RESEARCH PAPER International Journal of Agricultural Sciences, Vol. 5 Issue 1, January to May, 2009 : 92-95

Combining ability analysis in restorer lines of sunflower (*Helianthus annuus* L.)

S.L. SAWARGAONKAR* AND M.K. GHODKE[1]
Department of Genetics and Plant Breeding, College of Agriculture, Marathwada Agricultural University, PARBHANI (M.S.) INDIA

ABSTRACT

Combining ability studies in sunflower were undertaken with a set of 8 x 8 half diallel excluding reciprocals for the characters days to 50% flowering, days to maturity, plant height, head diameter, pollen productivity, seed yield per plant, 100 seeds weight, filled seeds per head, husk content and oil content. The variance due to general and specific combining ability was highly significant for all the characters with the higher magnitude of the former. The parents were classified for their genetic worth in respect of different traits and prospects for use in hybridization programme. The majority of the hybrids showing positive sca effects mainly involved with positive better combining parents for seed yield per plant besides associated with desirable sca effects for component traits especially head diameter, number of filled seeds per head, plant height, pollen production crosses, 100 seeds weight, oil content. For husk content ten crosses recorded significant negative sca effect.

Key words : Combining ability, Sunflower, Restorer lines.

INTRODUCTION

Combining ability studies are frequently used by the plant breeder to evaluate parents and crosses for number of objectives. Sunflower (*Helianthus annuus L.*) is an important oilseed crop in India as well as in world. It is the fourth largest oil crop, after soybean, oil palm and rape seed (Fernandez-Martinez *et al.*, 2004). Evolution of high yielding hybrids requires identification of good combining restorer lines. The combining ability analysis like diallel studies provides a useful tool to the breeder in this direction. Therefore, the present study was undertaken to estimate the general and specific combining ability effects for the selection of potential of parents and crosses.

MATERIALS AND METHODS

The experimental material comprised of one set of half diallel crosses in sunflower, comprising eight diverse parents *viz.*, J/6 , DMLT-1Y, MR-1, 6 D-1R, NDR-1, LR-451, NDR-856, LR-3322 and their 28F_1s excluding reciprocals was grown at Oilseed Research Station, Latur in a Randomized Block Design with three replications. The plant to plant distance was kept at 30 cm. The per plant data obtained as the average of five randomly selected competitive plants of each genotype for days to 50% flowering, days to maturity, plant height, head diameter, pollen productivity, seed yield per plant, 100 seed weight, filled seeds per head, husk content and oil content (%) and were analyzed for combining ability as per method 2, Model I of Griffing (1956).

RESULTS AND DISCUSSION

The knowledge of combining ability helps in identifying superior parents and specific cross combinations, which can be exploited for different breeding purposes. In the present study 8 restorer lines were used for synthesis of 28 restorer hybrids. The results on analysis of variance for combining ability for ten characters are described (Table 1). The mean sum of squares due to general and specific combining ability were highly significant for all the characters studied, indicating the importance of both additive and non-additive gene effects in expression of these characters. The magnitude of general combining ability variances was larger than specific combining ability variances for all characters indicating predominance of additive gene action. The results on general and specific combining ability effects for parents and hybrids, respectively are presented in Table 2 and 3.

The estimates of gca effects of parents:

Four parents out of 8 parents exhibited negative significant gca effect for plant height. Parent 6D-1R exhibited highest negative gca effect (-7.37) followed by NDR-856 (-4.40). Three parents exhibited significant gca effects for head diameter. J/6 exhibited high positive gca effect (1.82) followed by NDR-1 (0.65) and DMLT-1Y (0.55), respectively. Hence, J/6, NDR-1 and DMLT-1Y were considered to be good general combiners for head diameter. Four parents exhibited positive significant gca effect for pollen productivity. The parent J/6 exhibited high positive gca effect (0.09) followed by 6D-1R (0.07), MR-1 (0.04) and NDR-1 (0.03). Hence, J/6, 6D-1R,

* **Author for correspondence.** [1]Oilseed Reasearch Station, LATUR (M.S.) INDIA

Table 1 : Analysis of variance for combining ability

Source of variation	df.	Mean sum of square									
		Days to 50% flowering	Days to maturity	Plant height (cm.)	Head diameter (cm.)	Pollen productivity / plant (g)	Yield /plant (g)	100 seed weight (g)	Filling (%)	Husk content (%)	Oil content (%)
gcs	7	91.71**	39.51**	382.27**	11.55**	0.049**	208.12**	2.18**	85.33**	329.07**	22.76**
sca	28	4.96**	5.93**	254.42**	6.47**	0.048**	72.86**	0.89**	75.48**	139.38**	5.91**
Error	70	1.51	2.69	7.88	0.50	0.001	1.97	0.04	7.43	7.76	1.01

* and ** indicates significance of values at P=0.05 and 0.01, respectively

Table 2 : Estimates of GCA effects of parents

Sr. No.	Parents	Days to 50 % Flowering	Days to Maturity	Plant Height (cm.)	Head Diameter (cm.)	Pollen Productivity/ plant (g)	Yield /plant (g)	100 seed weight (g)	Filling (%)	Husk Content (%)	Oil Content (%)
1.	J/6	-3.04**	-3.04**	11.87**	1.82**	0.09**	9.73**	0.52**	5.77**	-6.7**	0.97**
2.	NDR-856	3.03**	2.13*	-4.40**	-0.05	-0.06**	-3.04**	-0.41**	-0.27	-1.13	-1.79**
3.	MR-1	0.39	-1.07*	1.40	-0.88**	0.04**	-1.44**	-0.34**	0.07	-4.2**	-2.56**
4.	6D-1R	1.19**	1.69*	-7.37**	-1.58**	0.07**	-2.01**	0.05	-4.03**	-2.0*	1.46**
5.	DMLT-1Y	-5.01**	-2.54**	1.33	0.55*	0.02*	2.13**	0.89**	2.17**	5.0**	0.88**
6.	NDR-1	4.29**	1.46*	-3.87**	0.65**	0.03**	0.59	-0.21**	-1.07	10.80**	-0.8**
7.	LR-451	-0.01	1.09	-3.60**	0.32	-0.11**	-5.54**	-0.32**	-1.97*	-4.13**	0.82**
8.	LR-3322	-0.84*	0.29	4.63**	-0.82**	-0.06**	-0.41	-0.18**	-0.67	2.27**	1.02**
	S.E.(m) (gi)	0.363	0.485	0.831	0.211	0.009	0.415	0.066	0.806	0.823	0.296
	S.E. (m) (gi-gj)	0.549	0.733	1.256	0.318	0.014	0.627	0.099	1.219	1.245	0.448

* and ** indicates significance of values at P=0.05 and 0.01, respectively

MR-1 and NDR-1 were considered to be good general combiners for high pollen production. For seed yield per plant two parents exhibited highly significant positive gca effects. Parent J/6 exhibited highly significant positive gca effect 9.73 followed by DMLT-1Y (2.13). Parents J/6 and DMLT-1Y were considered as good general combiners for this trait. Out of 8 parent's two parents have shown significant positive gca effect for 100 seeds weight. Parent DMLT-1Y (0.89) exhibited highest significant positive gca effect followed by J/6 (0.52) and can be considered as good general combiners for test weight. Eleven crosses have exhibited significant positive gca effects for 100 seed weight. Only two parents exhibited positive gca effect for per cent filled seeds per head. Parent J/6 (5.77) and DMLT-1Y (2.17) can be considered as good general combiner for per cent filled seeds per head. Four parents have recorded significant negative gca effect for husk per cent. Parent J/6 (-6.71) exhibited highest significant negative gca effect followed by LR-451 (-4.13), MR-1 (-4.21) and 6D-1R (-2.0). Only five parents out of 8 have recorded significant positive gca effects for oil content. Parent 6D-1R has exhibited significant positive gca effect (1.46) for oil content, followed by LR-3322 (1.02), J/6 (0.97) and DMLT-1Y (0.88) and LR-451 (0.82) as good general combiners.

The estimates of sca effects of crosses :

The crosses *viz.* 6D-1R x NDR-1 (-20.43) followed by MR-1 x NDR-1 (-17.87) and DMLT-1Y x LR-451 (-5.40) exhibited significant negative sca effect for plant height which is considered as good specific combiners for dwarf ness. For head diameter ten crosses have shown significant positive sca effect. Cross NDR-1 x LR-451 showed highest sca effect (4.94) followed by NDR-856 x DMLT-1Y (3.74), NDR-856 x LR-3322 (3.44) and J/6 x LR-451 (2.77 g). For pollen production fourteen crosses have shown significant positive sca effect (Kumar and Yadav, 1985). Cross NDR-856 x 6D-1R (0.37) have showed highest sca effect followed by NDR-856 x DMLT-1Y (0.29), NDR-1 x LR-3322 (0.28), MR-1 x 6D-1R (0.23) and J/6 x LR-3322 (0.22). Fourteen crosses out of 28 have exhibited significant sca effects for seed yield per plant, in desired positive direction. The cross 6D-1R x LR3322 has recorded highest significant positive sca effects (14.81,) followed by crosses NDR-856 x DMLT-1Y (12.31), J/6 x NDR-1 (11.75), MR-1 x 6D-1R (9.85), J/6 x MR-1 (9.11) and NDR-1 x LR-451 (9.01) indicating as good specific combiners for seed yield

Table 3 : Estimates of SCA effects of crosses

Sr. No.	Crosses	Days to 50% flowering	Days to maturity	Plant height (cm.)	Head diameter (cm.)	Pollen productivity / plant (g)	Yield / plant (g)	100 seed weight (g)	Filling (%)	Husk content (%)	Oil content (%)
1.	J/6 x NDR-856	-0.92	-1.94	9.20**	-0.53	0.08**	7.71**	0.87**	2.80	-1.08	4.21**
2.	J/6 x MR-1	-1.29	-2.08	9.73**	0.64	0.02	9.11**	0.62**	2.13	-4.68	-1.70*
3.	J/6 x 6D-1R	-4.09**	-2.51	0.83	1.01	0.20**	8.35**	1.15**	12.56**	-1.55	-1.48
4.	J/6 x DMLT-1Y	1.45	0.06	0.47	-0.13	-0.24**	0.55	-0.39	1.70	-3.55	-2.50**
5.	J/6 x NDR-1	2.15	3.72*	10.00**	-0.89	0.12**	11.75**	0.04	0.26	-7.68**	0.05
6.	J/6 x LR-451	1.78	3.42*	-0.93	2.77**	-0.18**	-3.79**	-0.84**	-14.50**	4.59	-0.03
7.	J/6 x LR-3322	1.95	2.22	8.17**	1.24	0.22**	3.08*	0.16	6.20*	-8.15**	1.13
8.	NDR-856 x MR-1	1.65	0.42	10.67**	-1.83**	-0.27**	-1.12	-0.41*	3.83	-2.81	-2.06*
9.	NDR-856 x 6D-1R	-1.82	-1.34	13.43**	2.21**	0.37**	-2.89**	0.05	4.93*	5.32*	-0.74
10.	NDR-856 x DMLT-1Y	1.38	0.56	16.07**	3.74**	0.29**	12.31**	0.39	-6.94**	-4.35	0.51
11.	NDR-856 x NDR-1	4.41**	-0.78	11.93**	0.97	-0.05	-1.82	1.93**	-10.04**	-10.48**	3.55**
12.	NDR-856 x LR-451	-1.29	-0.74	10.33**	2.64**	0.16**	-4.02**	0.45*	9.20**	0.79	-1.24
13.	NDR-856 x LR-3322	1.88	0.06	7.43**	3.44**	-0.09**	-3.15*	0.07	1.90	-10.28**	-2.49**
14.	MR-1 x 6D-1R	-2.52*	1.19	17.30**	2.04**	0.23**	9.85**	-0.44*	1.93	-1.95	-1.71
15.	MR-1 x DMLT-1Y	0.35	1.76	4.60	1.91**	0.21**	7.71**	0.75**	4.06	-9.61**	-1.24
16.	MR-1 x NDR-1	0.05	-2.91	-17.87**	1.47*	0.03	-7.09**	-0.04	-6.04*	11.92**	1.69
17.	MR-1 x LR-451	-132	-2.21	3.20	-0.53	-0.11**	2.71*	0.45*	0.53	3.52	-1.51
18.	MR-1 x LR-3322	-0.15	1.26	11.30**	0.27	0.14**	4.25**	0.99**	13.23**	5.12*	1.32
19.	6D-1R x DMLT-1Y	0.88	0.66	-0.30	0.27	0.12**	-3.39**	1.88**	7.16**	-15.15**	3.59**
20.	6D-1R x NDR-1	1.25	-0.34	-20.43**	-0.830	0.08**	-3.85**	0.40	-9.27**	31.39**	-4.85**
21.	6D-1R x LR-451	4.21**	4.36**	14.30**	-3.16**	-0.06*	-1.72	-0.83**	-14.04**	-6.01*	-0.25
22.	6D-1R x LR-3322	-2.62*	-4.84**	-0.60	-1.69**	0.03	14.81**	0.42*	10.66**	-11.08**	-4.48**
23.	DMLT-1Y x NDR-1	-1.22	-1.44	20.87**	-1.63*	0.04	2.35	-0.38	4.53	-22.95**	-0.53
24.	DMLT-1Y x LR-451	1.75	-0.41	-5.40*	-0.29	0.03	-1.85	0.20	4.10	-3.01	0.91
25.	DMLT-1Y x LR-3322	-2.09	5.06**	-2.30	-0.16	-0.12**	-1.99	-1.42**	-3.20	14.92**	-1.02
26.	NDR-1 x LR-451	-1.22	0.59	12.80**	4.94**	0.21**	9.01**	0.70**	16.66**	-10.48**	1.01
27.	NDR-1 x LR-3322	-.039	0.72	7.23**	2.74**	0.28**	3.88**	0.13	-6.97**	-4.88	0.02
28.	LR-451 x LR-3322	-0.09	-1.58	7.97**	-0.26	-0.01	2.68*	-0.13	-0.40	-2.95	1.64
	S.E. ± (Sij)	1.14	1.48	2.547	0.644	0.029	1.272	0.201	2.472	2.526	0.909
	S.E. ± (Sij-Sik)	1.648	2.202	3.768	0.953	0.043	1.882	0.298	3.666	3.737	1.345
	S.E. ± (Sij-Skl)	1.554	2.075	3.553	0.898	0.041	1.779	0.281	3.448	3.523	1.268

* and ** indicates significance of values at P=0.05 and 0.01, respectively

per plant. Highest significant positive sca effect of 100 seed weight was exhibited by NDR-856 x NDR-1 (1.93) followed by cross 6D-1R x DMLT-1Y (1.88), J/6 x 6D-1R (1.15), MR-1 x LR-3322 (0.99), J/6 x NDR-856 (0.87) and NDR x LR- 451 (0.70). These crosses may be considered as good specific combiners for 100 seed weight. Seven crosses out of 28 crosses have shown significant sca effect for filled seed per head. Cross NDR-1 x LR-451 has showed highest significant effect (16.66) followed by MR-1 x LR-3322 (13.23), J/6 x 6D-1R (12.56) and 6D-1R x LR-3322 (10.66). Ten crosses have recorded significant negative sca effects for husk per cent. The cross DMLT-1Y X NDR-1 has showed highest significant sca effect (-22.95) followed by 6D-1R x DMLT-1Y (-15.15), 6D-1R x LR-3322 (-11.08), NDR-1 x LR-451 (-10.48) and NDR-856 x NDR-1 (-10.48). Out of 28 crosses, three crosses have shown significant positive sca effect for this character. Cross J/6 x NDR-856 showed highest significant sca effect (4.21) for oil content followed by crosses 6D-1R x DMLT-1Y (3.59) and NDR-856 x NDR-1 (3.55) indicating that these crosses can be considered as good specific combiners for oil content (Putt, 1966). Sindagi *et al.* (1979) and Madrap *et al.* (1994) have reported significant desirable sca effects for days to maturity, filled seeds per cent and 100 seed weight. Andrei (1998) and Bhat *et al.* (1997) reported significant desirable sca effects for pollen productivity. They further reported that these crosses involved poor, average and high general combiners.

The parents J/6 was observed to be one of the best general combiners as it has shown significant gca effect for all characters except plant height followed by the parent DMLT-1Y for all the character except plant height, pollen productivity and husk percentage. The other parent *viz.* 6D-1R for high oil content, pollen productivity and dwarf plant height, NDR-1 for head diameter, pollen productivity and dwarf plant height. Parent LR-451 for low husk percentage, oil content and dwarf plant height. MR-1 for high pollen productivity and low husk content. The cross NDR-1 x LR-451 exhibited significant sca for the characters *viz.*, seed yield, 100 seed weight, head diameter, pollen productivity, seed filling per cent and low husk per cent followed by the cross 6D-1R x LR-3322. The cross 6D-1R x LR-3322 also exhibited significant sca effect for other yield contributing characters like days to 50 per cent flowering, days to maturity, low husk content and high seed filling percentage which indicated scope for exploiting this cross for earliness. The crosses which exhibited high per se performance, high heterosis, high sca in addition to high gca in both or at least in one parents were J/6 x NDR-1, 6D-1 R x DMLT-1Y, NDR-1 x LR-451, NDR-856 x 6D-1R, MR-1 x NDR-1. These R x R crosses may be used in breeding programme for the development of new 'R' line for getting more yield contributing characters. Also it is suggested that simple recurrent selection or biparental mating followed by reciprocal recurrent selection among the different crosses having desirable yield components may be effective in genetic amelioration of the characters under study.

REFERENCES

Andrei, E. (1998). Determination of the pollen amount in pollen fertility restorer sunflower inbred lines. *Cercetari-Agronomica Moldova*, **31**(3/4): 111-120.

Bhat, S., Vyakaranhal, B.S., Giriraj, K. and Nadaf, H.L. (1997). Effect of nipping and chemical application on pollen production of 6D-1 restorer line of sunflower hybrid KBSH-1 (*Helianthus annuus* L.). *Karnataka J. Agric. Sci.*, **10** (4) : 1246-1248.

Fernandez-Martinez, J., Velasco, L. and Perez-Vich, B. (2004). Progress in genetic modification of sunflower oil quality. Proc. 16th intercropping system. Sunflower conferemce Fargo, North Dakota, U.S.A., **2** : 1-14.

Griffing, B. (1956). Concepts of general and specific combining ability in relation to diallel crosses systems. *Aust. J. Biol. Sci.*, **9** : 463-493.

Kumar, D. and Yadav, L.S. (1985). Line x tester analysis for certain quantitive traits in brown sarson on normal and alkaline soils. *Sabrao. T.*, **17** : 21-28.

Madrap,I.A., Nerkar, Y.S., Makne, V.G. (1994). Extent of heterosis for seed yield in sunflower over three seasons. *J. Maharashtra agric. Univ.*, **19** (2) :201-203.

Putt, E.D. (1966). Heterosis, combining ability and predicted synthetics from a diallel cross in sunflower. *Can. J. Plant Sci.*, **46** : 59-67.

Sindagi, S.S., Kulkarni, R.S. and Seetharam, A. (1979). Line x tester analysis of the combining ability in sunflower. *Sunflower Newsletter*, **3** :11-12.

Received : February, 2008; Accepted : October, 2008