Executive Summary

UNIVERSITY OF GEORGIA **November 1999**

ORGANIC MATTER DYNAMICS IN THE SURFACE ZONE OF A USGA GREEN: PRACTICES TO ALLEVIATE PROBLEM

1999 Research Grant: $20,000
(Fourth year of Support)

Dr. Robert N. Carrow
Principal Investigator

It is the hypothesis of the author that two turfgrass grower problems arise by accumulation of organic matter (O.M.) In the surface 0 to 1.25 inch zone of a USGA green from an initial level of 1.0 to 3.0% (by weight) at establishment to 5 to 12% or more after 2 years. Organic matter accumulation occurs even under excellent management and regardless of specification (i.e., it is not dependent on specifications) due to the abundance of roots produced by bentgrass within this surface zone along with any thatch/mat accumulation. A considerable portion of the O.M. in the surface zone is as root tissue that can contribute to soil macropore plugging or sealing, under the conditions of: (a) O.M. content accumulates within this zone to an excessive level, or (b) the nature or characteristics of the O.M. is dramatically altered by rapid death of roots in this zone (i.e., causing a gel-like condition that greatly limits soil O_2 diffusion). The two proposed problems arising from surface O.M. occur at different times of the year and are the basis of two projects in Phase 1:

Phase I (1996-1998)

I. SUMMER Bentgrass Decline in Response to Root Deterioration and Plugging of the Macropores that are Essential for Soil O_2 Exhange and Maintenance of Water Infiltration.

II. Inhibition of Root Development, Soil O_2 Diffusion, and Infiltration (in SPRING/FALL) from the Zone of High Organic Matter Content.

The results for Phase I studies were summarized in the 1998 report.

Phase II (1999-2000)

Results from the two projects of Phase I were used in Phase II to formulate potential annual management programs (cultivation, topdressing) that, (a) would allow maximum root growth development in spring/fall without the decrease in rooting depth now observed on high sand golf greens a couple years after grass establishment, and (b) would maintain root viability in the summertime and minimize summer bentgrass decline caused by low soil O_2 exchange.

Also, the availability of a new type of verticutter (Graden) that can remove considerable O.M. without severe surface injury is being incorporated into the second phase. Some golf course

superintendents have used this device on bentgrass greens in place of spring core aeration because healing seems to occur more rapidly and this may allow earlier treatment and/or multiple spring treatment. Phase II study has been initiated in Spring 1999 and the treatments will allow for evaluation of whether the Graden can be used to replace all or part of core aeration operations.

Results To Date (Tables 1,2).

Less intrusive cultivation practices (QT = solid, quad tines, ¼ inch dia.; HJR = Hydro Ject in raised position, ¼" dia. holes) in the summer substantially increased (a) saturated hydraulic conductivity, and (b) soil O_2 level at 3.5 inches depth. All treatments not receiving summer cultivation by QT and HJR exhibited soil O_2 <12% versus >15% for QT/HJR treatments. A soil O_2 level of <10% is considered a severe O_2 stress for most plants. Also, SHC (sat. hydraulic conductivity; water infiltration rate) averaged 85 to 159 mm $hr.^{-1}$ for QT or JHR treatments versus 48 to 72 mm $hr.^{-1}$ without these treatments. Additional data on root and shoot parameters are also being obtained.

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Phase II (1999-2000)

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treatment. Phase II study has been initiated in Spring 1999 and the treatments will allow for evaluation of whether the Graden can be used to replace all or part of core aeration operations.

The description of the Phase II study is noted below:

USGA Bent Study Phase II
T-123

Objective: To determine the influence of various cultivation methods (core aeration, Graden verticutter, Solid Quad-tine, Hydroject) and programs on Penncross creeping bentgrass on:

- Soil O_2 status.
- Soil saturated hydraulic conductivity (SHC).
- Bentgrass shoot/root performance.
- Soil surface (0-3 cm) physical properties.
- Soil subsurface (3-6 cm) physical properties.

Treatments/Procedures: The six treatments were laid out on 15 April 1999 in a completely randomized block design with 4 blocks (reps) of 14 x 14 ft. The study will run until September 2001. Treatments are:

Treat. No.	Treatments		
1.	**Control**	No cultivation	
2.	**Core Aerate (2)**		
	C.A. (⅝") (2)	Topdressing	
	April 15	13 gal/plot=9.1 ft.^{3}/M^2	
	Oct. 10	13 gal/plot=9.1 ft.^{3}/M^2	
3.	**Graden Verticut (2)**		
	GRA (deep set) (2)	Topdressing	
	April 15 (d) + top	11 gal/plot = 7.7 ft.^{3}/M^2	
	Oct. 10 (10) + top	11 gal/plot = 7.7 ft.^{3}/M^2	
4.	**Graden (2) + QT/HJR (11)**		
	GRA (d) (2)	QT/HJR (11)	
	April 15 (d) + Top	Feb 15 (QT)	July 18 (HJR)
	Oct. 10 (d) + Top	Mar 15 (QT)	Aug. 6 (HJR)
		May 15 (QT)	Aug. 26 (HJR)
		June 6 (QT)	Sep. 16 (HJR)
d = deep = 1¾"		June 26 (QT)	Nov. 15 (QT)
Topdressing - see 3. above			Dec. 5 (QT)

5. **Graden (5) + QT/HJR (7)**

GRA (5)	QT/HJR (7)	
Mar. 15 (L) + Top	Feb 15 (QT)	Aug 6 (HJR)
April 15 (d) + Top	Jun. 6 (QT)	Aug 6 (HJR)
May 15 (d) + Top	Jun. 26 (QT)	Sep. 16 (HJR)
Oct. 10 (d) + Top	July 28 (HJR)	
Dec. 1 (L) + Top		

d = deep = 1¾", L = ¾"

Topdress for Light Graden = 5 gal/plot

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6. **Core Aerate (2) & Graden (3) + QT/HJR (7)**

CA (⅝") (2)	GRA (3)	QT/HJR (7)
April 15 + Top	Mar 15 (L) + Top	Feb 15 (QT) Aug 6 (HJR)
Oct 10 + Top	May 15 (L) + Top	June 6 (QT) Aug 26 (HJR)
	Dec. 1 (L) + Top	June 26 (QT) Sep. 16 (HJR)
		July 18 (HJR)

L = ¾"

Note: (a) all plots receive topdressing every 3-4 weeks at 0.75 to 1.50 ft.^{3} per 1,000 ft.^{2}. (b) Study initiated with 4-12-99 treatments. (c) All deep Graden and Core aeration cultivations receive the heavy topdressings noted in treatment 2 and 3. When the light Graden operation is used, the topdressing is at 5 gal./plot. (d) Replication. 4 reps in 14 x 14 ft. plots. (e) QT = Solid (¼" dia.) quad-tine at 2 x 2 spacing, 3" depth. (f) HJR = Hydro-Ject raised for ¼" hole on 2½" x 2½" spacing.

Treatment Summary:

Treatment Description

	Annual Cultivations				Top
Cultivation	CA	GV	QT	HJR	Applied ‡
Control	-	-	-	-	12
Core Aeration (CA) (2)	2	-	-	-	38
Graden Verticut (GV) (2)	-	2	-	-	34
GV (2) + QT/HJT (11)	-	2	7	4	34
GV (5) + QT/HJR (7)	-	5	3	4	49
CA (2) + GV (3) + QT/HJR (7)	2	3	3	4	48

‡ Approximate topdressing on annual basis in cubic feet (ft.^{3}) per 1,000 ft.^{2}

Data: 1. TQ, TD, TC. Monthly
2. Crop Scan. June, July, Aug, Sept, Oct.
3. Roots at 1-4" and 4-8" by root.
4. Soil physical conditions at 0-3 cm. and 3-6 cm. June 1-15, Sept. 1-15.
5. Soil O_2 and SHC.
   After May 15 GRA and HJR treatments for DAT 1-7, 20-25.
   After Aug 26 HJR treatments for DAT 1-7, 20-25.
   Before Feb 15 QT and the 2-3 days after.
   After Mar. 15 GRA and HJR treatments for DAT 1-7, 20-25.

Results To Date (Tables 1,2).

Less intrusive cultivation practices (QT = solid, quad tines, ¼ inch dia.; HJR = Hydro Ject in raised position, ¼" dia. holes) in the summer substantially increased (a) saturated hydraulic conductivity, and (b) soil O_2 level at 3.5 inches depth. All treatments not receiving summer cultivation by QT and HJR exhibited soil O_2 <12% versus >15% for QT/HJR treatments. A soil O_2 level of <10% is considered a severe O_2 stress for most plants. Also, SHC (sat. hydraulic conductivity; water infiltration rate) averaged 85 to 159 mm $hr.^{-1}$ for QT or JHR treatments versus 48 to 72 mm $hr.^{-1}$ without these treatments. Additional data on root and shoot parameters are also being obtained.

Activities Related to This Project

1. Several presentations (8) are being made in 1999 that relate to this project.

   - Problems of Managing Sand Based Fields. Sports Turf Managers Assoc. Nat. Conf. 13-15 January 1999. Phoenix, AZ.
   - Cultivation for Surface Problems. Reducing High Temperature Stresses on Cool Season Grasses. Michigan State Univ. Turf Conf. 19-21 January 1999. East Lansing, MI.
   - Low Soil Aeration (O_2): Causes and Correction. 36th West. Canada Turf. Assoc. Conf. 20-24 February 1999, Penticton, BC, Canada.
   - New Management Ideas to Alleviate Problems in Putting Greens. USGA Reg. Turf Conference. 31 March 1999, Nashville, TN.
   - Understanding and Managing Summer Bentgrass Decline on Putting Greens. 54th Ann. Oklahoma Turf. Conf. 17-18 November 1999. Oklahoma City, OK.
   - Management for Adequate Oxygen in Greens. Southern California Turf. Conf. 15 December 1999. Buena Park, CA.
   - Low Soil Aeration: Causes, Problems and Correction on Sand and Heavy Soils. (With G. Joo Lee). Georgia Turf. Conf. and Show. 7 December 1999. Atlanta, GA.

2. Carrow, R.N., P. O'Brien and C. Hartwigher. Summer Bentgrass Decline, Low Soil O_2 Problems — Controlling Organic Matter Accumulation in the Surface of High Sand Greens. USGA Green Section Record. This will be published as a special supplemental issue and will provide an indepth presentation on (a) problems arising from the high O.M. content surface layer of high sand greens. Both primary and secondary problems will be presented along with indepth management recommendations, (b) associated problems often encountered on bentgrasses but not directly or indirectly caused by the O.M. layer will also be presented.

Table 1. Organic Matter Dynamics in Surface of High Sand Greens (Phase II): Saturated Hydraulic Conductivity. (1999)

Treatment Description¶						Sat. Hydraulic Conductivity§							Times
	Cultivations As of 8 Oct. 99				Top.	24	8	9	20	2	24		in Top
Cultivation	CA	GV	QT	HJR	APPLIED‡	May	Jun	Aug	Aug	Sep	Sep	AVE	Group
						----------mm hr^{-1}----------							
Control	-	-	-	-	9	73	67	78	123	15	7	62	0/7
Core Aeration (CA)	1	-	-	-	22	72	63	54	101	47	71	72	0/7
Graden Veticut (GV)	-	1	-	-	20	57	46	12	11	12	149a	48	1/7
GV + QT/HJR	-	1	3	4	20	27	60	35	183a	71	131a	85	2/7
GV + QT/HJR	-	2	2	4	31	65	63	71	258a	121a	177a	126a	4/7
CA + GV + QT/HJR	1	1	2	4	33	36	54	181a	339a	154a	192a	159a	5/7
LSD						51	35	73	170	72	120	70	-
F-test						.32	.56	***	***	***	**	***	-
CV (%)						53	42	68	67	69	67	51	-

***, **, †, Significant statistical difference at 0.01, 0.05, and 0.10 probability, respectively.
‡ Approximate topdressing applied in cubic feet (ft.^{3}) per 1,000 ft^2. As of 8 Oct. 99.
§ The (a) denotes values in the top (best) statistical catergory.
¶ Treatment dates:
CA - 14 Apr.
GV - 14 Apr; 18 May
QT - 18 May; 3, 26 Jun.
HJR - 15 Jul: 16 Aug; 3 Sep; 1 Oct.

Table 2. Organic Matter Dynamics in Surface of High Sand Greens (Phase II): Soil O_2 Status. (1999)

Treatment Description¶						Soil O_2 at 3.5 inches§						
	Cultivations As of 8 Oct. 99				Top.	17	23	24	10	24		Times in Top
Cultivation	CA	GV	QT	HJR	APPLIED‡	Aug.	Aug.	Aug.	Sep.	Sep.	AVE	Group
						----------% O_2----------						
Control	-	-	-	-	9	11.0	10.0a	10.3	10.8a	10.5	10.5	2/6
Core Aeration (CA)	1	-	-	-	22	13.0a¶	12.5a	11.8a	11.5a	11.3	12.0	4/6
Graden Veticut (GV)	-	1	-	-	20	11.0	8.8	10.5	9.5	10.0	10.0	0/6
GV + QT/HJR	-	1	3	4	20	18.3a	18.5a	19.0a	16.5a	16.5a	17.8a	6/6
GV + QT/HJR	-	2	2	4	31	15.0a	14.8a	14.8a	14.5a	16.8a	15.2a	6/6
CA + GV + QT/HJR	1	1	2	4	33	17.3a	18.0a	20.0a	15.8a	16.0a	17.4a	6/6
LSD (.05)						6.8	8.7	9.0	6.4	4.4	5.1	
F-test						.15	.14	.13	.17	***	**	
CV (%)						32	42	42	33	22	25	

***, **, † Significant statistical difference at 0.01, 0.05, and 0.10 probably, respectively.

‡ Approximate topdressing applied in cubic feet ($ft.^3$) per 1,000 $ft.^2$ as of 8 Oct. 99.

§ All readings are 3 to 4 hours after irrigation except 24 Aug. which is 28 hrs after irrigation. The "a" denotes the top statistical (best) group.

¶Treatment dates CA - 14 Apr. QT - 10 May; 3, 26 Jun
GV - 14 Apr; 18 May HJR - 15 Jul; 16 Aug; 3 Sep; 1 Oct