COMBINING ABILITY STUDIES IN DIVERSE CMS SOURCES IN SUNFLOWER (HELIANTHUS ANNUUS L.)

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COMBINING ABILITY STUDIES IN DIVERSE CMS SOURCES IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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ABSTRACT

Combining ability studies were made in sunflower using line x tester analysis with seven diverse CMS lines (representing three cytoplasmic sources) and eleven testers. Analysis of variance revealed significant differences among the genotypes i.e., parents and hybrids. Non-additive type of gene action was found important for expression of all the characters studied. Among the lines, ARM 243B was found to be good general combiner for seed yield, oil content, oil yield, head diameter, number of filled seeds per head and 100 seed weight. R 272-1 and R-17 were good male parents for seed yield and oil yield. The cross combination PF-400A x P-356R was found to be promising for most of the characters such as seed yield, oil yield, early maturity, head diameter, stem diameter, number of filed seeds per head, seed filling per cent and 100 seed weight. Besides PET-1 source, other sources *viz.*, CMS PEF and CMS I used in the present investigation were equally efficient in expressing their fullest potential of yield and yield contributing characters.

INTRODUCTION

Yield is a complex character involving number of components each of which is polygenically controlled and thus susceptible to environmental fluctuations. Thus selection of parents for hybridization is therefore, a complex problem. Combining ability analysis helps in identification of suitable parents for further exploitation in breeding programmes. A wide range of variability and cytoplasmic male sterility are available in sunflower (*Helianthus annuus* L.). With a view to identify the lines with good combining ability and to identify the good specific crosses for further exploitation, the present investigation was under taken.

MATERIAL AND METHODS

In the present investigation eight CMS lines representing three diverse sources *viz.*, PET-1, the traditional cytoplasmic source, CMS I from *H. lenticularis* and CMS PEF from *H. petiolaris* ssp. *fallax viz.,* 243A (PET-1), ARM 245A (PET-1), ARM 238A (PET-1), 300A (PET-1) 302A (PET-I), IMS-1134 (CMS I), IMS-852A (CMS I) and PF-400A (CMS PEF) were crossed with eighteen elite inbred lines (developed by Directorate of Oilseeds Research, Hyderabad) in a Line x Tester design during *rabi* 2001-2002. The resultant hybrids were studied for maintainer/restorer reaction during *kharif* 2002 at Directorate of Oilseeds Research, Hyderabad, India. Based on the success of fertility restoration, a set of 77 hybrids (7 CMS lines x 11 inbred lines) were selected for further study. These hybrids were sown in a randomized block design with two replications along with their parents at College Farm, College of Agriculture, Hyderabad during *rabi,* 2002-2003. Data were recorded on days to 50% flowering, days to maturity, plant height, head diameter, stem diameter, number of filled seeds per head, number of unfilled seeds per head, seed filling per cent, seed yield per plant, 100 seed weight, oil content and oil yield.

The combining ability analysis was carried out following the model proposed by Kempthorne (1957). The covariance of half sibs and full sibs were used to obtain estimates of general and specific combining ability effects and their variances.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) for twelve characters indicated significant differences among the genotypes indicating wide diversity in the material. Mean sum of squares for crosses were also found to be significant for all the traits. Parents also showed similar behaviour. The significance of variance due to parents vs. crosses except for days to maturity and number of unfilled seeds per head suggested presence of heterosis in F_1s for most of the traits.

The mean sum of squares due to crosses was partitioned into lines, testers and interactions. The lines were found to be significant for all the characters except seed filling per cent and oil content, while the testers showed significant mean sum of squares for days to 50% flowering, days to maturity, plant height, number of filled seeds per head, 100 seed weight, seed yield and oil yield per plant. The interaction mean sum of squares were found to be significant for all the characters. The variance component due to specific combining ability (*sca*) was greater in magnitude than that of general combining ability (Table 1) for all the characters indicating predominance of non-additive type of gene action which is in agreement with the findings of Pathak *et al.* (1985), Sheriff *et al.* (1986) and Radhika *et al.* (2001).

The general combining ability effects (Table 2) indicated that the lines 302B and PF-400B were good combiners for days to 50 per cent flowering, days to maturity and plant height and the line ARM 243B was good combiner for seed yield, oil content, oil yield, head diameter, number of filled seeds per head and 100 seed weight. Among the male parents, R-274 and P-356R were recorded maximum negative *gca* effects for days to 50% flowering and days to maturity and R 272-1 and R-17 showed significant positive *gca* effects for seed yield and oil yield. These results were in agreement with those of Govindaraju *et al.* (1992), Alone *et al.* (1996) and Ashok *et al.* (2000).

Radhika *et al.* (2001) observed that *gca* for yield was related to *gca* for one or more yield components which was in conformity with the present study. The parents, which were good general combiners for economic traits, may be extensively used in hybridization programmes. The *sca* effects (Table 3) showed that no single cross showed maximum *sca* effects for all characters. The cross combinations PF-400A x R-273 for seed yield, oil yield and number of filled seeds per head, ARM 245A x 3376R for oil content, IMS-852A x R-298 for maturity, IMS-1B4 x R-856 for plant height, ARM 243A x R-856 for head diameter and stem diameter and 302A x R-856 for 100 seed weight recorded highest *sca* effects in desired direction.

The hybrid PF-400A x P-356R appears to be promising as it recorded significant *sca* effects for several traits which includes seed yield, oil yield, early maturity, head diameter, number of filled seeds per head, seed filling per cent and 100 seed weight. These results were in conformity with the earlier findings of Limbore *et al.* (1997), Bajaj *et al.* (1997), Ashok Kumar *et al.* (1998) and Devinder Pal Singh *et al.* (1999). In the majority of the crosses high *sca* effect was due to low x low, high x low and low x high combining parents which further substantiate the operation of non-additive gene action for the characters studied.

Besides PET-1 source, the other sources *viz.*, CMS PEF and CMS I sources used in the present investigation are equally efficient in expressing their fullest potential of yield and yield contributing characters. Thus breeders can safely use these sources to broaden the genetic base of CMS source and sunflower crop can be safeguarded from any eventuality of biotic and abiotic threats in future.

Table 1. Analysis of variance for combining ability for yield and yield components in sunflower

Source	df	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Stem diameter (cm)	Number of filled seeds per head	Number of unfilled seeds per head	Seed filling per cent	100 seed weight (g)	Seed yield per plant (g)	Oil content (%)	Oil yield per plant (g)
Replications	1	3.28	2.96	8.18	0.20	0.014	106.12	0.10	0.21	0.0005	0.66	3.17	0.39
Treatments	94	13.29**	16.35**	573.96**	5.23**	0.12**	46797.04**	4615.78**	138.93**	1.46**	173.27**	33.51**	25.23**
Parents	17	16.17**	18.52**	483.34**	8.88**	0.09**	29763.72**	6869.16**	259.49**	2.10**	106.22**	43.41**	7.34**
Parents Vs. Crosses	1	9.81**	0.59	13444.83**	100.91**	1.26**	832643.59**	107.75	1464.21**	37.05**	3893.11**	1320.21**	805.27**
Crosses	76	12.69**	16.07**	424.88**	3.15**	0.12**	40267.04**	4171.05**	94.52**	0.85**	139.32**	14.37**	18.96**
Lines	6	50.16**	58.97**	2087.40**	9.40**	0.59**	100396.62**	11040.31*	112.02	1.67**	329.85**	11.54	41.40*
Testers	10	41.00*	43.70**	527.57*	2.35	0.05	78917.47**	2197.05	119.91	2.40**	345.96**	19.31	46.88**
Lines x Testers	60	4.22**	7.13**	241.59**	2.66**	0.08**	27812.35**	3813.13**	88.54**	0.51**	85.83**	13.83**	12.07**
Error	94	1.33	1.06	16.03	0.56	0.005	536.25	111.16	2.71	0.03	2.15	1.00	0.34
Genetic components													
σ^2 *gca*		0.1478	0.1553	3.2022	0.0086	0.006	217.4993	6.2505	0.1044	0.0060	0.9341	0.0095	0.1240
σ^2 *sca*		1.4572	3.0388	111.9173	1.0323	0.0399	13635.9692	1850.1610	43.1146	0.2364	41.7033	6.4100	5.8316
σ^2 *gca* / σ^2 *sca*		0.1014	0.05 1 1	0.0286	0.0083	0.1504	0.0160	0.0034	0.0024	0.0254	0.0224	0.0015	0.0213

* Significant at 5 per cent level;
** Significant at 1 per cent level.

Table 2. Estimates of general combining ability (gca) effects for lines and testers for 12 traits in sunflower

PARENTS	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Stem diameter (cm)	Number of filled seeds per head	Number of unfilled seeds per head	Seed filling per cent	100 seed weight (g)	Seed yield per plant (g)	Oil content (%)	Oil yield per plant (g)
Lines												
ARM 243B	0.338*	0.59**	6.93**	0.31**	-0.01	19.73**	10.02**	-0.64**	0.38**	2.93**	0.60**	1.32**
ARM 245B	0.656**	0.91**	9.50**	0.50**	0.13**	23.37**	8.61**	0.27	0.32**	2.50**	-0.95*	0.64**
ARM 238B	1.292**	0.59**	13.39**	0.45**	0.21**	84.64*	-16.09**	3.72**	-0.01	3.75**	-0.02	1.38**
302 B	-2.799**	-2.99*	-11.72**	-1.34*	-0.17**	-116.63**	-18.43**	-1.26**	-0.36**	-6.98**	1 .00**	-2.43**
IMS-IB4B	1.156**	1.32**	-6.87**	0.37**	0.12**	-0.13	-16.61**	1.88**	0.04	0.14	-0.04	0.05
1MS-852B	0.70**	1.14*	-4.28**	-0.09	-0.04**	47.50**	43.02**	-3.23**	-0.20**	1.00**	-0.87**	0.14*
PF-400B	-1.34**	-1.58**	-6.94**	-0.20*	-0.22**	-58.49**	-10.52**	-0.74**	-0.16**	-3.34**	0.30**	-1.12**
SE(gi) Female	0.24	0.22	0.89	0.16	0.01	4.95	2.26	0.32	0.04	0.33	0.21	0.13
Testers												
R-273	1.53**	1.07**	-2.51*	0.60**	0.01	81.96**	-4.38	2.72**	-0.12*	2.98**	-2.15**	0.69**
R-274	.1 $9**	-3.00**	-2.81*	0.50*	-0.02	4.75	-1.59	-0.10	0.11*	1.00*	0.38	0.42*
P-356R	-1.89**	-1.85**	-4.32**	-0.37	-0.07**	-11.67	-17.16**	2.10**	-0.33**	-2.40**	-0.15	-0.95**
R-265	1.24**	1.42**	-4.91**	-0.38	-0.06**	-77.24**	9.47**	-3.65**	-0.72**	-6.85**	-0.47	-2.71**
3376R	1.10**	1.07**	-7.62**	-0.37	-0.08**	-154.31**	9.19**	-6.66**	-0.44**	-8.83**	0.86**	-3.21**
R- 1 7	-2.46**	-2.85**	1.04	0.07	0.05*	50.11**	-3.16	2.12**	0.49**	4.97**	-1.70**	1.40**
R-298	0.46	0.78**	7.06**	0.23	0.05**	56.39**	-12.27**	2. 79**	0.34**	4.02**	-0.38	1.35**
R-856	2.03**	2.00**	-5.07**	0.18	0.12**	10.96	1.05	1.18**	0.56**	2.50**	1.47**	1.48**
R-297	-0.46	0.35	5.25**	-0.62**	0.01	39.11**	23.40**	-1.26**	0.02	2.07**	1.33**	1.18**
R 272-1	-0.11	-0.21	1.44	0:32	0.03	78.61**	11.12**	0.82*	0.33**	5.48**	-0.18	2.00**
RHA-6D1R	1.39**	1.21**	12.46**	-0.17	0.05*	-78.67**	-15.66**	-0.06	-0.25**	-4.97**	0.99**	-1.65**
SE(gi) Male	0.30	0.28	1.12	0.20	0.01	6.21	2.83	0.40	0.05	0.41	0.26	0.17

* Significant at 5 per cent level ;
** Significant at 1 per cent level.

Table 3. Estimates of specific combining ability (sca) effects of promising crosses for 12 characters in sunflower

Crosses	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Stem diameter (cm)	Number of filled seeds per head	Number of unfilled seeds per head	Seed filling per cent	100 seed weight (g)	Seed yield per plant (g)	Oil content (%)	Oil yield per plant (g)
ARM 243B	0.338*	0.59**	6.93**	0.31**	-0.01	19.73**	10.02**	-0.64**	0.38**	2.93**	0.60**	1.32**
ARM 243A x 3376R	-1.69*	-2.02**	-2.66	-0.82	-0.14**	83.90**	13.76	2.14*	1.14**	.8.41**	-6.85**	1.44**
ARM 243A x R-856	-0.62	-0.45	22.48**	2.55**	0.38**	-135.87**	5.40	-5.92**	0.55**	-4.17**	-1.00	-2.00**
ARM 243A x R 272-1	3.01**	3.76**	-17.68**	-1.52**	-0.29**	151.48**	-47.16**	8.26**	0.12	9.05**	-0.49	3.24**
ARM 245A x R-265	0.34	0.79	0.65	-0.32	-0.02	171.70**	29.88**	2.00	0.59**	10.52**	-3.67**	2.89**
ARM245A x 3376R	0.48	0.65	11.90**	0.51	-0.10*	-64.22**	-14.32	-1.72	-0.04	-3.47**	5.03**	-0.33
ARM245A x RHA-6D1R	1.70*	2.01**	2.77	1.03	0.18**	130.63**	-59.97**	10.65	-0.72**	1.49	3.30**	1.46**
ARM 238A x R-265	-0.79	-0.38	-13.22**	-0.33	-0.08	-200.57**	59.09	-14.96**	-0.21	-9.29**	3.76**	-2.87**
ARM 238A x 3376 R	0.85	-0.52	-2.87	-0.05	0.01	22.50	10.37	1.54	-0.47**	-1.97	3.56**	0.01
ARM 238A x R-297	0.92	-0.31	6.54**	2.12**	0.23**	90.57**	-11.33	3.24**	0.44**	6.84**	0.55	2.90**
302A x P-356R	1.44	1.49*	-4.97	0.76	0.03	19.63	15.07*	-1.16	-0.13	0.50	3.96**	0.86
302A x R-856	1.01	0.63	9.54**	-0.22	-0.10*	-15.01	4.86	-1.93	1.15**	4.17**	0.90	1.70**
302A x RHA-6D1R	-0.34	1.92*	10.51**	0.61	0.31**	177.13**	27.57**	2.14*	1.00**	12.77**	-2.11**	4.41**
IMS-1B4 x R-274	-0.58	-2.18**	-3.57	-1.21*	0.004	182.70**	-20.81**	7.16**	0.50**	11.67*	-2.00*	3.77**
IMS-IB4 x R-856	0.05	-0.18	-21.90**	-1.40*	-0.49**	22.48	-44.45**	6.18**	-0.72*	-2.23*	0.47	-0.84
IMS-852A x P-356R	-0.55	-0.64	-0.94	-1.54**	-0.16**	70.99**	-20.88**	3.81**	0.70**	6.86**	-2.39**	1.88**
IMS-852A x R-298	-1.91*	-3.78**	7.74*	0.87	0.12*	-98.07**	37.22**	-6.34**	0.45**	-2.10	0.54	-0.53
IMS-852A x R-856	0.01	0.50	4.50	0.04	0.21**	190.35**	120.40**	-5.28**	-0.58**	5.56**	4.57**	3.54**
PF-400A x R-273	0.55	1.65*	18.71**	1.31*	-0.03	274.85**	8.88	5.15**	0.54**	15.62**	3.85**	7.00**
PF-400A x P-356R	-2.01*	-1.91*	3.36	1.09*	0.30**	93.49**	0.16	3.26*	0.37**	5.74**	0.55	2.31**
PF-400A x RHA-6D1R	-0.79	-1.98**	12.88**	2.02**	-0.01	80.49**	-20.33**	6.12**	0.89**	7.66**	-1.80	2.47**
SE (Sij)	0.80	0.74	2.97	0.54	0.05	16.43	7.51	1.07	0.14	1.10	0.71	0.45

* Significant at 5 per cent level;
** Significant at 1 per cent level.

REFERENCES

Alone, R.K. *et al.* (1996). *Indian J. Agric. Res.,* **30**: 215-220.
Ashok Kumar *et al.* (1998). *Ann. Agric. Res.,* **19**: 437-440.
Ashok, *S. et al.* (2000). *Crop Res.,* **20**: 457-462.
Bajaj, R.K. *et al.* (1997). *Crop Improv.,* **24**: 50-54.
Devinder Pal Singh *et al.* (1999). *J. Oilseeds Res.,* **16**: 38-42.
Govindaraju, T.A. (1992). *J. Oilseeds Res.,* **9**: 314-319.
Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Wiley and Sons, Inc, Delhi.
Limbore, A.R. *et al.* (1997). *J. Soils and Crops.,* **7**: 39-42.
Pathak, A.R. *et al.* (1985). *Indian J. Heredity.,* **17**: 12-22.
Radhika, P. *et al.* (2001). *J. Res. ANGRAU.,* **29**: 35-43.
Sheriff, N.M. *et al.* (1988). *Indian J. Agric. Sci.,* **55**: 315-318.