Combining Ability of $S_1$ and Derived $S_3$ Lines of Corn

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THE first corn hybrids produced by the Mexican Agricultural Program of The Rockefeller Foundation were combinations of first generation selfed lines. These hybrids yielded about 25 to 30% more grain than the open-pollinated varieties in the regions to which they were adapted (8). The $S_3$ lines were selected on the basis of their agronomic characteristics as well as their performance in topcrosses; consequently, these hybrids also offered improved resistance to lodging, earliness, and resistance to disease. Because the lines used were heterozygous, the hybrids were somewhat variable. It seemed that two general methods were available which might provide further improvements in yield and agronomic characteristics: first, the isolation of additional $S_1$ lines which might prove to be superior; or second, further inbreeding accompanied by visual selection, followed by recombination of selected advanced lines. In an effort to determine the gains which might be expected through further inbreeding and selection, data have been collected on the relative combining ability of the original $S_1$ lines and of the selected $S_3$ lines derived from them.

REVIEW OF LITERATURE

Various investigators have reported data favoring early testing. The work of Jenkins (1) indicates that combining ability of inbred lines is fixed as early as the $S_1$ generation. The data also suggest that inbreeding in high combining $S_1$ lines was accompanied by a decrease in combining ability, in spite of selection, while inbreeding and selection in low combining $S_1$ lines was generally accompanied by an increase in combining ability. In another study, Jenkins (2) concluded that within $S_1$ families “the limited segregation for yield prepotency permits, and emphasizes the importance of, early testing of the lines to determine their relative endowment with respect to factors affecting yield.” Sprague and Bryan (7) concluded that selection among $F_2$ families for combining ability was considerably more efficient than selection among $F_3$ families. It was also apparent from their data that the highest yielding $F_4$ segregate was derived from the highest $F_3$ line, and that the lowest yielding $F_4$ segregate was derived from the lowest $F_3$ line. Correlation appeared excellent between $F_3$ yield and $F_4$ mean yield. Sprague (6) presented data which indicate that $S_0$ plants exhibiting high or low combining ability in topcrosses transmitted this character to their $S_1$ progeny. Lonnquist (3) reported data for a divergent selection study within high and low combining $S_3$ lines. The $S_4$ lines highest in combining ability were obtained from the high $S_1$ lines, while the lowest $S_4$ lines were derived from the low $S_1$ lines. By retesting for yield after each generation obtained by early testing in $S_1$ and by proceeding only from the high $S_1$ lines.

Data which are critical of early testing were presented by Singleton and Nelson (5). Also, Hayes (4) found highly significant positive correlations among $F_3$ and $F_4$ lines in crosses with inbred testers. Since the correlation values could be by eliminating the two low families in early testing, expressed some doubt as to the practicality of early testing for combining ability.

MATERIALS AND METHODS

At the onset of the experiments reported in this paper, a large number of self-pollinations were made in various regions in Mexico for which hybrids were sought. The best $S_1$ lines were topcrossed with unrelated varieties to those regions. On the basis of yield trial results, combining $S_1$ lines were discarded. Only those lines which had the first cycle of discarding enter into the results reported here. The $S_1$ lines utilized for this study, therefore, are random samples of the varieties but are lines selected early in the inbreeding program on the basis of their combining ability.

The $S_1$ lines adapted in the Central Mesa (6,500 to 7,500 feet) were self-pollinated at the central breeding station in the State of Mexico. Inbreeding in $S_3$ lines for varieties was done at the winter breeding station at Jaloxtoc (4,600 feet). At each of these stations a rigorous selection for desirable agronomic characteristics was followed. The $S_3$ lines that survived the program all had their $S_1$ parents were then topcrossed with one to three testers adapted to those regions for which hybrids were sought.

The topcrosses of inbred and selected lines were tested there and at the Experiment Station at Ciudad Victoria, in the State of Hidalgo. The station in Hidalgo is about 15 miles from the station at Chapingo, and has a slightly drier season.

The topcrosses of inbred and selected lines from a testing station at Jaloxtoc were tested at the winter breeding station at Ciudad Victoria in the State of Tamaulipas, Obregón in the State of Sonora. The winter climate at Jaloxtoc is dry, and disease problems are not serious. Both stations in the State of Veracruz are located near sea level in the humid tropics of the Gulf Coast. The station at Ciudad Victoria has an elevation of about 1,500 feet, and the climate is semi-tropical, very similar to that at Jaloxtoc for 9 months. Ciudad Obregón is located in the valley of the Yaqui River, which has a very high summer temperature.

All experiments were designed as $7 \times 7$ for replications; yields were corrected for statistical differences, and the data were transformed to percent of average yields of three common check varieties. Summary of the work of Jenkins (4) is given in table 1. For example, the topcross of the $S_1$ line Qro. V-307 in 135% of the checks. In this particular family derived $S_3$ lines, but the number varied for the others. Their average yield in crosses was 140.6% of the sample checks, a slight increase over the topcross yield of the original SI line.