LINE X TESTER ANALYSIS OF THE COMBINING ABILITY IN SUNFLOWER *(H.annuus L.)*

R. Marinković, D. Škorić, B. Dozet, D. Jovanović

Institute of Field and Vegetable Crops, 21000 Novi Sad, Yugoslavia

SUMMARY

Line x tester analysis included 10 lines and three testers of sunflower. Among studied genotypes significant differences in mean values for all of the studied traits (plant height, mass of 1000 seeds, oil content, hull and kernel content in seed, yield of seed) were determined. The main role in inheritance of all of the studied traits was played by an additive component of genetic variance. Among the lines, the best general combiner was the line R 14 which expressed a significant positive effect of GCA on mass of 1000 seeds, kernel content and seed yield, and a negative one on plant height and hull content. Crossing of R-12 with T-2 showed a significant positive effect of SCA on the most of the studied traits such as mass of 1000 seeds, oil content, shell and kernel content in seed and seed yield.

INTRODUCTION

The increase of the areas under sunflower crop both in developed and in developing countries depends primary on the productivity of newly created hybrids. One of the most effective ways of increasing the yield of sunflower per area unit is the usage of heterosis through twoline hybrids. According to Anaščenko and Rožkova (1974), Fick (1975) and some other authors, SC-hybrids give from 20 to 30% heigher yield than the varietal populations.

However, in the process of studying heterosis, there arises a question of combining abilities of lines used as parental components of hybrids. It was found out that creation of inbred lines of good combining ability which posses some other good agronomic traits is very important for creating high productive hybrids.

Combining ability of parental lines as one of the basic traits which determines the heterosis of hybrid progenies is a genetically conditioned trait. According to Sprague and Tatum (1942) there are general and specific combining abilities. Authors are of the opinion that general combining ability is determined by additive inheritability factors, and specific combining ability by dominant and epistatic factors. Some other authors (Griffing, 1956; Falconer, 1967) are of the same opinion.

Since the combining line abilities can be tested only in crossings, various methods are used, one of which is the line x tester analysis (Kempthorne, 1957).

The objective of this investigation was to examine, using line x tester analysis, the general and specific combining abilities of some of the new sunflower lines for seed yield, plant height, mass of 1000 seeds, oil content and the way of inheritance of the above mentioned traits in F_1 generation, as well as the contribution of lines and tester in expression of the individual traits.

MATERIALS AND METHODS

Ten inbred sunflower lines (S_6), developed at the Institute of Field and Vegetable Crops in Novi Sad, were crossed with three testers. Three cytoplasmic male sterile lines with good combining abilities were used as testers. Three crossed heads were covered with natron paper bags before and after pollination. Lines, testers and their F_1 hybrids were planted at the experimental field of the Institute of Field and Vegetable crops at R. Šančevi in a randomized complete block design in three replicates. Each plot consisted of 4 rows with 12 plants in row. Distance between the rows was 70 cm, and between plants 25cm.

Twenty plants in each plot were chosen for observations on seed yield (g) per plant, plant height (cm), 1000-seed weight (g), oil content (%), hull content (%) and kernel content (%) in seed. The combining ability analyses were done in accordance with the procedures developed by Kempthorne (1957) and applied by Singh and Chouduary (1976).

RESULTS AND DISCUSSION

Analysis of variance revealed that the genotypes differed significantly for all the characters (Tab. 1). The mean squares due to parents also differed significantly, indicating great deal of diversity among them. Highly significant differences were also observed for the variance components, viz. parents vs crosses for plant height, 1000-seed mass and seed yield.

This showed expression of heterosis for these characters. The variance due to a general combining ability of the males was significant for plant height, 1000-seed mass and oil content, while that of the females was significant for all characters under study. In almost all cases, the variances due to a general combining ability were higher than the variances due to a specific combining ability. This indicates that there is a predominant role of the additive component for all characters under study.

The predominant role of additive component in the study of inheritance of some traits in sunflower is described by some other researchers: plant height (Rao et. al., 1977), 1000-seed mass (Putt, 1965; Kovačik et. al., 1972), oil content in seed (Putt, 1965; Fick,1975; Sindagi et. al., 1979), kernel content in seed (Marinković, 1985) and seed yield (Putt, 1965). However, some of the researchers found out that the predominant role in inheriting some of the studied traits is played by an nonadditive component: (Putt,1965; Velkov, 1980), seed yield (Kovačik et. al., 1972; Rao et. al., 1977; Sindagi et. al., 1980). None of the lines had significant positive or negative effects of general combining ability (GCA) on all of the six studied traits (Tab. 2). Line R-7 had significant positive effects of GCA on three traits (1000-seed weight, kernel content and seed yield); lines R-1, R-6, R-8, R-9 and R-10 had positive significant effect of GCA on two of the studied traits, and lines R-3 and R-4 on only one of the studied traits (hull content). This confirms the fact that there was a great genetic difference between the used lines.

High 1000-seed mass, high oil and kernel content in seed, low hull content and high seed yield per plant are desirable traits in sunflower. Line R-9 for plant height, lines R-3 and R-9 for 1000-seed weight, line R-15 for oil content, lines R-15 and R-12 for hull content in seed, line R-12 for kernel content in seed and line R-16 for seed yield were the best general combiners.

However, the best general combiner on the whole was the line R-14 which expressed significant positive effect of GCA on 1000-seed weight, kernel content and seed yield, and negative effect on plant height and hull content. It should be useful to evolve highly productive hybrids.

Between tester lines, T-3 for plant height, oil content and seed yield, and T-2 for 1000-seed weight, hull and kernel content in seed, were very good combiners. Tester T-1 was a very bad combiner for almost all of the studied traits.

Specific combining ability is a major component which can be utilized in heterosis breeding. None of the hybrid combinations had positive significant effect of specific combining ability (SCA) on all of the studied traits (Tab. 3). It explains why it is difficult to gather together all positive effects in one combination. Seven crosses for plant height, nine for mass of 1000 seeds, six for oil content, eight for hull content, six for kernel content and nine for seed yield per plant expressed positive significant effect of SCA indicating the potentiality of these hybrids for commercial exploitation. Crossings of R-12 with T-2 expressed significant positive effects of SCA on most of the studied traits such as mass of 1000 seeds, oil content, hull and kernel content in seed and seed yield per plant.

It is obvious that in many crossings with high SCA effect, one of the parents with good GCA and one with bad GCA are included, indicating that additive x dominance type of interaction was involved. However, few crosses between low x low general combiners produced higher SCA effects, suggesting epistatic gene action which may be due to genetic diversity in the form of heterozygous loci.

Lines, testers and their interaction revealed different contribution in expression of the studied traits (Tab. 4). Contribution of lines in the expression of oil content and content hull and kernel in seed was the greatest. More pronounced was the contribution of line in expression of hull content (72,80%) which was the greatest on the trial level. Contribution of testers in expression of plant height was the greatest. Its contributions in expression of oil content, hull and kernel content in seed and seed yield was almost neglected. Interaction between lines and testers expressed high contributions in many traits, being the highest in mass of 1000 seeds and seed yield.

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Table 1-Analysis of variance for combining ability

Source	d.f.	Plant height (cm)	1000-seed mass (g)	Oil content (%)	Hull content (%)	Kernel content (%)	Seed yield (kg)
Replications	2	2,65	0,12	2,00	0,03	0,07	0,97
Treatments	42	35,62**	20,47**	10,06**	8,48**	7,54**	21,10**
Parents	12	12,37**	17,79**	15,05**	15,85**	15,18**	17,72**
Par. vs. crosses	1	962,08**	459,37**	0,50	0,18	1,22	540,83**
Crosses	29	13,30**	6,44**	8,32**	5,72**	4,59**	4,58**
Lines	9	17,64**	6,21**	14,01**	13,42**	9,50**	6,14**
Testers	2	88,17**	27,65**	7,07**	0,11	2,60	3,07
Lines x Testers	18	2,81**	4,20**	5,62**	2,49**	2,36**	3,97**
Error	84						

Table 2- General combining ability effects of the parents on different characters

Parents		Plant height (cm)	1000-seed mass (g)	Oil content (%)	Hull content (%)	Kernel content (%)	Seed yield (kg)
Lines							
R-1	(1)	0,041*	1,271	-1,588**	1,857**	-1,511**	-0,385**
R-3	(2)	0,092*	5,004**	-0,8000**	1,246**	-1,011**	0,225**
R-4	(3)	-0,009	0,538	-1,872**	3,223**	-2,989**	-0,262**
R-6	(4)	-0,023	-1,718**	-0,160	1,590**	-1,356**	-0,245**
R-9	(5)	0,199**	3,950**	-0,969**	0,579*	-0,344	0,294**
R-10	(6)	0,020	-4,373**	0,770**	-1,443**	1,567**	-0,113
R-12	(7)	-0,091**	2,304**	0,351	-2,777**	2,411**	0,237**
R-14	(8)	-0,050**	2,538**	0,069	-0,932**	1,167**	-0,005
R-15	(9)	-0,147	-3,484	3,838**	-2,243**	0,622*	-0,369**
R-16	(10)	-0,031*	-6,040**	0,363	-1,099**	1,444**	0,622**
Testers							
T-1	(1)	-0,118**	-1,696**	0,188	0,030	0,204	-0,116**
T-2	(2)	-0,001	4,898**	-0,698**	-0,110	0,354*	-0,024
T-3	(3)	0,119**	-3,202**	0,510**	0,080	-0,559**	0,140**

*, ** Significant at 5% and 1% level, respectively

Table 3-Specific combining ability effects of the crosses on different characters

Crosses	Plant height (cm)	1000-seed mass (g)	Oil content (%)	Hull content (%)	Kernel content (%)	Seed yield (kg)
R-1 x T-1	-0,03	2,73*	0,32	-1,13*	0,78	-0,12
R-3 x H	-0,01	5,53**	-0,71	-0,72	0,48	0,47**
R-4 x H	-0,10**	-0,20	2,55**	-1,83**	1,60**	0,36**
R-6 x H	0,01	2,52	1,62**	-1,53**	1,30**	0,08
R-9 x H	-0,02	5,41**	-1,54**	1,25*	-1,48**	0,32**
R-10 x H	0,02	-4,56**	-0,36	1,24*	-1,36**	-0,40**
R-12 x H	0,06*	-2,34	-1,22**	1,77**	-1,40**	-0,63**
R-14 x H	-0,03	-0,20	-0,21	-0,51	0,27	-0,44**
R-15 x H	-0,02	-2,82*	-0,41	1,14*	0,48	0,33*
R-16 x H	0,05*	-6,06**	-0,85*	0,33	-0,67	0,04
R-1 x T-2	0,07*	-6,56**	0,62	-0,99*	0,63	0,16
R-3 x H	0,01	-7,33**	0,01	-0,05	-0,20	0,24*
R-4 x H	0,04	0,27	-2,78**	0,98*	-1,22**	-0,31*
R-6 x H	-0,01	-0,68	-0,87**	0,78	-1,02*	-0,15
R-9 x H	-0,11**	-9,05**	-1,68**	0,99*	-1,23**	0,13
R-10 x H	-0,06	7,15**	-0,05	-1,02*	0,56	-0,31*
R-12 x H	-0,04	5,34**	1,12**	-0,99*	1,45**	0,39**
R-14 x H	0,05*	3,50**	0,00	-0,77	0,52	-0,28*
R-15 x H	0,01	2,79*	2,46**	0,18	1,43**	0,13
R-16 x H	-0,01	4,58**	1,15**	0,90	-0,92	-0,01
R-1 x T-3	-0,10**	3,84**	-0,94*	2,12**	-1,42**	-0,04
R-3 x H	0,00	-7,33**	0,70	0,76	-0,29	-0,70**
R-4 x H	0,07*	-0,06	0,23	0,85	-0,37	-0,05
R-6 x H	0,00	-1,84	-0,75*	0,75	-0,27	0,06
R-9 x H	0,12**	3,65*	3,21*	-2,24**	2,71**	-0,46**
R-10 x H	-0,06*	-2,59	0,41	-0,21	0,80	0,71**
R-12 x H	-0,04	-3,00*	0,10	-0,78	-0,04	0,24*
R-14 x H	0,05*	-3,30*	0,20	1,28**	-0,80	0,72**
R-15 x H	0,01	0,02	-2,87**	-1,31**	-1,92**	-0,46**
R-16 x H	-0,05	1,48	-0,30	-1,22**	1,59**	-0,03

*, ** Significant at 5% and 1% level, respectively

Table 4-Average contribution (%) of lines, testers and their interaction in expression of individual traits

	Plant height (cm)	1000-seed mass (g)	Oil content (%)	Hull content (%)	Kernel content (%)	Seed yield (kg)
Contribution of LINES	41,16	29,92	52,24	72,80	64,23	41,58
Contribution of TESTERS	45,72	29,59	5,86	0,13	3,90	4,63
Contribution of L x T	13,12	40,49	41,90	27,07	31,87	53,79