

Reliability of salinity screening *Lolium* genotypes using field grown versus greenhouse techniques

L. R. Nelson, J. Crowder, Texas AgriLife Research and Extension Center, P.O. Box 200, Overton, TX 75684 USA, lr-nelson@tamu.edu; M. A. Foster, Texas AgriLife Research Station at Pecos, TX USA; Texas A&M System

Abstract

Lolium multiflorum and *perenne* as well as some other turf species were evaluated during the 2008-2009 growing season in the greenhouse at Overton, as well as in the field at Pecos, Texas. The immersion technique conducted in the greenhouse was repeatable and we believe effective in screening genotypes of salt tolerance. Screening genotypes in the field at Pecos, may be effective for the type of salinity present in that environment; however, the “salt” from NaCl added to water in the greenhouse versus high salt in soils of west Texas apparently is different. Therefore results from these two environments were not compatible.

Introduction

High salinity in water from aquifers and soils in many regions of Texas is problematic to the turf industry. Marcum (2004) rated most cool-season grasses as very susceptible to high salinity with perennial ryegrass having more tolerance than *Poa trivialis* and annual ryegrass. Rose-Fricker and Wipff (2001) screened Kentucky bluegrass cultivars at 10,000 mg salt L⁻¹ and perennial ryegrass at 17,000 mg L⁻¹ when grown in sand in salt tanks. Brilman (2006) screened perennial ryegrass for germination in 10,000 mg salt L⁻¹ and seedlings at concentrations of 12,000 mg salt L⁻¹ and reported differences among genotypes for rate of germination and for seedling growth. Nelson (2009) described a technique where ryegrass seedlings were grown in sand in flats periodically immersed in high salinity water and differences between genotypes were observed. This experiment was conducted to compare field screening of ryegrass with the immersion technique and if results were compatible.

Materials and Methods

Twenty-seven genotypes were tested in a field trial at Pecos, and in two greenhouse experiments at Overton, Texas. A detailed salinity test (Saturated Past Extract) of a soil sample collected at Pecos indicated sodium levels at 609 mg kg⁻¹ (26.501 meq/L) and calcium at 675 mg kg⁻¹ (33.683 meq/L). Soil pH was 8.2. Water analysis from the Pecos well water was 477 mg kg⁻¹ sodium, 1125 mg kg⁻¹ chloride with total dissolved salts at 3853 mg kg⁻¹. At Pecos, one g of seed of each entry was planted in 1 m rows on Oct. 28 (3 replications). No significant rainfall occurred; therefore all water was applied by flood irrigation. Salinity damage ratings were taken on a 1 to 9 scale where 9 was most severe. During the spring of 2008 a glasshouse study was established at the Texas AgriLife Research and Extension Center at Overton, Texas. The glasshouse salinity screening technique involved planting seed in Quikrete Play Sand and 3% peat moss by volume, which was placed in plastic inserts in trays. Each tray was 27 cm wide by 42 cm in length. The plastic insert had 4 x 4 cm squares 4 cm deep. Oceanic Natural Sea Salt Mix was added to the well water and was placed in a plastic tank filled to a depth of 15 cm.

Treys were immersed in high salinity water for 2 min. every 3 to 4 days. Salt concentrations began at 5000 mg kg⁻¹ (8 d S/m) and were gradually increased over time until near the end of the screening period, when salt concentrations were 9,800 mg kg⁻¹ (15.8 d S/m). Five replications were treated with the above salt treatments. A control, immersed in well water, consisting on one replication was used to make comparisons with the salt treated plants. Ratings were also made on entries from this treatment. The corrected ratings are the actual rating, minus the rating from the untreated (salt) plants in “rep 6”. This trial was repeated (Exp. B) to test reliability of procedure. The rating for each entry should increase from one date to the next date. Late in the rating period of both experiments many ratings were near 8 on a 1 to 9 scale, where 9 = dead plants, indicating many plants were dead.

Results

At Pecos, ratings were made at three dates (Table 1). By comparing salt damage ratings at all three dates, it was apparent some entries demonstrated tolerance to salt damage. PSB (Pecos BLK) and Pecos BLK 07-08 were selected from space plants for 2 or more generations at Pecos. They appear to be somewhat salt tolerant; however, it may be that they are becoming adapted to that soil type and environment and not just high salinity. Other genotypes which had low salinity damage ratings were K-31 tall fescue, TMI-Puccinella distant, an alkali grass, and TXR2008-TF-PR-85, an intermediate ryegrass.

In greenhouse trials at Overton (Tables 2), data are shown for 2 dates on each experiment. Most entries had ratings higher than 7 indicating severe salt damage. Generally speaking the tall fescue entries had lower ratings than annual or perennial ryegrass. TMI-Puccinella distans was the most tolerant entry in both experiments A & B, just as it was in the field trial. Soprano perennial ryegrass was more tolerant to salt than other ryegrass entries. The PSB and Pecos BLK 07-08 entries did not show tolerance to high salt in the immersion treatments in the greenhouse. It was obvious from the data that we had a significant amount of senescence in the untreated (salt) plants. This could have been due to poor light quality, poor water quality, high temperature in the greenhouse, especially in the Exp. B, or some other factor. It was useful to compare the actual rating and the corrected rating for each entry for each date. If an entry had very high actual ratings such as 9 indicating all plants were dead, and also its corrected rating was 6, (indicating the control had a rating of 3), then this entry was very susceptible. SS3 had a high salt damage rating of 8 on 9 Feb; however, the corrected rating was 3 for that date. This indicates that it may be relatively tolerant to salt damage. Utilization of a correction factor as stated above did not seem to improve the reliability of rating the entries for salt damage. The C.V.'s for the corrected means were higher than the actual ratings which may be a result of the mathematical process in that the corrected means were small, or we analyzing smaller numbers. We ran a simple correlation analysis of the means from the field trial against the means shown in Table 2 for experiments A & B. The field means were not significantly correlated with means from either greenhouse experiment. Means from Exp. A were highly correlated with means from B ($r = 0.51$, $p = 0.006$). Salinity means in Exp. A were highly correlated to corrected means from Exp. A, as would be expected. In Exp. B, salinity means were not correlated with the corrected means. This may have been due to environmental conditions, as Exp. A was conducted during the middle of the cool season, and B was conducted in the late spring, when mid-day greenhouse temperatures were quite warm. The high temperatures resulted in the senescence (high rating) on the plants which were not treated with high salinity.

Acknowledgment

This research was supported by United States Golf Association

References

Brilman, L. 2006. Seed Research of Oregon. <http://www.sroseed.com>

Marcum, K.B. 2004. 4th International Crop Sci. Cong, Brisbane Australia. 18 p.

Nelson, L.R. and M.A. Foster. 2009. Proc. Int. Turfgrass Soc. Annex – Tech. Papers, p. 21-22.

Rose-Fricker, C. and J.K. Wipff. 2001. International Turfgrass Society Res. Jour. 9:206-212.

Table 1. Salinity damage ratings in field at Pecos, TX in 2009.

Entry		Date of Rating		
		4 February	21 March	8 May
Phenom	PR [‡]	4.3 [†]	3.0 [†]	3.7 [†]
Sidewinder	TF	4.7	4.0	4.3
Cochise IV	TF	5.3	5.3	5.0
TF – 152	TF	6.0	4.3	5.3
K 31	TF	2.3	2.7	2.3
Gulf	AR	2.3	3.0	4.0
TXR2004-TF-EM	IR	1.7	2.3	4.0
06 B Lp	PR	5.3	4.0	3.7
PSG-4MSH	PR	6.0	2.7	4.0
08-8 Lh	IR	4.7	4.3	3.3
IS-PR 385 BLK	PR	4.7	4.3	5.0
TMI-Puccinella dis	AIG	6.3	1.7	1.0
TXR2008-TF-PR-85	IR	4.0	2.0	1.3
TXR2008-PR-1	PR	4.3	3.3	4.7
RKS	PR	5.7	4.7	5.0
Soprano	PR	5.3	3.7	4.0
Soprano Myco	PR	5.7	3.7	5.7
TXR2006-TF-AxP	IR	4.7	2.7	3.7
TXR2008-TF-AxP F4	IR	5.0	3.3	3.3
TXR2006-TF-PR-LS	IR	2.7	3.0	3.7
Panterra	AR	1.3	3.0	4.7
SS3	AR	4.0	2.0	2.7
TAMTBO	AR	4.0	3.3	3.3
TFCT-1	AR	4.0	2.7	2.7
TF-F-LM	AR	3.7	2.7	2.7
PSB (Pecos BLK)	AR	4.3	2.7	2.7
Pecos BLK 07-08	AR	2.0	2.0	2.7
Mean		4.2	3.2	3.6
C.V.		33.8	35.3	36.8
LSD (0.05)		1.9	1.5	1.8

Planted Oct 28, 2008.

[†]Ratings were taken on a 1-9 scale where 1 = best and 9 = most stunted.[‡]Indicates turf species where PR = perennial ryegrass; AR = annual ryegrass; TF = tall fescue; IR = intermediate ryegrass; and AIG = alkali grass.

Table 2. Greenhouse salinity screening experiment A and B, Overton, TX 2009.

		Date plants were rated for salt damage							
Entry		Experiment A				Experiment B			
		26 Jan		9 Feb		22 Apr		22 May	
		Act [†]	Cor [‡]	Act [†]	Cor [‡]	Act [†]	Cor [‡]	Act [†]	Cor [‡]
Phenom	PR [§]	4.2	3.2	7.6	4.6	5.8	1.8	7.4	2.2
Sidewinder	TF	4.8	3.8	6.6	4.6	3.6	0.6	5.8	1.8
Cochise IV	TF	3.6	1.6	6.2	4.2	3.8	0.8	5.2	1.2
TF – 152	TF	3.6	1.6	6.2	2.2	4.6	2.6	5.6	3.6
K 31	TF	4.6	2.6	7.2	4.2	4.0	3.0	5.6	3.6
Gulf	AR	4.2	3.2	8.0	5.0	4.6	1.6	8.0	4.4
TXR2004-TF-EM	IR	5.0	3.0	7.6	3.6	5.6	1.6	8.0	4.0
06 B Lp	PR	3.6	2.6	7.0	6.0	4.6	2.6	7.2	3.6
PSG-4MSH	PR	4.0	3.0	6.6	3.6	6.6	1.6	8.2	3.2
08-8 Lh	IR	6.0	5.0	9.0	6.0	5.6	2.4	7.2	2.4
IS-PR 385 BLK	PR	4.4	3.4	7.6	5.6	4.8	0.8	8.2	3.2
TMI-Puccinella dis	AIG	4.4	3.4	5.4	1.4	3.6	0.8	6.2	1.2
TXR2008-TF-PR-85	IR	5.0	4.0	8.2	5.2	5.2	1.2	8.4	4.4
TXR2008-PR-1	PR	3.6	0.8	6.8	3.2	5.2	2.2	8.4	3.4
RKS	PR	3.8	2.8	7.2	5.2	5.0	1.0	6.8	2.8
Soprano	PR	3.4	2.4	5.4	3.6	5.0	1.0	7.6	3.6
Soprano Myco	PR	3.2	2.2	6.8	4.2	4.6	0.6	8.0	4.0
TXR2006-TF-AxP	IR	4.4	3.4	7.8	4.8	5.8	1.8	8.0	3.0
TXR2008-TF-AxP F4	IR	4.6	2.6	8.0	4.0	5.8	1.8	7.8	2.8
TXR2006-TF-PR-LS	IR	4.6	3.4	7.8	4.8	6.0	2.0	7.6	3.6
Panterra	AR	4.8	3.8	8.2	5.2	6.4	2.4	7.8	1.8
SS3	AR	4.6	1.6	8.0	3.0	7.0	1.2	8.4	2.4
TAMTBO	AR	4.8	3.8	8.0	5.0	4.4	2.4	8.0	3.4
TFCT-1	AR	4.8	4.0	8.2	5.2	5.8	1.8	8.0	3.0
TF-F-LM	AR	4.2	3.2	7.8	4.8	5.0	1.0	7.8	3.8
PSB (Pecos BLK)	AR	5.2	4.2	8.2	6.2	6.2	1.2	8.0	2.0
Pecos BLK 07-08	AR	5.0	4.0	8.4	5.4	5.0	1.0	7.6	3.6
Mean		4.4	3.1	7.4	4.5	5.2	1.6	7.4	3.0
C.V.		29.8	42.8	13.6	22.8	21.8	61.5	15.4	29.5
LSD (0.05)		NS	1.4	1.1	1.1	1.2	1.0	1.2	0.9

[†] Actual salt damage rating on a 1 to 9 scale, where 1 = best and 9 = dead.

[‡] Corrected rating were actual ratings minus rating for untreated plants of that genotype.

[§] PR = perennial ryegrass, AR = annual, IR = intermediate, TF = tall fescue, and AIG = alkali grass.