The Effect of Selection for Combining Ability Within Segregating Lines of Corn

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The development of inbred lines that give superior performance in hybrid combination is the primary goal of present-day methods of corn breeding. Many questions concerning the underlying principles involved in their development must be answered if most efficient progress is to be made in the breeding programs.

One of the pertinent questions confronting the corn breeder is the stage of inbreeding at which tests for combining ability can be made most efficiently for the purpose of eliminating those lines not likely to be of value in the corn breeding program. Two rather divergent schools of thought have developed in this connection in recent years. One favors early testing of $S_o$ or $S_1$ genotypes on the theory that a selected sample of such plants based on tests of combining ability provides a better sample for inbreeding than does a random sample from the same population (1, 8). The other holds that visual selection is effective in improving combining ability during the early inbreeding generations and if discarding is done on the basis of topcross tests in the first or second inbred generation, many ultimately worthwhile lines might be thrown away (5).

It is the purpose of this paper to report the results of a study which bears on this problem. The primary objective was to determine the extent to which combining ability of lines might be altered by selection through the aid of topcross performance tests in subsequent selfed generations following their evaluation in the $S_1$. It is quite generally agreed that selection for yield genotype can be done most effectively on the basis of progeny tests, although visual selection on the basis of characters denoting vigor as well as on freedom from diseases, etc., may be expected to enhance the yielding ability of selected segregates. Selection in this study was based primarily upon progeny performance as measured in topcross tests. In this way it was possible to determine more accurately the stability of combining ability after the $S_1$ generation as inbreeding progressed. Although it may be possible to practice effective selection for yielding ability in lines based upon visual appearance only, the relatively low heritability estimates reported for yield in corn (6) indicate that proportionately more progress might be made in the breeding program by using progeny performance (topcross tests).

Procedure

An open-pollinated variety of Krug yellow (strain) was used as the source material in this study. $S_o$ plants were self-pollinated in 1942; however, it caused excessive lodging in the fall permitted of all but 86 at harvest. The 86 $S_o$ lines were evaluated for relative combining ability for yield through to the parental variety in 1944.

In studying the stability of combining ability of the $S_1$ through subsequent selfed generations, it seems to begin with lines which differed materially in stability. Therefore, on the basis of the frequency distribution of 1944 topcross yields, 15 lines, eight from the upper portion of the yield range and seven from the lower portion, were selected for further study. The two groups of $S_1$ lines differed by more than twice the standard error of a mean difference, and therefore, considered significantly different in a manner as measured by their topcross performance.

Divergent selection for high- and low-combining ability was practiced within each selfed generation in each $S_1$ line. This was done by selecting divergent sublines within each $S_1$ line. On the basis of topcross performance, a high- and low-combining $S_1$ plant was chosen to represent the directions of selection for yield within each $S_1$ line. In view of the difficulty in accurately evaluating combining ability on a selected plant on the basis of a single year's performance, whenever two sister-lines gave similar performances, both were continued until a more critical evaluation was made. The selected progenies were grown ear-to-row, and selection within the $S_1$, $S_2$, and $S_3$ generations was made in this manner.

The parental variety, Krug, was used as the tester in evaluating the $S_1$ lines as pointed out previously. The difficulties inherent in sampling a highly heterogeneous tester and the expected decline in variability following inbreeding, a single cross (Wf9 × M14) was used as the tester in subsequent generations. The parental $S_1$ was crossed to the single-cross tester to obtain a control of their relative combining ability with it.

Topcrosses made after each generation of selfing were used as the basis for selection of the desired lines for each family to be continued into the next generation. Topcrosses of the selected high- and low-lines within the $S_1$ to $S_3$ for which seed was available were the basis of the experiment.

Results

Although selection for combining ability was based on the basis of topcross performance and during generations of selfing, the test of topcross performance of selected divergent sublines in 1948 provided evidence of real progress made during the course of the experiment unconfounded with seasonal differences. Topcross yield per plot was 15.72 pounds (92.8 bushels per acre)