Predicting Synthetic Varietal Performance in Alfalfa from Clonal Cross Data

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IN THE development of synthetic varieties of alfalfa and other crops, selection of the best possible combinations is always a major problem. The magnitude of this evaluation problem is indicated by the fact that working with only ten clones, a plant breeder could produce 1023 different synthetic varieties. The total number of different clonal crosses possible among ten clones is only 45. Therefore, if synthetic variety performance can be predicted from clonal cross behavior, the task of evaluation can be considerably lightened. This study was designed to secure data on the value of predicting the performance of synthetic varieties of alfalfa from the behavior of all possible crosses among the clones of which each synthetic is composed.

The comparisons reported in this paper are for yield of forage, winter hardiness, recovery after cutting, and stand persistence. Ten alfalfa clones were chosen for the study and all of the comparisons were made under field conditions. The performance of one 3-clone and two 4-clone synthetics was compared with the performance of the 15 possible crosses produced from their respective parental clones.

LITERATURE REVIEW

Many methods of measuring each of the four characters considered in this study have been described. In measuring winter hardiness, Tysdal and Crandall (11) found a significant correlation (.62) between results obtained in a cold chamber and those from field studies at Saskatoon, Sask. These investigators were satisfied that they could make effective progress in breeding for winter hardiness on the basis of either test. Heuser (3) suggested counting the number of stomata per unit area of leaf as a measure of winterhardiness in alfalfa. He suggested that a correlation exists between the number of stomata and the degree of winterhardness, plants with few stomata being the most hardy. Recently rate of germination of alfalfa seed at various osmotic concentrations has been investigated as a measure of winterhardiness (7). Torsell et al. (9) made actual counts of dead and living plants in each plot and gave each living plant a score for vigor.

To estimate persistence, Rønningen and Hess (8) advocated using third-year-stand notes. Such a procedure, if precise enough, would greatly simplify one of the forage breeder's most difficult tasks. Persistence is an especially difficult character to work with because of the length of time involved in studying it and because of the complex of factors involved in its expression. The consideration of greatest importance is years over which a profitable forage crop can be harvested. Because persistence is of great importance to farmers, it needs to be considered by plant breeders more than it has been in the past. Its major components in the North Central States are believed to be winterhardiness and resistance to bacterial wilt (12). There are probably other factors affecting this character.

Twamley (10) concluded that although the evidence is not critical, it favors an autotetraploid origin of alfalfa with a later development of some allopolyploid characteristics. Hal- dane (4) calculated that in contrast to diploids, in which equilibrium should be reached immediately in the syn-2 generation, the approach to equilibrium in autopolyploids would be asymptotic; however, the greatest decrease in vigor should occur in the first generation after synthesis. Graumann and his associates (1, 2) published data comparing four generations of synthetic varieties which seemed to indicate that the greatest reduction in vigor in alfalfa is between the syn-1 and the syn-2 generations. In the present study, syn-2 performance was observed and compared to the average clonal cross performance.

MATERIALS AND METHODS

Ten clones were selected from the alfalfa breeding program at Minnesota for this study. Four clones of a common origin were used to constitute one synthetic, Minnesota Syn B; 4 clones of diverse origins were used to constitute Minnesota Syn F; and 3 unrelated clones, one of which appears in Syn F, were used to constitute Minnesota Syn G.

The clonal cross seed was produced in the greenhouse by hand pollination using a folded blotter paper to transfer pollen from one plant to another. F1 plants of clonal crosses constituting the respective synthetics were transplanted to isolated plots and permitted to intercross to produce the syn-2 seed.

Three replications of 5-row plots 20 feet long, with a thick and a thin seeding rate for each entry, were seeded in June, 1955. The thick seeding rate was approximately 9 pounds per acre and the thin rate was about 2½ pounds per acre. Three replications of 2-row plots for spaced plant studies also were established. Three commercial varieties, Narrangassett, Ranger, and Vernal, were included as checks. The synthetic and its six clonal crosses (or three in the case of Syn G) plus the check varieties comprised a unit. The three “synthetic units” were arranged in a 3 X 3 latin square. Within each synthetic unit the 10, or 7, entries were completely randomized.

Forage yield and other information were obtained in 1956 and 1957 and additional limited data in 1958. Analyses of variance were calculated for making tests of significance between each synthetic variety and its component clonal crosses and among clonal crosses. The significance of the observed differences were ascertained with the F test. The “among clonal crosses” sums of squares were partitioned into general and specific combining ability components according to the method proposed by Griffing (3). Correlation coefficients were calculated to measure the degree of association between the thick and thin seeding rates and between the thick seeding rate and the spaced planting. Co-variance analysis was used to adjust for leafhopper and gopher damage in one crop.

EXPERIMENTAL RESULTS

Forage yield—Three cuttings were harvested each year in 1956 and 1957. The plots were cut with a 38-inch sickle bar mower and the forage from each plot weighed immediately. On the basis of samples taken at intervals of 10 to 15 plots, the green weights were converted to tons of hay (15% moisture) per acre.

There was very good agreement between the thick and thin seeding rates for forage yield (r = .94). Therefore, the data for the 2 seeding rates have been combined and