Salt Tolerance Of Some Potential Low-input Turfgrass Species

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URI TURF

Introduction

Grasses used to vegetate roadsides in cold-winter areas are exposed to substantial amounts of salt (NaCl) from pavement de-icing. Alkaligrass (*Pucinellia distans*) is the most salt-tolerant of the cool-season grasses, able to withstand 25 dS m^{-1} (16000 ppm) with only 50% decline in shoot growth (Marcum 2008). However, alkaligrass is not well adapted to the acidic soils and mesic climate of New England, showing poor persistence even on moderately fertile soils. Commonly used salt-tolerant turf species such as perennial ryegrass, creeping bentgrass, and slender creeping red fescue are more adapted but struggle on droughty, infertile soils under low-input conditions. The purpose of this study was to evaluate the range of salt tolerance in species which have shown potential for use under low-input conditions and identify germplasm which could be used to develop grasses tolerant of both seasonal salt stress and acidic, infertile soils in mesic climates.

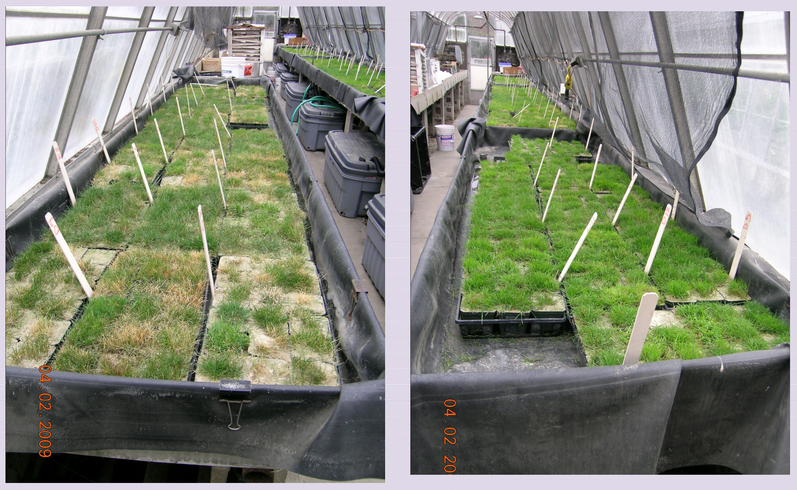


Figure 1. Salt screening system in the greenhouse at URI. Treated flats are on the left, controls on the right. The image was taken after two weeks at 7,500 ppm NaCl. The nutrient solution is stored in the tanks under the bench and pumped through the bays 2-3 times each day. The system can accommodate 252 accessions.

Grasses Screened

Four cool-season grass species were chosen for screening based on general adaptation to low-input conditions: *Festuca rubra*, *Festuca ovina*, *Koeleria macrantha*, and *Deschampsia cespitosa*. The two *Festuca* species were *sensu latu*, and included a range of subspecies and varieties. A total of 63 accessions of *F. rubra*, 40 accessions of *F. ovina*, 55 accessions of *K. macrantha*, and 55 accessions of *D. cespitosa* have been screened since 2007.

Screening Methodology

Screening is conducted in a cool greenhouse during the winter and spring using ambient light. Plants are grown in sand in an ebb-and-flow hydroponics system using modified Hoagland's solution supplemented with sodium chloride. The system is designed to provide uniform salinity stress while minimizing nutrient deficiency, drought, and waterlogging. Each accession is represented by 6 pots, each 7.5 cm x 7.5 cm x 10 cm, sown with 10-15 seeds. Accessions are randomly assigned to flats of 18 pots, which are randomized within the bench. Flats are irrigated with nutrient solution and covered with clear plastic until seeds have germinated. Grasses are maintained at 1" using a reel mower and scissors. Salt treatment begins after grasses have tillered, 2-3 months after seeding. Four pots for each accession are treated with salt; the 2 control pots receive Hoagland's solution with no added salt. Salinity is increased by either 1000 ppm or 2500 ppm every two weeks, depending on the expected tolerance of the species. Data is collected at the end of each two-week period.

Data Collection and Analysis

The day before data collection the plants are top-dressed with dry sand to mask any algae growing in the pots. Each flat is photographed from above using a digital camera and a light box . Photoshop is used to crop the image to the edges of the flat and add pink lines marking the edges of the pots. SigmaScan macros are then used to divide the image into the 18 individual pots and to calculate the % green cover for each pot.

The % cover on each date is adjusted by the % cover for the pot at 0 ppm NaCl, just prior to the beginning of the salt treatment. This compensates for differences in stand caused by variable seed germination. The treatment and control averages are then calculated for each accession at each salt level. The final green cover is the mean treatment value as percent of the mean control value on that date. Expressing the cover as a percent of the control permits comparison between species that differ in growth habit.

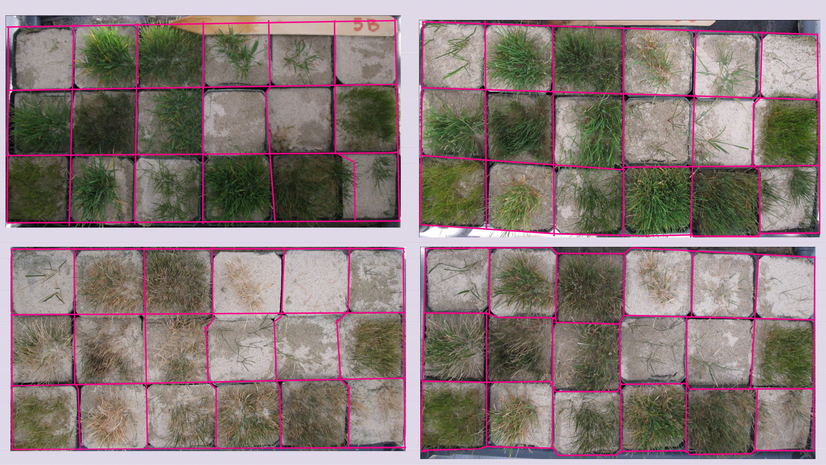
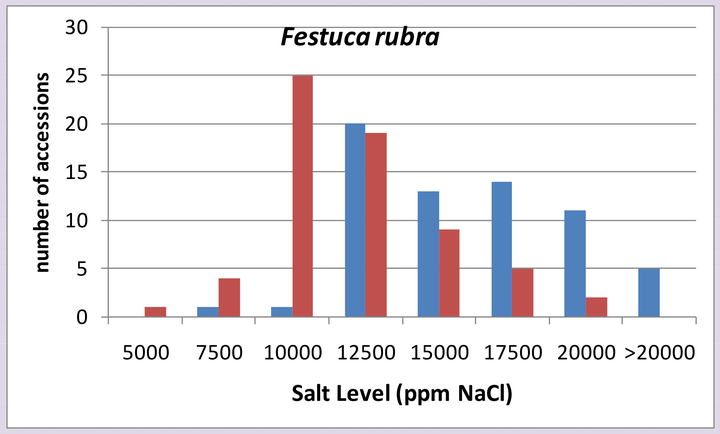
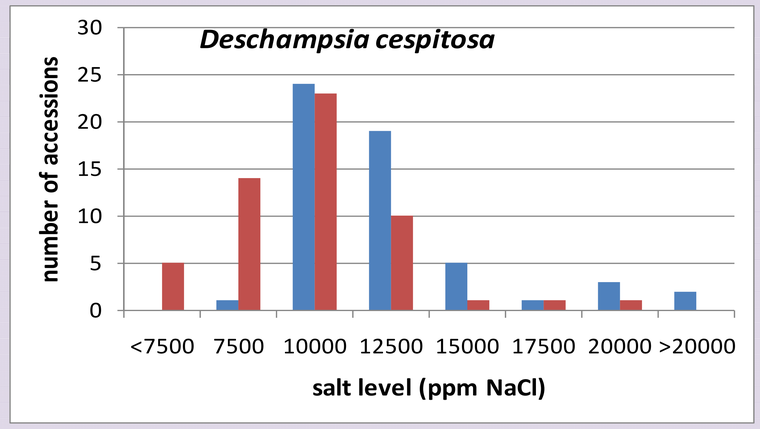
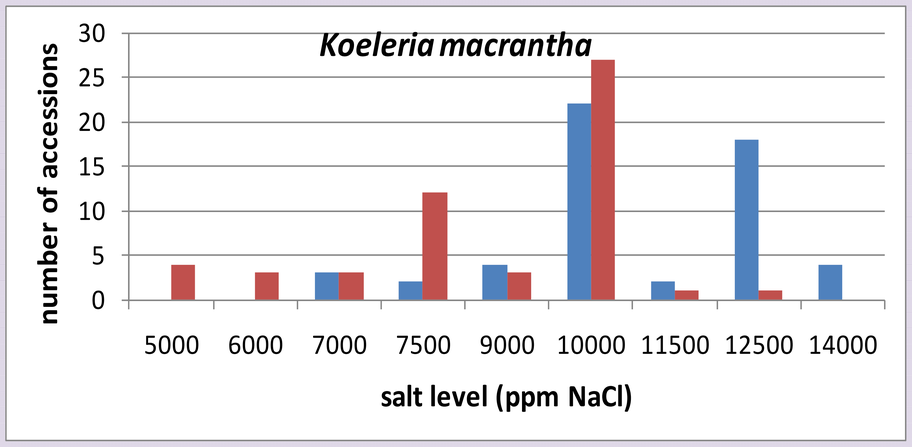


Figure 3. 2010 flat 5b. Clockwise from top left @ 0 ppm, 5,000 ppm, 7,500 ppm, and 10,000 ppm NaCl.







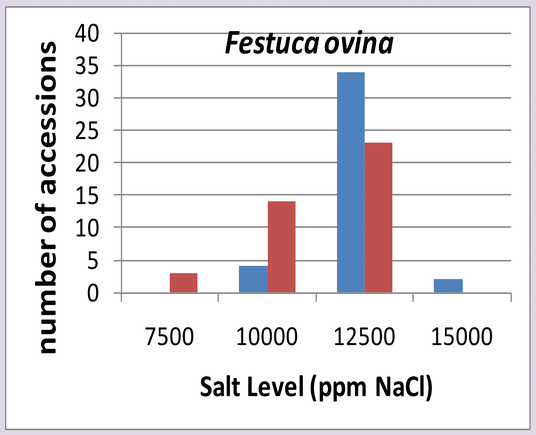


Figure 2. Distribution of salt tolerance among accessions of *Festuca rubra*, *F. ovina*, *Koeleria macrantha*, and *Deschampsia cespitosa*. Red columns indicate the LD50 or salt level at which the treated plants have less than 50% as much green cover as the controls. Blue bars indicate the maximum salt level at which treated plants retained any green tissue.

Accessi	Species	LD50	Maximum Salt
516571	*Festuca rubra*	20,000	20,000
598504	*Festuca rubra*	20,000	22,500
303008	*Festuca rubra* subsp. *commutata*	17,500	20,000
406314	*Festuca rubra*	17,500	22,500
565013	*Festuca rubra*	17,500	20,000
619007	*Festuca rubra*	17,500	22,500
619017	*Festuca rubra*	17,500	22,500
314440	*Koeleria macrantha*	12,500	12,500
430287	*Koeleria macrantha*	11,500	12,500
311043	*Deschampsia cespitosa*	15,000	20,000
538923	*Deschampsia cespitosa*	17,500	22,500
440297	*Deschampsia cespitosa*	20,000	22,500
Epic	*Festuca rubra*	15,000	22,500
7.0929	*Festuca* hybrid	15,000	20,000
577111	*Festuca rubra*	15,000	20,000
595057	*Festuca rubra*	15,000	20,000
619011	*Festuca rubra*	15,000	20,000
632526	*Festuca rubra*	15,000	20,000
610839	*Festuca rubra*	12,500	20,000
619010	*Festuca rubra*	12,500	20,000
6.0858	*Festuca* hybrid	10,000	20,000
595051	*Festuca ovina*	12,500	15,000
614892	*Festuca trachyphylla*	12,500	15,000
312456	*Koeleria macrantha*	10,000	14,000
477978	*Koeleria macrantha*	9,000	14,000
230256	*Koeleria macrantha*	7,000	14,000
13043	*Koeleria macrantha*	6,000	14,000
478597	*Deschampsia cespitosa*	12,500	20,000
577070	*Deschampsia cespitosa*	12,500	20,000

Table 1. Top-performing accessions from each species for LD50 and/or maximum salt tolerance. Species designations are from GRIN.

Results

For each accession the LD50 and the maximum level of salt tolerated were recorded. Maximum salt levels are generally higher than LD50 levels, but correlation between the two is only moderate, with r-values of .51 to .78. The most tolerant accessions each year were included in the following year's screening; values for these accessions reflect all years. The distributions of the LD50 and maximum salt level for each species are shown in Figure 2. For comparison, alkaligrass has an LD50 of 20,000 ppm in our system.

- *Festuca rubra* LD50 values ranged from 5,000 ppm to 20,000 ppm with a mode of 10,000 ppm. Maximum salt levels ranged from 7,500 ppm to greater than 20,000 ppm with a mode of 12,500 ppm.
- *Festuca ovina* LD50 values ranged from 7,500 ppm to 12,500 ppm with a mode of 12,500 ppm. Maximum salt levels ranged from 10,000 ppm to 15,000 ppm with a mode of 12,500 ppm. There was much less variation in salt tolerance among the *F. ovina* accessions than in the other species.
- *Koeleria macrantha* LD50 values ranged from 5,000 ppm to 12,500 ppm with a mode of 10,000 ppm. Maximum salt levels ranged from 7,000 ppm to 14,000 ppm with a mode of 10,000 ppm.
- Deschampsia cespitosa LD50 values ranged from less than 7,500 to 20,000 with a mode of 10,000 ppm. Maximum salt levels ranged from 7,500 ppm to greater than 20,000 ppm with a mode of 10,000 ppm.

Conclusions

More salt tolerant accessions were identified in *Festuca rubra* than in the other species, perhaps because there has been more selection for salt tolerance in this species. It was interesting that not all of the accessions with LD50 values above 15,000 were slender creeping red fescue. *Deschampsia cespitosa* had a similar range of salt tolerance *to Festuca rubra*, suggesting that selection for salt tolerance would be successful in the species. The ranges were smaller for both *Festuca ovina* and *Koeleria macrantha* but the modes were similar to *Festuca rubra*. Selection could produce varieties with moderate levels of salt tolerance which might be very useful when combined with the excellent tolerance of these species to drought, acidic, infertile soil.

Acknowledgements

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Marcum, K. B. (2008) Relative Salinity Tolerance of Turfgrass Species and Cultivars. in M. Pessarakli, ed. Turfgrass Management and Physiology pp. 389-406.