Relative Effectiveness of Recurrent Selection for Specific and for General Combining Ability in Corn

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THE general combining ability of an inbred line of corn relative to other lines is usually determined by topcross tests involving one or more genetically heterogeneous, heterozygous testers. This practice is based on the assumption that a broad gene base tester is more effective than a homogeneous tester in evaluating the genotype of a line with respect to frequency of favorable yield genes. A narrow gene base tester such as a stable inbred line or a single cross between stable lines generally has been considered to be of little value for this purpose. There has no doubt been hesitancy on the part of many corn breeders to initiate recurrent selection for specific combining ability as proposed by Hull (1), because of the expectation that lines derived from such work would be of little value in combinations not involving the tester used.

Matzinger (6) suggested that the ranking of lines for general combining ability can be accomplished most economically through the use of a tester having a broad genetic base. However, he reported a much wider range in acre yields with inbred testers than with single cross or double cross testers, and he pointed out the possibility that test crosses involving the use of an inbred tester may allow more chance for discrimination than if single cross or double cross testers are used. Jenkins (2) proposed the production of synthetic varieties by a procedure which has come to be known as "recurrent selection for general combining ability". This procedure, which utilizes a broad gene base tester, has been reported effective in improving combining ability for grain yield (3, 4, 9). Lonnquist and Runbaugh (5) concluded that the single cross WF9 X M14 was of no value as a tester for general combining ability. Hull (1) presented several arguments favoring overdominance as a partial explanation for heterosis in corn, and recommended that "recurrent selection for specific combining ability" be given a trial. He pointed out that a stable inbred line would be a more effective tester than a single cross in building up a high complementary relation between the tester and the crossbred lot under selection. McGill and Lonnquist (7) found that 2 cycles of selection for combining ability with WF9 X M14 were effective. Sprague et al. (11) reported that 2 cycles of selection for combining ability with the inbred line Hy resulted in yield increases of 6.5 bushels per acre in one series and 20.0 bushels per acre in another. No report on a direct comparison of narrow base and broad base testers for combining ability in a recurrent selection experiment was found in the literature.

The present study was initiated to provide information

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3 on the relative effectiveness of an inbred line tester and a genetically heterogeneous tester with regard to combining ability for grain yield.

MATERIALS AND METHODS

A composite variety having an extremely broad genetic base, including genotypes from the U.S. Corn Belt, Southeastern U.S.A., and Central and South America, was developed by F. H. Hull of the Florida Agricultural Experiment Station and maintained by bulk sibbing for several generations. This population, hereafter referred to as Florida 767, was the source of lines used to initiate the experiment and also served as the broad base tester. The inbred line F6, one of the parents of the double cross Dixie 18, was chosen as the narrow base tester mainly because of its vigor, uniformity, and ease of handling in the nursery. This line is about average in combining ability and seems to carry genes dominant for low kernel-row number.

In 1952 about 300 Si lines from Florida 767 were planted in the breeding nursery at Gainesville. Individual plants were selected on the basis of low ear height and other desirable characteristics, and were selfed and outcrossed to either F6 or Florida 767. Choice of testers for selected plants was at random. At harvest no cross on Florida 767 was saved unless at least 10 well-pollinated ears were obtained. Sixty test crosses in each series were grown in separate experiments in 1953 at 4 locations in North Florida with 2 replicates per location. Single-row plots 30 to 40 feet long were used in a randomized block design. The double cross hybrid Dixie 18 was included as a check every 20th plot. On the basis of grain yield, standability, and resistance to rice weevil, 11 lines were selected from each tester group and were intercrossed separately in the winter of 1953-54. The second and third cycle test crosses were grown in 1955 and 1957, respectively, and were handled in the same way as the first cycle except that Si rather than S, plants were outcrossed to the testers and 100 crosses were tested in each group. The top 40 for grain yield in each group of third cycle test crosses were retested at 5 locations in 1955 to obtain more precise information, and selection was based on the 2 years' data. The fourth cycle test crosses were made in 1960 with S Si lines as seed parents in isolated crossing blocks, and were grown in 1961 at 5 locations with 2 replicates at each of 2 locations and 1 replicate at each of the other locations. Poor stands caused the loss of 1 location with 2 replicates; so the fourth cycle test crosses were analyzed as randomized block designs with 5 replicates, ignoring locations.

The 2 series were conducted as nearly as possible in exact parallel in all 4 cycles. The crosses were grown in separate tests for each tester but in adjacent blocks of the same fields.

In 1954 the 4 composites resulting from intercrossing selected lines in each of the first 2 cycles of selection were advanced another generation by bulk sibbing about 200 plants in each population. In 1959 these second generation composites and the 10 selected third cycle lines from each tester group were crossed with 11 testers which were unrelated to the original population. One of these 11 testers was a single cross, 3 were relatively homozygous lines, and the other 7 were Si lines from various sources, as a group they represent a wide range of genotypes. In making this set of crosses, pollen was collected from at least 100 plants of each composite, and approximately equal amounts of pollen from the third cycle lines were mixed to represent the selected third cycle material. These 66 test crosses (6 populations X 11 testers), along with 6 plots per replicate of Dixie 18, were grown in a split plot design with testers as main plots at 3 locations (Gainesville, Hapac and Quincy) with 2 replicates per location in 1960 and 1961.

Additional test crosses for cycle evaluation were made in 1959 with the 6 populations described above as pollen parents and the inbred tester F6 (the narrow base tester used in this experiment).