Selection of Drought Tolerance in Alfalfa using Real-Time Drought Monitoring Techniques

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Drought is a significant limiting factor for crop productivity worldwide. Drought stress is common in regions used for growing the perennial crop alfalfa (*Medicago sativa L.*). Alfalfa core accessions from the Germplasm Resource Information Network collection including *M. sativa* ssp. *sativa*, M. *sativa* ssp. *falcata*, *M. sativa* ssp. *varia*, and *M. sativa* ssp. *caerulea* originating from multiple countries and those collected from arid regions were evaluated in the field. Data on plant morphology, drought physiology parameters and agronomic performance was collected for three years. Individuals from 20 accessions were selected from the 233 accessions evaluated based on their overall performance, survival rate, flowering rates, pod production, lodging, fall dormancy, field persistence, biomass yield, relative water content and forage quality. Further, the selected accessions were evaluated in the greenhouse to understand the physiological and molecular mechanisms used to cope with drought stress. Soil moisture sensors were used to monitor drought conditions in real time and assess the rates of water use for each plant. Drought physiology parameters evaluated and traits collected included chlorophyll content, leaf water potential, osmotic potential, stomatal conductance, relative water content, internode length, stem moisture content, biomass yield, and soil volumetric water content. Significant correlations were found between the different physiological parameters and accessions evaluated. The top performing accessions selected from the field trial showed consistent biomass yield and unique physiological traits when they were evaluated for drought stress in the greenhouse. For example, drought tolerant plants had higher osmotic potential under drought stress suggesting the production of osmoprotectants as a strategy to cope with reduced water availability. The accessions selected from the field had higher water use efficiencies as they produced more biomass per unit of water utilized. Metabolomics approaches and genotyping by sequencing (GBS) are being explored to further understand drought tolerance mechanisms in the selected accessions. Implementation of drought studies using sensors to characterize alfalfa genotypes contrasting for drought response in the field and the greenhouse combined with genomics and metabolomics analyses will facilitate the development of tools to select drought tolerant alfalfa accessions. The ultimate goal is to utilize these approaches to develop alfalfa cultivars with drought tolerance and persistence.

Key words: Drought; phenotyping; drought; sensors; genotyping by sequencing; water use efficiency.