Morphological changes in alfalfa selected to survive high salinity

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In semiarid areas typical of the Intermountain region of the Western US soil salinity limits or prevents crop production. Lack of water makes reclamation of these saline soils prohibitive. The alternative is to grow salt tolerant cultivars. Alfalfa has been characterized a moderately salt sensitive with a threshold of 2.0 dS/m electrical conductivity (EC). Salinity causes a general stunting of the whole plant in alfalfa but stem growth is usually more affected than leaf growth (Fick et al. 1988, ASA Monograph 29, P163-194). Our objective was to quantify differences in the morphological characteristics of stem node number, stem height and corresponding changes in leaf to stem ratio of three alfalfa populations selected for salt tolerance and their parents.

Half-sib families from three alfalfa populations developed using the greenhouse method described by Peel et al. (2004, Crop Sci. 44:2049-2053) were tested. The populations were selected from falcata (BC79) and sativa backgrounds (SII, CkSltn). The materials were established at USU's Evan's research farm near Logan, Utah and at Pacific Corp's Hunter coal fired power plant near Castledale, Utah. The Hunter site was on saline soil and also irrigated with saline water from the power plants cooling towers. Average soil salinity was an EC of 4.5 and irrigation water an EC of 7.0. Stem length, and node number per stem were measured three times during the 2010 and 2011 growing seasons prior to each harvest and leaf to stem ratio on harvests one and two in each year.

The number of nodes per stem was significantly lower under the saline conditions, 10.5 versus 12.8. Similarly about a 30% reduction in stem length was observed in the saline (42.4 cm) compared to the non-saline test (61.6 cm). Under non-saline conditions node number was no different in the SII and CkSltn populations than their parents but about 10% lower in the BC79 population than its parent. In the saline test node number of the BC79 population averaged 9% higher, SII averaged 10% lower and CkSltn did not differ from their respective parental means. Plant stem length was less in all salt tolerant populations than their parental means under non-saline conditions but averaged 13 and 9% higher in the BC79 and SII populations and no different in the CkSltn population compared to their respective parents.

Leaf to stem ratio was significantly different at the two test sites averaging 0.96 at the non-saline test and 1.28 under the saline test. Under the non-saline conditions all populations averaged higher leaf to stem ratios than their parents, which corresponds to the shortened stem lengths observed. Under the saline conditions leaf to stem ratio averaged 16 and 5% lower in the BC79 and SII populations respectively but 13% higher in the CkSltn populations that their respective parents. Even though the BC79 and SII population leaf to stem ratio means were lower than their parents, both contained half-sib families with ratios higher under saline conditions than their parents.

A definite effect of saline conditions was observed on stem length, number of nodes per stem and leaf to stem ratio. Selection for tolerance to saline conditions among the tested materials appears to have had a variable affect on plant morphology in the different populations. In general stem length and node number was lower under non-saline conditions and no different to higher under saline conditions. The positive effect in the selected material is a higher leaf to stem ratio (more leaf mass relative to stem mass) than their parents in both saline and non-saline conditions and less stunting under saline conditions.