Executive Summary

UNIVERSITY OF GEORGIA **November 1999**

SEASHORE PASPALUM ECOTYPE TOLERANCE TO ROOT LIMITING SOIL STRESSES AND TRAFFIC STRESSES

1999 Research Grant: $25,000

(Second Year of Support)

Dr. Robert N. Carrow
Principal Investigator

Root Limiting Soil Stresses Component

The breeding/genetics paradigm of Dr. R.R. Duncan's program for seashore paspalum (SP) (Paspalum vaginatum) is to systematically determine ecotype tolerance to important stresses. Of particular interest is genetic-based resistance to soil chemical and physical factors that limit root development/longevity. In this project, SP ecotypes are screened for root responses to 4 of the 6 edaphic factors that limit rooting. This multiple stress approach provides important information for SP resistance to individual and multiple soil stresses and is highly effective in identifying SP ecotypes with high nutrient uptake efficiency and drought resistance via possessing a deep, extensive, viable root system. Root tolerance assessment to the major edaphic stresses has been a "missing ingredient" in almost all breeding programs targeted to improve drought resistance, water-use efficiency, or nutrient-use efficiency. The four studies included in this project are:

Study 1. Evaluation of Seashore Paspalum Ecotypes and Selected Grasses To The Acid Soil Complex.

Eighty-four seashore paspalum ecotypes and three control grasses (common bermudagrass, Tifway bermudagrass, and Meyer zoysiagrass) were plugged (3.5 in. dia. x 3 in. deep; A = 0.07 $ft.^2$) on 30 June 1998 into two adjacent sites at 4.5 feet centers. Both sites were a Cecil kaolinitic clay soil with 23% clay (A horizon) and 45% (B horizon). Site A was at pH 4.2 to create the acid soil complex stress which consists of Al/Mn toxicities and potential deficiencies of Mg, K, Ca, and P. Site B was at pH 6.5. Both sites imposed the root stresses of high soil strength in a non-cracking soil, drought stress, and high soil temperatures. Study completed 26 July 1999.

For maximum multiple root stress tolerance and potential for good performance under adverse soil/drought conditions a turfgrass should: (a) have an acceptable, inherent growth rate under the low pH conditions (where all soil stresses are present and severe), and (b) exhibit a low pH/high pH growth ratio that is near 1.0. A grass could possess good tolerance to the multiple root stresses (i.e., high low pH/high pH ratio) but have slow inherent growth rate

(Example, Temple 2, Fidalayel, PI 509022). Conversely, other grasses may have a higher inherent growth rate but somewhat lower low pH/high pH ratio (i.e., common bermuda, Tifway bermuda, K7). The seashore paspalum HI 101 has both characteristics.

Seashore paspalums with a low pH/high pH ratio of $\geq$ 1.0 are particularly strong in tolerance to the "acid soil complex" stress. These were able to grow as good or better at pH 4.2 than at the higher pH conditions. The SP ecotypes exhibiting this trait were: PI 509022, Temple 2, HI 101, PI 509021, and Fidalayel. For developing SP's that could be grown with limited inputs (water, lime, fertilizers) and under severe soil stress conditions, these ecotypes demonstrate considerable potential in the SP germplasm base.

Study 2. Fairway Type Seashore Paspalums: Rooting, Water Use, Drought Resistance.

Nine seashore paspalum ecotypes and Tifway bermudagrass were established 16 July 1998 using a limited quantity of stolons due to availability. Turf coverage, quality, color and density ratings were taken in 1999. Rooting and water use (ET) data were also obtained and are under analyses.

Study 3. Traffic Tolerance of Seashore Paspalum Ecotypes.

Twenty nine seashore paspalums, three bermudagrasses (TifSport, TifEagle, Tifway), and Meyer Zoysiagrass were stolonized on 12 August 1999. In 2000, these will be assessed for tolerance to: (a) wear, and (b) traffic-wear plus soil compaction.

Study 4. Salinity and Salinity + Drought Tolerances of Seashore Paspalum Ecotypes.

This study will involve 34 seashore paspalums to be screened for salinity tolerance $\pm$ drought stress with salinity up to seawater (EC_w = 54 d Sm^{-1}) and applied by overhead irrigation. The greenhouse facility is 80% completed and the study will be conducted this winter.

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In this project, SP ecotypes are screened for root responses to 4 of the 6 edaphic factors that limit rooting. This multiple stress approach provides important information for SP resistance to individual and multiple soil stresses and is highly effective in identifying SP ecotypes with high nutrient uptake efficiency and drought resistance via possessing a deep, extensive, viable root system. Root tolerance assessment to the major edaphic stresses has been a "missing ingredient" in almost all breeding programs targeted to improve drought resistance, water-use efficiency, or nutrient-use efficiency. The four studies included in this project are:

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Results are summarized in Table 1. For maximum multiple root stress tolerance and potential for good performance under adverse soil/drought conditions a turfgrass should: (a) have an acceptable, inherent growth rate under the low pH conditions (where all soil stresses are present and severe), and (b) exhibit a low pH/high pH growth ratio that is near 1.0. A grass could possess good tolerance to the multiple root stresses (i.e., high low pH/high pH ratio) but have slow inherent growth rate (Example, Temple 2, Fidalayel, PI 509022). Conversely, other grasses may have a higher inherent growth rate but somewhat lower low pH/high pH ratio (i.e., common bermuda, Tifway bermuda, K7). The seashore paspalum HI 101 has both characteristics.

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Activities Related To This Project or Seashore Paspalum

1. Research information from Study 1 was incorporated into the germplasm release documents requesting release of Sea Isle 2000 (AP-10) and Sea Isle 1 (Fwy-1) seashore paspalums. These are released and in the process of licencing for growers.

2. Ph.D. candidate Geungjoo (Joo) Lee from South Korea is completing a study on salinity tolerance mechanisms of seashore paspalum that provides insight to experimental direction for salinity phases of this project.

3. Ph.D. candidate Laurie Trenholm completed a series of studies on wear and nutritional aspects that provide direction for experimental approaches for the traffic study phase. Dr. Trenholm is now at the University of Florida in a turfgrass research/extension position.

4. Presentations given in 1999 that relate to this project are:
   - Managing Salt-Affected Soils. Sports Turf Manager Assoc. Nat. Conf. Phoenix, Az. Jan. 1999.
   - GCSAA 70th Inter. Golf Conference and Show. Orlando, Fl. Feb. 1999. Two-day workshop on "Salt-Affected Turfgrass Sites."

5. Publications in 1999 that relate to this project are:
   - A book entitled: Seashore Paspalum: The Environmental Grass. R.R. Duncan and R.N. Carrow, Ann Arbor Press, Chelsea, Mi. (Dec. 1999) (260 pages).
   - Duncan, R.R. and R.N. Carrow, 1999. Turfgrass molecular genetic improvement for abiotic/edaphic stress resistance. In D.L. Sparks. (Ed.). Advances in Agronomy 67:233-306. Academic Press, Inc., New York, NY. This is the most referenced publication in agriculture.
   - Trenholm, L.E., R.N. Carrow, R.R. Duncan, 1999. Relationship of multispectral radiometry data to qualitative data in turfgrass research. Crop Sci. 39: (3): 763-769.
   - Trenholm, L.E., R.R. Duncan, R.N. Carrow, 1999. Wear tolerance, shoot performance, and spectral reflectance of seashore paspalum and bermudagrass. Crop Sci. 39: (4): 1147-1152.
   - Trenholm, L.E., R.R. Duncan, R.N. Carrow, 1999. Mechanisms of wear tolerance in seashore paspalum and bermuda grass. Submitted to Crop Sci.

- Trenholm, L.E., R.R. Duncan, R.N. Carrow, G.H. Snyder, 1999. The influence of silica on growth, quality, and wear tolerance of seashore paspalum. Submitted to Crop Sci.

- Trenholm, L.E., R.N. Carrow, and R.R. Duncan, 1999. Wear tolerance, growth, and quality of seashore paspalum in response to nitrogen and potassium. Submitted to Crop Science.

- Lee, Geungjoo, R.R. Duncan, and R.N. Carrow, 1999. Salinity tolerance of seashore paspalum ecotypes: Physiological responses of shoot growth. Submitted to Crop Science.

- Duncan, R.R., and R.N. Carrow, 1999. Establishment and grow-in of paspalum golf course turf. Golf Course Manage. 67 (5): 58 - 62.

- Carrow, R.N., R.N. Duncan, and M. Huck, 1999. Treating the cause not the symptoms - irrigation water treatment for better infiltration. USGA Green Section Record 37 (6): in press.

- Duncan, R.R., R.N. Carrow, and M. Huck. Effective use of seawater irrigation on turfgrass. USGA Green Section Record (submitted).

- Huck, M., R.R. Duncan, and R.N. Carrow. Effluent water, nightmare or dream come true. USGA Green Section Record. (in preperation).

Table 1. Multiple root stress tolerance of seashore paspalums (1998 – 1999). The top 10 in each category and selected rankings of other grasses.

Growth at low pH§			pH Growth Ratio			Stress Index ‡		
Rank A	Grass	Cover FT[2]	Rank B	Grass	Low pH / High pH†	Over all Rank	Grass	Stress Index Rank A + B
1	**Com. bermuda**	21.5	1	**PI 509022**	4.05	1	**Com. bermuda**	10
2	**Tifway bermuda**	9.6	2	**Temple 2**	2.30	2	**HI 101**	12
3	**K 7**	4.5	3	**HI 101**	1.84	3	**K 7**	14
4	HI 9	2.1	4	PI 509021	1.13	4	**PI 509022**	15
5	AP 4	1.8	5	**Fidalayel**	0.98	5	**Tifway bermuda**	16
6	K 8	1.5	6	SIPV 2-1	0.76	6	**Temple 2**	20
7	AP 6	1.3	7	SIPV 1	0.72	6	**Fidalayel**	20
8	Meyer zoysia	1.2	8	KC 4	0.67	6	SIPV 2-1	20
9	K 4	1.2	9	**Com. bermuda**	0.66	6	HI 9	20
9	**HI 101**	1.2	10	PI 28960	0.62	7	SIPV 1	21
9	HI 34	1.2	11	**K 7**	0.53	8	PI 509021	22
10	PI 509018-3	1.1	13	HYB 7	0.45	8	PI 28960	22
10	AP 11	1.1	14	**Tifway bermuda**	0.41	9	HYB 7	23
10	HI 3	1.1	15	Meyer zoysia	0.40	9	Meyer zoysia	23
10	Polo	1.1	16	HI 9	0.39	10	KC 4	24
10	TCR1 (MKDER)	1.1	36	Salam	0.10	32	Salam	52
10	HYB 7	1.1	37	Sea Isle 2000	0.09	33	Sea Isle 2000	53
12	PI 28960	0.9	40	Sea Isle 1	0.06	38	Sea Isle 1	59
14	**PI 509022**	0.7	40	Adalayd	0.06	38	Adalayd	59

14	SIPV 1	0.7	(Lowest)			(Lowest)		
14	SIPV 2-1	0.7	46	Excalibre	0.0	43	Excalibre	66
15	**Fidalayel**	0.6	46	HI 13	0.0	43	HI 43	66
16	KC 4	0.5	46	HI 2	0.0	43	HI 6	66
16	Sea Isle 2000	0.5	46	HI 6	0.0	43	HYB 5	66
16	Salam	0.5	46	HYB 5	0.0	43	Mauna Key	66
18	**Temple 2**	0.3	46	Mauna Key	0.0			
18	PI 509021	0.3						
19	Sea Isle 1	0.2						
19	Adalayd	0.2						
(lowest)								
21	HI 13	0.0						
21	Excalibre	0.0						
21	Mauna Key	0.0						
21	HYB 5	0.0						
	Mean	1.0			0.29			
	F-test	**			**			
	CB (%)	124			301			
	LSD (0.5)	1.7			1.3			

‡ High ratio is best. A ratio of 1.0 = equal growth at low pH and high pH. A ratio > 1.0 = greater growth at low pH than high pH.

‡ Low = Best. Stress Index scale is:

SI ≤ 10	Superior
SI 11 to 16	High
SI 17 to 20	Moderate
SI 21 to 30	Moderately low
SI > 30	Low

§ Original plug area was 0.07 ft.^{2}

Table 2. Turf establishment rate (cover) and quality of 9 SP and 1 bermudagrass.

	Turf Cover				Turf Quality			
	1998	1999						
	21	13	16	16	15	16	16	16
Grass	Aug	May	July	Aug	May	Jul	Aug	Sep
	----------%----------				----------9 = ideal----------			
Adalayd	9	53	75	86	4.7	4.3	5.6	6.3
AP 1	6	37	78	83	3.5	4.4	4.9	5.7
Sea Isle 1	20a‡	76a	99a	99a	6.5a	6.9a	7.3a	7.1a
HYB 7	17a	72	97a	97a	5.4	6.3a	6.5a	6.7a
Q36313	13a	66	93a	92a	5.8	5.8	6.7a	6.5a
Taliaferro	7	51	76	88	5.4	4.9	6.2	6.2
TCR 1	9	59	87	95a	5.6	6.2a	6.3	6.7a
TCR 6	10a	65	93a	99a	5.2	6.3a	7.1a	6.7a
Temple 1	13a	68	91a	99a	5.8	6.4a	7.0a	6.9a
Tifway berm.	12a	90a	100a	100a	6.8a	5.8§	7.0a	7.2a
LSD (.05) =	10	16	11	9	.73	.82	.99	.60
F-test =	†	***	***	***	***	***	***	***
CV (%) =	20	18	8	7	9	10	11	6

***, **, †, Significant difference at probability level of 0.01, 0.05, and 0.10, respectively.
‡ The letter "a" denotes the top (best) statistical group.
§ Tifway bermudagrass exhibited scalp injury on this date.

Table 3. Turf establishment rate (cover) and quality of 9 SP ecotypes and 1 bermudagrass.

	Turf Color				Shoot Density			
Grass	13 May	16 Jul	16 Aug	16 Sep	13 May	16 Jul	16 Aug	16 Sep
	9 = dark green				9= ideal			
Adalayd	6.4	6.3	7.4a	7.0	4.8	4.5	5.7	6.6
AP 1	6.0	6.8	4.3a	6.7	3.6	4.8	5.6	6.2
Sea Isle 1	7.2a‡	7.7a	7.5a	7.3	6.5a	7.3a	7.3a	7.3a
HYB 7	6.4	7.4a	7.0	7.3	5.6	6.7a	6.6a	6.8a
Q 36313	6.5	7.1	7.4a	7.1	6.0	6.2	6.8a	6.6
Taliaferro	6.9a	7.1	7.4a	7.0	5.5	5.3	6.3	6.5
TCR 1	7.0a	7.4a	7.4a	7.3	5.9	6.5a	6.4a	6.9a
TCR 6	6.9a	7.3a	7.5a	6.8	5.3	6.7a	7.2a	6.9a
Temple 1	7.0	7.7a	7.4a	7.2	6.0	6.8a	7.2a	7.0a
Tifway berm.	6.9a	6.3	7.0	7.2	7.0a	7.0a	7.3a	7.3a
LDS (.05)	.51	.48	.31	.60	.80	.88	.97	.57
F-test	***	***	**	.36	***	***	••	••
CV (%)	5	5	3	6	10	9	10	6

***, **, † Significant difference at probability level of 0.01, 0.05, and 0.10, respectively
‡ The letter "a" denotes the top (best) statistical group.