Testing Combining Abilities of Diverse Alfalfa Populations

Muhammet Sakiroglu and E. Charles Brummer
Agronomy Department, Iowa State University, Ames, IA 50011

Alfalfa (*Medicago sativa* L.) yield not only leveled over the past 25 years in the Midwestern U.S. but also slightly decreased. Brummer (1999) proposed a semihybrid model to overcome the stagnation. The key for a successful semihybrid model is the identification of improved germplasm with superior agronomic traits as well as good combining ability between delineated heterotic groups. Heterotic groups are genetically distinct germplasms that, when hybridized, repeatedly produce progeny that express heterosis. Three main heterotic groups may exist in the United States: dormant *M. falcata*, semidormant *M. sativa*, and nondormant *M. sativa*. Because nondormant alfalfa cannot be used in the upper Midwestern USA due to severe winterkill, we conducted three cycles of recurrent selection in four nondormant cultivars to substantially decrease winter injury (Weishaar et al., 2005). The objective of this study was to test General Combining Ability (GCA) and Specific Combining Ability (SCA) of the nondormant derived alfalfa germplasm when crossed to elite Midwestern US cultivars.

Four elite Midwestern alfalfa cultivars and the four nondormant derived populations were hand crossed in a half diallel mating design. A seeded trial consisting of three row plots of 36 entries including all possible crosses and parents was established at one Iowa location in 2003 and harvested in 2004 and 2005. Transplanted trials were also established at two Iowa locations and harvested in 2005. Analysis of the data was conducted according to Analyses II and III of Gardner and Eberhart (1966) as clarified by Murray et al. (2003), using a general linear model approach. Entries were divided into parents (varieties) and crosses. Cross effects were further subdivided into heterosis, average heterosis, variety heterosis, general combining ability (GCA), and specific combining ability (SCA). Evaluations were based on individual harvests as well as total yearly yield.

In the seeded trial, GCA effects were present at each individual harvest and at the total yearly yield in 2004 but were present only at the first harvest in 2005; SCA effects were detected only at the third and fourth harvest in 2004 whereas they were present at the first harvest, second harvest and yearly total yield of 2005. In the transplanted trial, we detected GCA effects at the third harvest, fourth harvest and at the yearly total biomass in Ames. At Nashua we detected GCA effects at the first second and fourth harvests but not at the total biomass yield. SCA effects were present only at the fourth harvest in Ames and first two harvests in Nashua. None of the individual harvests or yearly total biomass yield had SCA effects.

The results of this experiment suggest that no consistent advantage is present in crossing nondormant derived germplasm with elite semidormant cultivars. Although particular crosses exhibited heterosis, this is not necessarily related to dormancy class of origin, and could be found between any populations, provided sufficient testing is undertaken.

Reference:

Brummer, E.C. 1999. Capturing heterosis in forage crop cultivar development. Crop Sci. 39:943–954.

Gardner, C.O., S.A Eberhart. 1966. Analysis and interpretation of the variety cross diallel and related populations. Biometrics 22:439–452.

Murray, L.W., I.M. Ray, H. Dong, and A. Segovia-Lerma. 2003. Clarification and reevaluation of population-based diallel analyses: Gardner and Eberhart analyses II and III revisited. Crop Sci 43:1930–1937

Weishaar, M. A., E. C. Brummer, J. J. Volenec, K. J. Moore, and S. Cunningham. 2005. Improving winter hardiness in nondormant alfalfa germplasm Crop Sci 45: [Jan-Feb].