BENCHMARKING ALFALFA IMPROVEMENT IN THE LAST CENTURY

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Although genetic selection continues to be an important means by which we increase yield and stress tolerance of alfalfa (Medicago sativa L.), we rarely take time to critically assess our progress. Genetic improvement of alfalfa yield and persistence has been slow relative to other crop species. Ipson (MSc. Thesis, UW-Madison, 1991) used Wisconsin variety trial data obtained between 1959 and 1989 to determine that genetic selection had increased forage yield of alfalfa 0.5% per year. During this interval the average alfalfa yield in Wisconsin nearly doubled. This indicates that 80% of the enhanced forage yield that occurred during this period was due to improved management rather that cultivar improvement. Holland and Bingham (Crop Sci. 34:953-957, 1994) reported that genetic selection improved forage yield average 0.18% annually between 1898 and 1985.

In a paper currently in press with Field Crops Research ("Physiological Genetics of Alfalfa Improvement: Past Failures, Future Prospects") we discuss issues related to alfalfa improvement. Our objectives were to 1) examine the progress made during the last century in alfalfa improvement; 2) discuss how selection for discrete traits such as disease resistance or winter hardiness during the last two decades has impacted alfalfa persistence; and 3) assess the potential impact of using molecular tools to improve agronomic performance of alfalfa in the decades ahead. What follows is a synopsis of Objectives 1 and 2 from this article.

Our analysis compared forage yield improvement of cultivars released between 1907 and 1995 that were tested in 715 variety trials conducted in the US between 1986 and 1998. This information was compiled in an Access database kindly provided by Dr. Wayne Hartman and Dan Wiersma. When forage yield at Harvest 1 or 2 was regressed against year of cultivar release, the slope of the line was not significant indicating little improvement in forage yield at these harvests had occurred. Regression analysis of Harvest 4 yields versus year of release indicated that between 1978 and 1998 forage yield increased 3.6% per year. This may be due to the introduction of less fall dormant cultivars during the last two decades, and the greater fall growth that occurs with these plants.

Because several locations report both yield and stand persistence in variety trial reports, we also were able to evaluate the impact of selection for greater disease resistance and improved winter hardiness on alfalfa persistence. Alfalfa producers, seed marketers, and university extension educators generally believe that alfalfa persistence is positively correlated with the level of resistance to these diseases. It is generally assumed that if some disease resistance is good, higher levels of resistance are better. There was a positive association between greater disease resistance and percent stand in 9 of the 37 trials where percent stand in Year 4 or 5 was reported. Surprisingly, in 4 of the 37 trials, higher disease resistance ratings were associated with reduced percent stand.

However, in most trials (24 of 37), there was no association between cumulative disease resistance rating and alfalfa stand in Year 4 or 5. This suggests that the alfalfa pathogens currently being selected for may not be as widespread as generally believed, and that other factors contribute stand losses in alfalfa.

Improving winter hardiness has been a second focus of the alfalfa breeding community over the 100 years. Recently, this effort has been facilitated by the development of a standard test for winter survival. This test has been used to quantify winter hardiness of existing cultivars, and develop new germplasms with improved winter hardiness. Like disease resistance ratings, however, differences in percent stand in Year 4 or 5 of these variety trials were not associated with winter survival ratings in most trials (32 of 39, 82%). These results suggest that selection for enhanced winter survival using current methods generally has not been effective for increasing alfalfa stand persistence. It should be noted that effective selection for winter survival is difficult because each winter is unique varying in many things including the severity and duration of the low temperatures, snow cover, ice sheeting, and other undefined environmental factors. New approaches to identify genotypes with improved winter survival may enhance gain from selection for this trait.

A remaining issue that impacts our interpretation of these findings is the manner in which alfalfa stand is determined in these variety trials, and most studies where alfalfa persistence in of interest. Aboveground, nondestructive counting of crowns is often used to determine percent stand. This procedure may not be sufficiently accurate to detect differences in stand caused by greater disease resistance or better winter hardiness if they do in fact exist in these variety trials. Recently, Coutts et al. (Coutts, J.H., Kallenbach, R.L., Nelson, C.J., 2001. Determining plant density of alfalfa: To dig or not to dig? Agron. Abstr. C06-nelson094437-P, Amer. Soc. Agron., Madison, WI.) reported that aboveground inspection significantly underestimated alfalfa plants/m2 because clusters of 2, 3, and 4 plants can be mistaken for a single plant, especially at high plant populations. Though difficult and expensive, it may be necessary to excavate plants in future studies in order to accurately determine alfalfa stands and improve persistence of this species.