An Investigation of the Salt Tolerance of Turfgrasses

By Bradley A. Smith

INTRODUCTION

Soil salinity can be a significant problem for turf managers, particularly in the western half of the U.S. In arid or semiarid regions, natural precipitation is too low to leach soluble salts from soil, salts may be blown in from salty bodies of water, and the irrigation water, including sewage treatment plant wastewater, often contains significant quantities of salts (Harivandi et al., 1992). In Wisconsin, salinity problems arise primarily from the use of deicing salts on roadways, sidewalks, and parking lots.

There are three main causes of salt injury in turfgrasses. First, excess soluble salts in the root zone can increase to the point where water uptake is restricted. This results when the salts in soil increase to the point where the osmotic pressure of the soil water exceeds that of the plant itself. In essence, the turfgrass plants then become drought stressed despite adequate amounts of water in the soil. Second, accumulation of salts in the turfgrass plant can limit normal uptake of essential nutrients, eventually causing deficiencies. Finally, if the percentage of the soil's cation exchange capacity occupied by sodium exceeds about 15%, soil clay particles may begin to disperse. These particles then migrate downward, fill in soil pores, and disrupt soil drainage. Over time, the problem becomes so severe that turfgrasses can no longer survive (Harivandi et al., 1992).

Turfgrass species and cultivars differ in their salt tolerance. These differences arise for three reasons: differences in ability to adjust tissue osmotic pressure according to the osmotic pressure of the soil; differences in capacity to regulate ion uptake and avoid toxicity; and difference in the ability of plant protoplasm to oppose harmful effects of accumulated ions (Harivandi et al., 1992). These are the attributes that provide the basis for plant breeders to improves turfgrass salt tolerances.

Turfgrass salt tolerance is difficult to assess. Results from laboratory and greenhouse studies can be quite different from what is observed in the field. The environmental stresses often encountered in the field contribute to the problem. Stresses due to drought, temperature extremes, nutrition or disease pressures make turfgrass more susceptible to salt injury. These are the reasons why this investigation was conducted under field conditions.

METHODS

The present study was set up on the University of Wisconsin-Madison campus in a 108 by 10 foot strip of land located between a well traveled street and an adjacent sidewalk. Both the street and sidewalk receive frequent salt applications during winter by the University Physical Plant. Typical applications are 200 to 300 pounds of sodium chloride per lane mile and 3 to 5 gallons of calcium chloride per ton of sodium chloride. This equates to 2.15 to 3.23 pounds of sodium chloride applied to the street bordering the research area.

Eighteen different turfgrass treatments were selected (Table 1) and planted in the research area in the fall of 1996. Futerra mulch was used to improve germination and prevent seed wash. As winter approached, temperature recorders were inserted into the soil in five distinct locations. The recorders were placed near the edges of the sidewalk and roadside curb, 12 inches from the sidewalk, and in the center of the plot area. The purpose was to see if there were any correlations among soil temperature, soluble salt concentration, and turfgrass salt injury.

As the snow and ice began to melt in spring, color/quality ratings of

Table 1. Turfgrasses tested for salt tolerance.

Treatment	Specie	Cultivar(s)
1	Slender creeping fescue	Dawson
2	Slender creeping fescue	Seabreeze
3	Slender creeping fescue	Barcrown
4	Creeping red fescue	Jasper
5	Creeping red fescue	Salty
6	Chewings fescue	SR 5100
7	Chewings fescue	SR 5000
8	Chewings fescue	Bridgeport
9	Hard fescue	SR 3000
10	Hard fescue	Scaldis
11	Hard fescue	Reliant
12	Hard fescue	Nordic
13	Perennial ryegrass	Manhattan II
14	Alkali grass	?
15	Kentucky bluegrass	Park
16	Boulevard lawn mix	Dawson, Alkali grass, Dimension, Geronimo, Cannon
17	Kellogg's salt tolerant mix	?
18	Wis. DOT mix	Salty, Reliant, Jamestown II (Perr. rye)

the turfgrass were taken for each plot. A scale of 0 (unacceptable quality) to 9 (excellent quality) was used for the ratings. The plots were rated for percent ground cover and the seed lots tested for germination. After the soil had thawed, samples were collected 2 inches and 2 feet from the sidewall and street and analyzed for soluble salts (saturated soil electrical conductivity) and exchangeable cations.

RESULTS AND DISCUSSION

Analysis of the soil samples collected in April revealed pH values of 7.3 and 7.6, electrical conductivities of 3.5 to 3.8, and sodium saturations of 1.3 and 17.4% (Table 2). According to Richards (1954), these electrical conductivities should reduce the yields of only the most salt-sensitive crops, a group that includes a number of landscaping plants, but not turfgrass. On the other hand, the 17.4% sodium saturation is in the range where soil clays begin to disperse and create impermeable soils.

Table 2. Soil analysis in April 1997.

Soil analysis	Distance from sidewalk: 2 inches	12 inches
pH	7.6	7.3
Electrical conductivity, mmhos cm^{-1}	3.5	3.8
Exchangeable cations, me 100 g^{-1}		
Ca	10.25	10.75
Mg	4.50	4.92
K	0.48	0.41
Na	3.22	2.43
Percent Na saturation	17.4	13.1

Table 3. Turfgrass germination and ground cover.

Treatment	Cultivars	Germination	Ground cover: March 12	April 2
		%	%	%
1	Dawson	83	93	95
2	Seabreeze	79	40	60
3	Barcrown	76	48	55
4	Jasper	85	51	66
5	Salty	ND†	63	75
6	SR 5100	94	43	55
7	SR 5000	74	45	45
8	Bridgeport	89	61	70
9	SR 3000	75	39	48
10	Scaldis	85	42	60
11	Reliant	27	10	33
12	Nordic	100	45	65
13	Manhattan II	ND	63	90
14	Alkali grass	0	—	—
15	Park	10	22	30
16	Boulevard lawn mix	27	30	40
17	Kellogg's mix	76	40	55
18	Wis. DOT	41	70	83

†ND = not determined.

Percentages of ground cover on March 12 ranged from a low of 10 for Reliant hard fescue to a high of 93 for Reliant slender creeping red fescue (Table 3). Increases in ground cover between March 12 and April 2 indicate ability to recover from salt injury and ranged from 0 to 27%. Thus, there appeared to be substantial differences in turfgrass salt tolerances.

Because some of the turfgrass seed was known to be more than 1 year old, germination tests were run to see if this could account for some of the differences in ground cover. As shown in Table 3, seed viability ranged from 0 to 100%. Unfortunately, alkali grass was the one found to have zero viability. Alkali grass (*Puccinellia* spp.) is reported to be the only truly salt-tolerant turfgrass species (Harivandi et al., 1992).

The germination data clearly show that this has to be taken into account when interpreting the estimates of ground cover. This was done by calculating the percent ground cover per percent seed germination (Table 4). Based on these values for March 12, the grasses tested might be separated into the following groups:

<u>Very low salt tolerance</u>
SR 5100
Scaldis
Reliant
Nordic

<u>Low salt tolerance</u>
Seabreeze
Barcrown
Jasper
SR 5000
Bridgeport
SR 3000
Kellogg's Mix

<u>Moderate salt tolerance</u>
Dawson
Park
Boulevard Mix
DOT Mix

A second measure of salt tolerance is the increase in ground cover between March 12 and April 2. These increases are presented in Table 4 in the form of the ratio of April:March ground cover. From this perspective, Reliant hard fescue was outstanding. Grasses showing the *(Continued on page 39)*

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least amounts of regrowth were Dawson and SR 5000.

Turfgrass salt tolerances are generally assigned by species. In this study, when the averages for the fine fescues (Table 4) were calculated, the relative salt tolerances were slender creeping red fescue > creeping red fescue > hard fescue = chewings fescue. Actually, the latter three species appeared to have essentially the same level of salt tolerance. These rankings agree with those of Harivandi et al. (1992).

The results of this study point out some of the problems in testing turfgrasses for salt tolerance. For reasons cited earlier, testing has to be done under field conditions where other stresses may be present. But the research is then subject to annual variations in the amounts of deicing salts applied and variable winter and spring weather. Lastly, seed viability must be taken into account during the first year.

Table 4. Percent ground cover per percent seed germination

Treatment	Cultivar	Ground cover/germination		
		March 12	April 2	April/March
1	Dawson	1.12	1.14	1.02
2	Seabreeze	0.51	0.76	1.49
3	Barcrown	0.63	0.72	1.14
4	Jasper	0.60	0.78	1.30
5	Salty	—	—	—
6	SR 5100	0.46	0.58	1.26
7	SR 5000	0.61	0.61	1.00
8	Bridgeport	0.68	0.79	1.16
9	SR 3000	0.52	0.64	1.23
10	Scaldis	0.49	0.70	1.43
11	Reliant	0.37	1.22	3.30
12	Nordic	0.45	0.65	1.44
13	Manhattan II	—	—	—
14	Alkali grass	—	—	—
15	Park	2.20	3.00	1.36
16	Boulevard lawn mix	1.10	1.48	1.34
17	Kellogg's mix	0.53	0.72	1.39
18	DOT mix	1.70	2.02	1.19

REFERENCES

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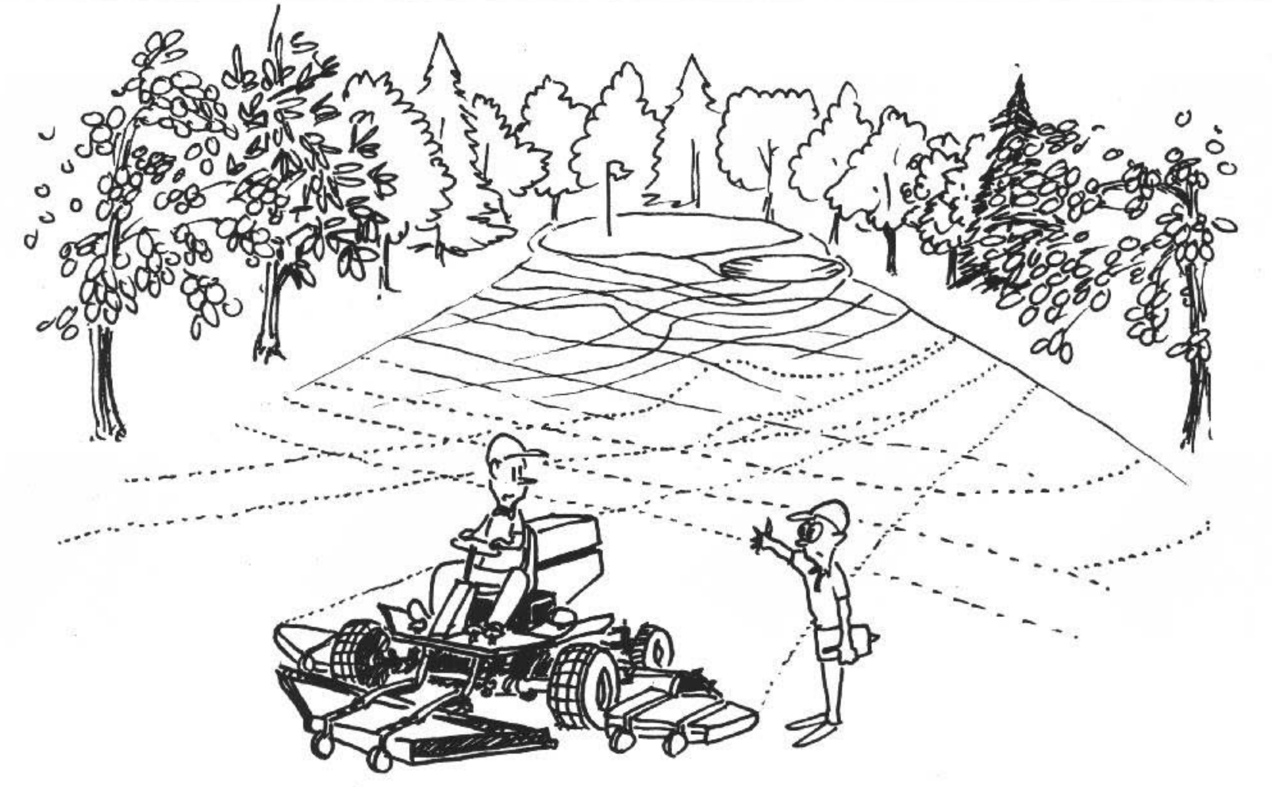

"WELL OF COURSE MY MOWING LINES AREN'T STRAIGHT. I'VE HAD TO STEER AROUND A LOT OF LEAVES."