HYBRID PERFORMANCE OF SELECTED SUNFLOWER LINES USING TWO INBREDS AS TESTERS VERSUS THEIR SINGLE-CROSS TESTER

J.F. MILLER; W.W. ROATH; J.J. HAMMOND *

INTRODUCTION

Efficient estimation of line performance in hybrid combinations is important in a breeding program of sunflower *(Helianthus annuus* L.). Currently, elite inbred lines being used in commercial production are also used by breeders as inbred testers. The resultant testcrosses estimate commercial potential of female lines and provide information pertaining to specific combining ability. However, in long-term population improvement, the use of these specific inbred testers may not be the most effective method. Utilization of the F_1 single cross between the two restorer lines is proposed for estimating general combining ability and for decreasing expense of crossing and testing hybrids.

The objectives of this study were to determine relative effectiveness of inbred versus single-cross testers in identifying potential of female breeding lines; determine whether epistasis is significant in the genetic systems controlling selected morphologic and agronomic traits; and to evaluate the importance of additive and dominance variance for traits not influenced by epistasis.

MATERIALS AND METHODS

Ten randomly selected female lines were crossed with three testers, two of which were restorer inbred lines (RHA 274 and RHA 278), and the third was the F_1 single-cross between the two restorers (RHA 274/RHA 278). The hybrids were grown two years in a randomized complete block design with three replications, in single rows, 91 cm. wide, 6.1m. long, 4.9 m. being harvested. Seeding rate was

* USDA-SEA-AR, Agronomy Department, North Dakota State University, Fargo, ND 58105

60 seeds/row and plots were thinned to 50,000 plants/ha. Measurements were recorded for flowering date, height, head diameter, seed weight, oil percentage, and yield.

The triple testcross analysis (Kearsey and Jinks, 1968), and extension of the Experiment III design (Comstock and Robinson, 1952), provides a test for epistasis as providing an efficient estimate of additive and dominance variance. The comparison of female inbred line x (F_1 vs. restorer inbreds) interaction as well as the comparison of F_1 vs. restorer inbreds are a measure of epistasis. In the absence of epistasis, the variance among female inbreds is an estimate of 1/4 the additive genetic variance; the female inbred X restorer inbred interaction is an estimate of the dominance variance.

TABLE 1

Mean yield and oil percentage of ten female inbred lines crossed with three testers and planted two years, 1978-1979.

Restorer parents	Female inbred line											
	HA 60	HA 89	HA 124	HA 234	HA 290	HA 291	HA 300	HA 301	HA 302	HA 303	Mean	LSD 0.05
	kg/ha											
Yield												
RHA 274	2892	2545	2510	1919	2444	1669	2466	2359	2391	2104	2330	NS
RHA 278	2385	2831	2494	1751	2143	1929	2278	2082	2001	2563	2246	
F_1 (RHA274/ RHA278)	2644	2731	2628	1870	2278	1645	2276	2077	2207	2201	2256	
Mean of RHA 274 and RHA 278 Hybrids	2638	2688	2505	1835	2294	1799	2372	2220	2196	2334	2277	
LSD* 0.05	370											
Oil												
RHA 274	35.1	38.7	37.3	39.0	38.1	39.8	42.4	41.3	42.7	41.7	39.6	1.8
RHA 278	37.3	42.4	38.8	40.5	41.5	43.1	42.5	42.6	42.6	45.0	41.6	
F_1	36.8	38.9	38.3	38.3	41.9	39.7	42.4	42.2	44.9	42.8	40.7	
Mean of RHA 274 and RHA 278 Hybrids	36.2	40.6	38.1	39.8	39.8	41.5	42.5	42.0	42.7	43.4	40.5	
LSD** 0.05	3.1											

* Least significant difference (0.05 probability) for testing differences within restorer parents means.

** Least significant difference (0.05 probability) for testing differences within female inbred line means.

RESULTS AND DISCUSSION

Significant differences among the female lines in all combinations with the restorer testers were observed (Table 1). Consistently highest in yield were hybrids with HA 89, HA 60, and HA 124 used as females. The interaction of female with restorer parent was significant, indicating that the three testers did not rank the females identically. However, if a breeder were to select the top 40% of the inbred lines for advancement in an improvement program, three of the top four in yield would have been consistently identified in the top four. Therefore, it appears that utilizing any one of the three testers will differentiate or identify the highest-yielding potential female lines in a population or inbred development program.

The mean oil percentage of all hybrids in the two years studied was 40.5% (10% moisture basis) (Table 1). Significant differences in mean oil percentage among restorer testers and female lines were found. The interaction between female and male parents was nonsignificant indicating that hybrids with the three testers gave very similar rankings. Bias may have resulted if a breeder was attempting to identify the hybrid with the highest oil percentage; however, utilizing any one of the three testers would be effictive in identifying the top 40%.

Detection of epistasis is indicated in Table 2 by significance of either interaction mean square. Nonsignificant mean squares for all traits studied indicated that epistasis appeared to be a minor factor in the overall genetic variation in these sunflower lines. Additive variances were more important, with dominance variances being important only in yield (Table 3). Since partial dominance predomi-

TABLE 2

Mean squares of components to test for epistatic deviations.

Source	Dif.	Yield	Oil percentage	Height	Head diameter	Seed weight	Flowering date
F_1 vs. restorer inbred	1	33,524 NS	1.02 NS	34.8 NS	13.23 NS	6.03 NS	0.94
Year X male	2	43,964	8.67	22.5	8.04	3.28	0.34
Female X male	18	137,116	3.35	14.5	3.15	0.58	1.25
Female X (F_1 vs. restorer inbred)	9	28,323 NS	3.84 NS	21.5 NS	1.87 NS	0.63 NS	1.75 NS
Year X female X male	18	94,962	2.89	17.7	2.79	1.53	4.32
Error	116	64,635	—	16.9	2.37	—	—

TABLE 3

Estimates of additive (σ_A^2) and dominance (σ_D^2) variance components for selected traits of sunflower

Trait	σ_A^2	σ_D^2
Yield	130,416**	25,168**
Oil percentage	7.63**	—0.01
Height	15.60**	—0.86
Head diameter	—0.11	0.14
Seed weight	1.05*	—0.25
Flowering date	2.04**	—2.25

*, ** Significantly different from zero at the 0.05 and 0.01 probability levels, respectively. Negative values which may be interpreted as zero.

nates for yield (degree of dominance estiamte = 0.62), a possibility exists for the eventual development of stable, high-yielding, open-pollinated varieties of sunflower equal in yield to hybrids. This factor may have significant implications in countries which primarily use open-pollinated varieties at present.

In the U.S., hybrids have distinct advantages over open-pollinated varieties for parameters other than yield. These include: disease resistance, where dominant genes controlling resistance are present in both female and male parents, giving the hybrid multiple resistance; uniformity in plant height, flowering date and seed quality; and improved self-fertility. Self-fertility is important because a large acreage of sunflower production is grown in areas lacking sufficient pollinator populations for adequate fertilization of open-pollinated varieties. These advantages justify continued hybrid development by our program at the present time. Results of this study also indicate that breeders should develop population improvement schemes utilizing breeding methods such as recurrent selection for general combining ability, reciprocal recurrent selection, or reciprocal full-sib selection to utilize the large additive portion of genetic variance detected in this study. However, in long-range population improvement, improving characters such as those mentioned above, in addition to yield and oil percentage, can be accomplished utilizing specific selection methods. Development of high-yielding synthetics or open-pollinated varieties with these characteristics is feasible.

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