Variation and Its Evaluation Within and Among Strains of Bromus inermis Leyss. I. Spaced-Plant Studies

K. L. Lebsock and R. R. Kalton

The nature and extent of variability in plant populations are of prime importance in any crop improvement program. In forages, as with many other crops, breeding generally begins with phenotypic selection in space-planted nurseries comprised of variable plant populations. To facilitate such selection for desired traits, knowledge of the fraction of the observed total variability attributable to genetic causes would be helpful. Range in expression and average merit exhibited by plant populations of different strains for various characteristics also need consideration, since low variability and merit are not conducive to genetic advance. The present investigation was designed to obtain additional information in these regards through detailed evaluations of individual plants representing 21 varieties and strains of Bromus inermis Leyss. Several seed lots of four of the varieties, Fischer, Lincoln, Achenbach, and Elsberry, and three vegetatively-propagated clones of southern origin also were included for comparison.

Main objectives of the study were: (1) to compare plant populations of the different strains for mean performance and range in important agronomic traits on a space-planted basis, (2) to compare plant populations of different seed lots of the same strain in the same manner to determine if genetic alterations had occurred due to production of seed in regions at varying distances from the area of origin and (3) to measure plant-to-plant variability and to estimate the extent to which this variability was genetically controlled. It also was intended to use the results and plant materials as a basis for initiating a recurrent selection program.

REVIEW OF LITERATURE

Evaluation of strain performance is of practical significance in all crop breeding programs. Kalton and Wilsie (5) and Wilsie (10) reviewed a number of studies dealing with the performance of different northern, southern, and intermediate strains of bromegrass. In general, the southern strains have exceeded those of northern origin in over-all agronomic performance in the Midwest.

The genetic stability of a grass variety grown for forage and seed production over a wide area is an important consideration, since natural selection pressure might cause genetic changes in the population. Wilsie (10) demonstrated that natural selection apparently modified the genetic composition of northern strains of bromegrass when grown in Iowa. However, no data were found concerning similar alterations in genotype within southern varieties of bromegrass. Smith and Graber (9) found that such changes occurred in Ranger alfalfa. First generation seed produced in Arizona and in Montana differed in height and winter hardiness, but yield differences were not significant. Differences were more marked in second generation seed increases. In a similar study under New York conditions, Murphy and Kohli (8) found no important differences among seed increases of Ranger alfalfa from Nebraska, Montana, and Arizona with respect to yield, disease reaction, recovery, stand, and vigor.

Various methods have been used to estimate the extent of genetic variation among spaced plants of forage grasses. McDonald, et al. (7) and Kalton, et al. (4) obtained estimates of total genetic variation by subtracting environmental (among clone members) variance from the total variance of S, populations of bromegrass and orchardgrass. Burton (1) found that estimates of genetic variation percentage (heritability) were negative or low for some quantitative traits in pearl millet, indicating that phenotypic selection for forage or seed yield in a spaced-plant nursery would lead to negligible genetic advance. On the other hand, environment had relatively less effect on expression of height, leaf width and certain other agronomic characters. More recently, Burton and DeVane (2) estimated genetic variation in replicated clones of tall fescue. In this study, comparatively high heritability estimates obtained for forage and seed yield were attributed, in part, to a reduction of environmental effects through replication. Calculated expected gain values indicated that selection among replicated, space-planted clones of tall fescue could lead to substantial genetic improvement in forage and seed production.

MATERIALS AND METHODS

All data were obtained from a space-planted nursery established in April 1951 at the Agronomy Farm, Ames, Iowa. Included were seven seed lots of Fischer, eight of Lincoln, three of Achenbach, two of Elsberry, twelve other varieties and strains from the United States and Canada, five introductions from Turkey, and three vegetatively-propagated clones of southern origin for a total of 40 entries. Seed lots of the four southern varieties were produced in various parts of the Midwest, with the exception of one lot of Fischer produced in New York. All were certified and most were one seed generation removed from the originating source. Introductions from Turkey were received through the courtesy of M. M. Hoover of the Regional Plant Introduction Station at Ames.

All seed entries were established in the greenhouse in early April and transplanted to the field in the first week in June. Plant material for the three clones was propagated at the same time, using one- or two-tiller propagules so that size was similar to the seedlings. Plant spacings were 38 inches within and between rows, with border plants included on all sides of the nursery. The design was a randomized complete block with ten replications, each plot consisting of a single row of ten plants. Stand establishment generally was excellent and over 95% of the plants survived through 1951 and 1952, except for those of a few strains generally of intermediate or northern origin. Approximately 75 pounds per acre of N was added to the nursery early in 1952 to encourage maximum plant development.

All plants were evaluated individually for fall vigor in October, 1951, for vigor, height, spread, leaf width and leaf diseases during June and early July in 1952, and for aftermath recovery in mid-August, 1952. Vigor ratings were based on spread, height, and density and ranged from 0 (dead) to 10 (maximum vegetative growth). Height was measured in inches from ground...