Alfalfa Cold Hardiness: Past Failures and Future Prospects

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Alfalfa (*Medicago sativa* L.) is the most important forage legume grown in North America, but long-term persistence of this perennial species at extreme latitudes is thought to be limited by winter hardiness. Our goal is to understand the physiological and molecular mechanisms controlling alfalfa winter survival. Using closely related germplasms differing in fall dormancy and winter survival, we have identified and characterized several cDNAs expressed in taproots and crown buds that are associated with winter survival. Accumulation of sugars, particularly raffinose and stachyose, also is correlated with alfalfa winter hardiness. Non-dormant germplasms with extensive fall growth fail to accumulate these sugars and express these genes, and these germplasms die during winter. Autumn management also has a tremendous impact on alfalfa winter survival. For example, defoliation in October interferes with alfalfa cold acclimation, and increases winter injury (Fig. 1). To our surprise, defoliation in October does not alter expression of key cold acclimation genes in taproots when compared to plants left intact in October. Furthermore, taproot sugar concentrations were higher in taproots of October-defoliated plants when compared to intact plants (Fig. 2). These unexpected results highlight the complex nature of winter survival mechanisms in this species. Continued integration of genetic, molecular, and physiological approaches will be necessary to accelerate research progress aimed at improving alfalfa winter survival.

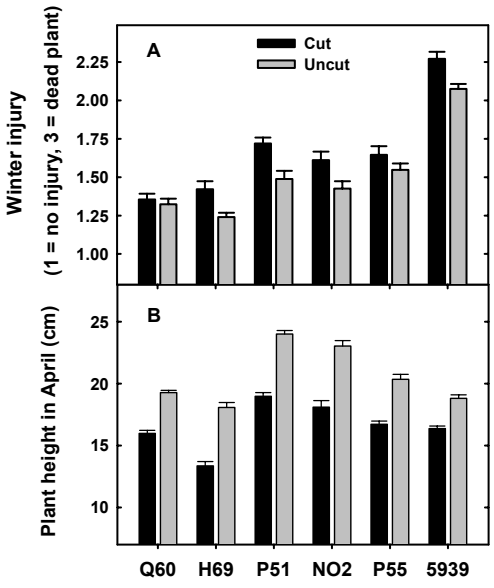

Figure 1. Impact of fall cutting on winter injury and spring vigor of six alfalfa germplasms differing in fall response to fall cutting.

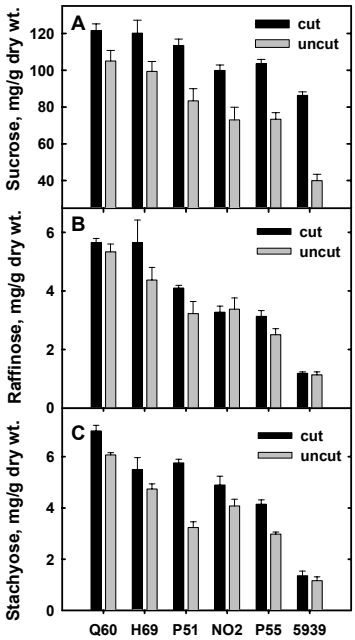

Figure 2. Increase in sucrose and RFO levels in taproots of six alfalfa germplasms in fall dormancy.