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Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

USGA supports research to develop alternative grass species for golf course use that can withstand greater environmental stresses including drought, salt, heat, and cold. University of Arizona scientists report on some of their findings as they continue to develop desert saltgrass (*Distichlis spicata*) for use in arid, saline environments.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 290 projects at a cost of $25 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Responses of Twelve Inland Saltgrass Accessions to Salt Stress

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SUMMARY

Work continues at the University of Arizona to develop inland saltgrass (*Distichlis spicata*) as a turf species for arid and saline environments. Twelve inland saltgrass clones were studied to evaluate their growth responses under increasing levels of salinity stress. The research found:

- Saltgrass shoot (clippings) dry matter and general quality decreased linearly with increased salinity for all clones.
- For most clones, there was no difference among root dry matter at different salinity levels.
- Considering all study parameters, there was a wide range of salinity tolerance found among the twelve saltgrass clones.

Desert saltgrass, *Distichlis spicata* (L.), a potential forage plant and turf species, is found in saline conditions, or in soils which experience extended drought periods. It is found in arid and semi-arid regions. The United States Golf Association (USGA) has shown a great deal of interest in the potential development of this species for turf use. Most of the research work on this species has been conducted at the University of Arizona and Colorado State University. Positive and promising results have already been obtained from these studies (2, 3, 4, 5).

Materials and Methods

Plant Materials

Twelve inland saltgrass accessions were used in a greenhouse to evaluate their shoot (clippings) and root dry weights, and general quality under salinity stress conditions, via a hydroponic technique using "Instant Ocean salt" in Hoagland solution.

Plant Establishment

The grasses were grown as vegetative propagules in half-strength Hoagland nutrient solution (1). Three replications of each treatment were used in a randomized complete block (RCB) design in this investigation. The plants were grown in this nutrient solution for 42 days. During this period, the plant shoots were cut weekly in order to reach full maturity and develop uniform and equal size grasses. At the last harvest, day 42, the roots were also cut to 2.5 cm length to have plants with uniform roots and shoots for the stress phase of the experiment.

Salt Treatment

The salt treatments were initiated by gradually raising the EC (electrical conductivity) of the nutrient solutions to 6, 20, 34, and 48 dS m^{-1}

Clones of inland saltgrass were grown in increasing more saline hydroponic solutions to test their tolerance to salinity stress.

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Grass	Electrical Conductivity (dS m^{-1}) 6	20	34	48
	..........grams..........			
A37	1.10cde	0.57bcde	0.27cde	0.15c
A49	1.26bcd	0.77ab	0.32bcde	0.13c
A50	1.65ab	0.60bcd	0.21de	0.17bc
A60	1.03cde	0.38e	0.17e	0.13c
72	1.38bc	0.82a	0.38abc	0.19bc
A86	1.66ab	0.86a	0.26cde	0.14c
A107	0.95de	0.52cde	0.30bcde	0.20bc
A126	0.83e	0.41de	0.18e	0.15c
A128	1.37bc	0.73abc	0.52a	0.30a
A138	1.09cde	0.46de	0.36abcd	0.25ab
239	1.67ab	0.88a	0.44ab	0.15c
240	1.94a	0.91a	0.49a	0.24ab

The values are the means of 3 replications of each treatment.
The values in each column followed by the same letters are not statistically significant at the 0.05 probability level.

Table 1. Saltgrass shoot (clippings) dry weight (grams) under increasing levels of salt stress (dS m^{-1}).

by adding Instant Ocean salt. After the final salinity levels were reached, the shoots and roots were cut and discarded prior to beginning the stress phase of the experiment.

Plant shoots (clippings) were harvested biweekly for the evaluation of the dry matter production. The harvested plant materials were oven dried at 60^{o} C and dry weights were recorded. At the termination of the experiment, plant roots were also harvested, oven dried at 60^{o} C, and dry weights were recorded. Also, turfgrass quality was evaluated weekly and recorded.

Statistical Analysis

The data were subjected to analysis of variance, using SAS statistical package (6). The means were separated, using Duncan Multiple Range test.

Results and Discussion

The results for the shoot (clippings) dry weights, root dry weights, and the grass general quality are presented in Tables 1 - 3, respectively.

Clipping Dry Weights

Clipping dry weights of all clones decreased with increased salinity (Table 1). A marked reduction in clipping dry weight occured at EC 34 dS m^{-1} across all clones. Only a few clones produced any measurable top growth at EC 48 dS m^{-1} (Table 1).

Root Dry Weights

The effect of salinity on root dry mass was less dramatic compared to shoot dry mass (clippings). Clone 240 had excellent root growth at EC 6 dS m^{-1} and the second highest root production at

Grass	Electrical Conductivity (dS m^{-1}) 6	20	34	48
	....*grams*	....		
A37	0.74cde	0.99def	1.10cdef	0.78cd
A49	1.61b	1.11cdef	1.56bcd	1.03bcd
A50	1.83b	1.65a	1.94abc	0.74cd
A60	1.46bc	1.71a	1.31bcde	0.84bcd
72	0.77cde	0.93def	0.72def	0.50d
A86	1.06bcde	1.18bcde	0.76def	0.81bcd
A107	0.68de	0.84ef	0.53ef	0.68cd
A126	0.50e	0.68f	0.26f	0.48d
A128	3.46a	1.50abc	2.05ab	1.18bc
A138	1.17bcde	0.88def	0.43ef	2.28a
239	1.31bcd	1.30abcd	2.82a	1.21bc
240	3.36a	1.63ab	1.25bcde	1.42b

The values are the means of 3 replications of each treatment.
The values in each column followed by the same letters are not statistically significant at the 0.05 prob ability level.

Table 2. Saltgrass root dry weight (grams, cumulative values) under increasing levels of salt stress (dS m^{-1})

EC 48 dS m^{-1} (Table 2), but had poor quality under high salinity level. The same was true for clone 239. A138 had twice the root mass of most other clones at EC 48 dS m^{-1}, but had essentially no green foliage at EC 48 dS m^{-1} at the end of the test. Across all EC levels there was only a 20% reduction in root growth from EC 6 to EC 48 dS m^{-1}.

General Quality

The grass (clone) x EC interaction effect was significant for turf quality, showing that some clones decreased at different rates for overall quality as salinity increased (Table 3). Quality scores for various clones ranged from 2.8 to 9.7at different salinity levels. At EC 20 dS m^{-1}, quality scores ranged from 5.1 to 9.7 (Table 3) throughout the entire test. All clonal entries had good quality and full maintenance of green tissue retention at EC 6 dS m^{-1} at the end of the trial (Table 3). After seven weeks at EC 34 dS m^{-1}, entries 239 and 240 were the only clones to have quality ratings of 6.0 or greater (Table 3). These two clones represented the best quality clones at EC 34 dS m^{-1} at the end of the test.

At EC 48 dS m^{-1}, no entries produced an acceptable plant quality (scores of 6 or better). Most clones decreased in quality as EC increased from EC 6 to EC 48 dS m^{-1}, but the entries 239 and 240 showed a more of typical halophytic response, having an increase in quality at EC 20 dS m^{-1} over that observed at EC 6 dS m^{-1}.

Grass	Electrical Conductivity (dS m^{-1}) 6	20	34	48
	....................................Quality (1-10)......................................			
A37	8.0cde	5.1f	3.3g	2.6e
A49	7.7def	6.4d	4.3ef	2.8e
A50	8.6abc	7.2bc	5.0cd	4.0bc
A60	8.2bcd	5.5ef	3.9fg	3.5cd
72	9.0a	7.4bc	5.9b	4.8a
A86	8.5abc	6.7cd	5.7b	3.9bc
A107	7.5def	5.9def	5.4bc	4.4ab
A126	6.7g	5.3f	4.6de	3.9bc
A128	7.1fg	6.2de	5.0cd	3.0de
A138	8.6abc	7.9b	5.4bc	4.2ab
239	8.9ab	9.3a	6.6a	4.2ab
240	9.2a	9.7a	7.1a	2.8e

The values are the means of 3 replications of each treatment.
The values in each column followed by the same letters are not statistically significant at the 0.05 probability level.

Table 3. Quality (1-10, where 1 equals dead grass, 6 = acceptable quality, and 10 = exceptional quality) of saltgrass selections under increasing levels of salt stress (dS m^{-1})

Conclusions

The results of the shoot/root dry mass and the general grass quality showed that the maintenance of green foliage and clipping tolerance under saline hydroponic conditions are under physiological conditions/adjustments that are not totally related to dry matter production in shoots/roots. This was corroborated by the results that clones which maintained the highest quality under EC 34 dS m^{-1} exhibited either a large increase in root mass (239), or only a small increase of the root mass (240) produced at EC 6 dS m^{-1}. Likewise, clone A138 produced a large increase of its EC 6 dS m^{-1} root mass at the highest EC level of 48 dS m^{-1}. However, it could not maintain green foliage at six weeks of exposure to this high EC. The same was true for dry matter clipping production that occurred in a more narrow range of values than did root production.

In terms of salinity tolerance (quality), green foliage retention was empirically the best assessment of the clonal response to increased salinity levels. For large-scale screening of saltgrass germplasm, the maintenance of green tissue at a specific EC level would seem to be adequate as a simple selection method for salinity tolerance.

Acknowledgements

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