Evaluation of Yield Potentialities of Oat Crosses From Bulk Hybrid Tests

R. E. Atkins and H. C. Murphy

The breeding of improved varieties of cereal crops has become more complex both from an agronomic and pathological viewpoint. Yielding ability of present varieties may be approaching the upper limit attainable and disease problems are continually becoming more complex through the production of new forms or physiologic races of the various pathogens. To meet these problems breeding practices should be of a type that will enable the plant breeder to observe large numbers of crosses and to evaluate their potential value as quickly as possible.

The investigations reported here were initiated to determine the value of replicated yield tests in early generation bulk oat populations as a basis for eliminating potentially poor yielding crosses.

Review of Literature

The work of previous investigators both with self- and cross-fertilized species pertinent to the problems encountered in the use of the bulk hybrid method in plant breeding investigations has been reviewed rather extensively by Kalton (7). The articles reviewed here are especially applicable to the use of the bulk method in breeding small grains.

In a study of six barley crosses, Immer (6) grew the bulk \( F_2 \), \( F_3 \), and \( F_4 \) generations in replicated yield trials to determine their breeding value. The two crosses that produced the highest yields in \( F_2 \) and \( F_3 \) were found also to be among the highest in \( F_4 \), while two other crosses were relatively low-yielding in all generations tested. It was concluded that such yield trials may be used to discard certain crosses since the proportion of high-yielding genotypes in the low-yielding crosses would be less than in crosses with a higher average yield.

Results of studies of 379 barley crosses made from 28 parent varieties selected from all over the world were reported by Harlan, Martini, and Stevens (3). Selections were made from each cross in the eighth generation in proportion to their previous yield performance in bulk rows. The yields of the crosses before selection were made found to be a sound indication of the crosses from which high-yielding segregates might be expected. It was concluded that the low-yielding crosses could have been discarded without loss on the basis of their pre-selection yields.

Harrington (4) conducted replicated half-rod row yield trials with bulk unselected seed of ten wheat crosses in \( F_2 \) and with six crosses in \( F_3 \). The yielding value of the latter six crosses was determined later by replicated rod row yield trials with single lines in the \( F_6 \), \( F_7 \), and \( F_8 \) generations. Harrington found that replicated bulk \( F_2 \) tests could be used to indicate potentialities of wheat crosses, and that bulk \( F_2 \) supplemented value in this regard.

Nineteen wheat crosses were handled by the bulk method in an experiment by Florell (2). Selections from nine of the crosses in \( F_3 \) and from ten crosses grown in replicated rod row plots. The average yield of 45 selections grown in the replicated yield test was above the average yield of all check rows.

The effects of natural selection and competition mount importance in any consideration of the value of hybrid method of breeding cereal crops. Suneson and Wiebe (10) grew mixtures of different varieties of barley and varieties of wheat in 1/50-acre plots over a period of years. They found that competition between varieties stands often caused results considerably different from those expected on the basis of the yield performance of the varieties grown in pure stands. It was concluded that the relative yield of a variety was not necessarily a criterion of its ability to survive in a mixed population and hence suggested a limitation for the success of the bulk population method.

Materials and Methods

Ten crosses were selected from a group of 70 barley populations to study the performance of the bulk relative to a random group of segregates from the bulk for yield and other agronomic characters. Yields of \( F_2 \), \( F_3 \), and \( F_4 \) generations grown in successive years replicated rod row tests at Ames, Iowa, were available. On the basis of these data five crosses were classified as high and five as low in yield. Yields of the ten crosses expressed as a percentage of the average yield of Boone, Tama, and Marion for the period are given in Table 1. While the yields of the crosses varied considerably from generation to generation, they were chosen among the most consistently high or low-yielding group from which they were chosen.

In addition to the bulk hybrid seed of the ten crosses to 125 individual panicles of each cross were selected in the \( F_5 \) or \( F_6 \) generation of the bulk populations in 5-foot rows for study in 1946. By selecting 50 of these at random from each of the ten crosses, together with a seed of each cross and the standard varieties Clint and the total number of entries for the yield test was increased. This made possible the use of an 8x8x8 cubic lattice yield test grown in 1947 at Ames, Iowa.

Three replicates, or one set of the lattice, were prepared procedure given by Day and Austin (1) for assigning numbers to the entries. The analysis of variance of the calculated by the punched card machine method for