PROMISING SALINITY TOLERANCE IN BERMUDAGRASS GERMPLASM

Andrea L. Maas[1*], Richard Layton[1], and Benjamin G. Mullinix[2]

INTRODUCTION

Increasing regulation of water use requiring low quality secondary water sources be used for turfgrass and the need for low cost disposal of drainage water on forage land have prompted the need to identify productive high quality salt tolerant grasses (Marcuan & Pessarakli, 2006; Suyama et al. 2007). Typically studies have focused on several species of grasses and a limited number of genotypes within species never the less differences among cultivars have been demonstrated (Adavi et al., 2006). Recently one study looked at 35 different cultivars of bermudagrass and was able to clearly demonstrate differences in salt tolerance; however five of the top 10 were sterile triploid plants precluding their use as breeding material. Cultivar differentiation was shown to be contributed to level of salt gland secretion efficiency (Marcuan & Pessarakli, 2006). A Large scale survey of bermudagrass germplasm material has not been published. Identification of fertile bermudagrass plants with the highest levels of tolerance would allow the development of forage and turf type bermudagrasses that retain high forage and turf qualities commonly attributed to bermudagrass, but also have the ability to thrive in a saline environment. The objective of this study was to identify bermudagrass [*Cynodon dactylon* (L.) Pers.] germplam with improved salinity tolerance for development of new cultivars.

MATERIALS AND METHODS

Plant materials:

- 108 Tetraploid lines germplasm lines taken from the USDA-ARS core collection maintained at Tifton, Georgia (Anderson, 2005).
- 'Tifton 86' an accession from seed collected in 1978 by W.W. Hanna near the Dead Sea for a tolerant control, and Tifton 10 a 54-chromosome bermudagrass accession collected by G.W. Burton in 1974 for an intolerant control (Francois, 1988).
- Four *Paspalum veginatum* Swartz. lines 'Adalayd', 'Sea Isle 1', 'Sea Isle Supreme', & 'advanced University of Georgia line 03.5.278 as Paspalum has been shown to be more salt tolerant then bermudagrass (Marcum and Murdoch, 1994).

Testing methods:

- Plants were greenhouse established in 6" inch pots, two pots per table of each entry were grown on three tables.
- Water was applied through an overhead misting system (Figure 1). Once plants were established the salinity of water applied was increased in 50mM increments over a six wk period until 300mM NaCl (17.5g·l^{-1}), was reached.
- Fourteen day growth clipped shoot weights were taken twice prior to treatment with 300mM NaCl (17.5g·l^{-1}), and three times during treatment (Figure 2).

Statistics:

- Data were normalized on an individual pot basis. Due to differentiation in basic top growth and establishment characteristics of the various genotypes untreated clipped weights were used to normalize data for comparison.
- Data were analyzed using ordinary least squares procedure with SAS statistical package (SAS Institute, 2003).

[1]USDA-ARS, Coastal Plain Exp. Sta., Tifton GA 31794 , [2]Experimental Statistics, The University of Georgia, Tifton, GA 31793, *corresponding author Andrea.Maas@ars.usda.gov

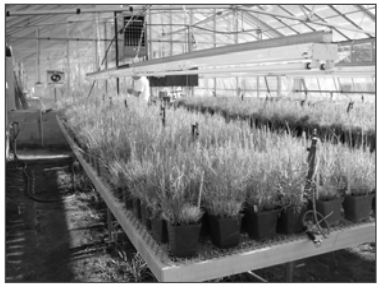

Figure 1. Bermudagrass plants growing pre-salinity treatment in the greenhouse.

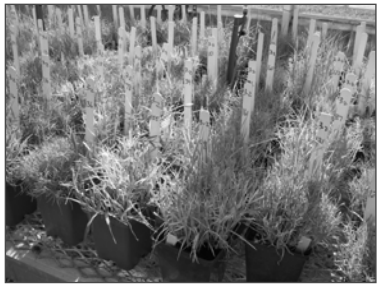

Figure 2. Bermudagrass germplasm growth after 6 weeks treatment with 300mM NaCl (17.5g·l^{-1})

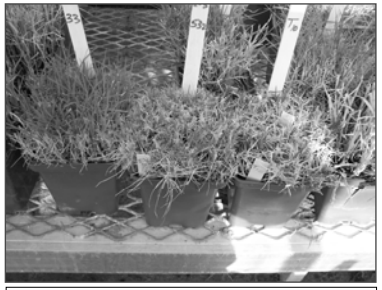

Figure 3. Left to Right core number 33, "Tifton 86' (532) previously published salinity tolerant control, & 'Tifton 10' (T10) previously published low salinity tolerant control.

RESULTS

Weighted mean growth under treatment with 300mM NaCl (17.5g·l^{-1}) saline solution ranged from 5.0 g to .62 g top growth for 14 day growth (Table 1). Several accessions including entries 53, 33 96, 41,and 9 demonstrated higher levels of salinity tolerance then previously reported for bermudagrass (Figure 3). Core numbers are reported here due to some incongruence with the passport data of the material. Visual appearance tended to align well with rankings. Basic growth habits of the most tolerant lines included material suitable for use in both turf and forage development.

Previous studies have indicated that the point of significant reduction in shoot growth occurs at approximately 300mM NaCl (Francois, 1988; Marcum & Murdoch, 1994). It was thought that this salinity level would produce the biggest differences between tolerant and intolerant lines. Unfortunately unusually high temperatures in the last couple of weeks of testing, created difficulty in maintaining correct salinity levels in the pots causing a great deal of environmental variation from clipping to clipping and table to table. This variation contributed to the high LSD reported here, however based on the fact that all four Paspalum cultivars were in the top ten percent of entries for this test it is believed that the general rankings are reasonably accurate. Further study with those lines ranked highest and lowest are underway to verify the results presented here.

entry	Adjusted clip weight (grams)	entry	Adjusted clip weight (grams)	entry	Adjusted clip weight (grams)	entry	Adjusted clip weight (grams)
53	4.9	29	2.4	60	2.0	16	1.7
Seaisle1	4.1	141	2.4	142	2.0	126	1.6
33	3.8	81	2.4	34	2.0	111	1.6
03.5.278	3.7	110	2.4	86	2.0	69	1.6
Sea Isle Supreme	3.73	151	2.4	18	2.0	144	1.6
96	3.6	28	2.4	143	1.9	10	1.6
41	3.6	22	2.4	55	1.9	44	1.5
9	3.3	59	2.4	161	1.9	150	1.5
91	3.2	128	2.4	149	1.9	43	1.5
87	2.9	63	2.4	134	1.9	175	1.5
Atalade	2.9	155	2.3	125	1.9	120	1.5
113	2.9	172	2.3	106	1.9	146	1.5
121	2.8	13	2.3	122	1.9	130	1.4
85	2.7	163	2.3	73	1.9	133	1.4
12	2.7	79	2.3	19	1.9	135	1.2
42	2.7	131	2.3	116	1.9	129	1.2
68	2.7	97	2.3	49	1.8	160	1.1
132	2.6	115	2.3	101	1.8	153	1.1
30	2.6	15	2.3	70	1.8	136	1.1
119	2.6	25	2.2	26	1.8	173	1.1
21	2.6	32	2.2	78	1.8	36	1.1
61	2.6	148	2.1	147	1.8	92	1.0
Tifton 10	2.6	95	2.1	168	1.8	152	1.0
Tifton 86	2.6	77	2.1	104	1.7	137	1.0
27	2.6	145	2.1	98	1.7	140	0.9
157	2.6	11	2.1	74	1.7	118	0.7
24	2.5	158	2.1	164	1.7	139	0.6
56	2.5	138	2.1	165	1.7		
20	2.5	83	2.1	84	1.7		
$LSD_{0.05}$ is 2.4							

Table 1. Weighted mean growth under treatment with 300mM NaCl (17.5g·l-1) saline solution by entry.

CONCLUSION

Several accessions including core numbers 9,33, 41, 53, 91, and 96 have demonstrated higher levels of salinity tolerance then previously reported for bermudagrass. This material is currently under further study for potential for development of new germplasm lines for the development of forage and turf type hybrids.

REFERENCES

Adavi, Z. K. Razmhoo, and M. Mobli. 2006. Salinity tolerance if bermudagrass (*Cynodon* spp. L.C. Rich) cultivars and shoot Na, K and Cl contents under a high saline environment. Journal of Horticultural Science & Biotechnology. 81(6) 1074-1078.

Anderson, W.F. 2005. Development of a forage bermudagrass (*Cynodon* sp.) core collection. Grassland Sci. 51:305-308.

Francois, L.E.. 1988. Salinity Effexts on Three Turf Bermudagrasses. HortScience, 23:706-708.

Marcum, K.B. and C.L. Murdoch. 1994. Salinity Tolerance Mechanisms of Six C_4 Turfgrasses. J. Amer. Soc. Hort.Sci. 119:779-784.

Marcum, K.B., and M. Pessarakli. 2006. Salinity tolerance and salt gland excretion efficiency of bermudagrass turf cultivars. Crop Sci. 46:2571-2574.

SAS Institute. 2002. SAS user's guide. Statistics. Version 9.1 ed. SAS Inst., Cary, NC.

Suyama, H., S.E. Benes, P.H.Robinson, S.R. Grattan, C.M. Grieve, G. Getachew. 2007. Forage yield and quality under irrigation with saline-sodic drainage water: Greenhouse evaluation. Agricultural water management 88:159-172.

ACKNOWLEDGMENTS

•Wayne W. Hanna, Crop and Soil Science Dept., Univ. of Georgia, Coastal Plain Exp. Stn, for providing 'Tifton 10' and 'Tifton 86' for testing.

•Paul L. Raymer, Crop and Soil Science Dept., Univ of Georgia, Georgia Experiment Station. For providing four *Paspalum veginatum* Swartz. lines 'Adalayd', 'Sea Isle 1', 'Sea Isle Supreme', & 'advanced University of Georgia line 03.5.278.