Selecting for Winter Hardiness in Non-Dormant Alfalfa.

Mindy A. Weishaar, E. Charles Brummer, and Jeffrey J. Volenec*

Department of Agronomy, Iowa State University, Ames, IA 50011
***Department of Agronomy, Purdue University, West Lafayette, IN 47907**

Alfalfa in the Midwestern United States typically becomes dormant in autumn in response to decreasing photoperiod and cooling temperatures, a response that allows the plants to survive the stresses of winter. A non-dormant plant does not have this period of slowed growth, which is preferable from an autumn yield standpoint. A strong phenotypic correlation exists between dormancy (fall height) and winter hardiness, although genetic correlations are less striking (Brummer et al., 2000). The objective of this study was to determine if selection within non-dormant cultivars for decreased winter injury was effective and to determine the indirect effect of winter injury selection on autumn growth. Between 1997 and 2000, three cycles of selection were conducted in four non-dormant cultivars (5939, GT13R+, CUF101, and Magna 8) by recurrently selecting and intercrossing the most vigorous surviving plants of each population in the spring following establishment. In May 2001, the original cultivars and the three cycles of selection, i.e., C0, C1 (missing in CUF101 and 5939), C2, and C3, of all four varieties were planted with six check cultivars in the field at Ames, IA and West Lafayette, IN. Plants were spaced 10 cm apart within rows spaced 75 cm apart. Yield was measured in September and November 2001 at both locations. In November 2001, one half of the plants in each plot was removed from the field and separated into crowns and roots, which were stored at -80°C. The plant material was then freeze-dried, ground to pass a 1 mm screen, and analyzed for sugar, starch, and protein levels. The remaining plants remained in the field over winter and were dug and scored for winter injury using the NAAIC standard test in April 2001 (McCaslin and Woodward, 1995). In September 2001, forage yield for CUF101 and 5939 at Ames showed a positive linear trend across cycles but no trend was observed for any variety at West Lafayette. In November no trend in yield was noted for any variety at either location. These results indicated that selection for winter survival did not depress yield and may have improved it earlier in the season. Height was measured in October of 2001 to assess fall dormancy, and a significant negative linear trend across all cycles, for all varieties, and in both locations was observed. Thus, our results parallel those of Cunningham et al. (1998) who detected decreased winter injury in CUF101 populations selected for shorter autumn height. Among the laboratory traits, a positive linear trend in total sugars for all varieties in Ames and for CUF101 and GT13R+ in West Lafayette was the only clear change noted. We have demonstrated that selection based solely on winter injury can dramatically improve winter hardiness in non-dormant populations, and while a concomitant decrease in autumn plant height occurred, autumn yield appeared to be unaffected.

Brummer et al., 2000, Crop Sci. 40:971; Cunningham et al., 1998, Crop Sci. 38:962; McCaslin and Woodward, 1995, NAAIC Standard Tests.