Developing Alfalfa Varieties for High Salinity Production Systems

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Salinity is a problem in many areas of the world in both irrigated and non-irrigated regions. Salinity problems are increasing due to the effects of climate change on variable water supplies and long-term use of irrigation. Competition for the best soils for vegetable and high-value crop production is likely to push alfalfa (*Medicago sativa* L.) and agronomic crops onto more marginal soils with high salinity. Additionally, utilization of saline wastewater or degraded drainage water may be an important resource in a future of limited water supplies. While alfalfa is often characterized as intolerant to salinity, with thresholds of yield reductions beginning about 2.0 dS/m EC_o, recent data have documented higher tolerance of improved varieties in greenhouse studies. Testing of salinity tolerance in the field is essential to understanding the true tolerance of the crop, since field conditions include complex soil interactions and irrigation effects. We sought to determine the effects of applications of high salinity irrigation water (EC_w 8.0-11.0 dS/m) in a Mediterranean environment on clay-loam soils in the San Joaquin Valley of California, utilizing a split plot design with two salinity treatments (Low, High) as the main plot and 35 semi- to non-dormant varieties (FD 7-9) as the sub plot with four replications. Irrigation was applied using subsurface drip irrigation over the 4-year study (2017-2020). Yields were measured in ~8 cuts/year using small-plot equipment, and forage quality was determined using Near Infrared Spectroscopy (NIRS). The main effects of salinity and variety had significant effects on the yield and quality of alfalfa. The average yield loss due to high salinity irrigation over the four-year study was 22%, but salinity effects increased from 4% in year one to 32% in year four. However, average salt-affected yields under high salinity treatments were still economically viable, with yields averaging 10.2 t/a (22.9 Mg/ha) vs non-saline at 14 t/a (32.9 Mg/ha) in year four. Fiber content (NDF, ADF) levels were somewhat reduced in saline plots, exhibiting a typical effect of drought. Few significant variety X salinity interactions were observed. However, we were able to analyze some differences in slope (relative yields between low saline and high saline conditions) between specific lines. Some varieties lost less than 10% of their yield under high saline conditions while others lost more than 25%. "Salinity tolerance" should not be solely determined by the relative yields under saline vs. non-saline conditions, but also by the absolute yields under saline conditions, since some lines with steep slopes also were top yielding lines under high saline conditions. These field trials revealed that more complex soil interactions, such as soil crusting, lack of water infiltration, water ponding, and soil structure may be more important in reducing yields than salinity per-se. Considerable soil variation was observed. Additionally, these field trials confirm that alfalfa should be considered a crop to be highly tolerant to soil salinity after establishment, a key trait for a future of water limitations. Breeding goals for salinity tolerance should include absolute yields, relative yields, as well as tolerance of sub-par soil conditions (e.g. lack of drainage, crusting) which are secondary effects of salinity in the field.