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Per se PERFORMANCE AND COMBINING ABILITY IN SUNFLOWER *Helianthus annuus* L.

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ABSTRACT

A study was undertaken to assess the utility of inbred lines as parents in the heterosis breeding in Sunflower by adopting Line X Tester analysis. The *per se* performance of the parents and hybrids revealed that the hybrids in general were superior to the parents for 11 characters studied. Combining ability analysis revealed the preponderance of non-additive gene action for all the characters. The lines CMS 5A, CMS 1A and CMS 86 A3 and the testers MH 10, MH 20 and MH 12 recorded the highest GCA for most of the yield attributes. The inbreds CMS 1 A, CMS 86 A3, MH 10m MH 20 showed high GCA and mean values. Similarly in hybrids the SCA and mean expressions were high for the crosses CMS 290 A x MH 20, CMS 86 A3 x MH 2, CMS 86 A3 x MH 10 and CMS 1 A x MH 1.

KEY WORDS: Sunflower, *Per Se*, Combining ability, Inbreds

To achieve remarkable gains in the productivity of sunflower, combining ability for yield and its component traits is necessary. These studies are useful in identifying the superior parents which on combination would give rise to more desirable segregants. In the present investigation, combining ability was studied on different yield components for proper exploitation of the genetic material in breeding programme.

Table 1 Analysis of Variance (mean squares) for Combining ability in Sunflower

Characters	Parents df=14	Female df=4	Male df=9	Male Vs Female df=36	Crosses df=49	Parents Vs crosses df=1	Error df=192	GCA	SCA	GCA/SCA
Days to flowering	24.87**	33.82**	6.20**	156.41**	17.89**	9.70**	2.56	0.35	3.19	0.11
Days to fifty per cent flowering	29.90**	57.17**	6.78*	130.20**	17.86**	189.87**	2.73	0.51	2.79	0.18
Plant height	913.46**	1323.94**	832.05**	4.19**	413.36**	716.37**	9.10	0.22	103.09	0.002
Stem girth	0.15**	0.05**	0.17**	0.26**	0.10**	0.0012**	0.01	0.001	0.03	0.03
Head diameter	1.16	2.18	0.59	2.20	16.84**	356.11**	4.99	0.01	3.17	0.004
Number of leaves	36.98**	29.56**	44.33**	0.38	32.19**	10.80**	1.17	0.59	7.31	0.08
Hundred seed weight	1.71**	3.60**	1.05**	0.13	1.55**	1.85**	0.06**	0.09	0.26	0.30
Husk content per cent	12.18**	13.16**	6.08**	63.19**	29.87**	83.51**	0.10	0.75	6.61	0.11
Days to maturity	5.60**	2.30**	2.88**	43.20**	7.66**	34.59**	0.71	0.12	1.55	0.08
Oil per cent	9.40**	8.95**	10.63**	0.12	32.83**	54.46**	0.32	0.92	7.26	0.13
Yield per plant	166.99**	124.78**	204.30**	0.09	355.50**	388.95**	1.55	5.79	72.78	0.08

* Significant at 5% level

** Significant at 1% level

MATERIALS AND METHODS

For assesment of combining ability of the parents, five lines and 10 restorers were used. The genotypes used as lines were 290 A, 86 A3, 1A, 2A and 5A. These were crossed with 10 diverse pollinators *viz.*, MH 1, MH 2, MH 6, MH 10, MH 11, MH 12, MH 13, MH 20, MH 22. The parents along with the resultant 50 hybrids were evaluated in a randomised block design with four replications during summer 1995 at Tamil Nadu Agricultural University, Coimbatore. Each entry was raised in two rows of 4 m length in each replication. A spacing of 60 cm between rows and 30 cm between plants was adopted. The measurements were taken in five randomly selected competitive plants at each entry at appropriate stages for 11 characters *viz.*, days to flowering, days to fifty per cent flowering, days to maturity, plant height, stem girth, head diameter, number of leaves per plant, husk content, hundred seed weight, oil content and seed yield per plant. The oil content was estimated using nuclear magnetic resonance spectrometer (Oxford 4000 series) and expressed in percentage. The mean values were subjected to combining ability analysis and estimation of variance components as per line x teser mating design (Kempthorne 1957).

RESULTS AND DISCUSSION

The analysis revealed that the variances due to parents, lines and testers were highly significant for all the characters except head diameter (Table 1) and variances due to line x tester interaction shows significance for characters days to first flowering, days to fifty per cent flowering, plant height, stem girth, husk content and days to maturity. Thus it is evident that there exists the wide genetic variability in the selected inbred lines

Table 2. Mean expression of parents

Genotypes	Days to first flowering	Days to 50% flowering	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	Number of leaves per plant	100-seed weight (g)	Husk Content (per cent)	Days to maturity	Oil per cent	Yield per plant (g)
Lines											
CMS 290 A	46.50**	53.00	145.23**	2.12	10.34	25.65	2.89	26.13**	83.75**	39.16	26.98**
CMS 86 A3	52.75*	60.25**	182.00**	2.18	10.96	25.65	5.25	29.15	85.25	42.35	27.81**
CMS 1 A	46.00	50.50	160.85	2.12	11.74	22.25	5.07	26.55**	84.25	38.96	39.81
CMS 2 A	45.75*	52.25	146.42**	1.99**	10.20	20.15	4.82	24.15**	83.25**	38 96	26 18**
CMS 5 A	47.25*	52.50	183.01	2.28*	9.88	26.50	4.38	27.18**	84.50	38.86	29.79
Testers											
MH 1	53.50	59.00**	168.21	2.09	10.19	27.96	4.11*	30.25	86.50	38.16**	28 87
MH 2	50.75	57.25	179.47	2.01	9.61	28.10	4.26	29.65	86.50	37.66**	36 67
MH 6	51.50	56.75	154.95**	2.11	9.74	17.95	4.22	28.65*	85.50	40.26**	33.86
MH 10	49.50	55.25	182.13	2.14	10.50	24.73	5.44	29.85	85.00	39.46	37.97
MH 11	50.25	58.00	173.89	1.94**	10.73	25.05	4.04**	29.08	86.00	39.16	25.83**
MH 12	50.75	54.75	133.01**	1.54**	9.82	25.04	5.21	26.60**	84.50	42.06	21.63**
MH 13	51.00	56.00	156.30**	2.23	10.59	22.65	4.92*	30.12	87.00	36.91**	38.50
MH 14	49.50	56.50	160.30**	2.02	10.22	27.15	4.84	27.12**	85.50	40.65	19.84**
MH 20	51.50	56.75	161.57	1.74**	10.44	20.20**	4.06**	28.55*	87.00	40.36**	23.38**
MH 22	52.50*	58.00	172.41	2.16	10.35	22.90**	4.74	28.35	86.50	41.16	35.38
Mean (Parents)	49.93	55.78	164.07	2.04	10.35	24.15	4.55	28.10	85.40	39.61	30.17

for all the trials studied except head diameter, hence liable for combining ability analysis. For gene action, as the magnitude of SCA variance is greater than GCA variance and the ratio of GCA : SCA variance falls below one, it proposes the preponderance of non-additive gene action for the characters studied (Table 1). Similar results for these traits were reported by Kadkol *et al.* (1984), Sheriff *et al.* (1985) and Singh *et al.* 1986. This non-additive gene action indicates that the inbreds can be used for heterosis breeding to obtain better segregant and exploitation of hybrid vigour is also possible with these materials.

The analysis of inbreds for *per se* performance Table 2) shows that some genotypes expressed high mean values for many characters. Among lines, CMS 86 A3 (for plant height, stem girth, hundred seed weight, husk content, oil content) and CMS 1A (for girth, 100 seed weight, husk content and yield per plant) and in Tester MH 10 (for plant height, stem girth, 100 seed weight, oil content and yield per plant) expressed high values for the key characters. The inbreds, CMS 1A, MH 2, MH 6, MH 10, MH 13, MH 10 showed high values for yield. Similarly for general combining ability, the lines CMS 5 A, CMS 1A, CMS 86A3 were found to be good combines for many key characters and it testers, MH 10, MH 20, MH 12 had exhibited high GCA values for yield and other component traits. As per Kadambavanasundaram (1980), the parents with high GCA effects and high mean performance have better breeding value. Based on this, genotypes satisfying both the GCA effect and mean expression are considered for selecting superior parents. Accordingly, lines CMS 1A, CMS 86 A3, and inbreds MH 10, MH 20 and MH 22 were judged as the best parents and interpreted that crossing CMS 1A, CMS 86A3 with testers MH 10, MH 20 might result in superior segregants for the above said traits.

Table 3. Estimates of general combining ability effects of parents in sunflower

	Days to first flowering	Days to 50% flowering	Plant height (cm)	Stem girth (cm)	Head diameter (cm)	Number of leaves per plant	100-seed weight (g)	Husk Content (per cent)	Days to maturity	Oil per cent	Yield per plant (g)
Lines											
CMS 290 A	0.05	0.44*	1.84**	0.08**	-1.14	-1.90**	-0.20**	-0.07	-0.29*	-0.76**	-4.63
CMS 86 A3	1.40*	1.27**	1.40*	-0.07**	0.13	-0.70**	-0.36**	1.49**	0.66**	2.26**	2.72**
CMS 1 A	-0.17	-0.26	0.21	-0.03**	0.76*	0.68**	0.50**	-0.65**	-0.34**	-0.46**	0.89**
CMS 2 A	0.60**	-0.81**	-5.89**	-0.06**	-0.95**	0.16	-0.03	1.13**	-0.41**	0.71**	0.35*8
CMS 5 A	-0.66	-0.66**	2.86**	0.08**	-0.75*	1.76**	0.18**	-1.89**	0.31**	-1.74**	0.66**
Testers											
MH 1	0.58*	0.29	3.74**	0.03**	0.19	0.02	-0.64**	0.56**	0.29**	-5.95**	
MH 2	1.33**	1.49**	2.41**	-0.02**	-0.63	-0.51*	0.03	1.39**	1.26**	-0.64**	-0.45**
MH 6	-1.12**	-0.91**	-9.57**	-0.01**	-0.82	1.19**	0.14**	-1.85**	-0.09	-0.06	-5.33**
MH 10	-1.02**	-1.56**	3.76**	0.04**	0.30	0.27	0.28**	1.62**	-1.09**	0.23**	1.96**
MH 11	-0.12	0.69*	-0.83	0.04**	-0.60	1.36**	-0.21**	-1.14**	-0.14	1.57**	-0.25
MH 12	-1.27**	-0.91**	-1.68**	-0.08**	0.50	0.38	0.42**	-0.31**	-0.59**	0.76**	11.99**
MH 13	-0.88**	-1.51**	2.43**	-0.02**	0.36	-0.35	.06	0.55**	-0.59**	-0.72	1.73**
MH 14	1.73**	0.84**	2.74**	0.00	-0.30	-1.59**	-0.38**	-0.47**	-0.49**	0.92**	-5.46**
MH 20	0.93**	1.69**	2.42**	0.05**	0.29	0.63**	0.22**	-0.11**	0.06	1.51**	5.23**
MH 22	-0.12	-0.10	-1.10	-0.02**	-0.84*	-1.42**	-0.58**	-0.28**	1.06**	-1.42**	-3.45**

Table 4 Estimates of specific combining ability for seed yield in the crosses and desirable effects of component traits in sunflower

Male/Female	Seed yield per plant					# Component traits with desirable sca effects				
Parents	CMS 290 A	CMS 86 A3	CMS 1 A	CMS 2 A	CMS 5 A	CMS 290 A	CMS 86 A3	CMS 1 A	CMS 2 A	CMS 5 A
MH 1	9.91**	-4.57**	-5.33**	-1.67**	1.66**	1	3,9	4,6,7,8,10	1,3,4	3,4,9,10
MH 2	9.43	1.26**	-5.65**	-7.42**	-7.42**	5,8	1,2,3,4,5,9	4,7,8,9,10	3,10	1,2,4,10
MH 6	2.46	4.93**	-12.81**	2.54**	2.54**	3,4,6,7,8,10	6,10	2,9	8	4
MH 10	-0.53	8.03**	2.71**	-1.66**	-1.66**	1,2,3,7,10	4,8	4,10	6	3,4,8
MH 11	-11.03**	9.36**	1.60**	-9.81**	-9.81**	10	4,8	6	3,7,8,9,10	2,3,4,9
MH 12	5.37**	0.31	-3.95**	2.19**	2.19**	4,5,6,7	8	1,2,10	4,8	3,7,9,10
MH 13	-4.13**	-6.06**	5.96**	-7.82**	-7.82**	6,8	10	4,5,6,8	4,9	3,4,6,7,10
MH 14	2.77**	-4.66**	-2.64**	11.06**	11.06**	9	2,7,9	3,6,8	4	8,10
MH 20	-7,32**	-3.95**	19.48**	-6.19**	-6.19**	1,2,3,5,8,9	6,10	8	7,9,10	4,6,7
MH 22	-6.93**	-4.64**	1.18**	18.78**	18.78**	6,7,8,9	1,2,3,4,6,8,10	6,8	4,6,8	

1. Days to first flowering 2.Days to fifty per cent flowering 3. Plant height 4. Stem girth 5. Head diameter 6. Number of leaves 7. 100 seed weight 8. Husk Content 9. Days to maturity 10. Oil per cent

Among the hybrids, about 38 cross combinations showed significant mean expression for yield and the hybrid CMS 2 A x MH 10 had exhibited the highest value. The SCA effects of hybrids indicated that none of the hybrids showed significant SCA effect for all the traits. Nevertheless, majority of the hybrids and positive SCA effect for all the traits. Nevertheless, majority of the hybrids had positive SCA effects for two or more traits studied. In this study, the cross combinations CMS 86 A3 X MH 10, CMS 86 A3 X MH 2 and CMS 5 A x MH 12 had significant positive SCA values for seven characters including yield per plant (Table 4). This were followed by CMS 290 A X MH 6 and CMS 260 A X MH 20 for six traits each. Similarly the hybrids CMS 290 A x MH 10, CMS 1 A x MH 1, CMS 1 A x MH 2 expressed significant positive SCA for five characrters each. The SCA effect for seed yield (Table 4) revealed that 21 and 25 hybrids depicted positive and negative estimates respectively. The highest value of SCA effect for seed yield was given by the hybrid CMS 1 A x MH 20.

The best cross combinations were considered based on both *per se* performance and SCA effects. The crosses CMS 290 A x MH 20, CMS 86 A3 X MH 2, CMS 86 A3 X MH 10 and CMS 1 A x MH 1 were found to be the best giving high per se and SCA effects for yield and most of the yield attributing traits. Hence these aforementioned hybrids can be used and manipulated for further breeding programme.

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