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CHARACTERIZATION OF SOME BROOMRAPE RESISTANT LINES FOR THEIR COMBINING ABILITY EFFECTS TO UTILIZE IN SUNFLOWER HYBRID BREEDING

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SUMMARY

Seven broomrape resistance incorporated HA-89-derived female lines were evaluated to assess their combining ability effects in this study. Combining ability effects of 8 CMS lines (seven broomrape resistance introduced backcross derivatives of HA-89 plus HA-89 itself) in combination with 2 restorer lines were assessed by using the line x tester analysis technique. General and specific combining ability effects were estimated on 6 traits. Most of them were found to be improved for the GCA effects in hybrid combinations compared with the background line HA-89.

Key words: **Sunflower, *Helianthus annuus* L., broomrape (*Orobanche cumana* Wallr.), line x tester analysis, GCA effects, SCA effects.**

INTRODUCTION

One of the major objectives of the sunflower hybrid breeding program at the Thrace Agricultural Research Institute, Edirne, Turkey, is to develop broomrape-resistant lines and hybrids. Most hybrids developed here have broomrape-resistant female lines in their cross combinations. But one of the unwanted traits they are facing is poor self compatibility. Therefore, broomrape resistance was attempted to be incorporated into a line which had good self compatibility but susceptible to broomrape. HA-89 has the good self compatibility character (Škaloud and Kovačik, 1994; personal observation) and is utilized in many sunflower breeding programs.

After 3-4 backcrosses and selection for *Orobanche* resistance, HA-89 type maintainer lines were obtained. At the same time, they were converted into sterile PET1 cytoplasm by at least 5 backcrosses to make CMS lines. Seven new sunflower females obtained by this method were tested with *Orobanche* and found that except CMS-4, all others were resistant to broomrape (Aydin, 1996).

It is important to know combining ability effects of the lines in hybrid breeding programs (Tyagi, 1988). Besides their resistance to *Orobanche*, it is also valuable to assess other improved traits of these newly developed female lines. The objective of this study was to evaluate broomrape resistance incorporated seven HA-89-derived lines for their combining ability effects in hybrid combinations.

MATERIALS AND METHODS

The experiments were conducted at the Thrace Agricultural Research Institute, Edirne, which is in the Northwest part of Turkey, in 1992-93.

Seven broomrape resistance introduced HA-89-derived lines (CMS-1, CMS-2, CMS-3, CMS-4, CMS-5, CMS-6 and CMS-7) plus CMS HA-89 were used as females. Two restorers, 0536-R and 3510-R, were used to make hybrid combinations with the 8 females. In 1992, the 8 CMS lines and 2 restorers were crossed to get sufficient amount of seeds of 16 F_1 hybrids. Hybrids were planted in a randomized complete block design with 4 replications in 1992. The plots consisted of 4 rows, 70 cm apart and 7.5 m length while plant to plant distance was maintained at 30 cm. The data were collected for achene yield, oil content, days to flowering and physiological maturity, plant height and 1000-achene weight. Achene yield was taken from heads harvested and threshed from the 2 central rows per plot. The oil content data were obtained by using NMR. Days to flowering and physiological maturity were taken as the number of days from emergence date. Plant height was measured at the physiological maturity time.

Variance analysis was calculated through software MSTAT-C version 1.3 developed at the Michigan State University, USA. General combining ability (GCA) and specific combining ability (SCA) effects were done by adopting the line x tester analysis technique (Singh and Chaudhary, 1979).

RESULTS AND DISCUSSION

Analysis of variance for combining ability in sunflower hybrids for 6 traits is given in Table 1.

Table 1: Analysis of variance for combining ability in sunflower hybrids for some traits

Source of variation	Df	Achene yield	Oil content	Days to flowering	Days to phy.maturity	Plant height	1000 achene weight
Female	7	629.51**	2.66	2.92	4.31	384.16**	30.85**
Restorer	1	737.12**	0.15	16.00**	39.06*	531.88**	24.50*
Fem.xRest.	7	36.71	0.95*	0.79**	3.24	27.83	3.37
Error	45	85.94	0.42	0.15	1.64	23.38	2.14

* and ** significant at 0.05 and 0.01, respectively

The variances due to general general combining ability (GCA) of the females were highly significant ($p \leq 0.01$) for achene yield, plant height and 1000-achene weight while it was non-significant for oil content, days to flowering and maturity. The variances due to general combining ability of restorer lines were highly significant ($p \leq 0.01$) for achene yield, days to flowering, plant height and significant ($p \leq 0.05$) for days to maturity and 1000-achene weight. The variances due to specific combining ability (SCA) of hybrids were highly significant ($p \leq 0.01$) for days to flowering and significant ($p \leq 0.05$) for oil content. This indicated that oil content was governed by non-additive gene action while gene action for achene yield, days to physiological maturity, plant height and 1000-achene weight was additive. Additive and non-additive gene actions were equally important for days to flowering. Dominguez and Miller (1988) and Sindaghi *et al.* (1979) reported that GCA effects were more important for achene yield, plant height and maturity traits. GCA effects were also important for 1000-achene weight (Dominguez and Miller, 1978; 1988) and oil content (Škorić, 1978). Some reports are emphasizing a greater proportion of SCA variance for achene yield, 1000-achene weight, days to flowering, plant height (Griraj *et. al.*, 1987) and days to physiological maturity (Mihaljčević, 1988; Tan, 1993).

Estimates of general combining ability effects of female and restorer lines are presented in Table 2. While CMS HA-89 was exhibiting highly significant negative GCA value for achene yield, its backcross derivative CMS-4 was the best general combiner for this character. It is unlucky that broomrape resistance of CMS-4 and its hybrids with 0708-R and 3510-R were susceptible class, as compared with the other HA-89-derived lines (Aydin, 1996). Although it was not significant, CMS-3, CMS-5 and CMS-6 had positive GCA effects on achene yield. GCA value for oil content was highly significant and positive for CMS-2 and significant for CMS-6. Most of the female lines had significant and highly significant GCA values for 1000-achene weight. But this effect was positive for CMS-7, CMS-5 and CMS-2. GCA values of 6 female lines were highly significant for plant height. While CMS-7, CMS-6 and CMS-4 had tendency to increase plant height, CMS-1, CMS-2 and CMS-3 had decreased plant height. CMS-3 could be used for developing early flowering and maturing hybrids. Except for oil content, the two restorer lines had significant and highly significant GCA values for increasing or decreasing the traits observed. Restorer 0708-R was good for increasing achene yield, shortening flowering and maturity days and plant height. 3510-R had a positive significant GCA value for increasing 1000-achene weight.

Specific combining ability (SCA) effects of 16 hybrid combinations are presented in Table 3. Out of the 16 cross combinations only 2 hybrids showed significant SCA values for days to flowering. SCA values of hybrids were not significant for the other traits.

The proportional contribution of the female lines to the total variance was high for all traits except days to physiological maturity. It ranged from 32.8 % to 81.8 %

Table 2: General combining ability effects of female and restorer lines

Female and restorer	Achene yield	Oil content	Days to flowering	Days to phy. maturity	Plant height	1000 achene weight
CMSHA-89	-16.82**	-0.22	0.66**	0.03	-0.54	-1.87**
CMS-1	-3.74	0.19	-0.34*	-0.34	-9.82**	-0.80
CMS-2	-2.20	1.03**	0.03	-0.22	-5.79**	-0.70
CMS-3	6.05	-0.39	-1.22**	-1.47**	-5.89**	1.05*
CMS-4	14.32**	0.01	0.28*	0.28	4.82**	-1.67**
CMS-5	2.52	-0.39	0.03	0.16	0.48	2.75**
CMS-6	0.67	0.54*	0.66**	0.53	6.42**	-1.63**
CMS-7	-0.79	-0.77**	-0.09	1.03**	10.32**	2.87**
0708-R	3.40	-0.05	-0.5**	-0.78**	-2.88**	-0.62*
3510-R	-3.40	0.05	0.5**	0.78**	2.88**	0.62*

* and ** significant at 0.05 and 0.01, respectively

with maximum values (higher than 73.3 %) for 1000-achene weight, achene yield, plant height and oil content. The contribution of two restorer lines to the total variance was proportionally small except for days to physiological maturity. It ranged from 0.6 % to 42.5 % with maximum values of 38.2 % and 42.5 % for days to flowering and maturity, respectively. The smallest contribution in the interaction of females x restorers was recorded for achene yield (4.8 %), the largest for oil content (26.1 %).

Table 3: Specific combining ability effects of female and restorer lines

Cross	Achene yield	Oil content	Days to flowering	Days to phy. maturity	Plant height	1000 achene weight
CMSHA-89 x0708-R	2.143	0.186	-0.375	0.156	0.145	-0.381
CMSHA-89 x3510-R	-2.143	-0.186	0.375	-0.156	-0.145	0.381
CMS-1 x0708-R	-3.036	0.123	0.125	0.281	3.195	0.569
CMS-1 x3510-R	3.036	-0.123	-0.125	-0.281	-3.195	-0.569
CMS-2 x0708-R	-0.633	0.436	0.500*	-0.406	-1.370	0.869
CMS-2 x3510-R	0.633	-0.436	-0.500*	0.406	1.370	-0.869
CMS-3 x0708-R	0.006	-0.527	-0.250	0.156	0.145	-0.556
CMS-3 x3510-R	-0.006	0.527	0.250	-0.156	-0.145	0.556
CMS-4 x0708-R	1.825	0.098	-0.250	-1.094	-0.917	-0.581
CMS-4 x3510-R	-1.825	-0.098	0.250	1.094	0.917	0.581
CMS-5 x0708-R	-3.051	-0.527	-0.001	-0.719	-0.430	-0.681
CMS-5 x3510-R	3.051	0.527	0.001	0.719	0.430	0.681
CMS-6 x0708-R	2.240	0.073	-0.125	-0.094	-3.342	0.781
CMS-6 x3510-R	-2.240	-0.073	0.125	0.094	3.342	-0.781
CMS-7 x0708-R	0.506	0.136	0.375	0.906	-0.167	-0.190
CMS-7 x3510-R	-0.506	-0.136	-0.375	-0.906	0.167	0.190

* significant at 0.05

CONCLUSION

It is important to know the combining ability effects in order to identify valuable inbred lines to utilize in sunflower hybrid breeding programs. Broomrape resistance incorporated HA-89-derived lines were assessed for their combining ability effects in this study. Most of them were found to be improved for the GCA effects in hybrid combinations compared with their background line HA-89.

CMS-2, CMS-3, CMS-5 and CMS-6 can be utilized as parental lines in sunflower breeding programs to develop *Orobanche*-resistant hybrids with improved yield and maturity traits.

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CARACTERIZACIÓN DE ALGUNAS LÍNEAS RESISTENTES A JOPO PARA SUS EFECTOS DE APTITUD COMBINATORIA PARA SER UTILIZADAS EN MEJORA DE HÍBRIDOS

RESUMEN

Siete líneas resistentes a jopo derivadas de HA-89 fueron evaluadas para valorar sus efectos de aptitud combinatoria en este estudio. Los efectos de aptitud combinatoria de las 8 líneas CMS (siete líneas resistentes a jopo derivadas de HA-89 mas la misma HA-89) en combinación con dos líneas restauradoras fueron valoradas utilizando la técnica línea x probador. Los efectos de aptitud combinatoria general y específica fueron estimados para sur caracteres. La mayor parte de ellos fueron mejoradas para efectos de aptitud combinatoria en combinaciones híbridas en comparación con la línea HA-89.

CARACTÉRISATION DE LIGNÉES RÉSISTANTES À L'OROBANCHE POUR LEUR VALEUR EN COMBINAISON ET LEUR UTILISATION POUR LA SÉLECTION D'HYBRIDES DE TOURNESOL

RÉSUMÉ

Dans cette étude, on a évalué les effets d'aptitude à la combinaison de sept lignées dérivées d'HA-89 dans lesquelles a été incorporée la résistance à l'orobanche. Les effets d'aptitude à la combinaison de 8 lignées CMS (sept descendances d'HA-89 backcrossées résistantes à l'orobanche plus HA-89) en croisement avec deux lignées restauratrices ont été estimés en utilisant la technique d'analyse lignée x testeur. L'aptitude générale et spécifique a été estimée sur 6 caractères. La plupart des lignées ont montré une amélioration de l'AGC par rapport au fonds génétique de la lignée HA-89.