A Repeatable Method of Screening for Salinity Tolerance in Alfalfa

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In semiarid regions, salinity concentrations often limit or prevent crop production. For many agriculture purposes such as arid range lands, the cost and lack of water make reclamation of saline soils prohibitive. The alternative is to grow salt tolerant species and cultivars. Even though the literature contains numerous reports indicating variability for tolerance to salinity in many crops, few salt tolerant cultivars are available. The lack of salt tolerant cultivars maybe attributed to factors including inadequate means of detecting and measuring plant response to salinity and ineffective selection methods. Our objective was to develop a greenhouse protocol that is simple and consistently separates genotypes for their relative ability to survive under saline conditions.

The study was conducted at Logan, UT. In 2000 and 2001, 12 alfalfa (*Medicago sativa* L.) cultivars were seeded in 3.8 X 21 cm cone-shaped containers plugged with capillary matting and filled with silica sand. Silica sand is an inert media that will minimize the accumulation of salt. The bottom openings were plugged with capillary matting which confined sand to the cones and slowed the flow of water into the cones when placed in the salt solution. When seedlings reached the first trifoliate leaf stage, all water applications were made by immersing flats containing the plants into a complete nutrient solution. Plants were dipped on Monday and Thursday mornings every week for the duration of the study. Sand remained moist between each application of the nutrient/salt solution and water stress did not occur. After 6 wk of growth when roots were well developed, salt was added to the nutrient solution starting at an EC of 3.0 dS m^{-1} and increased in 3 dS m^{-1} increments every 1 to 2 wk until an EC level of 18 dS m^{-1} was reached. The incremental increase in salt concentration was done to avoid physiological shock and rapid plant death. To avoid an imbalance in the salt-nutrient solution, NaCl and $CaCl_2$ were used in proportions to maintain a sodium adsorption ratio (SAR) of 3.5. Each cultivar was represented by 30 plants in each of four replications. Plant mortality was recorded each time plants were dipped in the salt solution. Probit analysis was used to estimate the time and salt dose to reach 50 (LD_{50}) and 75% (LD_{75}) mortality. Probit results were compared to cultivar ranking for mean percent plant mortality when overall trial mortality reached approximately 50 and 75%.

Significant differences ($P \leq 0.05$) were observed among cultivars at all levels of mortality where comparisons were made. Pearson correlation coefficient between 2000 and 2001 LD_{50} and LD_{75} values was $r=0.83$ ($P<0.001$) and $r=0.86$ ($P<0.001$) respectively. Rank correlations were slightly higher at $r_s=0.90$ ($P<0.001$) at the LD_{50} level, and $r_s=0.88$ ($P<0.001$) at the LD_{75} level. Pearson correlation coefficient between years when overall trial mortality was near 50 and 75% mortality was $r=0.93$ ($P<0.001$) and $r=0.81$ ($P=0.001$) respectively. Rank correlations between 2000 and 2001 based on means when overall trial mortality levels were approximately 50 and 75% were $r=0.92$ ($P<0.001$) and $r=0.85$ ($P<0.001$), respectively. The correlations between mean percent cultivar mortality rankings and the probit-based rankings were above $r=0.90$ ($P<0.001$) in both years.

High correlations between years, when comparing both means and results from probit analysis verify that this protocol produces repeatable results. Furthermore, high rank correlations between the levels of mortality indicate that relative rankings of cultivars remain consistent even as mortality increases to the 75% level. This protocol provides a method to effectively screen large numbers of plants for their relative ability to survive under saline conditions. It is simple and requires relatively little investment. While we used this protocol to evaluate alfalfa, it should be equally effective, with minor modifications, to screen other perennial and annual crops. Furthermore, this protocol will be useful as a selection tool since virtually any level of selection intensity can be obtained and survivors from the best families selected.