

**EXECUTIVE SUMMARY**  
**END OF YEAR REPORT (Nov 1, 1999)**  
**GROW-IN AND CULTURAL IMPACTS ON USGA PUTTING GREENS AND THEIR MICROBIAL**  
**COMMUNITIES**

Dr. R.E. Gaussoin, Principal Investigator

Dr. Rhae Drijber, Dr. William Powers, Mine Aslan, Milda Vaitkus, Leonard Wit, Cooperators

The overall goal of this project is to develop a better understanding of the impact of grow-in procedures on putting green establishment and performance. Impacts on the physical, chemical, and microbiological factors associated with the USGA root zones and rhizosphere are emphasized in the project.

The five year project is composed of three phases, One: Construction and Grow-in, Two: Microbial Community Assessments, and Three: Grow-in Procedure Impacts on the Long-term Performance of the Putting Green. Phases One and Two span three year periods, while Phase Three will involve experiments repeated over the five years of the project.

Two separate USGA-specification root zone mixtures - one composed of sand and peat (80/20 ratio) and one a combination of sand, peat, and soil (80/15/5 ratio) - were developed in 1996. Materials used for construction complied with USGA Greens recommendations for physical characteristics and organic matter content. First year greens (1997 Greens) were constructed in late summer of 1996, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000 ft<sup>2</sup>) in the spring (May 30) of 1997. Second year greens (1998 Greens) were constructed in the summer of 1997, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000 ft<sup>2</sup>) in the spring (May 27) of 1998. Third year greens (1999 Greens) were constructed in the fall of 1998 and allowed to settle over the winter. They were seeded with Providence creeping bentgrass (1.5 lbs/1000 ft<sup>2</sup>) in spring (May 26) of 1999. The fourth year greens have been constructed and will be allowed to settle over the winter. They will be seeded with Providence creeping bentgrass in the spring of 2000.

Establishment results were similar in greens established in 1997, 1998 or 1999. For three consecutive years it was found that higher inputs will initially increase cover during grow-in. This increase may not translate to earlier opening for play if environmental stress conditions occur that result in damage to lush, immature turf.

**I. Title: GROW-IN AND CULTURAL IMPACTS ON USGA PUTTING GREENS AND THEIR MICROBIAL COMMUNITIES**

**II. Principal Investigator:** Dr. R.E. Gaussoin, Principal Investigator

**Cooperators:** Dr. Rhae Drijber, Dr. William Powers, Mine Aslan, Milda Vaitkus, Leonard Wit

**III. Purpose:** The overall goal of this project is to develop a better understanding of the impact of grow-in procedures on putting green establishment and performance. Impacts on the physical, chemical, and microbiological factors associated with the USGA root zones and rhizosphere are emphasized in the project.

**IV. Location:** The project is being conducted at the University of Nebraska's John Seaton Anderson Turfgrass Research Facility located near Mead, NE.

**V. Introduction:** The five year project is composed of three phases, One: Construction and Grow-in, Two: Microbial Community Assessments, and Three: Grow-in Procedure Impacts on the Long-term performance of the Putting Green. Phases One and Two span three year periods, while Phase Three will involve experiments repeated over the five years of the project.

**VI. Methods:** Two separate USGA-specification root zone mixtures - one composed of sand and peat (80/20 ratio) and one a combination of sand, peat, and soil (80/15/5 ratio) - were developed in 1996. Materials used for construction complied with USGA Greens recommendations for physical characteristics and organic matter content. First year greens were constructed in late summer of 1996, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000ft<sup>2</sup>) in the spring (May 30) of 1997. Year two greens were constructed in 1997. They were allowed to settle over the winter and were seeded in the spring (May 27) of 1998. Year three greens were constructed in 1998, allowed to settle over the winter and seeded in May 1999. Year four greens were constructed in 1999 and will be allowed to settle over the winter. They will be seeded in the spring of 2000.

In 1999, Accelerated and Controlled grow-in treatments were applied prior to and after seeding of the year three greens according to the treatment schedule outlined in previous reports.

Data collected on year one through year three greens were: (1) color (1-9=most green), (2) quality (1-9=best quality), (3) ball roll distance (Stimpmeter), and (4) surface hardness (Clegg).

Soil physical properties were examined annually, in October. Infiltration rates were measured in the field using a 6" single-ring infiltrometer. Soil cores were sampled and analyzed for water retention and total porosity using pressure plate techniques.

Soil chemical properties were analyzed annually, in the spring, prior to treatment, and in the fall. Samples for microbial characterization were also collected in the spring and fall.

## **VII. Results:**

### **1997 Greens**

- (1) Early season (6/15) vegetative cover was greater for root zone mix plots containing soil than those without soil; 71% versus 67%, respectively (Table 1). There was no effect of grow-in treatment. Quality and color were unaffected by differences in the root zone mix (Tables 1 and 2).
- (2) High humidity and little precipitation in July of 1998 resulted in evidence of *Pythium* sp., as well as direct high temperature injury. Pythium damage was evaluated in mid-July on a scale of 1-9, with 9 indicating greatest damage. The accelerated treatment exhibited greater decline than the controlled grow-in (7.5 vs. 3.0) (Table 2). There was no effect of root zone mix and quality was not adversely affected. No quality or color differences were observed from data collected in 1998 and 1999.
- (3) A significant interaction between treatments was found for ball roll distance on June 15, 1998 (Table 3). The soil-less root zone mix with accelerated grow-in treatments had longer ball roll than the controlled or soil-containing mix. Root zone mix had no effect on ball roll. On most observation dates, grow-in treatment also had no effect on ball roll; differences between accelerated (7 ft) and controlled (6.5 ft) grow-in treatments were observed on September 24 in 1998.

The soil-containing root zone mixture had higher surface hardness than the soil-less mix on all observation dates in 1997, 1998 and 1999 (Table 4). Surface hardness was not affected by grow-in treatment. In 1998 the soil-less media had a lower bulk density than the soil-containing treatment (Table 6).

- (4) Soil infiltration rates in 1997, 1998 and 1999 were not significantly different between root zone mixes. In 1999 the accelerated grow-in treatment had infiltration rates faster than the controlled (Table 5).
- (5) There appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix (Table 7).

### **1998 Greens**

- (1) No quality or color differences were observed among treatments in 1998 or 1999 (Tables 1 and 2).
- (2) Ball roll distance was greater in controlled (6.3 ft) versus accelerated (5 ft) greens in October of 1998, while root zone mix had no effect (Table 3).

- (3) **Surface hardness was greater in the root mix containing soil than in the soil-less mix in 1998 and 1999 (Table 4). Grow-in treatments did not have any effect on surface hardness.**
- (4) **Soil infiltration rates were not significantly different between root zone mixes or grow-in treatments in 1998 or 1999 (Table 5).**
- (5) **As was seen for the 1997 Greens, there appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix (Table 7).**

#### **1999 Greens**

- (1) **Accelerated treatments had significantly lower quality on three of four evaluation dates in 1999, primarily due to stand loss from environmental injury (Table 1).**
- (2) **An observed trend toward higher stress injury was similar to results for greens constructed in 1997 and 1998 (Table 2).**
- (3) **Similar to results from the 1997 and 1998 greens, the soil-containing root zone had greater surface hardness (Table 4).**
- (4) **Infiltration was not affected by grow-in or root zone treatments (Table 5).**

#### **VII. Summary: Results to date indicate the following:**

**Microbial biomass was not affected by root-zone mix or grow-in procedure on plots established in 1997. Microbial biomass increased over 200% from Spring to Fall and decreased 40-60% as sampling depth increased. There appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix.**

**Water infiltration measurements from treatments established in 1997, 1998 or 1999 did not differ in establishment or subsequent years.**

**Establishment results were similar in greens established in 1997, 1998 or 1999. For three consecutive years it was found that higher inputs will initially increase cover during grow-in. This increase may not translate to earlier opening for play if environmental stress conditions occur that result in damage to lush, immature turf.**

Table 1. Cover and Quality Means for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.

Root Zone Mix	%Cover		Quality				
	1997	1998	1997	1998 Results		1999 Results	
1997 Greens	7/3	6/15	8/1	7/14	9/1	9/15	
sand/peat	68.3	66.7*	5.2	5.8	6.5	6.8	
sand/peat/soil	78.3	70.8	6.2	6.0	6.5	6.3	
1998 Greens							5/27
sand/peat							6.0
sand/peat/soil							6.0
1999 Greens							7/27 8/26 9/22 10/26
sand/peat							4.5 6.7 5.8 5.8
sand/peat/soil							4.5 7.3 6.3 6.7

Grow-in Treatment	%Cover		Quality				
	1997 Results	1998 Results	1997 Results	1998 Results		1999 Results	
1997 Greens	7/3	6/15	8/1	7/14	9/1	9/15	
Accelerated	84.2*	69.2	3.0*	5.7	6.2	6.3	
Controlled	62.5	68.3	8.3	6.2	6.8	6.8	
1998 Greens							5/27
Accelerated							6.0
Controlled							6.0
1999 Greens							7/27 8/26 9/22 10/26
Accelerated							3.0* 7.2 5.0* 5.2*
Controlled							6.0 6.8 7.2 7.2

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

**Table 2. Decline, Pythium Damage, Injury, and Color Means for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.**

Root Zone Mix	Decline	Pythium Damage	Injury	Color		
	1997 Results	1998 Results	1999 Results	1997 Results	1998 Results	1999 Results
1997 Greens	8/1	7/14		8/15	9/1	
sand/peat	5.2	5.3		7.2	7.2	
sand/peat/soil	4.7	5.2		7.2	7.7	
1998 Greens						5/27
sand/peat						6.8
sand/peat/soil						7.0
1999 Greens			6/22			7/27 8/26 10/26
sand/peat			6.3			6.5 5.0 7.3
sand/peat/soil			4.5			6.3 5.0 7.7

Grow-In Treatment	Decline	Pythium Damage	Injury	Color		
	1997 Results	1998 Results	1999 Results	1997 Results	1998 Results	1999 Results
1997 Greens	8/1	7/14		8/15	9/1	
Accelerated	4.7	7.5*		7.2	8.7*	
Controlled	5.2	3.0		7.2	6.2	
1998 Greens						5/27
Accelerated						7.2
Controlled						6.7
1999 Greens			6/22			7/27 8/26 10/26
Accelerated			6.8			6.2 3.7* 7.3
Controlled			4.0			6.7 6.3 7.7

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

1999 Greens		Color 9/22	
Treatment	Accelerated	Controlled	
sand/peat	7.3	7.7	
sand/peat/soil	6.3	8.3	

LSD (0.05)= 1.5

**Table 3. Ball Roll Distance in feet (Stimpmeter) for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.**

Root Zone Mix	1997 Results			1998 Results					1999 Results			
	8/4	9/16	10/22	5/21	7/14	8/14	9/24	10/14	5/27	6/22	7/27	8/26
<b>1997 Greens</b>												
sand/peat	2.6	2.1	2.4*	6.3	8.1	8.7	6.9	6.1	2.8	2.9	3.5	3.1
sand/peat/soil	2.6	2.1	2.6	6.3	8.3	8.7	6.7	6.4	2.8	2.9	3.6	3.1
<b>1998 Greens</b>												
sand/peat							6.3	5.6	3.1	2.7	3.4	3.1
sand/peat/soil							6.2	5.7	3.1	2.7	3.5	3.1

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

Grow-In Treatment	1997 Results			1998 Results					1999 Results			
	8/4	9/16	10/22	5/21	7/14	8/14	9/24	10/14	5/27	6/22	7/27	8/26
<b>1997 Greens</b>												
Accelerated	2.5	2.1	2.3*	6.1	8.2	8.7	7.0*	6.1	2.8	2.9	3.5	3.1
Controlled	2.6	2.2	2.7	6.4	8.2	8.7	6.5	6.4	2.9	3.0	3.5	3.1
<b>1998 Greens</b>												
Accelerated							6.0	5.0*	3.2	2.7	3.4	3.0
Controlled							6.5	6.3	3.1	2.6	3.5	3.2

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

<b>1997 Greens</b>		<b>Stimpmeter (6/15/98)</b>	
Treatment	Accelerated	Controlled	
sand/peat	8.2	8.4	
sand/peat/soil	8.6	8.0	

LSD (0.05)=0.3

**Table 4. Surface Hardness (Clegg) for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.**

Root Zone Mix	1997 Results			1998 Results						1999 Results					
	8/4	9/16	10/22	5/21	6/15	7/14	8/14	9/24	10/14	5/27	6/22	7/27	8/26	9/22	10/18
<b>1997 Greens</b>															
sand/peat	47.9*	56.4*	56.1*	53.0*	54.8*	57.8*	60.8*	57.4*	64.2*	52.3*	57.8	58.2*	58.4*	56.4*	61.9*
sand/peat/soil	60.3	68.3	68.1	60.8	64.0	70.2	71.1	65.2	75.1	57.9	58.2	65.6	64.5	60.8	67.6
<b>1998 Greens</b>															
sand/peat								67.1	78.9*	60.4	64.0*	66.9*	65.8*	64.9	69.6*
sand/peat/soil								74.3	91.3	62.8	68.8	74.0	72.4	69.7	76.9
<b>1999 Greens</b>															
sand/peat													64.1*	65.7*	67.1*
sand/peat/soil													74.5	70.7	75.1

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

Grow-In Treatment	1997 Results			1998 Results						1999 Results					
	8/4	9/16	10/22	5/21	6/15	7/14	8/14	9/24	10/14	5/27	6/22	7/27	8/26	9/22	10/18
<b>1997 Greens</b>															
Accelerated	53.0	61.2	61.7	56.8	59.2	64.9	63.3	61.9	70.3	54.9	57	62.4	61.6	58.2	65.5
Controlled	55.2	63.5	62.4	57.0	59.6	63.2	68.6	60.7	68.9	55.2	59	61.3	61.3	59.0	64.0
<b>1998 Greens</b>															
Accelerated								70.3	85.9	61.7	65.3	70.3	69.8	68.6	73.3
Controlled								71.1	84.3	61.4	67.6	70.6	68.5	66.1	73.2
<b>1999 Greens</b>															
Accelerated													69.6	68.6	71.1
Controlled													68.9	67.8	71.1



**Table 5. Infiltration at 2 inch soil depth (inch/hour) for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.**

Root Zone Mix	1997 Results	1998 Results	1999 Results
<b>1997 Greens</b>	<b>10/20</b>	<b>10/17</b>	<b>10/18</b>
sand/peat	21.6	23.8	24.9
sand/peat/soil	20.3	19.8	22.9
<b>1998 Greens</b>			
sand/peat		20.9	19.9
sand/peat/soil		19.2	20.5
<b>1999 Greens</b>			
sand/peat			20.1
sand/peat/soil			18.4

Grow-In Treatment	1997 Results	1998 Results	1999 Results
<b>1997 Greens</b>	<b>10/20</b>	<b>10/17</b>	<b>10/18</b>
Accelerated	20.4	21.9	26.1*
Controlled	21.4	22.8	22.0
<b>1998 Greens</b>			
Accelerated		22.7	20.0
Controlled		17.9	20.3
<b>1999 Greens</b>			
Accelerated			21.2
Controlled			17.5

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

Table 6. Soil Physical Characteristics for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.

Root Zone Mix	1997 Results					1998 Results				
	Porosity (%)					Porosity (%)				
	Bulk Density g/cm <sup>3</sup>	$\lambda^1$	Total	Air-filled	Water-filled	Bulk Density g/cm <sup>3</sup>	$\lambda$	Total	Air-filled	Water-filled
<b>1997 Greens</b>										
sand/peat	1.46	1.33	45	30	16*	1.36*	1.06	49*	27	20
sand/peat/soil	1.49	1.39	44	31	13	1.42	1.04	47	26	19
<b>1998 Greens</b>										
sand/peat						1.43	1.3	46	26	20
sand/peat/soil						1.47	1.2	45	26	19

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

Grow-In Treatment	1997 Results					1998 Results				
	Porosity (%)					Porosity (%)				
	Bulk Density g/cm <sup>3</sup>	$\lambda$	Total	Air-filled	Water-filled	Bulk Density g/cm <sup>3</sup>	$\lambda$	Total	Air-filled	Water-filled
<b>1997 Greens</b>										
Accelerated	1.48	1.35	44	29	15*	1.39	1.00	48	26	20
Controlled	1.47	1.37	45	31	14	1.39	1.11	48	28	19
<b>1998 Greens</b>										
Accelerated						1.46	1.3	45	25	20
Controlled						1.43	1.2	46	27	19

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

<sup>1</sup>Pore size distribution index (slope of water release curve)

Table 7. Lipid P Values (nmol/g) for USGA/GCSAA Greens Construction Project. John Seaton Anderson Turfgrass Research Facility, Mead, NE. University of Nebraska.

Root Zone Mix	1997 Results				1998 Results					
	Spring 0-6"	Fall 0-3"	Fall 3-6"	Change 0-6"	Summer 0-3"	Summer 3-6"	Fall 0-3"	Fall 3-6"	Change 0-3"	Change 3-6"
<b>1997 Greens</b>										
sand/peat	10.4*	20.0	14.4	6.7	23.9	11.8	27.7	17.9	3.8	6.1
sand/peat/soil	7.7	20.2	13.0	9.0	23.7	9.3	31.2	13.8	7.5	4.5
<b>1998 Greens</b>					<b>Spring 0-6"</b>		<b>Fall 0-3"</b>	<b>Fall 3-6"</b>		<b>Change 0-6"</b>
sand/peat					13.9		20.9	18.5		5.7
sand/peat/soil					16.3		22.8	18.3		4.2

\* Asterisk denotes significant ( $p \leq 0.05$ ) differences between treatment means within years.

Grow-In Treatment	1997 Results				1998 Results					
	Spring 0-6"	Fall 0-3"	Fall 3-6"	Change 0-6"	Summer 0-3"	Summer 3-6"	Fall 0-3"	Fall 0-3"	Change 0-3"	Change 3-6"
<b>1997 Greens</b>										
Accelerated	8.1	21.2	13.5	9.2	24.4	11.5	30.0	14.7	5.6	3.3
Controlled	10.0	19.0	13.9	6.5	23.1	9.7	28.8	17.0	5.7	7.3
<b>1998 Greens</b>					<b>Spring 0-6"</b>		<b>Fall 0-3"</b>	<b>Fall 3-6"</b>		<b>Change 0-6"</b>
Accelerated					15.6		19.5*	17.6		2.9
Controlled					14.7		24.3	19.1		7.1