Evaluating Alfalfa Salinity Tolerance in the Field: What are the Challenges?

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The use of saline water for irrigation is increasing in the western United States and many other parts of the world due to increasing demand for high quality water from municipal and environmental sectors and a declining water supply due to climate change and drought. Alfalfa can be successfully grown at higher salinities than previously thought, but long-term impacts on soil quality should be considered, along with the salt tolerance of crops that might follow in the rotation. Seed companies have invested considerable resources into developing more salt tolerant varieties of alfalfa which creates the need for variety trials to compare salinity tolerance in the field. For replicated, small plot trials, it is essential to establish uniform salinity and soil moisture throughout the experimental field, but this has been a challenge under saline-sodic conditions due to reductions in water infiltration, often leading to non-uniform penetration of water and salts into soil.

Here we present the results of our second and third field trials, hence referred to as Trial 2 and Trial 3, which evaluated improved alfalfa varieties, selected for salt tolerance, with comparison to CUF101 as a public control. Both trials were conducted for three full growing seasons in clay loam soils irrigated with saline-sodic water (7- 10 dS/m EC_w and SAR =16) that was also high in boron (8 ppm (= mg/L)). The low saline (LS) irrigation water averaged 1.2 dS/m in Trial 2 and 0.6 dS/ m EC_w in Trial 3. Twenty-one alfalfa varieties were evaluated in Trial 2 and 35 varieties in Trial 3. Trial 2 was basin-irrigated and soil salinities at the end of the 2nd and 3rd growing seasons were very high (15.1 dS/ ECe, average 0-150 cm soil depth). Surprisingly, the cumulative dry matter yield over three years with 7 to 8 cuts/year showed an average yield loss of only 11% (range 9 to 13%) under HS irrigation as compared to LS, indicating economically-viable alfalfa production under these highly saline conditions. However, three varieties had greater than 20% yield loss. In Trial 3, saline-sodic water of similar salinity (7-10 dS/m EC_w), SAR and boron concentration, was delivered by subsurface drip irrigation (SDI) to avoid the problems with slow infiltration and less than uniform soil salinity and moisture experienced in Trial 2. The accumulation of soil salinity over 3.5 years of saline SDI irrigation in Trial 3 resulted in lower salinity (7.5-12.5 dS/m ECe, 0-180 cm soil depth) than in Trial 2; however, there was greater yield reduction with cumulative alfalfa yields being reduced by 24% under HS irrigation when averaged over all varieties and the three complete years. The reason for the greater yield loss in Trial 3 is not fully understood, but it may be due to the delivery of the saline water directly to the root zone and more extreme summer heat and lower soil moisture. EM38 soil surveys were used to assess the spatial variability in soil salinity in the final year of Trial 3 and similar to Trial 2, we found variation in soil salinity both in the LS and HS experimental basins.

Our results suggest that for the varieties tested, economic yields of alfalfa can be achieved at soil salinities of 5-10 dS/m ECe, and possibly higher, for one production cycle provided that the stand is established under low salinity conditions. This builds on the enhanced salt tolerance for improved varieties of alfalfa reported by Cornacchione and Suarez (2015 and 2017), and it provides even stronger evidence as these varieties were evaluated in the field under high transpiration conditions and in saline-sodic soils that can also challenge the varieties due to slow infiltration, tough surface crusts and longer periods of soil saturation following irrigation.

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