Evaluation of Bulk Hybrid Tests for Predicting Performance of Pure Line Selections in Hard Red Winter Wheat

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H YBRIDIZATION, followed by selection of desirable segregates, is one of the important methods of small grain improvement. Efficiency in breeding self-pollinated crops can be increased if the value of crosses or selections is determined during early generations. This paper reports the results of an experiment designed to determine the value of early generation bulk hybrid tests to predict the performance of pure line selections in hard red winter wheat.

LITERATURE REVIEW

Harlan et al. (5) carried 579 bulked barley crosses as unselected populations for 7 generations and found that a preselection yield classification of the crosses agreed with the relative yield of selections made in the F1 generation. It was concluded that the low yielding group of crosses, constituted by the poorer types, could just as well have been discarded before selection. Atkins (1), however, found that selection based on several plant characteristics contributing to yield was not effective in isolating high yielding lines from bulked barley crosses grown in Iowa. Immer (7) suggested that the average yield of bulk F2 and F3 generation barley crosses would be valuable for detecting the better crosses of a group. Graujs et al. (4) reported most of the variance in yield of bulked F2 barley progenies to be nonheritable. The more homozygous F1 generation showed increased heritability of yield.

Harrington (6) found that bulk F4, supplemented by F3 generation yield results accurately evaluated six wheat crosses when selected lines were tested in F4, F5, and F6 generations.

Atkins and Murphy (2) classified 10 out crosses as high or low yielding on the basis of bulk F3 through F6 generation tests and found that as many high yielding F1 segregates came from the crosses classified as low yielding as from the high yielding group. Test weight was found to be reliably predicted in this study.

Kalton (8) found maturity, plant height, and lodging to be relatively constant in the bulk F3, F4, and F5 generations of 25 soybean crosses, but yield differences were inconsistent from generation to generation. Mahnud and Kramer (9) reported that the effect of environment was great enough to reduce yield heritability estimates on early generation tests of soybeans to negligible values, while those for earliness and plant height remained high. Tests of bulk populations of F1 through F4 generations of soybean crosses were not reliable in predicting yield or maturity date of selections, but lodging and height evaluations were consistently indicative of the performance of these same selections, according to Weiss (11) and Weiss et al. (12).

MATERIALS AND METHODS

Ten varieties of winter wheat, representing a wide range of types, were intercrossed in all possible combinations in 1942. The parental varieties were: Blackhull, CI 6251; Cheyenne, CI 8883; Chiefkan, CI 11754; Comanche, CI 11673; Early Blackhull-Tennar, KS 2757; Marquillo-Oro, CI 11979; Nebred, CI 10094; Pawnee, CI 11669; RedChief, CI 12109; and Tennar, CI 6956. All are, or have been, commercially important varieties in the hard red winter wheat area except Ks 2757 and CI 11979. The 45 crosses were grown in bulk from the F1 through the F7 generation. The 45 bulked crosses and their 10 parents were grown in 1946, 1947, and 1948. The F1 generation was grown all 3 years, the F2 in 1947 and 1948, and the F3 in 1948. A randomized complete block design, with single- or 2-row, 8-foot plots replicated 5 or 10 times was used for these early generation tests. Seed from the parents and F3 bulks was spaced planted in 1949; 10 plants were selected at random from each cross and 5 from each parent. Seed of these individual plants was increased in 1950 and 7 or 8 pure line selections from each cross and 2 from each parent were grown in 2-row and 4-row plots 8 feet long in a 7 by 7 by 7 cubic lattice design in 1951 and 1952. Yield in grains per 8-foot row, plant height in inches, date in May on which the half-bloom stage was reached, and test weight in pounds per bushel were recorded for all kinds in this study. All tests were conducted at Manhattan, Kans.

The statistical methods as outlined by Cochran and Cox (3), Snedecor (10), and Yates and Cochran (13) were used throughout the study. Combined analyses of variances, using all the available data for any one generation, were performed for each characteristic studied. Each early generation kind was characterized by combining and analyzing results of F2, F3, and F4 generations grown in 1946, 1947, and 1948, respectively. Product-moment correlation coefficients for each characteristic were calculated between logical combinations of generations and years. Results of the cubic lattice trials were analyzed by the punched-card method at the Statistical Laboratory, Kansas State College.

EXPERIMENTAL RESULTS

Table 1 summarizes most of the data obtained during the course of the study. Variety averages are given to characterize each parent. The performances of the bulks are based on 3 successive generation-year results of tests involving the 9 bulked crosses with 1 parent in common. Such an average is the logical one to use to characterize early generation bulked cross performance, since results of successive generations grown in consecutive years would be available in a practical early generation test program. Selection averages cover the 2-year performance of the 64 or 65 pure lines having a common parent. Direct comparisons between varieties, bulks, and selections should not be made since different years are involved.

Yield

A combined analysis of F2 (1946), F3 (1947), and F4 (1948) generation yields showed no significant difference among the 55 kinds. Average yields ranged from 206.4 to 136.2 g, with 8.34 as the standard error of a kind mean. However, there were highly significant differences in yield between kinds in all generations and years. When kinds were ranked according to yield, a striking inconsistency in relative yield from generation to generation and year to year was apparent.

Correlations, shown in table 2, were significant in only one out of 11 individual comparisons. This highly significant yield correlation between F2 and F3 generations, when year to year variation was eliminated by growing them both in 1947, might indicate a certain degree of relationship; however, the correlation between these same generations was not significant.