DNA MARKER ASSISTED BREEDING FOR ALFALFA FORAGE PRODUCTIVITY IN DROUGHT STRESSED AND MESIC ENVIRONMENTS

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A significant portion of the U.S. alfalfa acreage resides within drought-prone environments of the Great Plains and western regions. Consequently, efficient breeding strategies are needed to reduce the impact of water stress on alfalfa forage yield. This study evaluated the potential of using DNA marker assisted selection (MAS) technology to improve alfalfa forage productivity in drought-prone and well-watered environments. This process initially involved identifying DNA markers that were associated with alfalfa forage and root biomass production during drought stress. Some of these single-dose allele markers were then transferred into different alfalfa cultivar backgrounds over two generations using DNA MAS. Twenty-eight MAS-derived populations, a Cycle 0 marker donor population, and three parent cultivars were evaluated in the field over three years under limited irrigation (LI) and normal irrigation (NI) management conditions near Las Cruces, NM. In the first-generation MAS populations, selection for high shoot and high root biomass markers, and selection against low shoot and low root biomass markers, benefited forage productivity by 1% to 19% in the LI study. These same populations, however, yielded similarly to each other in the NI study. To produce the second-generation MAS populations, five of the first-generation MAS populations, and the Cycle 0 base population, were each mated to three alfalfa cultivars which possessed varying degrees of drought tolerance. Most first-generation MAS populations yielded less than the second-generation MAS populations in both studies. Significant forage yield differences ($P<0.10$) ranging from 13% to 27% were detected among the six second-generation MAS hybrids within each cultivar group in the LI and NI studies. These results suggested that MAS impacted alfalfa productivity in all three cultivar backgrounds in both evaluation environments. Some second-generation MAS populations derived from two of the cultivars outperformed their cultivar parent by 3% to 14% in the LI study, with the greatest improvement occurring in the cultivar that exhibited the greatest sensitivity to drought stress. In the NI study, some second-generation MAS populations derived from each of the three cultivars outperformed their cultivar parent by 4% to 6%. The highest yielding second-generation MAS population derived from each cultivar in the LI study was also identified as the top performing population in the NI study. Collectively, these results suggest that DNA marker assisted breeding approaches can be used to develop alfalfa cultivars with improved forage productivity in both drought-prone and well-watered environments.