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Genetic Analysis of Superior Crosses for Quantitative Traits in Sesame (*Sesamum indicum* L.)

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Sixteen genotypes consisting of ten lines and six testers were crossed in line x tester fashion. The hybrids and their parents were used to estimate three types of heterosis, *sca* effects for 11 quantitative traits. Based on the *sca*, heterosis and *per se* performance, the superior crosses were identified for each trait. The crossesPKDS-62 x IS 562 B and KKS-98049 x KMR-78 which showed superior performance in yield and yield contributing traits and these were the best among the 60 crosses studied. These crosses may be used for commercial exploitation of heterosis in sesame.

Introduction

Sesame (*Sesamum indicum* L.) is one of the oldest oil seed crops known and used by man. Regarded as the "Queen of oil seeds", oil extracted from sesame is among the highly prized few edible oils by virtue of its quality. The antioxidants sesamin and sesmolin increase the oil quality by making it resistant to rancidity. Sesame seed is rich in oil (50-53%) and protein (20-26%) on an average. Sesame oil is semidrying and most stable against oxidative rancidity and used in various industries besides in cooking. The oil is also rich in vitamin-E and contains an essential amino acid methionine (3.4%) (Mosjidis 1982).

Myanmar, India and China are the top three sesame producing countries in the world. But, the productivity of sesame in India is very low (432 kg/ha) compared to China (1382 kg/ha) and Myanmar (565 kg/ha) (FAO, 2017). Though sesame is predominantly self-pollinated crop, considerable cross pollination has been recorded. The epipetalous nature of stamens and high heterosis will pave the way to development of hybrid sesame. In this study an attempt has been made to find the level of heterosis and identification of superior crosses for heterosis exploitation.

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 on crossing and production of hybrids with low cost. The work on heterosis has been reviewed from time to time on yield and yield components in sesame. Thus, the aim of heterosis analysis is to find out the best combination of parents for their prospects for future use in hybrid breeding programme. In the present investigation, heterosis was measured over mid parent, better parent and standard check (Swetha til) for yield and yield components. A high level of heterosis and *sca* effects in 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, India 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 parent (KMS 5-396, JCS-507, IS 562 B, SI-3171, KMR-78 and TKG-22) in a line x tester mating design. These selected parents were crossed in L x T fashion to generate 60 hybrids in *Kharif*, 2007. These 60 crosses along with their parents and checks were evaluated randomized block design with three replications at college farm, college of agriculture, ANGRAU, Rajendranagar, Hyderabad during *Rabi*, 2007-08, 2008-09. Each genotype in each replication was sown by dibbling the seeds in four rows of plot 4 m 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 attained physiological maturity.

Morphology of all sesame genotypes were characterized by 11 quantitative traits on ten randomly tagged plants in each genotype. 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). The mean of ten plants for all the characters, except days to 50% flowering and days to maturity was utilized for carrying out statistical analysis. For days to 50% flowering and days to maturity was recorded on plot basis. Line x tester analysis was carried out according to 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

A comparison of five best cross combinations for various characters is presented in Table 1. The perusal of *sca* effects of different characters in present investigation revealed that *sca* effects and *per se* performance of the crosses were closely related, which indicates that the hybrids with high *per se* performance need be the one with high *sca* effects and *vice versa*. But for the character, days to 50 per cent flowering (desirable in negative direction) high correlations between the *sca* effects and *per se* performance of the F_1 crosses was observed, which signifies the contribution of additive gene effects in the inheritance of these traits. So the cross combinations may be selected either on the basis of *sca* or mean performance or in combination.

With regard to 1000 seed weight significant positive *sca* effects observed in twelve (12) hybrids. The crosses JCS-720 x KMS 5-396 (low x high), CST 2001-5 x IS 562B (high x low), KKS-98049 x JCS-507(low x low) involved parents of high x low, low x high and low x low indicating the presence of genetic diversity among the parents. The trait oil content recorded significant *sca* effects in 24 crosses in positive direction. The crosses SI-7818 x SI-3171(high x low), KMR-108 x KMR-78 (low x high), PKDS-62 x JCS-507(low x low) were the good specific combiners for oil content. Presence of at least one parent with high *gca* effects indicating that a high general combiner in the cross combination might result in good specific combination.

For the trait chlorophyll content eight crosses recorded significant positive effects.The crosses JCS-724 x SI-3171 (low x high), S-0018 x KMR-78 (high x low), KMR-108 x TKG-22 (low x low) exhibited significant positive *sca* effects. The trait oil content recorded significant *sca* effects in 24 crosses in positive direction. The crosses SI-7818 x SI-3171(high x low), KMR-108 x KMR-78 (low x high), PKDS-62 x JCS-507(low x low) were the good specific combiners for oil content. Presence of at least one parent with high *gca* effects indicating that a high general combiner in the cross combination might result in good specific combination.

The highest *sca* effects for seed yield are observed in 11 crosses *viz.,* PKDS-62 x IS-562 B (low x low), KKS-98049 x KMR-78 (low x low), CST 2001-5 x TKG-22 (high x low), SI-7818 x SI-3171 (high x low), KKS-98049 x SI-3171 (high x high). Almost all types of combinations produced superior hybrids for seed yield per plant. The first five crosses which recorded high *sca* effects for yield also exhibited significant *sca* effects in desired direction for important yield contributing traits *viz.,* days to 50 per cent flowering, plant height, number of effective primaries per plant, number of capsules per plant, capsule length, seeds per capsule, 1000 seed weight and oil content indicating the possibility of exploiting these cross combinations for yield improvement in sesame through heterosis breeding. Interestingly, except IS 1547 A x KMS 5-396 these five cross combinations exhibited non significant *sca* effects for oil content. This suggested that high yielding hybrids with acceptable levels of quality traits should be considered. Of the eleven hybrids exhibited positive *sca* effects for yield, none exhibited significant *sca* effects for oil content except the cross combination PKDS-62 x IS 562 B, IS-1547 A x KMS 5-396, CST 2001-5 x TKG-22 and KKS-98049 x JCS-507 which recorded desirable *sca* effects for oil content.

High *sca* effects observed in the crosses for the characters studied were either due to high x high, high x low, low x high and low x low combining parents. The ideal specific combination should be the one where high magnitude of *sca* in addition to high *gca* in both or at least one of the parents is present. Similar results of high x low / low x high, low x low has been reported by earlier workers Neelima *et al.,* (2004) and Rauf *et al.,* (2006).

Significant but negative heterosis over mid parent and better parent was recorded in eleven and twenty five crosses respectively for days to 50 per cent flowering. While three crosses were found to be significantly earlier than the standard check. Negative heterosis is considered to be desirable since earliness is preferred over later flowering in different situations. Negative heterosis over mid parent was reported by Saravanan and Nadarajan (2002), Karad et al., (2002) and Raghunaiah (2005) reported significant negative heterosis over commercial check.

Sixteen crosses exhibited significant negative heterosis over mid parent for days to maturity whereas only twenty seven crosses recorded significant negative heterosis for better parent and seven crosses recorded negative heterosis for standard check. Similar results over mid parent are being reported by Mishra and Sikarwar (2001), Nijagun et al.,(2003)and over better parent by Raghunaiah (2005).

More number of crosses (25) exhibited significant positive heterosis over mid parent for number of effective capsules per plant compared to heterosis over better parent (12 crosses). The crosses IS 1547 A x KMS 5-396, CST 2001-5 x KMS 5-396 and KMR-108 x JCS-507 recorded the highest positive significant heterosis over both mid and better parents, whereas five crosses recorded significant positive heterosis over the check. The crosses SI-7818 x KMS 5-396 and SI-7818 x SI-3171 found to exhibit all three types of heterosis considerably. Significant positive heterosis over standard check is in agreement with the findings of Mothilal and Manoharan (2004)

Significant positive heterosis over mid parent, better parent and standard check was observed in eleven, five and thirteen crosses respectively for number of seeds per capsule. The crosses KMR-108 x IS 562 B observed to be exhibit both heterobeltiosis and average heterosis. The cross JCS-724 x SI-3171, CST 2001-5 x JCS-507, CST 2001-5 x IS 562 B and KMR-24 x KMS 5-396 found to exhibit all three types of heterosis considerably. Relative heterosis has also been reported by Mothilal and Ganesan (2005).

With regards to 1000 seed weight significant positive *sca* effects observed in twelve hybrids and seven crosses recorded significant and positive mid parental heterosis, whereas five and twelve hybrids recorded heterobeltiosis and standard heterosis respectively. The crosses JCS-720 x KMS 5-396, CST 2001-5 x IS 562 B and KKS-98049 x JCS-507 recorded considerable heterosis over mid parent, better parent and standard check. Significant positive heterosis over better parent is being reported by Ray and Sen (1992).

In case of oil content twenty one and seven crosses exhibited significant and positive heterosis over mid parent and better parent respectively, whereas none of the crosses recorded significant positive heterosis over standard check. The hybrids S-0018 x TKG-22, JCS-720 x IS 562 B, S-0018 x IS 562 B, JCS-720 x TKG-22, KMR-24 x TKG-22, KMR-24 x IS 562 B and SI-7818 x SI-3171 exhibited heterosis over mid parent and better parent. Positive heterosis over mid parent was reported by Deepa and Ananda (2001) and significant positive heterosis over better parent and commercial check is given by Raghunaiah (2005).

For seed yield per plant significant positive heterosis was observed in 27 crosses over mid parent, 16 crosses over better parent and 5 crosses over standard check. The crosses SI-7818 x SI-3171, PKDS-62 x IS 562 B, KKS-98049 x SI-3171 and KKS-98049 x KMR-78 were exhibited considerable high heterosis over mid parent, better parent and standard check, while the crosses IS 1547 A x KMS 5-396 and JCS-724 x SI-3171 were recorded highest heterosis over both mid parent and better parent.

Table.1 Analysis of variance for combining ability for yield and yield component characters in sesame

Source of variation	Degrees of freedom	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective primaries/ plant	No. of effective capsules/ plant	Capsule length (cm)	No. of seeds/ capsule	1000-seed weight (g)	Seed yield/ plant (g)	Oil content (%)	Chlorophyll content (SPAD Units)
Replications	2	0.96	1.45	0.96	0.19*	78.733	0.03	17.046	0.056	0.24	0.098	**9.73**
Treatments	75	10.96**	20.58**	263.23**	6.59**	1564.857**	0.06**	125.683**	0.281**	16.93**	29.057**	**56.71****
Parents	15	24.74**	22.17**	158.63**	2.45**	1079.83**	0.05**	100.09**	0.34**	13.73**	50.70**	**69.24****
Parents vs Crosses	1	1.07	5.13**	189.16**	22.98**	4224.06**	0.11*	58.82**	0.43**	85.80**	56.54**	**416.82****
Crosses	59	7.61**	20.44**	291.08**	7.37**	1643.10**	0.06**	133.30**	0.26**	16.57**	23.08**	**47.42****
Lines	9	18.29**	20.71	703.66**	8.67	2533.13	0.05**	121.08	0.46	18.84	39.09	**84.27**
Testers	5	22.29**	34.71**	246.84**	5.79**	740.04**	0.06	128.30**	0.20	12.27**	1.07	**16.13****
Line x Testers	45	3.84**	18.81**	213.48**	7.28**	1565.43**	0.06**	136.30**	0.23**	16.60**	22.33**	**43.53****
Error	150	0.77	0.63	6.83	0.07	120.54	0.02	14.03	0.02	1.39	0.15**	**12.58**
Total	**227**	**4.14**	**7.23**	**91.49**	**2.23**	**597.37**	**0.03**	**50.95**	**0.11**	**6.51**	**9.70**	**27.14**

Table.2 Performance of five superior crosses for each of eleven characters in sesame

Cross	*per se* performance	*sca* effect	Parent 1		Parent 2		Heterosis over		
			per se	*gca* effect	*per se*	*gca* effect	MP	BP	Swetha til
Days to 50 % flowering									
SI-7818 x SI-3171	36.00	-1.85**	37.00	-0.217	38.33	-1.206**	-4.42**	-6.09*	**-5.26****
JCS-724 x IS 562 B	36.00	-1.61**	34.00	-1.494**	40.00	-0.172	-2.70	-10.00**	**-5.26***
KMR-24 x IS 562 B	36.00	-1.77**	34.67	-1.	40.00	-0.172	-3.57*	-10.00**	**-5.26***
JCS-724 x KMR-78	36.67	-0.47	34.00	-1.328**	38.00	-0.639**	1.85	-3.51	**-3.51**
KMR-108 x SI-3171	37.00	0.04	36.00	-1.494**	38.33	-1.206**	-0.45	-3.48	**-2.63**
Days to maturity									
SI-7818 x TKG-22	90.33	-3.54**	94.67	-1.106**	94.33	-0.239	-4.41**	-4.58**	**-3.90****
KMR-24 x KMR-78	90.67	-3.38**	93.67	-0.694**	94.33	-1.006**	-3.55**	-3.89**	**-3.55****
JCS-720 x SI-3171	90.67	-2.51**	91.00	0.25	91.67	-1.272**	-0.073	-1.09	**-3.55****
KMR-24 x IS 562 B	91.00	-4.12**	93.60	-0.361	99.00	0.061	-5.54**	-8.08**	**-3.19***
CST 2001-5 x SI-3171	91.33	-0.56	94.00	0.25	91.67	-1.272**	-1.62	-2.84*	**-2.84***
Plant height									
S-0018 x TKG-22	98.00	-14.77**	131.67	-1.639**	117.6	-2.43**	-22.30**	-27.23**	**-24.23****
KMR-108 x SI-3171	99.33	-15.37**	128.13	-9.493**	116.63	-1.813**	-18.83**	-22.48**	**-23.20****
PKDS-62 x KMR-78	99.67	-22.49**	125.47	-8.181**	130.07	-2.566**	-21.99**	-23.37**	**-22.94****
IS 1547 A x SI-3171	109.13	-7.21**	129.43	0.029	116.63	-1.813**	-11.30**	-15.68**	**-15.62****
JCS-724 x KMR-78	109.87	-15.91**	129.27	-6.537**	130.07	-2.566**	-15.27**	-15.53**	**-15.05****
No. of effective primaries/plant									
S-0018 x KMR-78	8.33	1.23**	5.83	0.373**	6.20	-0.383**	38.50**	34.41**	**5.93***
PKDS-62 x IS 562 B	8.00	4.55**	5.53	0.707**	6.33	0.297**	103.21**	82.69**	**61.02****
SI-7818 x SI-3171	7.80	3.82**	7.20	0.557**	6.00	0.05	99.42**	81.15**	**46.61****
KKS-98049 x SI-3171	7.70	1.41**	6.97	1.034**	6.00	0.05	44.00**	37.80**	**22.03****
KKS-98049 x IS 562 B	**7.67**	**0.23**	**6.97**	**1.034****	**6.33**	**0.297****	**24.70****	**24.40****	**10.17****

Table.2 continued…

Cross	*per se* performance	*sca* effect	Parent 1		Parent 2		Heterosis over		
			per se	*gca* effect	*per se*	*gca* effect	MP	BP	Swetha til
No. of effective capsules/plant									
KMR-108 x JCS-507	152.50	48.94**	118.73	7.716**	126.73	5.989*	37.24**	31.11**	**30.20****
PKDS-62 x IS 562 B	149.90	38.41**	120.07	14.261**	110.93	-2.621	35.85**	33.90**	**22.22****
SI-7818 x KMS 5-396	146.27	27.21**	85.62	13.144**	86.00	4.066*	99.63**	95.07**	**18.65****
SI-7818 x SI-3171	144.27	24.53**	85.62	13.144**	98.33	0.739	62.61**	38.02**	**14.85***
KKS-98049 x SI-3171	143.90	26.17**	125.03	10.144**	98.33	0.739	27.88**	19.91**	**13.98***
Capsule length									
PKDS-62 x IS 562 B	3.00	0.42**	2.36	0.097**	2.42	0.015	25.49**	23.93**	**12.48****
SI-7818 x SI-3171	2.84	0.29**	2.53	0.032	2.55	0.044	11.88**	11.37**	**6.37**
S-0018 x SI-3171	2.74	0.21**	2.36	0.015	2.55	0.044	11.82**	7.58	**2.75**
IS 1547 A x TKG-22	2.69	0.19**	2.44	-0.023	2.39	0.045	11.25**	9.96*	**0.62**
JCS-720 x KMS 5-396	2.62	0.20**	2.53	-0.048	2.22	0.005	10.46**	3.55	**-1.75**
No .of seeds per capsule									
KMR-24 x KMS 5-396	76.47	10.12**	65.93	2.109*	69.97	2.238**	12.53**	9.29*	**26.59****
JCS-724 x SI-3171	75.93	12.66**	63.30	4.365**	55.27	-3.089**	28.09**	19.96**	**25.71****
KMR-24 x KMR-78	73.33	6.80**	65.93	2.109*	69.07	2.418**	8.64*	6.18	**21.41****
KKS-98049 x KMR-78	72.87	10.18**	53.53	-1.735	69.07	2.418**	18.87**	5.50	**20.63****
CST 2001-5 x IS 562 B	71.33	6.13**	63.60	3.398**	59.07	-0.195	16.30**	12.16*	**18.10****
1000 seed weight									
JCS-720 x KMS 5-396	3.77	1.00**	2.66	0.068	2.54	0.149**	44.74**	41.46**	**55.02****
CST 2001-5 x IS 562 B	3.53	0.54**	3.17	0.394**	2.45	0.037	25.61**	11.41**	**45.20****
CST 2001-5 x TKG-22	3.13	0.21**	3.17	0.394**	3.27	-0.035	-2.84	-4.38	**28.72****
CST 2001-5 x KMS 5-396	3.11	0.02	3.17	0.394**	2.54	0.149**	9.05*	-1.70	**18.11****
KKS-98049 x JCS-507	**3.07**	**0.51****	**2.62**	**0.055**	**2.51**	**-0.045**	**19.80****	**17.12****	**26.47****

Table.2 continued…

Cross	*per se* performance	*sca* effect	Parent 1		Parent 2		Heterosis over		
			per se	*gca* effect	*per se*	*gca* effect	MP	BP	Swetha til
Seed yield/plant									
PKDS-62 x IS 562 B	18.24	6.33**	12.37	-0.683*	10.43	-0.192	59.99**	47.41**	**19.51****
KKS-98049 x KMR-78	18.17	4.54**	13.38	0.749**	12.81	0.100	38.71**	35.73**	**19.04****
SI-7818 x SI-3171	17.99	3.23**	11.38	1.128**	8.70	0.850**	79.24**	58.11**	**17.90****
CST 2001-5 x TKG-22	17.69	3.85**	12.11	1.949**	12.62	-0.887**	43.08**	40.22**	**15.94****
KKS-98049 x SI-3171	17.45	3.07**	13.38	0.749**	8.70	0.850**	58.07**	30.38**	**14.35***
Oil content									
SI-7818 x SI-3171	51.60	9.18**	47.5	1.403**	48.3	-0.261**	7.76**	6.91**	**-1.28***
KMR-108 x KMR-78	45.40	4.61**	45.0	-0.714**	40.4	0.186*	6.33**	0.89	**-13.20****
CST 2001-5 x TKG-22	44.50	1.41**	44.4	1.569**	35.5	0.209*	11.35**	0.15	**-14.92****
CST 2001-5 x KMR-78	44.50	1.50**	44.4	1.569**	40.4	0.186*	5.07**	0.30	**-14.80****
PKDS-62 x JCS-507	44.40	3.30**	44.5	-0.053	42.3	-0.094	2.30**	-0.22	**-14.99****
Chlorophyll content									
IS 1547 A x SI-3171	55.80	4.22**	45.99	2.986**	41.55	1.360*	27.47**	21.32**	**29.77****
S-0018 x KMR-78	54.23	4.70*	47.23	3.167**	45.64	-0.862	16.79**	14.82*	**26.12****
KMR-108 x TKG-22	53.36	4.85*	41.51	1.287	41.94	-0.003	27.86**	27.19**	**24.09****
S-0018 x JCS-507	53.30	3.12	47.23	3.167**	38.42	-0.213	24.46**	12.84*	**23.95****
JCS-724 x SI-3171	**52.80**	**5.31***	**41.42**	**-1.096**	**41.55**	**1.360***	**27.27****	**27.07****	**22.79****

Table.3 Heterosis over mid parent (MP), better parent (BP), check and *sca* effects of superior ten crosses for seed yield and other component characters in sesame

Cross	*per se*	Heterosis &*sca*	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective primaries / plant	No. of effective capsules/ plant	Capsule length (cm)	No. of seeds/ capsule	1000-seed weight (g)	Seed yield/ plant (g)	Oil content (%)	Chlorophyll content (SPAD Units)
PKDS-62 x IS 562 B	18.24	MP	-3.39	-5.02**	5.12	103.21**	35.58**	25.49**	6.72	16.87**	59.99**	6.75**	**10.33**
		BP	-5.00*	-5.65**	2.39	82.69**	33.90**	23.93**	5.30	8.32	47.41**	-6.51**	**-7.95**
		SH	0.00	0.71	4.77	61.02**	22.22**	12.48**	2.97	9.24	19.51**	-20.34**	**19.60****
		sca	-1.11*	-0.45	8.05**	4.55**	38.41**	0.42**	-0.62	0.19*	6.33**	0.53*	**4.36***
KKS-98049 x KMR-78	18.17	MP	2.93	0.36	-3.04	27.59**	-5.06	-3.58	18.87**	-5.51	38.71**	-3.71**	**2.21**
		BP	-1.60	-1.06	-5.01	20.57**	-6.69	-7.03	5.50	-15.22**	35.73**	-7.79**	**1.97**
		SH	7.89**	-0.71	-0.41	6.78*	-11.30*	-10.86**	20.63**	15.24**	19.04**	-22.19**	**8.74**
		sca	1.36**	-0.72	1.62	0.64**	-12.79*	0.00	10.18**	0.24**	4.54**	-0.48*	**1.92**
SI-7818 x SI-3171	17.99	MP	-4.42	1.61	13.37**	99.42**	62.61**	11.88**	10.45*	6.57	79.24**	7.76**	**4.74**
		BP	-6.09*	0.00	10.26**	81.15**	38.02**	11.37**	3.36	4.75	58.11**	6.91**	**3.69**
		SH	-5.26*	0.71	-0.57	46.61**	14.58*	6.37	8.49	6.50	17.90**	-1.28*	**0.20**
		sca	-1.85**	1.83**	-1.56	3.82**	24.53**	0.29**	7.73**	0.06	3.23**	9.18**	**-2.29**
CST 2001-5 x TKG-22	17.69	MP	0.00	-3.01**	5.82	9.71**	23.07**	-3.33	-1.86	-2.84	43.08**	11.35**	**4.79**
		BP	0.00	-3.18*	3.12	-3.42	16.83*	-9.20*	-5.87	-4.38	40.22**	0.15	**0.80**
		SH	3.51	-2.84*	-1.19	-4.24	-0.91	-7.62	7.94	28.72**	15.94*	-14.92**	**6.46**
		sca	-0.99	-1.59**	0.31	1.42**	26.02**	-0.10	0.42	0.21*	3.85**	1.41**	**-0.25**
KKS-98049 x SI-3171	17.45	MP	-5.00*	0.00	0.86	44.00**	27.88**	-2.15	8.58	-0.84	58.07**	-10.36**	**19.41****
		BP	-8.80**	0.00	-6.19	37.80**	19.91**	-2.34	6.88	-5.33	30.38**	-14.23**	**13.80***
		SH	0.00	-2.48	1.65	22.03**	13.98*	-6.34	-2.21	2.22	14.35*	-20.79**	**21.36****
		sca	**-1.07***	**-2.12****	**-0.73**	**1.41****	**26.17****	**0.03**	**1.89**	**-0.06**	**3.07****	**0.7099**	**5.12***

Table.3 continued…

Cross	*per se*	Heterosis &*sca*	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective primaries / plant	No. of effective capsules/ plant	Capsule length (cm)	No. of seeds/ capsule	1000-seed weight (g)	Seed yield/plant (g)	Oil content (%)	Chlorophyll content (SPAD Units)
KMR-24 x KMR-78	16.90	MP	7.34**	-3.55**	5.34	26.38**	7.06	5.07	8.64*	-6.15	53.90**	2.55**	**-1.78**
		BP	2.63	-3.89**	5.18	17.20**	5.87	3.23	6.18	-16.40**	31.91**	0.48	**-7.34**
		SH	2.63	-3.55**	5.77	-7.63**	-2.81	-8.11*	21.41**	13.63*	10.73	-19.13**	**10.91**
		sca	1.69**	-3.38**	9.41**	1.13**	14.56*	0.03	6.80**	0.36**	4.71**	-0.35	**3.23**
CST 2001-5 x KMS 5-396	16.72	MP	4.68*	-0.36	3.95	-25.00**	42.58**	5.41	-3.07	9.05*	67.58**	-10.15**	**5.28**
		BP	4.24	-0.71	-0.47	-27.95**	28.18**	-4.29	-7.48	-1.70	37.99**	-11.96**	**-0.65**
		SH	7.89**	-0.71	4.23	-22.46**	-2.30	-2.62	7.17	28.11**	9.54	-22.07**	**4.93**
		sca	1.14*	-0.86	5.03**	-0.79**	11.79	0.07	-2.90	0.02	1.43*	-2.20**	**-0.70**
IS-1547 A x KMS 5-396	16.48	MP	-1.60	3.16**	-5.16	15.91**	51.73**	11.59**	-6.65	-9.07*	68.99**	-10.79**	**10.55**
		BP	-7.52**	1.38	-7.26*	-3.94	35.73**	6.41	-11.39*	-13.76**	41.26**	-12.46**	**3.71**
		SH	7.89**	4.26**	-2.89	3.39	4.64	-2.62	2.64	0.60	7.97	-22.51**	**10.93**
		sca	0.25	0.53	7.59**	0.80**	35.92**	0.15*	0.04	-0.10	4.00**	2.44**	**-2.31**
KMR-108 x SI-3171	15.96	MP	-0.45	0.53	-18.83**	1.75	16.91**	5.16	2.38	15.02**	33.22**	-10.19**	**22.75****
		BP	-3.48	-1.74	-22.48**	-2.86	12.24	-1.44	1.33	14.11**	4.55	-11.46**	**20.96****
		SH	-2.63	0.35	-23.20**	-13.56**	1.50	-5.87	-7.29	12..04*	4.60	-21.62**	**16.78***
		sca	0.04	-0.95*	-15.37**	-0.46**	8.89	0.07	0.08	0.34**	2.29**	-6.81**	**0.31**
S-0018 x KMR-78	15.71	MP	-7.50**	-3.66**	-9.29**	38.50**	-3.45	0.56	-11.68**	-17.68**	22.27**	0.97	**16.79****
		BP	-11.90**	-4.83**	-10.84**	34.44**	-4.99	0.14	-12.07**	-25.83**	21.95**	-1.49	**14.82***
		SH	-2.63	-2.13	-7.16*	5.93*	-9.90	-10.86**	0.55	0.82	2.92	-23.92**	**26.12****
		sca	**-2.42****	**-0.88**	**7.43****	**1.23****	**4.15**	**-0.06**	**-1.24**	**-0.02**	**2.52****	**-1.45****	**4.70***

Table.4 Number of crosses with significant desirable heterosis for eleven characters in Sesame

Character	*sca* effect	Significant heterosis in the desired direction over		
		Mid parent	Better parent	Standard check (Swetha til)
1.Days to 50 % flowering	11	11	25	3
2. Days to maturity	20	16	27	7
3. Plant height	19	24	33	8
4. No.of effective primaries/plant	23	31	24	12
5. No.of effective capsules/plant	10	25	12	5
6. Capsule length	7	12	5	1
7. No.of seeds /capsule	15	11	5	13
8. 1000 seed weight	12	7	5	12
9. Seed yield/plant	11	27	16	5
10. Oil content	24	21	7	0
11. Chlorophyll content (SPAD)	8	24	16	23

Significant positive heterosis over mid parent has been reported by Uzun *et al.,* (2004), Mothilal and Ganesan (2005). While positive heterosis over better parent observed in agreement with earlier findings of Mothilal and Manoharan (2004), Mothilal and Ganesan (2005). The presence of standard heterosis for seed yield in few crosses is confirmed with the many workers *viz.,* Mothilal and Manoharan (2004), Raghunaiah (2005).

For 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. The Swetha til 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) (Table 2)

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 2), 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 situation could be attributable to high inter-allelic interaction canceling the individual effects of each other.

The cross SI-7818 x SI-3171 recorded significant heterosis for oil content in positive direction which also recorded considerable positive heterotic values for yield. For number of effective capsules per plant and seed yield, SI-7818 x KMS 5-396, SI-7818 x SI-3171, IS 1547 A x KMS 5-396, CST 2001-5 x KMS 5-396 and PKDS-62 x IS 562 B exhibited significant positive heterosis. Whereas the crosses KKS-98049 x KMR-78, JCS-724 x SI-3171, KMR-24 x KMS 5-396 and CST 2001-5 x JCS-507 exhibited significant positive heterosis for number of seeds per capsules and seed yield per plant. The crosses SI-7818 x KMS 5-396, KKS-98049 x JCS-507, JCS-720 x KMS 5-396, KMR-108 x SI-3171recorded significant heterosis for 1000 seed weight in positive direction which also recorded considerable positive heterosis values for yield. So these crosses can be exploited to improve the yield along with one or more traits through heterosis breeding.

In conclusion, the hybrids PKDS-62 x IS 562 B and KKS-98049 x KMR-78 which exhibited significant heterosis for yield were found to be early as they recorded significant heterosis in desired direction. SI-7818 x SI-3171, PKDS-62 x IS 562 B and KKS-98049 x SI-3171 which recorded high heterotic values for seed yield also exhibited high values for its important yield component traits such as effective capsules per plant, number of effective primaries per plant and capsule length.

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