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RESEARCH ARTICLE

ESTIMATION OF COMBINING ABILITY STUDIES IN SUNFLOWER (*Helianthus annuus* L.)

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ABSTRACT

Combining ability studies were made in sunflower using line x tester analysis with four diverse CMS lines and four tester. Analysis of variance revealed significant difference among genotype i.e., parents and hybrids. The estimation of Specific Combining Ability (SCA) variance was higher than General Combining Ability (GCA) variance, for all the characters except head diameters which indicate non additive gene action had more effect. The parents CMS-850 A, CMS-234 A and R-363 can be considered as superior parents with respect to seed yield and oil content. The crosses CMS-850 A x R-363 and CMS-89-1A x R-351 can be considered as the most promising crosses since they observed high per se performance and significant gca and sca effect for major characters.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop cultivating for its premier oil for manifold uses. Sunflower competes in the world oilseed scenario with the other three major oilseed crops viz. soybean, groundnut and rapeseed. In India, sunflower is predominantly cultivated in Karanataka, Andhra Pradesh and Maharashtra. It is grown in an area of 7.27 lakh hectare with a production of 5.00 lakh lakh tones and a productivity of 692 kg/ha (Anony. 2012-13). Its productivity is much lower than the world average. Thus received a great attention of breeders for genetic improvement as it has shown greater production potential under varying environments. For the success of any breeding programme the basic need is selecting proper parents for hybridization. Combining ability analysis provides information related to gene action controlling the quantitative characters and helps the breeder in the choice of suitable parents. The analysis of General Combining Ability (GCA) and Specific Combining Ability (SCA) helps in identifying potential lines/hybrids for the production of superior hybrids. The line X tester analysis (Kempthorne, 1957) is one of the simplest and efficient methods of evaluating a large number of inbreds for their combining ability and *per se* performance.

MATERIALS AND METHODS

Four CMS lines CMS234A, CMS-89-1A, CMS-821A and CMS-850 A were crossed with newly developed four restorer lines (R-351,R-363, R-545 and R-519) according to line x tester mating design during the kharif season of 2012-13 at Oilseeds Research Station, Latur (M.S.). Sixteen hybrids so produced were evaluated along with parents in a randomized block design with two replications during rabi 2012-13 for ten morphological and quantitative characters to estimate combining ability effects. The mean values were subjected to line x tester analysis (Kempthorne 1957) to estimate combining ability effects and variances. Each replication comprising 25 entries (16 F_1s and 9 parents including one check) were sown in 4.5 m x 3.0 m plot maintaining plant to plant distance 30 cm and row to row distance 60 cm with recommended package of practices. Observations were recorded on five randomly selected plants from each plot of all replications to record data on the following characters days to 50 % flowering, days to maturity, plant height, head diameter, seed filling, hull content, 100 seed weight, oil content, seed yield per plant and volume weight.

RESULTS AND DISSCISSION

The estimates of combining ability revealed that variation due to lines and testers was significant for all the traits (Table 1 & 2). The interaction effect (line x tester) was significant for all the traits. Variance due to SCA was greater than the variance due to GCA except head diameter indicating the predominant role of non-additive gene action for all the characters. Similar results were reported by Nehru (1993), Burli *et al.* (2001), Ravi-Rana *et al* (2004) and Devi *et al* (2005). The first important criterion of selection is per se performance of hybrids. There were significant differences among the hybrids.

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Table 1. Analysis of variance for parents and crosses for ten characters in sunflower

Characters	SOURCE								
	Replications 1 (d.f)	Treatments 23 (d.f)	Parents 7 (d.f)	CMS lines 3 (d.f)	Tester 3 (d.f)	Line v/s Tester 1 (d.f)	Parent v/s Crosses 1 (d.f)	Crosses 15 (d.f)	Error 23 (d.f)
Days to 50 % flowering	0.7500	37.252**	78.250**	24.166**	4.333**	462.25**	68.343**	16.047**	2.445
Days to maturity	0.520	37.3251**	87.82**	87.458**	32.12**	256**	82.510**	10.747**	2.999
Plant height (cm)	24.083	298.97**	532.37**	641**	262.54**	1016**	490.962**	177.248	11.229
Head dia. (cm)	0.128	3.6056**	3.55**	2.67**	5.27**	1.015**	20.2492**	2.520**	0.2579
Seed yield / Pl. (g)	0.2214	199.98**	51.77**	16.57**	95.54**	26.08**	717.46**	167.98**	1.057
Seed filling %	1.333	30.576**	44.49**	10.79**	47**	138**	68.3437**	21.56**	2.2898
100- seed wet.(g)	0.0256	1.945**	0.5932**	0.7408**	0.570**	0.218**	6.211**	2.292**	0.080
Volume wet. (g)	0.7650	26.650**	52.593**	34.246**	8.827**	238.93**	1.4089**	16.22**	0.9072
Hull content (%)	2.755	6.6612**	8.4634**	13.13**	4.81**	5.40**	5.7037**	5.8840**	1.4543
Oil content (%)	0.100	17.3546**	12.53**	4.12**	7.72**	52.20**	5.752**	20.37**	0.3151

** and * indicates significant at 1% and 5%, respectively.

Table 2. Variance for General and Specific combining ability

Characters	δ^2 gca (f)	δ^2 gca (m)	δ^2 gca (ave.)	δ^2 sca	δ^2 gca/sca
Days to 50 % flowering	0.4065	2.7399	1.5732	7.140**	0.2203
Days to maturity	-0.1418	1.5144	0.6863	4.6272**	0.1483
Plant height (cm)	16.4814	20.4936	18.4875	89.0488**	0.2076
Head diameter (cm)	0.5571**	0.5283**	0.5427**	0.4382**	1.2384
Seed yield / plant (g)	21.3863	22.4493	21.9178	80.65**	0.2717
Seed filling %	4.3427	1.780	3.0614	7.8985**	0.3876
100 seed weight (g)	0.3840	0.4087	0.3965*	0.7859**	0.5044
Volume weight (g)	5.5818**	-0.076	2.7526**	5.425**	0.5074
Hull content (%)	0.4484	0.2085	0.3285	2.8155**	0.1167
Oil content (%)	4.888	0.9765	2.9323	8.900**	0.3295

** and * indicates significant at 1% and 5%, respectively.

Table 3. Estimates of General Combining Ability (GCA) effects for lines and testers for 10 traits in sunflower

LINES	Characters									
	Days to 50 % flowering	Days to maturity	Plant height	Head diameter	Seed filling%	100 seed weight	Hull content %	Seed yield / plant	Volume weight (g)	Oil content %
CMS-234 B	-0.531	-0.531	5.484**	0.352 *	0.969	0.904**	0.588	5.319**	-2.416**	-1.27**
CMS-89-1 B	1.094	0.344	-4.216 **	0.764 **	2.469 **	-0.525**	-0.838	-1.437**	-0.013	0.778**
CMS-821 B	-0.781	-0.281	-2.216	-0.090	-1.031	-0.285**	0.763	-5.592**	-0.822**	-2.247**
CMS-850 B	0.219	0.469	0.947	-1.026 **	-2.406 **	-0.094	-0.513	1.710**	3.252**	2.741**
SE ±	0.5529	0.6123	1.1848	0.1796	0.5350	0.100	0.426	0.363	0.336	0.198
TESTER										
R – 351	-1.031	0.094	-2.803 **	-0.538 **	-1.781 **	-0.226*	-0.450	3.673**	-0.277*	-0.072
R – 363	2.094 **	1.844 **	-3.478 **	0.638 **	-0.156	0.965**	0.725	4.518**	0.083	1.403**
R – 519	-1.781 **	-0.531 **	6.747**	0.650 **	1.719 **	-0.346**	-0.587	-3.707**	0.160	-0.972**
R – 545	0.719	-1.406 **	-0.466	-0.750 **	0.219	-0.393	0.312	-4.483**	0.034	-0.359
SE ±	0.5529	0.6123	1.1848	0.1796	0.5350	0.100	0.426	0.363	0.336	0.198

** and * indicates significant at 1% and 5%, respectively.

Table 4. Estimates Specific Combining Ability (SCA) effect for ten character in sunflower

Sr. No.	Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Seed yield / plant (g)	Seed filling (%)	100 seed weight (g)	Volume weight (g)	Hull content (%)	Oil content (%)
	Crosses	1	2	3	4	5	6	7	8	9	10
1	CMS-234 A x R-351	-2.594 *	-0.469	-11.497**	0.241	-7.518 **	0.281	-1.015 **	-1.630 *	0.038	-1.028 *
2	CMS-234 A x R-363	-0.219	-0.719	9.178**	0.005	6.737 **	2.156	0.919 **	-0.110	0.812	0.697
3	CMS-234 A x R-519	0.156	0.656	-6.797*	-0.918 *	1.102	-0.719	-0.080	1.512 *	-1.875 *	-2.778 **
4	CMS-234 A x R-545	2.656 *	0.531	9.116**	0.672	-0.322	-1.719	0.176	0.228	1.025	3.109 **
5	CMS-89-1 A x R-351	-0.219	0.656	-0.797	0.658	12.398 **	-4.219 **	1.164 **	1.812 *	-1.688	5.272 **
6	CMS-89-1 A x R-363	-0.844	-0.094	2.428	-0.238	-6.437 **	-0.844	-1.513 *	-0.698	-0.412	-2.053 **
7	CMS-89-1 A x R-519	-1.469	-1.219	8.403**	0.030	-2.317 **	2.281 *	0.144	-3.485 **	-0.400	-0.628
8	CMS-89-1 A x R-545	2.531 *	0.656	-10.034**	-0.450	-3.645 **	2.781 *	0.205	2.371 **	2.500 *	-2.591 **
9	CMS-821 A x R-351	1.656	2.281	5.953*	-0.318	8.258 **	-0.219	0.334	1.546 *	0.863	-0.653
10	CMS-821 A x R-363	-2.469 *	-1.969	1.278	0.001	-9.087 **	-1.844	0.338	-1.229	-1.613	-0.278
11	CMS-821 A x R-519	3.406 **	2.906 *	-7.247**	-0.297	-0.852	2.281 *	-0.761 **	-0.597	2.350 *	0.897
12	CMS-821 A x R-545	-2.594 *	-3.219 *	0.016	0.613	1.680 *	-0.219	0.090	0.280	-1.600	0.034
13	CMS-850 A x R-351	1.156	-2.469	6.341*	-0.582	-13.139 **	4.156 **	-0.483 *	-1.728 *	0.787	-3.591 **
14	CMS-850 A x R-363	3.531 **	2.781 *	-12.884**	0.232	8.786 **	0.531	0.256	2.037 **	1.213	1.634 **
15	CMS-850 A x R-519	-2.094	-2.344	5.641*	1.185 **	2.066 *	-3.844 **	0.698 **	2.570 **	-0.075	2.509 **
16	CMS-850 A x R-545	-2.594 *	2.031	0.903	-0.835 *	2.287 **	-0.844	-0.471 *	-2.879 **	-1.925 *	-0.553

** and * indicates significant at 1% and 5%, respectively.

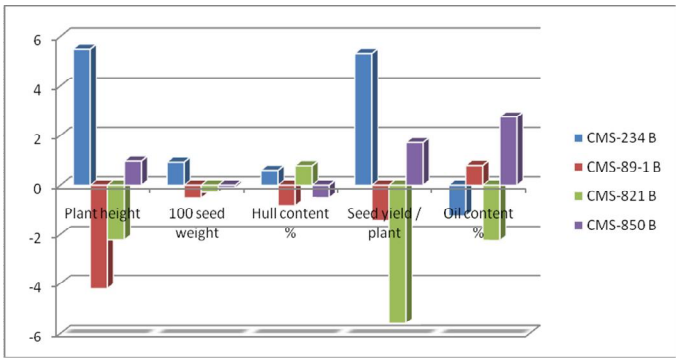

Fig. 1. Diagrammatic representation of GCA effect of lines for Important characters

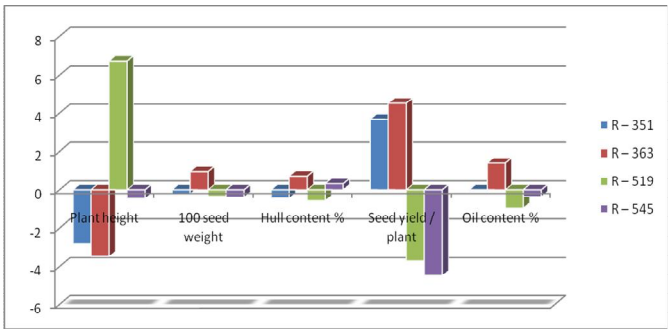

Fig. 2. diagrammatic representation of GCA effect of tester for Important characters

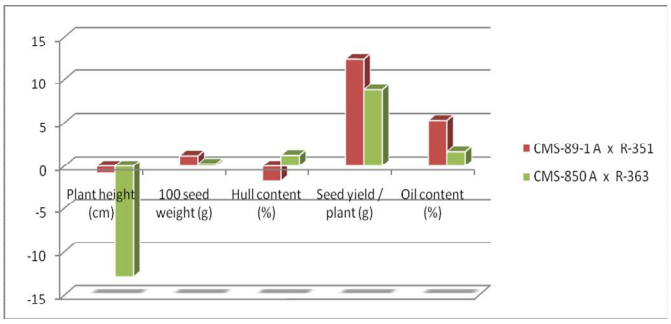

Fig.3. diagrammatic representation of SCA effect of two crosses for Important characters

Hybrids CMS-234 A x R-363, CMS-89-1 A x R-351 and CMS-850 A x R-363 recorded the high seed yield with high oil content. The estimation of GCA effects of parents (Table 3) is the second important criteria because parents with high mean value may not necessarily be able to transmit their superior traits to their progenies. The line CMS-89-1 A might be considered the best general combiner for plant height, head diameter, seed filling percentage and oil content. The line CMS-234 A for head diameter, 100 seed weight and seed yield. Among the testers R-363 may be selected as donor for plant height, head diameter, 100 seed weight, oil content and seed yield / plant. For improvement of a specific character the parents showing high GCA in desirable direction can be used as good donor for improvement of that character. Hence based on GCA effects and per se performance CMS-89-1 A, CMS-234 A and R-363 can be considered as superior parents for future breeding purposes. In contrast to GCA effects being attributable to additive genetic effects, SCA denotes dominance and epistatic gene effects. The results of SCA effects of crosses (Table 4) depicted that CMS-850 A x R-519 was good combination for head diameter, 100 seed weight, volume weight, oil content and seed yield. CMS-850 A x R-363 for plant height, volume weight, oil content and seed yield. CMS-89- A x R-351 for 100 seed weight, volume weight, oil content and seed yield / plant.

Considering the overall performance of parents and hybrids for seed yield and oil content the cross CMS-850 A x R-363 ranked first followed by CMS-89-1 A x R-351, both the crosses have high SCA effects for seed yield and oil content. The parents involved in the cross CMS-89-1 A x R-351 had high x high GCA effects. Hence superiority was due to presence of additive gene action. Another cross CMS-850 A x R-363 involved low x high GCA effects hence superiority was due to presence of non-additive gene action. The present research work revealed differential interaction of GCA and SCA variances. The ratio of GCA: SCA was less than unity for all the characters except head diameter indicating greater influence of non-additive gene action. To improve yield and oil content (%), some suitable parents and promising hybrids were identified. Among the lines CMS-89-1 A and CMS-234 A and among the testers R-363 possess good general combining ability effects for various traits. These lines may be used in hybridization programme. The results of this study suggest that cross CMS-89-1 A x R-351 and CMS-850 A x R-363 for seed yield and oil content can be considered as the most promising crosses for manifestation of seed yield, oil content and other important characters in sunflower.

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