HELIA, **18**, Nr. 23, p.p. 41-46 (1995) UDC 633.854.78:631.526.325

COMBINING ABILITY EFFECTS IN SUNFLOWER F_1 HYBRIDS

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Received: February 13. 1995.
Accepted: October 19. 1995

ABSTRACT

Combing ability effects of four cytoplasmic male sterile lines in combination with two restorer lines were calculated by using line x tester analysis technique at National Agricultural Research Centre, Islamabad. The line CMS-HA-89 was the best general combiner for yield, oil content and 100-achene weight. The restorer RHA-271 was a better general combiner as compared with RHA-273. The best specific combination for yield was CMS-HA-277 x RHA-271.

Key words: Line x tester analysis, GCA effects, SCA effects.

INTRODUCTION

Pakistan is facing extreme difficulties in the production of edible oil. There exists a huge gap in its production and consumption. Cotton seed is a major domestic contributor in the edible oil production. Now the situation has become more critical due to the prevalence of leaf curl virus disease on cotton crop. Consequently, the production of cotton seed has also been severely affected.

In this scenario, sunflower has the potential to meet the existing gap in the demand and supply. Presently, the cultivation of sunflower is gradually being preferred. But one of the limiting factors in its cultivation is the costly hybrid seed. This limitation demands more emphasis on the production of indigenous sunflower hybrid seed which is at par with the commercial hybrids in terms of yield and its F1 seed has a more economical price as well. Keeping in view the above circumstances this study was conducted.

General combining ability (GCA) and specific combining ability (SCA) effects are two efficient parameters to assess the yield performance of sunflower plant (Tyagi, 1988). The results of the study may indicate whether the lines have the potential to be included as parents in the hybridization programme or they require some further improvement through breeding.

MATERIALS AND METHODS

The experiment was established in 1993 spring season at National Agricultural Research Centre, Islamabad (latitude 33° 42' N, longitude 73° 08' E). Soil type was non-calcareous silty clay loam. Seed bed was prepared by two ploughings followed by planking. Fertilizer requirements were met by adding 90 kg N ha^{-1} and 60 kg P ha^{-1}. Entire

phosphorus was applied at the sowing time while nitrogen was equally split into three doses. The first dose was applied at the sowing time. The second and third dose were side-dressed at the head initiation stage and at the time of flowering, respectively. The experiment was planted manually with the help of a dibbler, under rainfed conditions. The meteorological data for the whole growing season are given in Table 5. These data could be referred for comparative evaluation of the material. Attack of main pests mainly *Heliothus armigera* was controlled by spraying Sumiciden @ 600 ml ha^{-1} at flowering stage. The experiment included four CMS lines (CMS-HA-89, CMS-HA-277, CMS-HA-301, CMS-HA-851) and two restorers (RHA-271 and RHA-273). Each line was crossed with each restorer in the spring 1992 and the total number of crosses was thus 8. The plot consisted of four rows 75 cm apart and 5 m long while plant-to-plant distance was maintained at 25 cm. The whole experiment was designed as randomized complete block with four replications. The data were collected from the two central rows for all days to 50 percent flowering, days to maturity, leaves per plant, plant height (cm) at physiological maturity, 100-achene weight (g), yield kg ha^{-1} and oil content (%). The heads were manually harvested at physiological maturity, sundried, threshed and weighed. The oil content data were obtained by using Nuclear Magnetic Resonance Oxford 4000. The analysis of variance due to traits studied was calculated through software MSTAT-C version 1.3 developed at Michigan State University, USA. The computation of GCA and SCA effects was done by adopting line x tester analysis technique (Singh and Chaudhary, 1979). This technique is an extension of the top cross method of testing GCA and SCA (Kempthorne, 1957). This experiment included only the crosses to assess their combining ability while ignoring the respective parents.

RESULTS AND DISCUSSION

The variance due to yield, 100-achene weight, oil content and days to maturity for all cross combinations was highly significant (Table 1).

Table 1. Analysis of variance for combining ability for different sunflower characters

Source of variation	df	Yield (kg ha^{-1})	100-achene weight (g)	Oil (%)	Days to maturity
Rep.	3	NS	NS	NS	NS
Cross combinat.	7	19.68"	5.17"	4.49"	5.32"
Error	21				
Non-add.	1	2.30	1.14	0.91	0.12
Residual	20				
CV (%)		7.73	12.16	5.59	3.08

NS – Non-significant
" – Significant at P = 0.01 level.

GCA of CMS-HA-89 was maximum for yield. Besides GCA effect its mean yield was also maximum. Similarly, the poorest general combiner was CMS-HA-851. It also had the lowest mean yield. The fact that there exists a positive correlation between GCA effects and yield means that SCA effects are negligible. As GCA tends to represent an assembly of different genes in one genotype, increased yield may be attributed to the heterotic effect of genes (Table 2). Similar observations were made by Tyagi (1988).

The best general combiner for 100-achene weight was CMS-HA-277. It had bold and heavier achenes and possessed the maximum negative GCA value for its oil content whereas CMS-HA-89 had the lowest GCA effects for 100-achene weight and it possessed the maximum value of GCA for its oil content (Table 2). These results seem to indicate that the increase in the weight of seed affects the oil content negatively (Gundaev, 1966).

The earliest line was CMS-HA-851 which had lowest GCA effect. CMS-HA-89 matured very late as indicated by its maximum GCA value.

Table 2. General combining ability effects for CMS lines

Lines	Yield (kg ha^{-1})	100-achene weight (g)	Oil content (%)	Days to maturity
CMS-HA-89	75.30	-0.31	0.50	0.22
CMS-HA-277	-16.00	0.22	-0.66	1.72
CMS-HA-301	12.37	0.15	0.02	-0.66
CMS-HA-851	-70.75	-0.06	0.12	-1.28

GCA effects of the restorer lines indicated the ability of RHA-271 to contribute positively towards yield and oil content. It also contributed for lower 100-achene weight and earliness. On the average RHA-271 proved more promising than RHA-273 (Table 3).

Table 3. General combining ability effects for restorers

Restorer	Yield (kg ha^{-1})	100-achene weight (g)	Oil content (%)	Days to maturity
RHA-271	714.49	-0.02	0.41	-0.16
RHA-273	488.75	0.01	-0.41	0.15

The best specific combination for yield (kg ha^{-1}) was CMS-HA-277 x RHA-271. The best combination for lower 100-achene weight was CMS-HA-301 x RHA-273 (Table 4). The best specific combination for earliness was CMS-HA-89 x RHA-271 whereas CMS-HA-301 x RHA-271 had maximum positive SCA effects which confirms its ability to mature late (Table 4).

Table 4. Specific combining ability effects of cross combinations

Cross	Yield (kg ha^{-1})	100-achene weight (g)	Oil content (%)	Days to maturity
CMS-HA-89 x RHA-271	28.40	-0.09	-0.12	-0.59
CMS-HA-277 x RHA-271	94.00	0.01	0.43	-0.34
CMS-HA-301 x RHA-271	-41.00	0.12	-0.31	0.54
CMS-HA-851 x RHA-271	-20.00	-0.04	0.01	0.41
CMS-HA-89 x RHA-273	28.00	0.10	0.17	0.6
CMS-HA-277 x RHA-273	-94.00	-0.01	-0.43	0.35
CMS-HA-301 x RHA-273	44.00	-0.12	0.31	-0.52
CMS-HA-851 x RHA-273	20.00	0.04	-0.01	-0.40

Table 5. Mean meteorological data of the whole growing period of the crop, spring 1993, NARC, Islamabad

Month	Air temp. (°C)		Relative humidity (%)		Wind speed (km/day)	Sunshine (hrs)	Total rainfull (mm)	Pan evapo (mm/day)
	Max.	Min.	0800	1400				
Jan.	15.2	2.9	92	53	71.8	5.8	28.3	1.5
Feb.	21.2	7.0	83	43	78.1	6.1	46.9	2.4
March	21.1	8.3	86	51	105.3	7.0	44.7	3.2
April	29.7	14.2	73	39	90.3	9.4	27.8	5.4
May	36.4	20.3	47	25	124.4	10.2	23.6	8.8
June	37.7	23.1	12	33	123.2	11.2	83.2	9.5

CONCLUSION

Combining ability effects are important in the identification of valuable inbred lines for use in hybrid combinations. Under these agro-ecological conditions (Table 5) CMS-HA-277 in combination with RHA-271 performed well for yield. But it is still necessary to test the stability of these lines across different environmental conditions which would provide more information about their potential use in Pakistan.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. Jerry F. Miller, Northern Crop Science Laboratory, North Dakota State Univ., USA, for the provision of lines (genetic material) for study.

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EFECTOS DE APTITUD COMBINATORIA EN HÍBRIDOS DE GIRASOL

RESUMEN

Los efectos de aptitud combinatoria de cuatro líneas androestériles citoplasmáticas en combinación con dos líneas restauradoras fueron calculadas usando el análisis línea x tester en el Centro Nacional de Investigación Agraria, en Islamabad la línea CMS-HA-89, fue el de mejor aptitud combinatoria general para rendimiento, contenido en aceite y peso de 100 semillas. El restaurador RHA-271 fue el de mejor aptitud combinatoria general en comparación con RHA-273. La mejor combinación específica para rendimiento fue CMS HA-277 x RHA-271.

APTITUDE À LA COMBINAISON CHEZ LES HYBRIDES F1 DE TOURNESOL

RÉSUMÉ

L'aptitude à la combinaison de 4 lignées mâle stériles croisées avec deux lignées restauratrices a été calculée selon la technique d'analyse des croisements lignés x testeur developpée au National Agricultural Research Center d'Islamabad. La lignée CMS-HA89 possède la meilleure aptitude générale à la combinaison pour le rendement, la teneur en huile et le poids de 100 akènes. La lignée restauratrice RHA271 possède une meilleure aptitude générale à la combinaison que RHA273. La meilleure aptitude spécifique à la combinaison pour le rendement a été trouvée dans le croisement CMS-HA277 x RHA 271.