Drought Tolerance of Twenty one Saltgrass (*Distichlis*) Accessions Compared to Bermudagrass

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Abstract

Fourteen (14) Arizona accessions and 7 Colorado accessions of Saltgrass (Distichlis spicata), collected from Arizona and Colorado and 1 Bermudagrass (Cynodon dactylon), cultivar Midiron (check), were studied in a greenhouse to evaluate their growth responses in terms of shoot dry weights and percentage of visual green under drought stress conditions. Plants were grown under normal (daily watering and weekly fertilizer application) for one year for complete establishment. Then, the plants were deprived from water for four months (January 5, 2001 - May 5, 2001). Plant clippings were harvested weekly, oven dried at 60 ^{o}C, and the dry weights were recorded. At each harvest, percentage of green cover were also estimated and recorded. After the last harvest, plants were re-watered to assess and compare the percent of recovery. Overall, the results (both shoot dry weights and the percent of the visual green) show that the A138 and A137 (Arizona accessions) were the best accessions and the C66 (Colorado accession) was the worst. Both the shoot dry weights and the percent of visual green cover decreased as the drought period progressed. In general, most of the saltgrass accessions were more tolerant to drought stress than the bermudagrass .

Introduction

Desert saltgrass (*Distichlis spicata*), an indigenous species of arid and semi-arid regions is a potential turf species that grows satisfactory in both salt-affected soils and soils under drought conditions. The plant is abundantly found under the worst salinity, sodicity, and drought conditions in the western regions of the United States, as well as on the sea-shores of several Middle-Eastern countries, Africa, South and Central American countries. The plant is an excellent candidate species for manipulation to produce dwarf and turf type varieties as well as producing cultivars more tolerant to salinity and drought stresses to be used as a turfgrass in arid and semi-arid regions of the world. In addition, this plant can be used as soil stabilizer and conservation for covering road sides and soil surfaces in soils with high risks of erosion.

The objectives of this study were to find the most tolerant accession(s) of saltgrass under drought stress conditions and to compare the drought tolerance of these saltgrass accessions to bermudagrass based on growth parameters under decreasing soil water contents.

1 Bermudagrass (*Cynodon dactylon*), cultivar Midiron (check), were studied in a greenhouse to evaluate their growth responses in terms of shoot dry weights and percentage of visual green cover maintenance under drought stress conditions. Plants were grown vegetatively in PVC tubes (6.35 cm diameter, 10.16 cm length) placed in galvanized Cans (45.72 cm diameter, 55.88 cm height) filled with fritted clay as plant anchor medium. Four replications (4 cans) of each plant were used in this investigation, in a Randomized Complete Block design.

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Plants were allowed to grow under normal (daily watering and weekly fertilizer application) for one year for complete establishment. During this period, plants were clipped weekly at 5.00 cm height in order to reach full maturity and developing uniform and equal size plants. The harvested plant materials were discarded. At the end of this phase of the experiment, the plants were uniform, fully established, and ready for the stress phase of the experiment. At this stage, plants were irrigated (saturated) for the last time, in early January, before the drought stress started.

Then, the plants were deprived from water for four months (January 5, 2001 - May 5, 2001). Plant clippings were harvested weekly at 5.00 cm height, oven dried at 60 ^{o}C, and the dry weights were recorded. The recorded data were considered the weekly plant dry-matter production. At each harvest, percentage of green cover was also estimated and recorded. After the last harvest, plants were daily re-watered to assess and compare the percent of their recovery.

The data were subjected to Analysis of Variance, using SAS statistical package. The means were ranked in ascending order.

Results and Discussion

The results of both shoot dry weights (Table 1) and the percentage of visual green cover (Table 2) showed a substantial variation among the tested accessions. The dry matter data (Table 1), shows that the greatest range between the clipping weights was 0.237, (0.081 - 0.318) for harvest 4, and the narrowest one was 0.009, (0.000 - 0.009) for harvest 14. The low stress tolerant grasses (i.e., C10 and C66) showed a marked reduction (about 50%) in clipping dry weights after 7 weeks (harvest 7) exposure to drought stress. However, a tolerant accession (i.e., A138) showed a similar (about 50%) after 10 weeks exposure to drought stress. This clearly indicates that some accessions were less tolerant to drought than the others. Both the clipping dry weights and the percent of visual green cover decreased as the drought period progressed. At the end of the drought period, some accessions were in full dormancy, while some showed about 20% green cover. However, there was no measurable growth by any plants after 14 weeks growth under drought stress condition. Overall, the results (both clipping dry weights and the percent of the visual green cover) showed that the A138 and A137 (Arizona accessions) were the best accessions and the C66 (Colorado accession) was the worst. This is supported by Kopec et al. (2000) findings that when these accessions of saltgrass were tested, mowed at 1.27 cm in 1.83 m X 1.22 m plots in the field for two years, the Arizona accessions showed superiority over the Colorado ones in most of the parameters evaluated. These include, percentage of green cover, density, uniformity, turf quality, and plant establishment. Marcum and Pessarakli (2000) tested these accessions under salinity stress. These investigators found essentially similar results. In the present study, most of the saltgrass accessions were more tolerant to drought stress than the bermudagrass. Bermudagrass reached full dormancy and/or necrosis stage before most of the saltgrass accessions (Table 2). Nevertheless, bermudagrass recovered faster than most of the saltgrass accessions after the plants were re-watered.

Conclusions

There were substantial variations among the tested accessions in regards to both dry matter production and percentage of visual green cover. Both the clipping dry weights and the percent of visual green cover decreased as the drought period progressed. Overall, the A138 and A137 (Arizona accessions) were the best accessions and the C66 (Colorado accession) was the worst. These results suggest that the A138 and A137 accessions showing superiority over other ones under drought stress conditions may be recommended for further tests and use as turfgrass under low maintenance conditions. Bermudagrass reached full dormancy before most of the saltgrass accessions. Therefore, bermudagrass is less tolerance to drought compared to saltgrass.

References

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Table 1. Means of clipping dry weights (g/pot) under drought stress, sorted by grass and by ascending values, for the 14 consecutive weekly harvests.

Grass	Harvest 1	Grass	Harvest 2	Grass	Harvest 3	Grass	Harvest 4
C66	0.032	C66	0.044	C10	0.049	C10	0.081
A41	0.033	A138	0.045	C66	0.050	C66	0.094
A48	0.033	C56	0.049	C56	0.050	Bermuda	0.105
A137	0.036	A137	0.049	Bermuda	0.070	C56	0.110
C56	0.036	C10	0.051	A138	0.073	A138	0.127
C10	0.037	A41	0.052	C11	0.080	A55	0.142
A138	0.037	A119	0.059	C12	0.088	A40	0.150
A55	0.038	A48	0.059	A48	0.090	C11	0.154
A61	0.039	A55	0.063	A61	0.093	C12	0.159
A119	0.041	A40	0.065	A40	0.093	A48	0.171
A51	0.046	A61	0.067	A137	0.098	A61	0.182
A40	0.047	A86	0.070	A119	0.104	A137	0.186
A86	0.050	C12	0.074	A55	0.107	A119	0.193
A65	0.053	C8	0.076	C8	0.108	C92	0.198
A77	0.056	C11	0.078	A41	0.118	A86	0.219
C12	0.059	Bermuda	0.088	C92	0.119	A41	0.221
A53	0.060	C92	0.090	A77	0.124	A77	0.241
C11	0.064	A53	0.094	A86	0.126	A53	0.248
C8	0.068	A77	0.096	A65	0.150	C8	0.253
A72	0.069	A51	0.101	A53	0.153	A65	0.283
Bermuda	0.069	A65	0.105	A51	0.162	A72	0.304
C92	0.078	A72	0.109	A72	0.169	A51	0.318
Mean	0.049		0.072		0.103		0.188

The values are means of 4 replications for each weekly clipping harvest.

Table 1. Continued

Grass	Harvest 5	Grass	Harvest 6	Grass	Harvest 7	Grass	Harvest 8
C10	0.082	C66	0.053	C66	0.034	C66	0.034
C66	0.084	C10	0.083	C10	0.047	C10	0.041
Bermuda	0.113	C56	0.090	C56	0.059	A61	0.051
C56	0.127	C12	0.116	A53	0.061	A41	0.052
A55	0.135	A40	0.120	A55	0.064	A55	0.057
A40	0.147	A55	0.131	A61	0.065	C56	0.058
C11	0.153	A41	0.134	A119	0.066	A40	0.061
C12	0.158	C92	0.135	A41	0.071	A53	0.061
A61	0.162	A61	0.137	A65	0.072	C11	0.062
A138	0.168	A77	0.148	A51	0.078	A119	0.062
A41	0.174	C11	0.151	A40	0.080	A77	0.065
A119	0.175	Bermuda	0.158	C8	0.080	A65	0.070
A77	0.178	A86	0.167	A77	0.081	C8	0.070
A86	0.182	A137	0.167	A48	0.082	A48	0.077
C92	0.187	A48	0.190	C92	0.083	A51	0.079
A53	0.193	A53	0.193	C11	0.088	A86	0.079
A137	0.197	A51	0.201	A86	0.090	C92	0.081
A48	0.201	A65	0.209	A137	0.103	A137	0.090
A65	0.232	A119	0.217	C12	0.108	C12	0.092
C8	0.240	A72	0.257	Bermuda	0.119	Bermuda	0.110
A51	0.241	C8	0.260	A72	0.150	A72	0.148
A72	0.260	A138	0.280	A138	0.267	A138	0.256
Mean	0.172		0.164		0.089		0.080

The values are means of 4 replications for each weekly clipping harvest.

Table 1. Continued

Grass	Harvest 9	Grass	Harvest 10	Grass	Harvest 11	Grass	Harvest 12
C66	0.034	C66	0.030	C66	0.016	C66	0.009
C10	0.042	A61	0.036	A41	0.017	C56	0.013
A61	0.043	C56	0.038	C56	0.021	A41	0.013
A41	0.049	A41	0.040	C10	0.022	C11	0.013
A40	0.054	C11	0.043	C11	0.022	C10	0.014
C56	0.054	C10	0.043	A61	0.022	A61	0.016
A55	0.055	A55	0.045	A53	0.023	A55	0.017
A119	0.056	A40	0.046	A51	0.024	A53	0.018
A65	0.057	A53	0.046	A55	0.024	A65	0.020
A77	0.060	A119	0.047	A119	0.025	A51	0.020
A53	0.061	A51	0.049	A40	0.027	C12	0.020
C11	0.061	A77	0.053	A77	0.027	A119	0.020
A51	0.066	A65	0.054	A65	0.028	C92	0.021
A86	0.069	C12	0.058	A48	0.030	A77	0.021
C92	0.076	A48	0.059	C12	0.030	C8	0.022
C8	0.076	C92	0.062	A86	0.031	A40	0.022
C12	0.079	A86	0.062	C92	0.031	A48	0.024
A48	0.081	C8	0.068	C8	0.032	Bermuda	0.027
A137	0.086	A137	0.071	Bermuda	0.040	A72	0.029
Bermuda	0.096	A72	0.079	A72	0.041	A137	0.032
A72	0.106	Bermuda	0.088	A137	0.041	A138	0.050
A138	0.179	A138	0.135	A138	0.064	A86	0.057
Mean	0.070		0.057		0.029		0.023

The values are means of 4 replications for each weekly clipping harvest.

Table 1. Continued

Grass	Harvest 13	Grass	Harvest 14
C66	0.001	C10	0.000
A41	0.003	C11	0.000
C56	0.003	C56	0.000
C11	0.003	C66	0.000
C10	0.004	C92	0.000
A53	0.004	A41	0.000
A61	0.005	A51	0.000
C12	0.007	A53	0.000
A55	0.007	A61	0.000
A51	0.007	A119	0.001
C92	0.008	A40	0.001
A65	0.008	A55	0.001
A40	0.008	A48	0.001
A119	0.008	A65	0.002
A86	0.008	C12	0.002
C8	0.008	A86	0.002
A48	0.009	C8	0.002
A77	0.010	A77	0.002
Bermuda	0.012	Bermuda	0.003
A72	0.014	A72	0.005
A137	0.019	A137	0.007
A138	0.027	A138	0.009
Mean	0.008		0.002

The values are means of 4 replications for each weekly clipping harvest.

Table 2. Means of percentage of plants visual green cover, sorted by grass and by ascending values, for the last eight consecutive weekly ratings.

Grass	Harvest 1	Grass	Harvest 2	Grass	Harvest 3	Grass	Harvest 4
A55	84	C11	51	C66	38	C66	34
A41	90	C10	53	C10	48	C10	43
C66	90	A77	55	C11	48	C92	43
C11	90	C66	58	C92	48	C11	44
C92	91	A53	58	A53	50	Bermuda	45
C56	91	C92	59	A77	53	A53	46
A77	93	A41	60	C56	54	A77	49
C10	93	C8	63	A41	54	C56	50
A65	94	C56	63	C8	56	A41	50
A61	94	A119	65	Bermuda	58	C8	51
A53	94	A55	66	A55	60	A119	55
A51	94	C12	69	A119	60	A55	56
A48	94	A51	69	C12	64	C12	60
Bermuda	95	A61	69	A51	65	A51	60
A119	95	A86	69	A61	65	A61	60
A86	95	A40	71	A86	66	A86	61
A72	95	A65	71	A65	69	A65	64
A40	95	A72	71	A72	70	A48	66
C12	95	A48	73	A40	71	A40	68
C8	95	Bermuda	73	A48	71	A72	68
A137	96	A137	76	A137	76	A137	74
A138	100	A138	95	A138	90	A138	90
Mean	93		66		61		56

The values are means of 4 replications for each weekly rating.

Table 2. Continued

Grass	Harvest 5	Grass	Harvest 6	Grass	Harvest 7	Grass	Harvest 8
C66	30	C66	23	A41	1	A41	1
C92	38	Bermuda	25	A51	3	A51	1
C10	39	A41	26	C66	4	A53	3
A53	39	A51	26	A72	4	Bermuda	3
Bermuda	40	A53	26	A53	5	C66	4
C11	41	C92	30	A61	5	A61	4
A51	41	A65	31	Bermuda	5	A72	4
A55	41	A77	31	A119	6	A119	5
A41	44	A55	35	A65	8	A65	6
A77	44	A61	35	A77	8	A86	6
C56	46	A119	35	A86	8	A77	8
C8	48	C10	36	C92	10	A48	9
A61	49	C11	36	A55	11	A55	9
A119	49	A172	38	A40	13	C92	10
A65	51	C56	40	A48	13	C10	11
A86	53	A86	40	A138	13	A138	11
C12	55	C8	43	C10	14	C56	13
A72	55	A48	46	C56	14	A40	14
A48	58	C12	50	A137	16	A137	14
A40	59	A40	50	C8	19	C8	18
A137	68	A137	53	C11	20	C11	18
A138	75	A138	54	C12	31	C12	31
Mean	48		37		11		9

The values are means of 4 replications for each weekly rating.