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EFFECT OF ENVIRONMENTAL CONDITIONS ON THE EVALUATION OF COMBINING ABILITY OF SUNFLOWER INBRED LINES

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SUMMARY

Crosses between six sunflower (*Helianthus annuus*) inbred lines were produced utilizing a partial diallel experimental design. After three years of testing it was found that the highest general combining ability (GCA) for seed weight per plant was produced by lines 3230 and 3004. For oil content the highest GCA was shown by lines 3230 and 3064. The environmental conditions influenced to a great degree the evaluations of specific combining ability (SCA), while general combining ability was determined to be more stable. The nonadditive gene effects for the seed weight per plant and oil content are more unstable in variable environments in comparison with additive gene effects.

Key words: Sunflower, combining ability, environment.

INTRODUCTION

Breeding of parent lines with high combining ability is one of the main preconditions for development of new highly productive hybrids. For the evaluation of this character different methods are used. Some authors indicate that the most appropriate method is the diallel analysis, with four methods developed by Griffing (1956). The most utilized and easily applied is Method IV.

Determination of combining ability is always accomplished in distinctive condition of plant growing. Because of this it is important to know how the environmental conditions and their interaction with the genotype influence the general combining ability (GCA) and specific combining ability (SCA). Such investigations were done especially in maize. According to some authors SCA varies to a greater extent, depending on the location and the year of testing, than GCA (Matzinger et al., 1959; Turbin et al., 1974; Christova, 1976). In other investigations, the authors indicated that the GCA was also greatly influenced by the growing conditions (Musijko et al., 1972).

The objective of the present work was to study the influence of environmental conditions on the evaluation of combining ability for two of the most important sunflower characters - seed weight per plant and oil content of the seed.

MATERIAL AND METHODS

Six sunflower inbred lines - 1234, 1607, 3004, 3041, 3064 and 3230 were crossed according to a partial diallel design. The origin of the line 1234 is the variety Smena, of the line 1607 the variety Majak. The other four lines were selected from different Bulgarian synthetic populations. In the course of three years, the one-way hybrid combinations were tested in the fields of IWS "Dobroudja". The trial was conducted by the full block design in three replicates with plots of 15 m^2. The seed weight per one plant was determined by hand cutting of 50 plants in each plot and threshing by microcombine. After measuring the moisture content, the seed weight per plant was calculated for dry seed. The oil content of the absolutely dry seed was determined by nuclear magnetic resonance, with two 10 g samples for each plot analyzed. The studied characters were calculated for: the least significant difference between the hybrids (LSD); average values of the hybrids of each line (mean L); general average value for all hybrids (mean G). The dispersion analysis for the interaction of environment and combining ability was realized by the method elaborated by Hotileva and Tarutina (1973).

RESULTS AND DISCUSSION

The data for seed weight per one plant are presented in Table 1. The productivity of hybrid combinations varied during the years of testing, as higher yields were obtained in the first year and lower in the third year. The higher yield was due to abundant rain which occurred in the summer of 1987, and dry conditions occurred in the next two years. In all cases, the hybrids derived from the line 3230 had the highest productive capacity. This line showed a high general combining ability for seed weight. The hybrid 1234 x 1607 and some other combinations including the lines 1607 and 3041 possessed unsatisfactory productivity.

Similar tendency was also established for oil content (Table 2). Over years, the values of each hybrid were not significantly changed under the influence of environmental conditions. The differences in the oil content between hybrids were well distinguished. The combination 3064 x 3230 had the highest oil content. The other hybrids which included these two lines also had relatively high oil contents. The other four lines probably have a low combining ability for this character, because of their low oil content percentages.

Table 1: Seed weight per one plant of hybrids produced by crossing six lines in a partial diallel. (g)

Year	Line	1607	3004	3041	3064	3230	Mean (L)
	1234	50.5	82.6	72.2	76.0	83.6	73.0
	1607		76.9	68.4	66.8	61.5	64.8
	3004			81.1	71.5	76.2	77.7
1987	3041				62.4	85.9	74.0
	3064					83.9	72.1
	3230						78.2
	Mean (G)						73.3
			L S D 0.05 =10.2 L S D 0.01 =13.7				
	1234	58.6	65.6	69.6	76.3	82.2	70.5
	1607		74.8	53.9	73.3	69.7	66.1
	3004			57.4	63.0	87.4	69.6
1988	3041				51.1	68.4	60.1
	3064					84.4	69.6
	3230						78.4
	Mean (G)						69.1
			L S D 0.05 =12.5 L S D 0.01 =16.8				
	1234	40.6	66.7	66.0	67.5	68.8	61.9
	1607		62.2	53.0	64.5	67.2	57.5
	3004			61.5	57.8	73.8	64.4
1989	3041				53.7	63.9	59.6
	3064					67.6	62.1
	3230						68.3
	Mean (G)						62.3
			L S D 0.05 =10.1 L S D 0.01 =13.6				

The results of the dispersion analysis regarding interactions between GCA and environment and SCA and the environment during the testing period are presented in Table 3. According to these two studied characters, the differences between the hybrids and the GCA of the parent lines were apparent. The differences of SCA were statistically significant concerning seed weight per plant and insignificant concerning oil content of seed. This analysis showed a great influence of the conditions of testing years on these two traits, and this influence was more clearly expressed for seed weight per plant.

The interaction "GCA x environment" was statistically significant but to a low extent. This means that the relative stability of the evaluations of GCA of the

lines over different years is available. On this basis the estimation of GCA could be done in one year of testing the hybrid combinations.

Table 2: Oil content in dry seed of hybrids produced by crossing six lines in a partial diallel. (%)

Year	Line	1607	3004	3041	3064	3230	Mean (L)
	1234	40.4	43.2	44.6	47.0	47.3	44.5
	1607		43.0	41.6	46.2	46.3	43.5
	3004			42.2	45.0	46.8	44.0
1987	3041				43.7	47.2	43.9
	3064					51.4	46.7
	3230						47.8
	Mean						45.1
			L S D 0.05 =1.4 L S D 0.01 =1.8				
	1234	42.1	40.3	45.7	47.0	47.6	44.5
	1607		40.5	41.6	45.7	47.0	43.4
	3004			41.4	43.8	43.6	41.9
1988	3041				44.4	46.2	43.2
	3064					50.3	46.2
	3230						46.9
	Mean						44.4
			L S D 0.05 =1.8 L S D 0.01 =2.4				
	1234	40.1	42.2	41.5	45.2	48.2	43.4
	1607		43.2	41.0	44.0	46.9	43.0
	3004			42.2	42.8	44.8	43.0
1989	3041				42.2	45.8	42.5
	3064					50.8	45.0
	3230						47.3
	Mean						44.0
			L S D 0.05 =1.4 L S D 0.01 =1.9				

The "SCA x environment" interaction of both studied characters was highly significant. This indicates that the specific combining ability is more influenced by the environment than the general combining ability.

The study of variability of the combining ability over environments gives the opportunity to make an assumption about the relative stability of additive and nonadditive gene factors. Many authors consider that GCA is determined by additive gene action, and SCA by nonadditive gene action (dominance and

epistasis). According to the present study, it is possible to conclude that the non-additive gene effects for the seed weight per plant and oil content are more unstable in variable environments in comparison with additive gene effects. The obtained results do not belittle the role of the genotype in the genotype x environment interaction.

Table 3: Dispersion analysis for interaction of GCA and SCA with the environmental conditions over years of testing

Source of variation	Degree of freedom	Mean square	
		Seed weight	Oil content
Hybrids	14	432.28**	34.56**
G C A	5	678.66***	61.88***
S C A	9	257.84*	5.11
Years	2	824.45***	82.22**
GCA/Years	10	312.86*	10.12*
SCA/Years	18	401.44**	19.97**
Error	46	54.22	3.13

CONCLUSIONS

The environmental conditions influenced the evaluation of combining ability of sunflower inbred lines. For the characters of seed weight per plant and oil content, the evaluation of the general combining ability was relatively stable over the different years of testing. Specific combining ability depended on the environmental conditions to a greater extent. The nonadditive gene effects for both characters were more unstable in variable environments in comparison with additive gene effects.

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EFECTO DE LAS CONDICIONES AMBIENTALES SOBRE LA EVALUACIÓN DE LA APTITUD COMBINATORIA DE LÍNEAS PURAS DE GIRASOL

RESUMEN

Se hicieron cruces entre seis líneas puras de girasol de acuerdo con un dialelo incompleto. Después de tres años de ensayos se encontró que la aptitud combinatoria más alta para peso de semillas y contenido de aceite la tuvieron las líneas 3064 y 3230. Las condiciones ambientales influenciaron en un alto grado sobre las evaluaciones de la aptitud combinatoria específica, mientras que las de la aptitud combinatoria general fueron más estables. Para tener una valoración real de la aptitud combinatoria específica, el testado de híbridos debe realizarse al menos dos años o en distintas localidades con condiciones ambientales diferenciadas.

EFFET DES CONDITONS DU MILLEU SUR L'ÉVALUATION DE L'APTITUDE À LA COMBINAISON DE LIGNÉES FIXÉES DE TOURNESOL

RÉSUMÉ

Des croisements entre six lignées fixées de tournesol on été faits selon un schéma dialléle incomplet. Aprés trois années de test, il a été trouvé que les lignées 3064 et 3230 possédent les aptitudes à la combinaison les plus élevées pour le poids de graines par plante et la teneur en huile. Les conditions du milleu influencent dans de fortes proportions les évaluations de l'aptitude spécifique à la combinaison alors que celles relatives à l'aptitude générale à la combinaison sont considérées comme plus stables. Afin de se faire une idée concrète de l'ASC, l'évaluation des combinaisons hybrides doit être poursuivie durant au moins deux années ou divers lieux différant par leurs conditions climatiques.