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Study of gene action and heterosis in monostem/shybranching genotypes in sesame (*Sesamum indicum* L.)

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Abstract

Eleven genotypes consisting of five lines (branched genotypes) and six testers (monostem genotypes) were crossed in a line x tester mating design. The resulting thirty hybrids were evaluated for general and specific combining ability, variance components and heterosis. The *sca* variance was greater than the *gca* variance for the traits days to 50 percent flowering, days to maturity, number of capsules, capsule length, number of seeds per capsule, 100-seed weight, seed yield per plant and oil content suggesting that these characters were governed predominantly by non-additive components. The GCA variances were predominant in plant height and number of branches, indicating that these characters were by and large governed by additive component of heritable variance. The line TMV3 showed high *gca* for seed yield, days to 50 percent flowering, days to maturity, plant height, number of capsules and oil content while the tester, KS 990812 recorded "significantly high *gca* effect for number of capsules. The specific combining ability effects showed that out of thirty hybrids, four hybrids *viz.,* CO 1 x Cordebergea, Paiyur 1 x KS 99153, TMV 4 x MT 34 and TMV 5 x KS 99037 showed significant positive *sea* effect for single plant yield. Regarding the branching characters all the thirty hybrids registered favourable *sea* effects. Heterosis was worked out over mid parent, better parent and standard parent CO1. The cross Paiyur1 x Cordebergea was early in flowering and duration, while the cross TMV5 x Cordebergea was having superior heterosis for monostem / shybranching nature with desirable seed yield per plant. TMV3 x KS 990813 was superior for number of capsules per plant and seed yield per plant. Paiyur Ix MT34 showed good performance for number of seeds per capsule and oil content with desirable heterosis for seed yield per plant. These superior crosses can be utilized for hybrid development.

Key words: Sesame, monostem/shybranching, combining ability and heterosis

Introduction

Sesame is one of the important and perhaps, the oldest of oil seed known to man. Although it has been cultivated for a long time, no significant increase in productivity has been achieved yet. This low productivity has been attributed to the occurrence of pests and diseases and also due to poor plant population. Population maintenance in branched types is easier as compared to unbranched types which could not become popular in any parts of the world probably for this reason. It is preferable to have uniculm/monostem/shybranching lines for high-density population for productivity improvement per unit area. Development of high yielding hybrid, may, therefore another option to overcome the present yield barrier of the crop. Considering the easy emasculation and availability of abundant pollen and large number of seeds/capsule, hand pollination and exploitation of heterosis is a feasible proposition in sesame.

The choice of the parents for hybridization can be made on the basis of combining ability as well as *per se* performance. Genetic information especially about the nature of combining ability is a prerequisite in fixing the suitable parents for heterosis breeding programme. Combining ability of genotypes gives useful genetic information regarding the selection of parents. It also helps in choosing suitable cross combination for recombination breeding. The magnitude of heterosis provides a basis for genetic diversity and guides to choice of desirable parents for developing superior hybrids. The main objective of this investigation was to identify good general and specific combiners and heterotic combinations for monostem/shybranching, yield and its component traits in sesame.

Materials and methods

In the present study, five genotypes *viz*., CO 1, Paiyur 1, TMV 3, TMV 4 and TMV 5 (branched) were crossed with six testers (menostem/shybranching) *viz*., MT 34, Cordebergea, KS 990812, KS 99037, KS 990813 and

KS 99153 using a line x tester mating design during December 2003-2004. The resulting 30 hybrids along with their parents were sown in a completely randomized block design in three replications during June 2004 (kharif season) at Department of Oil seeds, TNAU, Coimbatore. Each plot consists of three rows of 4m length spaced at 30 x 45 cm. Ten competitive plants were selected randomly from each plot from each replication for recording observation on days to 50 percent flowering, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, capsule length, number of seeds per plant, 100 seed weight, seed yield per plant and oil content. Days to 50 percent flowering, and days to maturity were recorded on plot basis. The data were subjected to combining ability analysis and estimation of variance components as suggested [1]. For all the characters, relative heterosis, heterobeltiosis and standard heterosis were estimated following Fonesca and Patterson[2]. The variety CO 1 was used as a standard parent.

Results and discussion

To exercise selection, variability among genotypes is a prerequisite. The analysis of variance for combining ability (Table 1) revealed significant divergence among the parents for all the characters excluding number of seeds per capsule and days to 50 percent flowering. Sumathi and Kalaimani [3] reported significant differences among parents for plant height, number of capsules per plant and seed yield per plant. Significant differences for number of primary branches have also been reported [4].

Partitioning of variance among the hybrids in the combining ability analysis revealed that the mean squares due to lines were highly significant for all the traits except for number of capsules per plant, 100-seed weight and number of seeds per capsule while the testers revealed highly significant differences only for the traits, number of capsules per plant and capsule length. This indicated that there was a good amount of genetic difference brought out by the lines. Line x Tester variance indicated that cross combinations were differentiating among themselves for all the characters except for plant height and number of primary branches per plant. Similar findings were reported for days to 50 per cent flowering and for number of capsules per plant and seed yield per plant.

Sufficient variability among the parents indicated that the parental combinations could generate potential and promising hybrids. The *sca* variance was greater than the *gca* variance for the traits days to 50 percent flowering, days to maturity, number of capsules, capsule length, number of seeds per capsule, 100-seed weight, seed yield per plant and oil content suggesting that these characters were governed predominantly by non-additive components. These components can be exploited by heterotic breeding programme. These findings support earlier observations [5] for days to 50 per cent flowering, capsules per plant and seed yield per plant.

The *gca* variances were predominant in plant height and number of branches, indicating that these characters were by and large governed by additive component of heritable variance. Under such situation improvement could be made following appropriate breeding programme of hybridization and selection, which may take care of fixable gene effect. This result is in conformity with those reported earlier for plant height and for number of branches per plant [6, 7].

Table 1. Analysis of variance for combining ability

		Mean squares							
		Days to 50 % flowering	Days to maturity	Plant height (cm)	No. of primary branches	No. of capsules/ plant	Capsule length	No.seeds/ capsule (cm)	100-seed weight
Lines (females)	4	43.93*	106.57*	1948.47**	40.73**	1244.87	0.165**	260.45*	0.0
Testers (males)	5	15.76	16.13	197.79	6.60	4938.79*	0.105*	104.92	0.0
Line x tester	20	14.99**	26.11**	102.14	3.75	1646.55**	0.034**	92.97**	0.0
Error	58	5.560	3.43	105.91	4.58	336.31	0.011	31.67	0.0
GCA		0.090	0.21	5.94	0.12	11.23	0.0007	0.55	0.0
SCA		3.143	7.56	–1.26	–0.277	436.75	0.0077	20.43	0.0
GCA/SCA		0.0286	0.0278	–4.714	–0.4332	0.0257	0.1	0.0269	0.0

*,**Significant at 5 % and 1 % levels, respectively

The estimates of *gca* effects (Table 2) indicated that the parental line TMV 3 and the tester KS 990812 are good general combiners for seed yield. In addition the line TMV3 showed high *gca* for days to 50 percent flowering, days to maturity, plant height, number of capsules and oil content while the tester, KS 990812 recorded significantly high *gca* effect for number of capsules. All the other parents recorded non-significant *gca* effect for seed yield except MT 34, which showed negatively significant *gca* effect for seed yield and number of capsules.

Considering the trait, number of primary branches, the line TMV 5 and the tester Cordebergea showed highly significant desirable (minimum number of branches) *gca* effects. The remaining lines and testers were moderately good general combiners for this trait except CO 1 and TMV 3. Good general combining parents have been reported for seed yield and primary branches by many researchers [3 and 8].

The specific combining ability effects (Table 3) showed that out of thirty hybrids, four hybrids *viz.,* CO 1 x Cordebergea, Paiyur 1 x KS 99153, TMV 4 x MT 34 and TMV 5 x KS 99037 showed significant positive *sea* effect for single plant yield. None of the hybrids had both the parents possessing high positive *gca* effects for seed yield. Regarding the branching characters all the thirty hybrids registered favourable *sea* effects. In addition, CO 1 x Cordebergea exhibited significant positive *sea* effect for number of seeds per capsule while, the hybrid TMV 4 x MT 34 showed significant *sea* effects for number of capsules per plant and 100-seed weight. The hybrid TMV 5 x KS 99037 recorded high *sca* effect for number of capsules per plant, none of the hybrids exhibited superior *sca* effects for all the characters.

Based on the above discussions the hybrid, TMV 5 x KS 99037 has been adjudged as superior hybrid in view of desirable *sca* effects and good general combining ability for the important economic characters followed by the hybrids namely CO 1 x Cordebergea, Paiyur 1 x KS 99153 and TMV 4 x MT 34. These hybrids will be selected as promising ones for recombination breeding to get desirable segregants with monostem/ shybranching genotypes along with high seed yield in early segregating generations.

Heterosis was calculated as percent increase or decrease over mid parent, corresponding better parent and standard parent. The range of three types of heterosis and number of crosses having desirable heterotic response for the characters studied are presented in Table 4. The top three crosses with highest relative heterosis, heterobeltiosis and standard heteriosis are presented in Table 5.

Table 2. Estimates of *gca* effects for different characters in sesame

Parents	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of primary branches	No. of capsules/ plant	Capsule length (cm)	Seeds/ capsule	100-seed weight
Lines								
CO 1	0.16	0.92*	1.29	1.47**	–2.19	0.00	–4.86**	0.0
Paiyur 1	–0.90	–0.36	0.96	–0.69	–11.01*	0.16**	5.36**	0.0
TMV 3	2.43**	3.20**	16.05**	1.72**	11.89**	–0.08**	–2.08	0.0
TMV 4	0.04	–0.24	–7.55**	–0.86	–1.41	–0.07**	0.80	–0.0
TMV 5	–1.73**	–3.52**	–10.76**	–1.64**	2.72	–0.01	0.77	–0.0
Testers								
MT3 4	–0.00	–0.40	–1.64	–0.90	–17.66**	–0.05	3.18	–0.0
Cordebergea	–1.27*	–1.20*	–5.36*	0.17	–27.32**	–0.09**	1.66	–0.0
KS 99037	–0.67	–0.27	5.24	0.07	12.16*	0.01	–2.35	0.0
KS 990815	0.40	–0.33	–0.25	–0.40	13.14**	–0.05	–3.94**	0.0
KS 990813	–0.20	–0.33	2.59	1.09	15.90**	0.13**	0.74	–0.0
KS99153	1.73**	1.87**	–0.58	1.02	3.78	0.05*	0.72	0.0
SE (Lines)	0.556	0.4364	2.4257	0.5046	4.3225	0.0241	1.3265	0.0
SE (Testers)	0.609	0.4781	2.6572	0.5528	4.7350	0.0264	1.4531	0.0

*,**Significant at 5 % and 1 % levels, respectively

Table 3. Estimates of *sca* effects for different characters in sesame

Hybrids	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	No. of primary branches	No. of capsule/ plant	Capsule length (cm)	Capsule breadth (cm)	Seeds/ capsule
CO 1 x MT 34	4.11**	3.68**	–1.61	0.29	–23.45*	–0.10	–0.01	–8.18*
CO 1 x Cordebergea	–1.29	–0.86	11.11	1.81	9.61	0.04	–0.01	7.71*
CO 1 x KS 99037	–0.22	–0.12	–3.17	–0.82	–19.68	–0.06	–0.02	–3.55
CO 1 x K.8990812	–0.29	–0.72	–5.14	–0.75	4.08	–0.00	0.00	–1.36
CO 1 x KS 990813	–0.69	–0.39	–2.14	–0.21	28.55**	0.14*	0.05	1.20
CO 1 x KS 99153	–1.62	–1.59	0.96	–0.33	0.91	–0.01	–0.01	4.18
Paiyur 1 x MT 34	0.17	–0.04	1.78	0.25	3.57	0.07	–0.03	3.94
Paiyur 1 x Cordebergea	–1.90	–4.24**	–4.36	–2.09	–3.71	–0.19**	–0.00	–3.97
Paiyur 1 x KS 99037	–1.83	–3.18**	1.27	0.28	–10.86	0.21**	0.02	6.70*
Paiyur 1 x KS990812	0.77	1.56	–3.68	0.29	2.83	0.04	0.01	4.86
Paiyur 1 x KS990813	2.70*	4.22**	2.32	0.29	0.43	–0.11	–0.01	–8.72**
Paiyur 1 x KS99153	0.10	1.69	2.66	0.97	7.73	–0.03	0.03	–2.81
TMV 3 x MT 34	–2.83*	–4.27**	–6.11	–0.96	11.41	–0.05	0.02	1.85
TMV 3 x Cordebergea	0.43	0.53	3.08	0.23	27.27*	0.02	–0.02	–0.63
TMV 3 x KS 99037	0.50	–0.07	–0.25	0.13	–7.89	–0.05	0.04	–4.63
TMV 3 x KS 990812	1.77	3.33**	9.90	1.60	–8.79	0.05	0.02	1.50
TMV 3 x KS 990813	0.70	1.67	1.74	0.44	4.64	0.03	–0.03	0.19
TMV 3 x KS 99153	–0.57	–1.20	–8.37	–1.45	–26.63*	0.01	–0.02	1.73
TMV 4 x MT 34	–1.11	–0.16	9.09	0.15	45.57**	0.10	0.02	2.96
TMV 4 x Cordebergea	5.16**	5.31**	–4.92	1.14	–11.90	–0.02	–0.02	–3.28
TMV 4 x KS 99037	–0.78	1.04	–4.52	–1.02	–5.85	–0.06	0.00	5.06
TMV 4 x KS 990812	–1.84	–2.22*	–3.63	–0.95	–9.76	–0.13*	–0.01	–8.98**
TMV 4 x KS 990813	–1.58	–2.22*	0.50	0.59	–18.26	0.02	–0.03	1.04
TMV 4 x KS 99153	0.16	–1.76	3.47	0.10	0.20	0.10	0.04	3.22
TMV 5 x MT 34	–0.33	0.79	–3.16	0.27	–37.09**	–0.02	0.01	–0.57
TMV 5 x Cordebergea	–2.40	–0.74	–4.91	–1.10	–21.27*	0.15*	0.04	0.18
TMV 5 x KS 99037	2.33	2.32*	6.66	1.43	44.28**	–0.05	–0.04	–3.58
TMV 5 x KS 990812	–0.40	–1.94	2.55	–0.20	11.64	0.05	–0.02	3.98
TMV 5 x KS 990813	–1.13	–3.28**	–2.42	–1.12	–15.36	–0.07	0.03	6.30
TMV 5 x KS 99153	1.93	2.86**	1.28	0.72	17.80	–0.06	–0.03	–6.32
SE	1.3613	1.0691	5.9417	1.2360	10.5879	0.0590	0.0319	3.2491

*,**Significant at 5 % and 1 % levels, respectively

The range of heterosis varied from –20.0 to 21.12 and –12.23 to 10.98 for days to 50% flowering and days to maturity, respectively, when all the three types of heterosis was considered. The cross Paiyur 1 x Cordebergea exhibited a significant negative heterosis over mid parent and better parent for both days to 50% flowering and days to maturity. The cross TMV 3 x KS 990812 recorded significant positive heterobeltiosis and standard heterosis for plant height. Heterosis ranged from –23.75 to 53.39. The similar results were reported by [9].

Heterosis for number of branches ranged from -23.75 to 53.39. Seventeen crosses expressed significant heterosis over CO 1 for monostem/shybranching. The cross TMV 5 x Cordebergea recorded negative heterosis

Table 4. Number of crosses showing desirable heterotic performance for branching nature and yield components

Items	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches	No. of capsules/ plant	Capsule length	Seeds/ capsule	100-seed weight
No. of crosses with desirable relative heterosis	2	2	23	2	25	6	2	15
No. of crosses with desirable heterobeltiosis	7	21	1	9	2	3	4	3
No. of crosses with desirable standard heterosis	10	21	2	17	2	20	4	2
Range of relative heterosis %	–13.53 to 21.12	–3.37 to 10.98	5.64 to 53.39	–9.20 to 76.69	–26.90 to 83.25	–9.68 to 15.58	–17.38 to 17.88	–9.47to 16.77
Range of heterobeltiosis %	–18.47 to 4.83	–12.23 to 1.49	–16.72 to 12.82	–51.41 to –2.03	–48.73 to 14.82	–13.25 to 10.26	–22.06 to 12.80	–14.16 11.80
Range of standard heterosis %	–20 to 9.03	–12 to 1.82	–23.75 to 9.58	–61.24 to 52.81	–38.61 to 21.58	–1.41 to 25.35	–16.75 to 33.70	–15.12 11.80

Table 5. Best three crosses showing high heterotic vigour for branching and yield components

Characters	Heterobeltiosis	Standard heterosis
Days to 50% flowering	Paiyur 1 x Cordebergea Paiyur 1 x KS 99037 MV 5 x Cordebergea	Paiyur 1 x Cordebergea Paiyur 1 x KS 99037 TMV 5 x KS 990813
Days to maturity	Paiyur 1 x Cordebergea TMV 5 x KS 990813 Paiyur 1 x KS 99037	Paiyur 1 x Cordebergea TMV 5 x KS 990812 TMV 5 x Cordebergea
Plant height	TMV 3 x KS 990812 - -	TMV 3 x KS 990812 TMV 3 x KS 99037 -
Number of primary branches	Paiyur 1 x Cordebergea TMV 5 x Cordebergea Paiyur 1 x MT 34	TMV 5 x Cordebergea TMV 5 x MT 34 TMV 5 x KS 990812
Number of capsules per plant	TMV3 x KS990813 CO 1 x KS 990813 -	TMV 5 x KS 99037 TMV 3 x KS 990153 -
Capsule length	CO 1 x KS 990813 Paiyur 1 x KS 99037 Paiyur 1 x KS 990813	Paiyur 1 x KS 99037 CO 1 x KS 990813 Paiyur 1 x KS 990813
Seeds/capsule	Paiyur 1 x MT 34 CO 1 x Cordebergea -	Paiyur 1 x MT34 TMV 5 x KS 990813 TMV 5 x MT34
100-seed weight	CO 1 x KS 99153 TMV 4 x Corebergea CO 1 x KS 990813	CO 1 x KS 99153 CO 1 x KS 990813 -
Seed yield/plant	CO 1 x Cordebergea CO 1 x KS 990812 TMV 3 x KS 990812	TMV 3 x KS 990813 CO 1 x KS 99153 TMV 5 x KS 99037
Oil content	Paiyur 1 x MT34 TMV4 x MT 34 TMV 4 x MT 34	Paiyur 1 x MT34 TMV 3 x Cordebergea -

both over better parent and standard parent. Heterosis for number of capsules per plant varied from -48.73 to 83.25. The cross TMV3 x KS 990813 showed positive heterosis over mid parent and better parent. The results are in agreement with the Jayaprakash and Sivasubramanian [10].

Heterosis for capsule length varied from –13.25 to –1.41. The crosses CO 1 x KS 990813, Paiyurlx KS 99037 and Paiyurlx KS 990813 recorded the significant positive relative heterosis, heterobeltiosis and standard heterosis. The crosses Paiyur 1 x MT 34 for number of seeds per capsule and CO 1 x KS 990813 and CO 1 x KS 99153 for 100 seed weight exhibited significant positive heterotic value on all the three bases.

The range of heteosis varied from –15.12 to 16.77 for seed yield per plant. Fifteen crosses expressed significant positive heterosis over the standard parent CO 1. The crosses TMV 3 x KS 990813 expressed high heterotic value for both relative heterosis and standard heterosis. It has also been reported by [11]. The cross Paiyurlx MT34 showed positive significant heterosis for all the three types of heterosis. Deepa sankar and Ananda kumar [9] reported relative and standard heterosis for this trait.

To conclude, The cross Paiyurlx Cordebergea was early in flowering and duration, while the cross TMV5 x Cordebergea was having heterosis for monostem/ shybranching nature with desirable seed yield per plant. TMV3 x KS 990813 was superior for number of capsules per plant and seed yield per plant. Paiyurlx MT34 was superior for number of seeds per capsule and oil content with desirable heterosis for seed yield per plant. These superior crosses can be utilized for heterosis exploitation.

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