Influence of Salinity Acclimation and Shock on Turfgrass Quality and Soil Characteristics

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Introduction

Salinity is a major problem in managing turfgrass in arid and semi-arid areas. High salinity inhibits turfgrass growth and reduces its aesthetical and functional uses. Soil aggregates deteriorate and clay particles flocculate under saline conditions, resulting in poor soil permeability and restricted water and air movement. Research has been conducted to select saline-tolerant turf species/cultivars, in which salt levels are generally gradually increased to slowly acclimate the plants to provent saline shock. Cold acclimation reduces freezing injury in plants; while, heat shock enhances high temperature stress tolerance in many turfgrasses. Turfgrass responses to salinity acclimation and shock is unclear. Furthermore, limited information is available on soil properties as affected by saline exposure methods.

Objectives

- To evaluate turfgrass responses to salinity acclimation and shock.
- To evaluate soil property changes under salinity acclimation and shock.

Materials and Methods

- Tall fescue *(Schedonorus phoenix)* (TF), Kentucky bluegrass (*Poa pratensis*) (KB), perennial ryegrass (*Lolium perenne*) (PR), and creeping bentgrass (*Agrostis stolonifera*) (CB) were sodded in 10 x 10 x 7.5 cm pots containing clay soil in May 2008 (Study 1).
- Grasses were kept in a greenhouse three months the saline exposure.
- The experiment was arranged in a split-plot design.
  - The whole-plot treatments were grass species, arranged in a RCBD with three replicates.
  - The sub-plot treatments included a tap water and a salt solution (1NaCl:1$CaCl_2$, w/w) which were applied in the following manner:
    1. Control (tap water, EC = ~ 0.5 dS m^{-1})
    2. Salinity shock (exposure to final concentration immediately) at 6 dS m^{-1} (LS)
    3. Salinity shock at 12 dS m^{-1} (HS)
    4. Acclimation at 1.5 dS m^{-1} every 3 d to reach a final concentration of 6 dS m^{-1} (LA)
    5. Acclimation at 3.0 dS m^{-1} every 3 d to reach a final concentration of 12 dS m^{-1} (HHA)
    6. Acclimation at 1.5 dS m^{-1} every 3 d to reach a final concentration of 12 dS m^{-1} (HLA)
- Grasses were mowed at 5 cm once every 6 d, except creeping bentgrass (1 cm). Nitrogen and micronutrients were applied at 46 kg ha^{-1} and 9 kg product ha^{-1}, respectively, before the experiment was initiated. Grasses were irrigated at 100% evapotranspiration (ET), calculated gravimetrically, every 3 d and were exposed to saline conditions for 72 d once reaching the final concentrations.
- Data were collected on visual quality and tissue electrolyte leakage (EL) every 12 d on 18 Oct., 30 Oct., 11 Nov., 23 Nov., and 5 Dec. 2008. Leaf water content and soil electrical conductivity (EC) and pH were recorded when the experiment was terminated.

Fig. 1. Grasses in a greenhouse.

- The experiment was repeated from 27 Feb. to 28 Apr. 2009 under similar conditions (Study 2, Fig. 1), except that sand was used as rootzone media for creeping bentgrass to mimic putting green conditions.
- Data were subjected to the PROC MIXED procedure and the means were separated by Fisher's protected least significant difference (LSD) at $P \le 0.05$ level.

Results

- Data from CB were excluded from statistical analysis because of variations in management and rootzone media compared to other species during both studies. Analysis indicated difference in several measured parameters and sampling dates between Study 1 and 2 (data not shown); therefore, results are presented separately in each study.
- *Soil EC and pH*: Soil EC and pH were not affected by turf species. Soil EC increased proportionally with irrigation salt levels, in reversed relationship of soil pH (Table 1).

Table 1. Soil electrical conductivity (EC) and pH as influenced by turfgrass species and saline application methods.

	EC (dS m^{-1})		pH	
	Study 1	Study 2	Study 1	Study 2
Whole - plot (species)				
KB	2.67 a‡	1.33 a	7.41 a	7.74 a
PR	2.54 a	1.28 a	7.41 a	7.76 a
TF	3.10 a	1.67 a	7.45 a	7.66 a
Sub - plot (appl. method)				
Control	0.67 d	0.51 d	7.81 a	7.97 a
LS	2.08 c	1.32 bc	7.40 b	7.69 bc
HS	3.82 ab	1.79 ab	7.36 bc	7.63 c
LA	2.17 c	1.29 c	7.45 b	7.74 b
HHA	4.29 a	1.76 ab	7.24 d	7.64 c
HLA	3.61 b	1.88 a	7.28 cd	7.64 c
Whole X Sub - plot	NS†	NS	NS	NS

† NS, nonsignificant at the 0.05 probability level.
‡ Means followed by the same letter within columns are not significantly different according to LSD (0.05).

- *Visual quality*: No differences were observed in the species or salt solutions in Study 1. No grass provided acceptable quality (quality ≤5) when Study 1 was terminated (Table 2). Grasses showed more severe damage in Study 2 (Fig. 2., Table 2). Tall fescue had higher quality than KB and RR. In general, quality decreased as the saline levels increased.

Fig. 2. Turfgrass visual quality in Study 2 (72 d after saline exposure).

Table 2. Turfgrass visual quality and tissue electrolyte leakage (EL) (%) as influenced by turfgrass species and saline application methods.

	Quality‡		EL‡	
	Study 1	Study 2	Study 1	Study 2
Whole - plot (species)				
KB	4.8 a	2.5 b	32.8 a	41.3 a
PR	4.8 a	3.1 b	32.9 a	22.1 b
TF	4.9 a	4.3 a	23.8 b	19.6 b
Sub - plot (appl. method)				
Control	5.2 a	5.4 a	25.4 c	10.3 c
LS	4.9 a	3.3 bc	26.9 c	22.2 b
HS	4.7 a	2.7 cd	34.1 ab	28.3 b
LA	4.8 a	3.8 b	28.8 bc	20.9 b
HHA	4.6 a	2.1 d	35.5 a	41.8 a
HLA	5.0 a	2.4 d	28.3 c	42.4 a
Whole x Sub - plot	NS†	NS	NS	*

* Significant at the 0.05 probability level.
† NS, nonsignificant at the 0.05 probability level.
‡ Data collected 72 d after saline exposure at the final concentrations are presented.
Means followed by the same letter within columns are not significantly different according to LSD (0.05).

- *Electrolyte leakage*: Tall fescue and grasses irrigated with tap water (control) had the lowest EL in both studies (Table 2). Saline acclimation did not reduce salt damage in Study 2 (Table 2).
- *Leaf relative water content*: Leaf relative water contents were higher in Study 1, ranging from 81 to 89% , compared to Study 2 (50 to 68%). No differences were observed in species and saline applications in either study (data not shown).

Conclusions

- Tall fescue had higher salt tolerance, followed by perennial ryegrass ≥ Kentucky bluegrass.
- Salt acclimation did not improve saline tolerance in this experiment.
- Saline injury may be influenced more by salt levels and length of salt exposure, rather than saline application methods.

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