COMBINING ABILITY AND HETEROSIS IN H.ANNUUS X H.ANNUUS (WILD) CROSSES

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INTRODUCTION

Most Novi Sad sunflower hybrids have in their pedigree RHA lines resistant or tolerant to Phomopsis helianthi Munt.-Cvet. and tolerant females - cms 22 and cms-74. Resistance sources have been progenies of interspecific crosses H.annuus x H.tuberosus and a local population from Morocco. Long-term investigations under field conditions and in greenhouse have confirmed the susceptibility of the cultivated H.annuus L. to the pathogen. It has been observed, however, that some RHA lines derived from the crosses H.annuus x H.annuus (wild), when combined with tolerant females, produce field tolerant hybrids. Considering the small number of resistance sources to Phomopsis helianthi, it was decided to study the tolerant RHA lines in more detail. This report summarizes the results of the preliminary investigation.

AIMS OF STUDY

1. To estimate components of genotypic variance.
2. To compare general combining ability (GCA) and specific combining ability (SCA) of tolerant branching RHA lines (commercial) against those of the tolerant branching RHA lines originating from the crosses H.annuus x H.annuus (wild).
3. To determine proportional contributions of the lines, testers, and their interactions to total variances.
4. To estimate the heterotic performance of the hybrids.

MATERIAL AND METHODS

Eleven RHA lines have been selected on the basis of their superiority in Phomopsis helianthi tolerance and early maturity from a group of more than 80 inbreds derived from crosses with the wild H. annuus populations HA-728, HA 72133, HA 72152 which had been received from Davis, CA in the course of the seventies. The commercial restorers RHA-N-K, RHA-C-B, and RHA-C-D were used as a check. The females cms-22 and cms-74 were used as testers. Each restorer was mated to each cms line generating 28 F_1 hybrids. The restorers, B-lines of the females, and their hybrids were grown after the system of random blocks in three replications at the sunflower breeding nursery of Institute of Field and Vegetable Crops at Rimski Šančevi. Between and within row distances were 70 and 25 cm, respectively. The folowing traits were recorded: days to flower, days to maturity, plant height, head diameter, 1000-seed mass, and seed yield per plant. Combining ability was analysed after Kempthorne (1957). Heterotic effects were calculated as percentage increase of F_1 over better parents.

RESULTS AND DISCUSSION

As the studied restorers differed in origin and morphological traits, positive heterosis, i.e., a larger portion of the dominant component of variance within the total variance, was expected.

The variance due to the general combining ability of the RHA lines was highly significant for days to flower, plant height, and 1000-seed mass, and significant for seed yield per plant. Non-significant values were recorded for days to maturity and head diameter. The B-lines exhibited the identical levels of significance for the same traits. The variance due to the specific combining ability was highly significant for all traits. The values of the ratio of variances, D/A, were positive and ranged from 1.8 and 2.8 (for days to flower and plant height, respectively) to 113,7 and 150.4 (for days to maturity and head diameter, respectively).

The genes for additive and non-additive action affected the inheritance of days to flower, plant height, 1000-seed mass, and seed yield per plant. The additive and the non-additive gene actions were almost equally important for plant height and seed yield per plant. The additive gene action was negligible for days to maturity and head diameter.

Kovačik and Škaloud (1972), Setty and Singh (1977), and Kadkol et al. (1984) report somewhat different data for certain traits, emphasizing a greater proportion of the SCA variance, while Sindaghi et al. (1979) point out a greater proportion of the GCA variance for yield characters.

Of the commercial restorers used, RHA-C-B turned out a very good general combiner for days to maturity and 1000-seed mass, and RHA-C-D a very good general combiner for days to maturity. Together with RHA-N-K, they showed highly significant and positive values for days to flower and plant height.

Of the 11 RHA lines selected from the crosses with wild H.annuus, 10 of them exhibited highly significant GCA values for plant height. Conversely, not a single restorer exhibited a positive GCA value for seed yield per plant. Nevertheless, RHA-ISM-27, RHA-ISM-50, and RHA-ISM-52 should be singled out as good general combiners for days to flower and plant height.

Regardless of the origin of the RHA lines, only a limited number of the hybrids displayed significant SCA values. These exceptions are the hybrids between both testers and RHA-C-B, RHA-ISM-52, and RHA-ISM-53 for days to maturity, RHA-ISM-53 and RHA-ISM-75 for plant height. High SCA values were recorded for combinations between a parent with good GCA and a parent with poor GCA.

The proportional contribution of the RHA lines to the total variances was high for all traits, ranging from 41.4 to 94.2 with the maximum values (>79%) for days to flower and plant height. On the other side, the contribution of the two testers was proportionally small, ranging from 0.05 to 14.4, with the maximum values (>11%) for days to flower, 1000-seed mass, and seed yield per plant and the minimum values (<2.5%) for head diameter, days to maturity, and plant height. The smallest contribution in the interaction L x T was recorded for plant height (<4.0%), the largest for days to maturity (58.5%) and head diameter (43.4%).

Highly significant negative heterotic effects (for days to flower) and highly significant positive heterotic effects (for plant height and seed yield per plant) were recorded in the hybrid combinations with the commercial restorers RHA-C-D, RHA-C-B, and RHA-N-K. In addition to that, all check restorers in combination with cms-22 expressed positive heterosis and in combination with cms-74 expressed negative heterosis for head diameter. Only RHA-C-D was either positively or negatively heterotic for all traits.

All combinations with the interspecific restorers exhibited negative heterotic effects for days to flower. When combined with cms-22, these restorers exhibited positive heterotic effects for head diameter, and when combined with cms-74 they exhibited negative heterotic effects for the same trait. The contribution of cms-22 to the positive heterosis for 1000-seed mass was evident. The hybrid combination cms-22 x RHA-ISM-75 exhibited highly significant positive or negative heterotic effects for all traits.

Phomopsis helianthi did not affect the accuracy of testing of the examined traits. While the susceptible control hybrid NS-H-26-RM had >80% attacked plants, not a single plants of the RHA lines and the testers exhibited disease symptoms.

TABLE 1. ANALYSIS OF VARIANCE FOR COMBINING ABILITY

SOURCE	df	Days to flowering	Days to maturity	Plant height	Head diameter	1000 seed mass	Seed yield per plant
LINES	13	43.86**	12.98	3.216.94**	5.04	73.71**	232.53*
TESTERS	1	103.19**	.25	1.029.50**	.65	160.19**	613.47*
LIN. x TEST.	13	3.14**	18.35**	117.83**	3.91**	20.88**	119.44**
ERROR	84	1.10	.52	12.47	.87	5.56	30.35

TABLE 2. GENERAL COMBINING ABILITY EFFECTS OF RHA LINES

RHA	Days to flowering	Days to maturity	Plant height	Head diameter	1000 seed mass	Seed yield per plant
Interspec.						
ISM-26	- .59	- .28	-17.49**	1.66	4.69	- .48
ISM-27	-2.70**	- .45	-15.51**	.61	1.69	5.17
ISM-28	-1.37	- .45	-12.17**	- .15	- .14	3.51
ISM-29	-1.55	- .78	-14.86**	1.08	-4.47	- .48
ISM-30	- .99	.38	-11.22**	- .48	-2.64	-2.48
ISM-47	1.54	- .78	- 1.16	.23	-3.97	.84
ISM-50	-2.84**	.88	-19.87**	-1.14	- .64	-13.48*
ISM-51	-1.29	1.21	-12.46**	-1.08	3.02	- 5.48
ISM-52	-3.54**	1.21	-22.69**	-1.69	-3.47	-10.15
ISM-53	1.30	2.71**	9.23**	.63	-4.64	3.01
ISM-75	.01	-1.11	8.47**	.55	2.52	4.84
Comercial						
RHA-C-B	2.87**	-1.61*	33.22**	- .40	- .14	8.17
RHA-C-D	6.22**	-2.78**	56.58**	- .06	6.19*	.51
RHA-N-K	2.94**	1.88**	19.95**	- .43	2.02	6.51

* and **; significant at 0.05 and 0.01 respectively

LITERATURE

KADKOL G.P., ANAND I.J., and SHARMA R.P. (1984), Combining ability and heterosis in sunflower. Indian J.Genet., 44(3):447-451.

KEMPTHORNE O. (1957), An Introduction to Genetic Statistics, John Wiley and sons. New York.

KOVAČIK A. and ŠKALOUD V. (1972), Combining ability and prediction of heterosis in sunflower (Helianthus annuus L.), Scientia Agricultural Bohemoslovaca, 4(4): 263-273. (Pl.Breed.Abstr., 43, 503).

SETTY K.L.T. and SINGH B. (1977), Line x tester analysis of combining ability in sunflower. Pantnagar J. Res. 2(1): 23-26.

SINDAGI S.S., KULKARNI R.S. and SEETHARAM A. (1979), Line x tester analysis of combining ability in sunflower (Helianthus annuus L.), Sunflower Newsletter, 3(2): 11-12.