Improved Understanding and Testing for Salinity Tolerance in Cool-season Turfgrasses

Paul Johnson, Utah State University
Shaun Bushman, USDA-ARS Forage & Range Research Lab

Start Date: 2012
Project Duration: 3 years
Total Funding: $75,000

Turfgrass and Environmental Research Online
Volume 14, Number 3 | May—June 2015

Objectives:

1. *Explore which physiological measurements are most efficient for the evaluation of salt stress and selecting for salt tolerance.*
2. *Use a field study to explore salt tolerance in lines of perennial ryegrass, Kentucky bluegrass, and alkaligrass.*
3. *Evaluate alkaligrass for variation in salt tolerance, establishment, and turfgrass quality characteristics.*
4. *Test tissue expression of the three calreticulin genes in tolerant and susceptible germplasm (including cultivars) from the three species, sequence the calreticulin alleles, and test association with salt tolerance.*

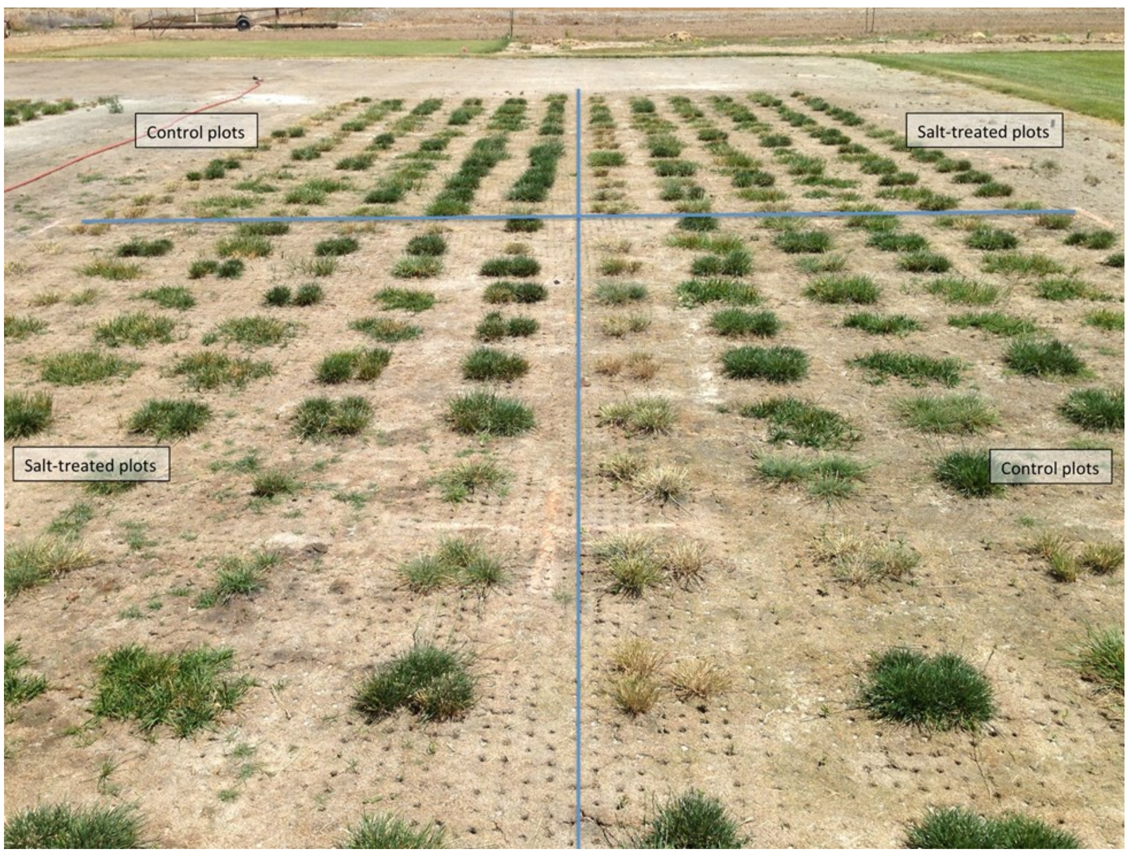

Figure 1. Overall plot photograph on July 9, 2014. Visual symptoms of salt stress were mild at this mid-summer date but growth was inhibited.

Water is a critial issue for sustainability of agriculture and urban areas in the North American West and as a result, is the primary focus of work at Utah State University (USU) and the USDA-ARS Forage & Range Laboratory (FRRL). As a result, our efforts touch the lives of everyone. Golf course superintendents are definitely part of our stakeholder group as they are frequently asked, or forced, to use less irrigation water and/or from lower quality sources. Yet at the same time, these turfgrass areas are asked to do more and be used by more people due to rapid population growth. Turfgrass with high quality, greater salt tolerance, and greater drought tolerance is essential.

Beginning in 2005, the FRRL and USU, both in Logan, Utah, started work in the area of salt and drought tolerance evaluation in *Poa*. Through a previous grant from the USGA, a large number of Kentucky bluegrass collections from the National Plant Germplasm System and other sources were evaluated for salt tolerance by submersing samples into solutions of increasing salt

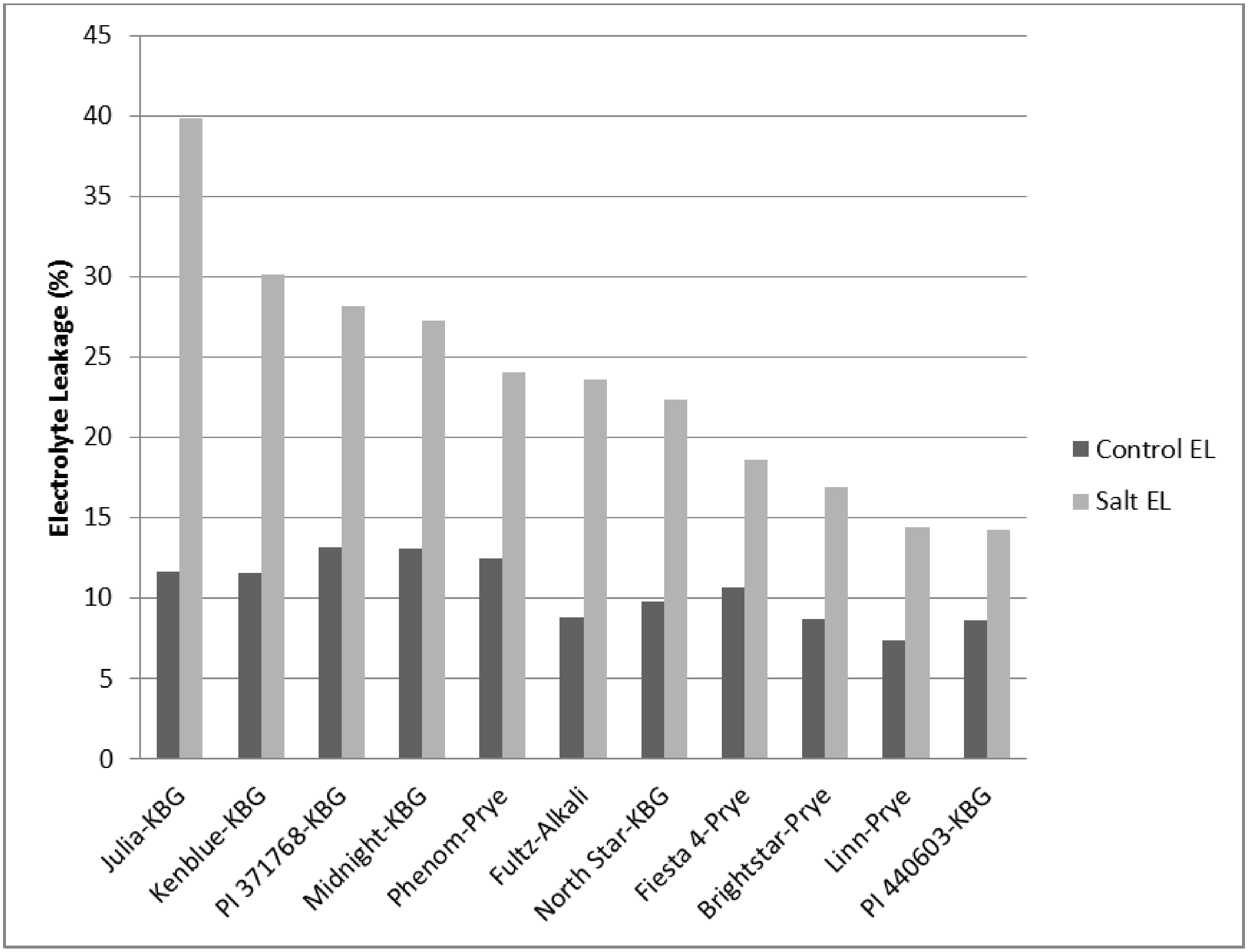

Figure 2. A preliminary look at stress responses as measured by electrolyte leakage. Notice that perennial ryegrass is generally more salt tolerant than Kentucky bluegrass (as expected), with the exception of PI440603. Alkaligrass was expected to have the lowest EL in response to salt stress, however heat stress significantly impacted its growth, even in 2014, No meaningful extrapolations should be made about EL in alkaligrass per se.

concentrations. Significant variation in salt tolerance was identified and those with potential were carried forward into further turf quality evaluations. Separate germplasm was evaluated under summer drought conditions common throughout the West. Results from these studies have been have been published in Robins et al., 2009 and Bushman et al., 2012. Additional genetic and physiological investigations on selected germplasm has been carried out to explore physiological and genetic mechanisms of drought and salt tolerance in *Poa*.

However it has historically been difficult to characterize and find consistent tolerance in germplasm due to interactions of climatic factors and variability in soil salinity. Therefore, this USGA funded project is focused on evaluating materials under increasingly representative conditions and to gain a better understanding of the mechanisms of salt tolerance.

In 2014 we focused on two parts of the project: 1) a repeat of a field salinity experiment combining visual, physiological, and molecular evaluations of bluegrass and ryegrass entries; and 2) continued study of *Puccinellia* (alkaligrass) germplasm for turfgrass quality traits.

Field Salinity Experiment

In 2014 we repeated field salinity experiments that were also conducted in 2013. As previously, our experiment was conducted at our Greenville Research Farm in Logan Utah to better represent field conditions, with a sand root zone to better control salinity levels within plot areas. Two treatments were imposed—a salt treatment, using sodium chloride and calcium chloride salts, and a control (no added salt). The salt treatment was started mid-June at 3 dS/m, increased to 6 dS/m in mid- July, then increased again to 9 dS/m in mid- August. Weather in the summer of 2014 was significantly cooler than in 2013, which minimized interactions of salt stress with heat stress. Volumetric water content and soil salinity was monitored throughout the experiment. Soil salinity in control plots was approximately 0.3 dS/m in control plots and went to 12 dS/m in the salt treated plots in August.

Overall visual stress or effect of the salt treatments on turfgrass quality was present as expected but less in 2014 compared to 2013, likely due to the reduced heat stress and increased August precipitation (Figure 1). Plant growth was impacted in 2014, ranging from 0 to greater than 50% reduction in growth due to salt stress. As with 2013, visual quality scores and electrolyte leakage data were collected. The relationship of electrolyte leakage and visual effects are being explored, but some varieties appear to have less visual impact with relatively high electrolyte leakage measurements (Figure 2).

Also in coordination with 2013, root and shoot tissue were collected four times during the study in 2014 for gene expression analysis. Samples must be ground at -80°C, and used for RNA extraction. Specific genes, as identified in a previously funded project, will be tested for expression differences among these lines and treatments. The sampling times equate to early spring before salinity stress was imposed, and two weeks after salinity stress was imposed at each EC level (3, 6, and 9 dS/m).

Potential of Alkaligrass for quality improvement

In short, little data was obtained in 2014 on the alkaligrasses evaluated for turfgrass quality, as most did not survive the high temperatures experienced in the summer of 2013. As a result, we have very low confidence that these materials will provide useful traits in the semi-arid western USA, but we will continue to explore the potential of the species.

Summary

- We observed consistent salt tolerance trends in key Kentucky bluegrass lines in year two compared to year one data as we impose salt stress under increasingly more realistic growing conditions.
- The most effective and efficient measurement procedures for detecting fine changes in salt stress continue to be electrolyte leakage along with visual traits.
- Gene sequences (alleles or paralogs) involved in cellular sodium and calcium channeling have been previously identified. Tissue was collected at 4 time points again in 2014 in order to test the expression levels of those channeling genes in this field study.
- Initial evaluation of Puccinellia lines show moderate potential in turfgrass quality in Spring, but high temperatures in summer appear most limiting.