SEMI-ANNUAL PROGRESS REPORT

CONCERNING

DEVELOPING SALT, DROUGHT, AND HEAT RESISTANT TURFGRASSES FOR MINIMAL MAINTENANCE

SUBMITTED BY:

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SEMI-ANNUAL PROGRESS REPORT FALL 1986
DEVELOPING SALT, DROUGHT, AND HEAT RESISTANT
TURFGRASSES FOR MINIMAL MAINTENANCE

USGA SUPPORTED SALT RESISTANCE PROGRAM

SIGNIFICANT CONTRIBUTIONS

I. Advancement of Science:

This research project has developed and improved useful research tools for consistent and rapid evaluation of both seeded and vegetative plant germ plasm bases for salt resistance. Specifically, the floating mat technique for seeded plant material and the aeroponic system for vegetative plant material.

II. Reduction in Water Use:

The identification of plant materials that will use soils and irrigation waters of reduced quality will decrease the dependence of the green industry on the potable water supply. This research project has begun to identify which plant materials have the potential to be utilized in reduced soil and water quality environments.

III. Reduction in Maintenance:

Plant materials that do not survive and/or remain functional under stress or less than optimum conditions have to constantly be replaced and receive extra maintenance resources. The identification by this research project of plant materials which will and/or will not survive and require less maintenance inputs under reduced soil and water quality conditions should help reduce maintenance costs. Utilization of these plant materials will reduce the inputs needed for continued renovations and extra care to maintain functional turfgrasses.

EXECUTIVE SUMMARY

1986 Fall Semi-Annual Progress Report
concerning
Developing Salt, Drought, and Heat Resistant
Turfgrasses for Minimal Maintenance

Principle Investigator: Dr. Garald Horst
Turfgrass Stress Physiologist

RESEARCH PERIOD OF THIS REPORT: November 1, 1985 to October 30, 1986

I. Research Accomplished:

1. Completed planned evaluation of 40 St. Augustinegrass germ plasm entries.

2. Continued refinement of the new technique for growth and development evaluation of multiple germ plasm entries grown under salt stress conditions.

3. Continued reception and increase of 28 bermudagrasses, 7 bentgrasses, 75 Buffalograsses, 3 Paspalums, and 78 zoysiagrasses.

II. Current Research:

1. Vegetative material of 29 Buffalograss germ plasm entries are being evaluated for salt resistance in the new greenhouse facility.

2. Pilot studies on vegetative establishment methods for evaluating zoysiagrass vegetative material are still in progress.

III. Research Planned 1986/1987:

1. Complete evaluation of Buffalograss germ plasm (May 1987). Expect to receive additional Buffalograss germ plasm entries from Nebraska this Fall.

2. Initiate zoysiagrass evaluation (March 1987).

3. Initiate evaluation of Paspalum germ plasm for salt resistance (March 1987).

4. Continue accumulation of bentgrass and bermudagrass germ plasm and expand cooperation with New Mexico and Oklahoma bermudagrass programs.

5. Begin to proto-type long term salt stress growing techniques for further greenhouse and field evaluations on germ plasm which exhibited reasonable salt resistance (May 1987).

USGA SUPPORTED TURFGRASS SALT TOLERANCE PROGRAM

I. INTRODUCTION

This Semi-annual report as required in the contract is for the period November 1, 1985 to October 30, 1986. Ms. Jo Ann Treat, Executive Vice President, Texas Research Foundation, and Mr. Charles Smith, Director, Administration and Services for United States Golf Association, signed the original contract agreement effective April 1, 1985. The research contract is established through the Texas A&M Research Foundation.

The following report represents the research accomplishments and research direction for the period November 1, 1985 to October 30, 1986.

II. IMPLEMENTATION

Previous studies involving salt resistance of several turf type grasses have been completed and reported. Continuation of salt resistance evaluations on Buffalograss are currently under way in the recently completed greenhouse facility. Methods for evaluating (rooting and growing) zoysiagrass sprigs to the growth stage where they may be evaluated are currently in progress. Cultivars exhibiting salt resistance and essential agronomic turfgrass qualities will be included in more advanced studies. These advanced studies are now planned for the greenhouse on modified media rather than aeroponically as our initial evaluations are completed. The most salt resistant genetic sources could be utilized in parent-progeny evaluations where the heritability of these traits could be defined along with the potential for improvement and utilization into new turfgrass types. Areas of past and present research are identified and briefly discussed in the following sections.

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GENERAL NOTE ON RESEARCH PROGRESS: The Research Center at El Paso has had a major construction project in progress for the past ten months. The result of this construction is new greenhouse facilities and equipment which should enhance the salt resistance research. However, it has also resulted in several problems in research maintenance which have caused the loss of some of the experiments. Due to the maintenance problem, the decision was made to continue with the root initiation experiments over the summer. Additional salt resistance experiments have been delayed until the new facilities were completed this fall. Completion date was for Sept. 1986, but construction delays have set the research back to early Nov. 1986.

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A. SALT RESISTANCE IN SEEDLING TURFGRASSES

Evaluation of Kentucky bluegrass (Poa pratensis L.), tall fescue (Festuca arundinacea Schreb.), and perennial ryegrass (Lolium perenne L.) cultivars have previously been reported. Information on the results of these studies may be obtained in these publications (1,2,3).

B. EVALUATIONS INVOLVING VEGETATIVE PLANT MATERIAL

Methods for evaluating salt resistance of vegetatively propagated turfgrasses have been and continue to be refined for specific species. Exclusion of light from the nutrient/salt solution and the plant root zone has continued to be the best method of reducing the algae problem encountered when working with nutrient solutions.

Many of the description specifics on the equipment and methods involved in the salt resistance evaluation of vegetative material was reported in the Annual Report dated November 1, 1985. Since that report date there have been several method and equipment modifications to help correct equipment and labor problems.

Stainless steel (epoxy coated) still were subject to corrosion from salt exposure. In addition, deeper tanks allow for a larger volume (12' deep) of saturated air in the root zone. Therefore, construction of epoxy coated wooden tanks was initiated in March 1986. However, the epoxy coating did not adhere to the wood under the saturated moisture conditions. In order to correct this problem, the tanks were coated with several layers of fiberglass resin during the summer period when construction repeadly interrupted service utilities to the salt resistance evaluation laboratory.

Additional modifications were also made in the mist system. Another complete mist nozzle, pump, and timer control was added to each evaluation tank chamber. These changes now achieve an almost "fail safe" root mist system.

C. ST. AUGUSTINEGRASS GERM PLASM SALT RESISTANCE.

OBJECTIVES: To evaluate the available gene pool for salt resistance in St. Augustinegrass (Stenotaphrum secundatum (Walt.) Kuntze) germ plasm.

PROGRESS: Forty St. Augustinegrass entries were included in the salt resistance evaluations (Table 1). Healthy nodes were selected to pre-root in silica sand in the greenhouse for 20 days. Initial experiments indicated salt concentrations of 30,000 and 20,000 ppm produced extremely high plant mortality rates. Therefore, salt concentrations of 5,000, 10,000, and 15,000 ppm were used for all the evaluations. The following establishment schedule was utilized: Lights are off the first day after planting. Light duration was then gradually increased in two hour intervals daily until a 16 hour day length is achieved. This day length schedule was then maintained for the duration of the experiment. Salt treatments and Subdue 2E (Pythium prevention) was added to the nutrient solutions on day 5 after planting.

The St. Augustinegrass nodes were grown in the salt solutions for 4 weeks. Harvest data include:

- Root lengths
- Stolon counts
- Root wet weights
- Root dry weights
- Stolon lengths
- Top wet weights
- Top dry weights

Top and root dry weights and root lengths appear to be the most useful criteria for comparing salt resistance of the St. Augustinegrass germ plasm entries. Variability of stolon count and stolon length was too great to be considered a useful salt resistance measurement criteria over the short evaluation time period.

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As of October 1986, four, 3-replication and one 2-rep experiments have been completed. There were two other 3-rep experiments executed. However due to events beyond the control of the turfgrass research group, the data from these two experiments could not be used in the final analysis. A third 3-rep experiment should be completed by December 1985.

Dry weight accumulation was used as the primary criteria for determination of salt resistance in St. Augustinegrass germ plasm entries. Thirty-five entries or 88 percent exhibited greater than a 50 percent reduction in top growth dry matter accumulation in response to the 5,000 ppm salt level (Table 2.). [1] A similar portion of the population (85 percent, 34 entries) exhibited less than 50 percent reduction in root dry weight. At the 10,000 ppm salt level, only 40 percent of the population (16 entries) had top growth dry matter accumulation at the 50 percent or greater level. This greater simulated level of root zone salts shifted the plant dry matter accumulation in favor of root production. This was indicated by the greater portion of the population (65 percent, 14 entries) that had root production levels greater than 50 percent of the control level production. The 15,000 ppm salt level effectively eliminated 95 percent of the St. Augustinegrass germ plasm population. The only two entries that survived and exhibited less than a 50 percent reduction in both top and root growth parameters was DALSA 8401 and DALSA 8403.

Root length was another measurement parameter used to differentiate among the St. Augustinegrass entries for salt resistance. This measurement did not produce a large reduction in the statistical base which was below the 50 percent level until the 15,000 ppm salt concentration was reached (Table 3). It was hypothesized that root length alone, which is quick and easy to measure, may be a good measurement of salt resistance. However, the slower dry weight measurements appear to produce the best germ plasm separation and salt resistance measurement.

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[1] The fifty percent level of measured biological parameters has been adopted as a base line for evaluation comparisons in biological systems.

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Salt resistance evaluation of St. Augustinegrass has been completed at this time. The two entries that appear to have the most potential for survival where soil and/or irrigation have salt loads are DALSA 8401 and DALSA 8403. This information has been transferred to Dr. M. C. Engelke for use in the St. Augustinegrass improvement program.

D. BUFFALOGRASS GERM PLASM SALT RESISTANCE.

OBJECTIVE: To evaluate the available gene pool for salt resistance in Buffalograss (Buchloe dactyloides (Nutt.) Engelm.) germ plasm.

PROGRESS: Twenty-seven buffalograss germ plasm were selected for the initial salt resistance evaluations (Table 4). Healthy nodes were pre-rooted in silica sand for 30 days. The same procedures are followed as the St. Augustinegrass except the buffalograsses are grown in the salt solutions for 6 weeks. Harvest data is also the same as for St. Augustinegrass. As of October 1986, three, 4-rep experiments have been completed. One of the three experiments was lost because of utility problems. Additional experiments will be executed after moving to the new greenhouse facility. Data gathered thus far continue to indicate that buffalograss has very limited salt resistance even at the lowest salt level (5,000 ppm). Results from the additional experiment tends to confirm the initial conclusions.

Additional buffalograss entries are being sent from the Nebraska Buffalograss breeding program as the Texas germ plasm base appears to have little salt resistance potential. The following results are included as a matter of reference as the salt resistance data base is not at this time large enough to draw conclusions on buffalograss salt resistance. Plant mortality of buffalograss grown in 3 salt concentrations indictes that less than 15% of the germ plasm entries survived the first two salt stress levels (Table 5). Less than 17% of the entries survived at a 50% level in all 3 salt stress concentrations.

The plant growth measurements in Tables 6 and 7 are of the 5 entries that exhibited greater than a 50% survivial rate in the salt treatments. These growth measurements indicate severe reductions in both top and root growth as related to salt stress. There appears to be little outstanding salt resistance in the germ plasm evaluated to data. However, evaluation of germ plasm from a broader geographic base may uncover genetic potential for salt resistance.

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Salt resistance evaluation of buffalograss has not been completed at this time therefore, data on additional growth and survivial measurements and conclusions on salt resistance potential will not be reported until completion.

E. METHOD FOR EVALUATING ZOYSIAGRASSES FOR SALT RESISTANCE

OBJECTIVE: To determine the best method in which to evaluate Zoysiagrass (Zoysia Willd.) germ plasm for salt resistance.

PROGRESS: Due to the extreme slow growing nature of zoysiagrass this species requires special methods of evaluation. This past summer we have continued our experiments on procedures to pre-root zoysiagrass nodes selected from stolons of germ plasm grown in pots in the greenhouse. It now appears that it will take two to three times as long to initiate good rooting from stolon nodes as compared to St. Augustinegrass and buffalograss. Scheduled time for salt resistance experiments on zoysiagrass are now for March of 1987, when the last phase of the buffalograss experiments are nearing completion.

F. METHOD FOR FURTHER EVALUATION ON ELITE SELECTIONS

OBJECTIVES: Determine methods for salt resistance evaluations on a soil medium where the salt concentrations may remain constant.

PROGRESS: Research on this phase of turfgrass germ plasm salt resistance evaluation has been delayed up until now because of new research facility construction. The facility has now been completed and pilot experiments on long term growth under saline conditions should begin this winter.

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RELEVANT PUBLICATIONS

1. Horst, G. L. and R. M. Taylor. 1983. Germination and Initial Growth of Kentucky Bluegrass in Soluble Salts. Agron. J. Vol. 75:679-681.

2. Horst, G. L. and N. B. Beadle. 1984. Salinity Affects Germination and Growth of Tall Fescue Cultivars. J. Amer. Soc. Hort. Sci. Vol. 109(3):419-422.

3. Horst, G. L. and N. B. Dunning. 1984. Germination and Initial Growth of Perennial Ryegrasses in Soluble Salts. Agron. Abstr. p.151.

4. Horst, G. L. and M. C. Engelke, and W. Meyers. 1984. Assessment of Visual Evaluation Techniques. Agron. J. Vol. 76:619-622.

5. Horst, G. L. 1985. Physiological effects of non-potable water on plant growth. Agron. Abstr. p.116.

6. Horst, G. L. 1985. Selection of turfgrass cultivars for salt resistance. Agron. Abstr. p.117.

7. Horst, G. L. 1986. Salt resistance and tolerance in turfgrasses. Proc. GCSAA Inter. Golf Course Conf. and Show. p.49-50.

LIST OF TABLES

Table 1. St. Augustinegrass inventory summary of germ plasm used in salt resistance evaluation experiments.

Experiment Assignment #	Entry name/ Pot #	Source		
1.	TXSA 8201	Beard	College	Station
2.	TXSA 8203	"	"	"
3.	TXSA 8208	Beard	College	Station
4.	TXSA 8218	"	"	"
5.	TXSA 8225	Beard	College	Station
6.	TXSA 8231	"	"	"
7.	TXSA 8262	Beard	College	Station
8.	FLORATAM	"	"	"
9.	BITTER BLUE	Beard	College	Station
10.	FLORATINE	"	"	"
11.	SCOTTS SEVILLE 516	Beard	College	Station
12.	GARRETTS 141	"	"	"
13.	FL 1815-1	Busey	Florida	
14.	FL 1811-3	"	"	
15.	FL 1918-4	Busey	Florida	
16.	FL 1921-2	"	"	
17.	FL 1845-8	Busey	Florida	
18.	DALSA 8210	Engelke	Dallas	
19.	DALSA 8211	"	"	
20.	DALSA 8212	Engelke	Dallas	
21.	DALSA 8213	"	"	
22.	DALSA 8214	Engelke	Dallas	
23.	DALSA 8215	"	"	
24.	DALSA 8216	Engelke	Dallas	
25.	DALSA 8217	"	"	
26.	DALSA 8218	Engelke	Dallas	
27.	DALSA 8201	"	"	
28.	DALSA 8202	Engelke	Dallas	
29.	DALSA 8203	"	"	
30.	DALSA 8204	Engelke	Dallas	
31.	DALSA 8205	"	"	
32.	DALSA 8206	Engelke	Dallas	
33.	DALSA 8207	"	"	
34.	DALSA 8208	Engelke	Dallas	
35.	DALSA 8209	"	"	
36.	SCOTTS 1081-4	O. M. Scotts		
37.	FA 108			
ENTRIES BELOW ADDED	10/85			
38.	DALSA 8401	Engelke	Dallas	
39.	DALSA 8402	"	"	
40.	DALSA 8403	Engelke	Dallas	

Table 2. St. Augustinegrass germ plasm top and root growth dry weight as grown in 5,000, 10,000, and 15,000 ppm soluble salt, expressed as percent of growth in the control treatment (deionized water).

Experiment Assignment #	Salt Concentration (ppm) 5,000 Top	5,000 Root	10,000 Top	10,000 Root	15,000 Top	15,000 Root
	Percent of Control Dry Weight					
1. TXSA 8201	55	75	--	72		
2. TXSA 8203	61	65	--	56		
3. TXSA 8208	62	105	57	93	--	65
4. TXSA 8218	67	80	54	64		
5. TXSA 8225	54	79	52	71		
6. TXSA 8231	61	73	56	69		
7. TXSA 8262	58	66	--	--		
8. FLORATAM	57	69	--	61		
9. BITTER BLUE	53	54	--	--		
10. FLORATINE	53	66	--	--		
11. SCOTTS SEVILLE 516	61	94	57	75		
12. GARRETTS 141	54	58	--	54		
13. FL 1815-1	72	108	72	100		
14. FL 1811-3	80	101	68	86		
15. FL 1918-4	68	95	59	83		
16. FL 1921-2	53	60	--	56		
17. FL 1845-8	54	69	--	65		
18. DALSA 8210	52	--	--	--		
19. DALSA 8211	50	67	--	52		
20. DALSA 8212	53	--	--	--		
21. DALSA 8213	59	94	--	--		
22. DALSA 8214	--	--	--	--		
23. DALSA 8215	57	60	--	--		
24. DALSA 8216	55	61	--	--		
25. DALSA 8217	83	98	58	87		
26. DALSA 8218	81	75	--	--		
27. DALSA 8201	62	69	--	--		
28. DALSA 8202	59	51	--	56		
29. DALSA 8203	83	85	61	56		
30. DALSA 8204	--	--	--	--		
31. DALSA 8205	61	85	52	61		
32. DALSA 8206	74	91	60	55		
33. DALSA 8207	90	108	81	98		
34. DALSA 8208	90	154	55	118	--	73
35. DALSA 8209	--	68	--	61		
36. SCOTTS 1081-4	--	--	--	--		
37. FA 108	51	71	--	69		
38. DALSA 8401	95	106	88	138	55	93
39. DALSA 8402	--	--	--	--		
40. DALSA 8403	86	121	74	70	53	65

Table 3. St. Augustinegrass germ plasm root growth length (mm) as grown in 5,000, 10,000, and 15,000 ppm soluble salt, expressed as percent of growth in the control treatment (deionized water).

Experiment Assignment #	Percent of Control Length — Salt Concentration (ppm) 5,000	10,000	15,000
1. TXSA 8201	74	70	
2. TXSA 8203	72	66	
3. TXSA 8208	65	78	63
4. TXSA 8218	73	80	55
5. TXSA 8225	80	79	59
6. TXSA 8231	79	77	64
7. TXSA 8262	64	--	
8. FLORATAM	81	68	57
9. BITTER BLUE	57	--	
10. FLORATINE	65	--	
11. SCOTTS SEVILLE 516	82	79	
12. GARRETTS 141	68	57	
13. FL 1815-1	89	94	66
14. FL 1811-3	80	83	59
15. FL 1918-4	78	83	61
16. FL 1921-2	76	65	
17. FL 1845-8	77	83	
18. DALSA 8210	58	53	
19. DALSA 8211	64	70	53
20. DALSA 8212	55	53	
21. DALSA 8213	56	59	51
22. DALSA 8214	52	68	
23. DALSA 8215	68	59	
24. DALSA 8216	65	63	51
25. DALSA 8217	76	77	
26. DALSA 8218	86	66	
27. DALSA 8201	92	62	
28. DALSA 8202	70	71	55
29. DALSA 8203	74	57	
30. DALSA 8204	58	60	
31. DALSA 8205	66	64	
32. DALSA 8206	86	73	
33. DALSA 8207	73	80	
34. DALSA 8208	93	100	57
35. DALSA 8209	55	65	
36. SCOTTS 1081-4	94	56	
37. FA 108	60	70	
38. DALSA 8401	96	113	85
39. DALSA 8402	--	--	53
40. DALSA 8403	53	79	61

Table 4. Buffalograss inventory summary of germ plasm used in salt resistance evaluation experiments.

ENTRY	SOURCE
PMT-4833	Swisher Co. Tx
PMT-4844	Donley, Tx
PMT-4854	Ochiltree Co. Tx
PMT-4860	Grayson Co. Tx
PMT-4866	Hansford, Tx
PMT-4868	Collins Co. Tx
PMT-4921	Austin Co. Tx
PMT-4932	Fannin Co. Tx
PMT-4974	Wharton Co. Tx
PMT-4998	Edwards Co. Tx
PMT-5000	Coryell Co. Tx
PMT-5015	Andever Co. Tx
PMT-5017	Falls Co. Tx
PMT-5059	Scurry Co. Tx
PMT-4814	Fort Bend Tx
PMT-4849	Sherman Co. Tx
PMT-4870	Hamilton Co. Tx
PMT-4912	Milam Co. Tx
PMT-4935	Lee Co. Tx
PMT-4987	Gonzales Co. Tx
PMT-4836	Travis, Tx
PMT-4911	Wise Co. Tx
PMT-4919	Washington Co. Tx
PMT-4944	Martin Co. Tx
PMT-4977	Goliad Co. Tx
PMT-5013	McLennan Co. Tx
PMT-5076	Coke Co. Tx

Table 5. Mortality of Buffalograss germ plasm at a 50 percent level or greater in 3 salt levels.

Entry	ppm Salts 5,000	10,000	15,000
PMT-4833	xxx	xxx	xxx
PMT-4844	xxx	xxx	xxx
PMT-4854	xxx	xxx	xxx
PMT-4860	-	-	-
PMT-4866	xxx	xxx	xxx
PMT-4868	xxx	xxx	xxx
PMT-4921	xxx	xxx	xxx
PMT-4932	xxx	xxx	xxx
PMT-4974	xxx	xxx	xxx
PMT-4998	xxx	xxx	xxx
PMT-5000	xxx	xxx	xxx
PMT-5015	xxx	xxx	xxx
PMT-5017	xxx	xxx	xxx
PMT-5059	xxx	xxx	xxx
PMT-4814	xxx	xxx	xxx
PMT-4849	-	-	-
PMT-4870	xxx	xxx	xxx
PMT-4912	xxx	xxx	xxx
PMT-4935	-	-	-
PMT-4987	xxx	xxx	xxx
PMT-4836	xxx	xxx	xxx
PMT-4911	xxx	xxx	xxx
PMT-4919	xxx	xxx	xxx
PMT-4944	xxx	xxx	xxx
PMT-4977	-	-	xxx
PMT-5013	-	-	-
PMT-5076	xxx	xxx	xxx

- Less than 50% mortality.
xxx greater than 50% mortality.

Table 6. Top growth dry weight of surviving Buffalograss germ plasm entries as salt stress was increased.

Entry	ppm Salts 5,000	10,000	15,000
PMT-4860	12*	15	17
PMT-4849	29	23	17
PMT-4935	76	46	33
PMT-4977	35	34	-
PMT-5013	25	20	2

*Values are percent of no salt stress growth.

Table 7. Root growth dry weight of surviving Buffalograss germ plasm entries as salt stress was increased.

Entry	ppm Salts 5,000	10,000	15,000
PMT-4860	10*	12	16
PMT-4849	29	22	19
PMT-4935	45	19	20
PMT-4977	26	23	-
PMT-5013	28	19	22

*Values are percent of no salt stress growth.