **	-15.22**	15.24**	15.97 **	35.73**	19.04**	40.27 **	-7.79**	-22.19**	-18.83**
CST 2001-5 x JCS-507	16.20**	27.48**	47.90 **	-11.76**	15.00**	15.73 **	29.16**	2.53	20.05 **	-6.08**	-20.22**	-16.77**
CST 2001-5 x KMS 5-.396	-7.48	7.17	24.34 **	-1.70	28.11**	28.93 **	37.99**	9.54	28.25 **	-11.96**	-22.07**	-18.70**
KMR-24 x IS 562 B	-7.18	1.32	17.55 **	-1.65	4.47	5.13	16.26	-20.57**	-7.00	1.66*	-18.18**	-14.64**
KMR-24 x TKG-22	-9.05*	4.30	21.01 **	-22.36**	4.51	5.18	-11.47	-26.80**	-14.30 *	2.77**	-17.28**	-13.71**
KMR-24 x KMS 5-396	9.29*	26.59**	46.87 **	-8.73	-3.04	-2.43	22.54*	-26.52**	-13.97 *	-7.85**	-18.43**	-14.90**
JCS-720 x IS 562 B	-12.23**	2.20	18.57 **	-12.48*	-4.09	-3.48	-10.12	-27.36**	-14.96 *	6.52**	-18.75**	-15.24**
JCS-720 x TKG-22	-10.33*	4.41	20.11 **	-30.75**	-6.77	-6.18	-20.45**	-34.23**	-22.99 **	6.61**	-18.69**	-15.17**
JCS-724 x SI-3171	19.96**	25.71**	45.85**	-7.18	2.25	2.90	45.00**	-7.93	7.80	-14.36**	-20.92**	-17.50**
S-0018 x IS 562 B	-26.39**	-16.56**	-3.19	-5.69	2.83	3.48	-3.54	-18.59**	-4.69	7.03**	-21.36**	-17.96**
S-0018 x TKG-22	-13.19**	-0.45	15.50 **	-13.19**	-0.45	10.87 *	-0.54	-16.06*	-4.28	10.94**	-18.49**	-14.97**
IS 1547 A x KMS 5-396	-11.39*	2.64	19.09 **	-13.76**	0.60	1.24	41.26**	7.97	26.41 **	-12.46**	-22.51**	-19.16**
PKDS-62 x IS 562 B	5.30	2.97	19.47 **	8.32	9.24	9.94	47.41**	19.51**	45.03 **	-6.51**	-20.34**	-16.90**

more yield per day and fit well in multiple cropping systems. Among the 60 hybrids, 27 hybrids exhibited significant negative heterobeltiosis over their respective better parents. Seven hybrids *viz.,* SI-7818 x TKG-22, JCS-720 x SI-3171, KMR-24 x IS 562 B, KMR-24 x KMR-78, KMR-24 x TKG-22, CST 2001-5 x SI-3171 and CST 2001-5 x TKG-22 were significantly heterotic for earliness over standard checks Swetha til and Rajeshwari. Early flowering in hybrids has been reported earlier (Maisuria et al., 2006). Shorter plant type is an important character of a hybrid to withstand lodging. Among 60 hybrids 21 hybrids were shorter than their better parents and hence exhibited significant negative heterobeltiosis. The significant negative heterosis in plant height was observed in five crosses *viz.,* S-0018 x TKG-22, KMR-108 x SI-3171, PKDS-62 x KMR-78, IS 1547 A x SI-3171 and JCS-724 x KMR-78 over standard check Swetha til. Sumathi and Muralidharan (2008) as well as Padmasundari and Kamala (2012) also observed similar results for plant height.

Heterosis for yield and yield components

Number of effective capsules per plant is known to directly contribute towards seed yield. Twelve hybrids recorded positive significant heterobeltiosis while, 5 hybrids *viz*., KKS-98049 x SI-3171, PKDS-62 x IS 562 B, SI-7818 x KMS 5-396, SI-7818 x SI-3171 and KMR-108 x JCS-507 exhibited significant positive standard heterosis over Swetha til. Minimum number of crosses exhibiting standard heterosis as compared to heterobeltiosis was also observed by Jayaprakash and Sivasubramanian (2000); Mothilal and Manoharan (2004) and Padmasundari and Kamala (2012).

Number of seeds per capsule is generally associated with more capsule length and this is one of the attributes for higher seed yields in sesame hybrids. For this trait, 5 hybrids recorded significant positive heterobeltiosis. Thirteen hybrids were found to be highly consistent with significant positive standard heterosis over both the standard checks Swetha til and Rajeshwari. Thousand seed weight of a genotype serves as an indicator to the end product *i.e.,* seed yield. Low seed yields in sesame hybrids are attributed mainly to the 1000 seed weight. The extent of 1000 seed weight directly influences the ultimate product (seed yield). Most of the hybrids exhibited negative heterosis for the trait, 1000 seed weight but positively associated with seed yield and as many as 12 hybrids manifested significant positive standard heterosis ranging from 15.77 (KMR-24 x JCS-507) to 55.02 (JCS-720 x KMS 5-396) percent. Seven and five hybrids exhibited superiority in desirable direction over mid and better parent respectively (Padmasundari and Kamala, 2012).

Oil content is an important character for higher yield. Seven hybrids could manifest significant positive heterobeltiosis ranging from -30.59 (KMR-108 x JCS-507) to 10.94 per cent (S-0018 x TKG-22). Very interestingly, none of the hybrids recorded significant positive standard heterosis over both the standard checks.

The present investigation revealed a high order of heterosis for seed yield per plant. Sixteen hybrids manifested significant positive heterobeltiosis ranging from -28.45 (PKDS-62 x KMR-78) to 58.11 per cent (SI-7818 x SI-3171). Five hybrids registered significant positive standard heterosis over Swetha til. The hybrids which exhibited highest heterosis over Swetha til were KKS-98049 x SI-3171, KKS-98049 x KMR-78, PKDS-62 x IS 562 B, SI-7818 x SI-3171 and CST 2001-5 x TKG-22. Both heterobeltiosis and standard heterosis of positive nature for seed yield per plant, was reported by Deepa and Ananda (2001), Nijagun et al. (2002) and Kumarasen and Nadarajan (2003).

Seed yield per plant is a multiplicative product of several basic components of yield. The increased seed yield is definitely because of increase in one or more than one yield component. In the above crosses the superiority of hybrids in seed yield was due to genetic divergent characters of parents *viz.*, number of effective capsules per plant, number of seeds per capsule and 1000 seed weight. Virmani et al. (1982) reported that high heterosis was due to genetic divergence in the parents and dominant nature of gene action.

Five cross combinations *viz.,* PKDS-62 x IS 562 B , SI7818 x SI-3171, KKS-98049 X SI-3171, KKS-98049 x KMR-78, CST 2001-5 x TKG-22 have been identified as promising. The cross PKDS-62 x IS 562 B possessed high *per se* performance (18.24 g), significant positive *sca* effect (6.33) and standard heterosis of 19.51 *per cent* over the best check Swetha til for seed yield per plant (Table 4), number of capsules per plant, capsule length, number of effective primaries per plant and chlorophyll content.

The cross KKS-98049 x KMR-78 exhibited significant positive *sca* effect (1.36) and standard heterosis (19.04%) along with the high *per se* performance of 18.17 g for seed yield per plant. The cross was also promising for primaries per plant, seeds per capsule, 1000 seed weight. The cross CST 2001-5 x TKG-22 was found to be good with significant positive *sca* effect (1.43) and standard heterosis (9.54%) along with the high *per se* performance of 16.72g for seed yield per plant. Besides seed yield, the cross had shown higher effective primaries per plant and 1000 seed weight.

The hybrids SI7818 x SI-3171 and KKS-98049 X SI-3171 recorded high standard heterosis (17.90% and 14.35%) over Swetha til, as well as significant positive *sca* effects (3.23 and 3.07) and high *per se* performance (17.99 g and 17.45 g) for seed yield per plant. Besides seed yield, the cross SI7818 x SI-3171was promising for effective primaries per plant, effective capsules per plant, capsule length and no.of seeds per capsule, whereas, KKS-98049 X SI-3171 was promising for effective primaries per plant and effective capsules per plant.

From commercial point of view, the superiority of new hybrids for yield can be judged by comparing their performance with the best cultivated hybrid/s or variety. Swetha til was therefore used as standard check in order to obtain information regarding superiority of new hybrids over the best cultivated varieties. The highest yielding hybrid PKDS-62 x IS 562 B (18.24 g) had the standard heterosis of 19.51 per cent and exhibited considerable amount of relative heterosis (59.99%) and heterobeltiosis (47.41%) and secured first position in respect of significant desirable *sca* effect (6.33)

In the present study, where the *per se* performance of the parents and the per cent heterosis of the resultant hybrids were considered with best ten crosses mentioned (Table 4), the hybrids PKDS-62 x IS 562 B and KKS-98049 x KMR-78 exhibited high *per se* performance for yield with considerable levels of heterosis, where parents involved in these crosses recorded substantial yield levels, whereas the hybrid resulting from low yielding parents, SI-7818 and KMS 5-396, exhibited substantial increase in yield with highest percent of relative heterosis and heterobeltiosis. Such a situation could be attributable to high inter-allelic interaction canceling the individual effects of each other.

From the foregoing discussion it can be clearly brought out that the cross combinations *viz.,* PKDS-62 x IS 562 B , SI7818 x SI-3171, KKS-98049 X SI-3171, KKS-98049 x KMR-78, CST 2001-5 x TKG-22 with higher standard heterosis for seed yield over high yielding commercial hybrid check Swetha til offers greater scope for exploitation of the hybrid vigour on commercial scale. The large scale testing of these crosses in all India Coordinated trials may result in commercial release in near future and thereby help in accelerating the rate of adoption of sesame hybrids in the India.

References

Deepa, S. P. and Ananda, K. C. R. 2001. Heterosis for yield and yield components in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsletter, 16: 6-8.

Table 4. Over all performance of superior 10 heterotic crosses for seed yield and other component characters in sesame

Cross	Heterosis & *sca*	Days to maturity	Plant height (cm)	No. of effective primaries/plant	No. of effective capsules/plant	No. of seeds/ capsule	1000-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
PKDS-62 x IS 562 B	MP	-5.02**	5.12	103.21**	35.58**	6.72	16.87**	59.99**	6.75**
	BP	-5.65**	2.39	82.69**	33.90**	5.30	8.32	47.41**	-6.51**
	SH	0.71	4.77	61.02**	22.22**	2.97	9.24	19.51**	-20.34**
	sca	-0.45	8.05**	4.55**	38.41**	-0.62	0.19*	6.33**	0.53*
KKS-98049 x KMR-78	MP	0.36	-3.04	27.59**	-5.06	18.87**	-5.51	38.71**	-3.71**
	BP	-1.06	-5.01	20.57**	-6.69	5.50	-15.22**	35.73**	-7.79**
	SH	-0.71	-0.41	6.78*	-11.30*	20.63**	15.24**	19.04**	-22.19**
	sca	-0.72	1.62	0.64**	-12.79*	10.18**	0.24**	4.54**	-0.48*
SI-7818 x SI-3171	MP	1.61	13.37**	99.42**	62.61**	10.45*	6.57	79.24**	7.76**
	BP	0.00	10.26**	81.15**	38.02**	3.36	4.75	58.11**	6.91**
	SH	0.71	-0.57	46.61**	14.58*	8.49	6.50	17.90**	-1.28*
	sca	1.83**	-1.56	3.82**	24.53**	7.73**	0.06	3.23**	9.18**
CST 2001-5 x TKG-22	MP	-3.01**	5.82	9.71**	23.07**	-1.86	-2.84	43.08**	11.35**
	BP	-3.18*	3.12	-3.42	16.83*	-5.87	-4.38	40.22**	0.15
	SH	-2.84*	-1.19	-4.24	-0.91	7.94	28.72**	15.94*	-14.92**
	sca	-1.59**	0.31	1.42**	26.02**	0.42	0.21*	3.85**	1.41**
KKS-98049 x SI-3171	MP	0.00	0.86	44.00**	27.88**	8.58	-0.84	58.07**	-10.36**
	BP	0.00	-6.19	37.80**	19.91**	6.88	-5.33	30.38**	-14.23**
	SH	-2.48	1.65	22.03**	13.98*	-2.21	2.22	14.35*	-20.79**
	sca	-2.12**	-0.73	1.41**	26.17**	1.89	-0.06	3.07**	0.7099
KMR-24 x KMR-78	MP	-3.55**	5.34	26.38**	7.06	8.64*	-6.15	53.90**	2.55**
	BP	-3.89**	5.18	17.20**	5.87	6.18	-16.40**	31.91**	0.48
	SH	-3.55**	5.77	-7.63**	-2.81	21.41**	13.63*	10.73	-19.13**
	sca	-3.38**	9.41**	1.13**	14.56*	6.80**	0.36**	4.71**	-0.35
CST 2001-5 x KMS 5-396	MP	-0.36	3.95	-25.00**	42.58**	-3.07	9.05*	67.58**	-10.15**
	BP	-0.71	-0.47	-27.95**	28.18**	-7.48	-1.70	37.99**	-11.96**
	SH	-0.71	4.23	-22.46**	-2.30	7.17	28.11**	9.54	-22.07**
	sca	-0.86	5.03**	-0.79**	11.79	-2.90	0.02	1.43*	-2.20**
IS-1547 A x KMS 5-396	MP	3.16**	-5.16	15.91**	51.73**	-6.65	-9.07*	68.99**	-10.79**
	BP	1.38	-7.26*	-3.94	35.73**	-11.39*	-13.76**	41.26**	-12.46**
	SH	4.26**	-2.89	3.39	4.64	2.64	0.60	7.97	-22.51**
	sca	0.53	7.59**	0.80**	35.92**	0.04	-0.10	4.00**	2.44**
KMR-108 x SI-3171	MP	0.53	-18.83**	1.75	16.91**	2.38	15.02**	33.22**	-10.19**
	BP	-1.74	-22.48**	-2.86	12.24	1.33	14.11**	4.55	-11.46**
	SH	0.35	-23.20**	-13.56**	1.50	-7.29	12..04*	4.60	-21.62**
	sca	-0.95*	-15.37**	-0.46**	8.89	0.08	0.34**	2.29**	-6.81**
S-0018 x KMR-78	MP	-3.66**	-9.29**	38.50**	-3.45	-11.68**	-17.68**	22.27**	0.97
	BP	-4.83**	-10.84**	34.44**	-4.99	-12.07**	-25.83**	21.95**	-1.49
	SH	-2.13	-7.16*	5.93*	-9.90	0.55	0.82	2.92	-23.92**
	sca	-0.88	7.43**	1.23**	4.15	-1.24	-0.02	2.52**	-1.45**

Jayaprakash, P. and Sivasubramanian, 2000. Heterosis and identification of superior crosses in sesame (*Sesamum indicum* L.). Ann. Agric. Res., 21(1): 55-57.

Kempthorne, O. 1957. *An introduction to genetic statistics*. John Wiley and Sons, New York, pp.545.

Kumaresan, D. and Nandarajan, N. 2003. Heterosis for yield and yield components in sesame (*Sesamum indicum* L.). Res. Crops, 4: 373-376.

Maisuria, A. T., Patel, J. C., Patel, K. G. and Solanki, B. G. 2006 .Study of best *per se* performance, heterosis and combining ability effects for seed cotton yield and its component characters through GMS system in Asiatic cotton. Cotton Res. J., August: 88-92.

Mothilal, A. and Manoharan, V. 2004. Heterosis and combining ability in sesame (*Sesamum indicum* L.). Crop Res., 27: 282-287.

Nijagun, H. G., Parameshwarappa, K. G. and Salimath, P. M. 2002. Studies on combining ability for exploitation of hybrid vigour in sesame. Crop Res., 23: 522-525.

Padmasundari , M. and Kamala, T. 2012. Heterosis in *Sesamum indicum* L**.** Asian J. Agric. Sci., 4(4): 287-290.

Panse, V. G. and Sukhatme, P. V. 1985. *Statistical methods for agricultural workers*, Indian Council of Agricultural Research, New Delhi.

Sumathi, P. and Muralidharan, V. 2008. Study of gene action and heterosis in monostem/shy branching genotypes in sesame (*Sesamum indicum* L.). Indian J. Genet., 68 (3): 269-274.

Virmani, S.S., Chaudhary, R.C. and Khush, G.S. 1982. Heterosis breeding in rice (*Oryza sativa* L.).Theor.and Appl. Genet., 63: 373-380.