1983 TURFGRASS SOIL MANAGEMENT RESEARCH REPORT

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Irrigation regime and nitrogen-potassium ratio effects on Adelphi Kentucky bluegrass

A study was conducted in 1983 at the Hancock Turfgrass Center on the effect of irrigation regime and the ratio of nitrogen to potash applied on Adelphi Kentucky bluegrass. This study is cooperative with J.M. Vargas, Jr. Treatments are outlined in Table 1. Throughout the growing season plots receiving approximately .17 inch of irrigation daily at noon were more uniformly green than plots irrigated either at approximately 80% of open pan evaporation or on wilt. In spite of the dry summer, the plots irrigated on wilt required irrigation only twice. All plots received about .1 inch of water after fertilization five times during the year.,

Few significant differences in quality rating occurred on plots receiving daily irrigation regardless of nitrogen or potash treatment. In contrast, those plots irrigated less frequently demonstrated significant responses to increasing N levels. There were no responses to increasing potash levels in spite of low soil test levels of potassium.

A similar study on a Penncross creeping green growing on a USGA green did not give similar responses. Watering rates used were 120%, 100%, and 80% of open pan evaporation. It is assumed that the perched water table which underlies all plots allowed water from more heavily irrigated plots to move laterally to drier plots.

Nitrogen fertilization programs on three creeping bentgrasses under greens conditions

Three creeping bentgrasses -- Penncross, Penneagle, and Emerald -- each received the nitrogen treatments shown in Table 2. Generally, Emerald did not exhibit as high quality turf as the other two grasses. Emerald was also more susceptible to dollarspot than the other two grasses.

Table 1. Effect of irrigation regime and levels of N and K on turf quality ratings of Adelphi Kentucky bluegrass. Ratings taken July 24, 1983. Averages for 3 replications.

Annual Treatment lbs./1000		Visual Turf Quality Rating (9=greenest)		
		Daily	80% Pan	Wilt
N	K_2O			
2	0	6.0dh[x]	4.7kn	4.3mo
4	0	7.0ab	5.5gj	5.0jm
6	0	7.2a	6.7ad	6.2cg
2	1	7.0ab	4.5lo	4.5lo
4	1	6.8ac	5.2ik	5.0jm
6	1	7.0ab	6.3df	6.0dh
2	2	6.7ad	3.8op	4.5lo
4	2	7.0ab	5.3hk	5.5gj
6	2	6.7ad	6.2cg	6.2cg
2	4	6.5ae	4.2no	4.0np
4	4	7.2a	5.5gj	5.5gj
6	4	7.2a	5.7fj	5.8ei
0	0	6.0dh	3.8op	3.3p

[x]means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Table 2. Effect of fertilization with N and K_2O, on turfgrass quality ratings of Emerald, Penneagle and Penncross creeping bentgrasses maintained under putting green conditions.

Treatment, lbs/1000/yr			Turfgrass quality rating (9=greenest)			
	N	Carrier	May 30	June 24	Sept 29	Nov 10
Emerald	1	Urea	2.7 m[x]	1.7 g	2.7 kl	3.2 i
	2	Urea	3.8 lm	2.0 pg	2.5 l	3.7 fi
	3	Urea	4.5 il	3.5 mn	3.0 jl	3.8 ei
	4	Urea	4.6 ik	4.1 kl	5.2 cf	4.5 ce
	6	Urea	7.3 ce	6.8 de	5.7 cd	4.7 cd
	8	Urea	7.8 bd	7.0 bcd	6.7 ab	5.8 b
	4[y]	Urea	7.4 ce	4.0 km	3.2 il	4.3 cf
	4[y]	Milorganite	5.5 hi	4.4 jk	5.0 df	3.2 i
	4	Am. Nit.	4.7 ik	4.7 hj	3.0 jl	4.2 cg
Penneagle	1	Urea	3.8 lm	2.1 op	3.0 jl	3.3 hi
	2	Urea	4.4 kl	2.5 no	3.0 jl	4.0 dh
	3	Urea	4.6 ik	3.8 lm	3.3 ik	4.2 cg
	4	Urea	5.8 gi	4.4 jk	5.2 cf	4.7 cd
	6	Urea	8.0 bc	7.3 bc	4.8 eg	4.8 c
	8	Urea	8.0 bc	7.6 ab	5.5 ce	6.2 b
	4[y]	Urea	6.8 ef	5.4 gh	3.7 hj	4.3 cf
	4[y]	Milorganite	5.8 gi	4.6 ik	4.5 fg	3.2 i
	4	Am. Nit.	5.8 gi	5.8 eg	3.3 ik	4.0 dh
Penncross	1	Urea	4.2 km	2.2 op	3.7 hj	3.8 ei
	2	Urea	4.4 bl	2.4 no	3.3 ik	4.2 cg
	3	Urea	5.0 ij	4.7 hj	3.8 hi	4.3 cf
	4	Urea	6.1 fg	5.8 eg	5.8 c	4.3 cf
	6	Urea	8.2 ab	7.7 a	6.5 b	5.7 b
	8	Urea	8.5 a	7.7 a	7.2 a	6.8 a
	4[y]	Urea	7.1 df	5.6 fh	3.8 hi	4.7 cd
	4[y]	Milorganite	6.1 fg	4.8 hi	5.0 df	3.5 gi
	4	Am. Nit.	6.0 fh	5.8 eg	4.3 gh	4.5 ce

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Nitrogen fertilizer programs on Penncross creeping bentgrass

The nitrogen fertilizer programs outlined in Table 3 have been applied to Penncross creeping bentgrass. Treatment 9 which receives 8 pounds N per 1000 square feet annually ranks consistently high because of the higher N rate. Other treatments gave responses as expected. The check plots received 1 pound N per 1000 square feet each in July and September to maintain minimal density of turf.

A similar study was conducted on annual bluegrass maintained under fairway conditions. Because of variability in the composition of annual bluegrass and fine fescue in these plots, treatment responses were not as marked as on the Penncross creeping bentgrass plots.

Nitrogen carrier comparisons on Loretta perennial ryegrass

The nitrogen carrier treatments outlined in Table 5 were applied to Loretta perennial ryegrass on July 7 by Al Muir, an undergraduate, fulfilling the requirements for a special project. The N rate was 1.6 pounds per 1000 square feet. This was a short term study. The more soluble N carriers tended to rank higher, especially in the first 2 to 3 weeks. These responses should be similar to what would be expected on a Kentucky bluegrass turf. Because of an error in fertilizer application, at a rate too high, there was not a top ranking (rating) on most dates. The data from those plots is not included in Table 5.

Nitrogen carrier comparisons on Penncross creeping bentgrass

A study comparing several greens fertilizers was initiated August 1 as outlined in Table 6. There were small differences among carriers when applied at similar N rates. The 25-0-25, 13-0-44 and 32-0-16 fertilizers are from Turf Chemicals, Inc., 22-4-10 from Lebanon and 22-0-16 from Scott's.

Nitrogen and iron responses of grasses

A series of treatments with urea and iron sources were applied to perennial ryegrass, Kentucky bluegrass and annual bluegrass in different locations here at the Hancock Turfgrass Research Center. Responses to foliar applications of iron (3 gallons water per 1000 squre feet) were more apparent at low N rates (1/2 pound or none) than when 1 pound N was applied per 1000 square feet. Foliar iron applications can be used cosmetically to improve turf color when modest N rates are appropriate. The response to foliar iron applications will be of limited duration since iron is relatively immobile in the plant and will be removed when the turf is mowed. Still the iron can be used to give a short term green color effect when this is desired if lower N rates are being applied. At higher N rates the iron response will tend to be masked by the response to soluble N.

Table 3. Treatments applied in Penncross bentgrass nitrogen carrier fertility study at the Hancock Turfgrass Research Center. Treatments initiated in 1982. Plot size is 6 feet by 6 feet. Averages for 4 replications.

Treatment		Month of application						
No.	N carrier	Nov	Apr	May	June	July	Aug	Sept
		Pounds N per 1000 sq. ft.						
1	IBDU (coarse)	1.0	---	---	0.5	0.5	0.5	1.0
2	Sulfur coated urea	1.0	---	---	0.5	0.5	0.5	1.0
3	Powder blue	0.5	---	---	0.25	0.25	0.25	0.5
	Urea	0.5	---	---	0.25	0.25	0.25	0.5
4	Powder blue	---	---	0.5	0.75	---	---	1.0
	Urea	---	---	0.5	0.5	---	---	1.0
5	Urea	1.0	---	---	0.5	0.5	0.5	1.0
6	Check[y]	---	---	---	---	---	---	---
7	Urea	---	1.0	---	---	---	---	1.0
8	Urea	---	1.0	1.0	1.0	---	---	1.0
9	Urea	---	2.0	2.0	2.0	---	---	2.0
10	IBDU (coarse)	---	1.0	1.0	1.0	---	---	1.0
11	Sulfur coated urea	---	1.0	1.0	1.0	---	---	1.0
12	Powder blue	---	0.5	0.5	0.75	---	---	1.0
	Urea	---	0.5	0.5	0.5	---	---	1.0
13	Urea	---	1.0	1.0	---	---	1.0	1.0
14	Ammonium nitrate	1.0	---	---	0.5	0.5	0.5	1.0
15	Ammonium nitrate	---	1.0	1.0	1.0	---	---	1.0
16	Milorganite	1.0	---	---	0.5	0.5	0.5	1.0
17	Milorganite	---	1.0	1.0	1.0	---	---	1.0
18	Oxamide	1.0	---	---	0.5	0.5	0.5	1.0
19	Oxamide	---	1.0	1.0	1.0	---	---	1.0

[y]Check plots received 1 pound N per 1000 square feet as urea in July and September.

Table 4. Effect of nitrogen carriers on quality of a Penncross creeping bentgrass green at the Hancock Turfgrass Center. Averages for 4 replications.

Treatment[z]		Turfgrass Quality Rating (9 = best)						
No.	Carrier	Dec. 15	Apr. 18	May 24	June 26	Aug. 1	Sept. 29	Nov. 10
1	IBDU	6.9 ad[x]	4.9 fg	5.0 ce	4.1 j	5.4 af	4.9 ce	4.0 ce
2	S.C. urea	7.1 ac	4.9 fg	4.5 df	5.4 gh	5.9 af	4.6 df	3.8 cg
3	P.B. + urea	7.4 ac	5.3 ef	5.6 bd	3.4 k	6.5 ae	5.5 bd	4.0 ce
4	P.B. + urea	4.9 ce	6.9 bc	5.1 ce	5.5 g	4.0 ef	5.3 cd	3.5 dh
5	Urea	8.3 a	6.8 bc	5.5 bd	4.4 ij	6.5 ae	5.1 cd	4.2 cd
6[y]	Check	4.5 de	3.3 h	2.3 h	2.4 l	3.5 f	2.9 i	3.5 dh
7	Urea	5.8 ae	5.4 ef	3.6 fg	4.1 j	4.4 df	3.9 fh	3.0 h
8	Urea	6.2 ae	6.1 ce	6.4 b	7.5 cd	5.6 af	6.3 b	3.4 eh
9	Urea	7.6 ab	8.7 a	8.9 a	8.8 a	7.9 a	8.8 a	6.9 a
10	IBDU	4.3 e	4.2 gh	4.5 df	7.1 de	6.4 ae	4.3 ef	3.5 dh
11	S.C. urea	6.1 ae	4.8 fg	4.0 eg	7.0 e	5.9 af	4.1 eg	3.4 eh
12	P.B. + urea	7.5 ac	6.4 ce	5.5 bd	7.5 cd	6.9 ad	5.3 cd	3.3 fh
13	Urea	5.9 ae	6.3 ce	6.1 bc	5.9 f	5.3 bf	6.3 b	4.4 c
14	Am. Nit.	8.3 a	7.3 b	5.8 bc	6.0 f	6.9 ad	5.6 bc	3.9 cf
15	Am. Nit.	5.3 be	5.8 df	5.4 bd	8.0 b	6.4 ae	5.5 bd	3.2 gh
16	Milorg.	4.9 ce	5.4 ef	5.6 bd	5.0 hi	4.6 cf	3.9 fh	5.0 b
17	Milorg.	6.1 ae	5.2 ef	3.0 gh	7.0 e	7.1 ac	3.3 gi	3.8 cg
18	Oxamide	5.9 ae	3.4 h	3.5 fg	4.3 ij	4.6 cf	3.8 fh	4.3 c
19	Oxamide	5.0 ce	3.4 h	3.0 gh	4.6 ij	5.2 bf	3.1 hi	3.5 dh

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

[y]Check plots received 1 pound N per 1000 square feet as urea in July and September.

[z]For treatment details, see Table 3.

Table 5. Nitrogen carrier study on Loretta perennial ryegrass. N applied at 1.6 pounds per 1000 square feet on July 7. Averages for 3 replications.

Carrier	Days After Application					
	5	11	17	22	27	32
	Visual Turf Rating (9 = Greenest)					
18-5-9 (Lebanon)	4.7 df[x]	5.3 de	5.3 df	5.7 de	5.7 cg	6.3 bc
32-0-16 (Turf King)	6.0 ac	6.3 bc	6.0 bd	7.0 bc	7.3 bc	7.0 bc
25-0-25 (Turf King)	6.7 ab	6.7 b	6.3 bc	7.5 b	7.5 b	6.8 bc
13-0-44 (Turf King)	6.3 ac	6.7 b	6.3 bc	7.0 bc	7.0 bc	6.8 bc
22-4-10+DCD (Lebanon)	5.7 bd	5.7 cd	6.3 bc	7.0 bc	6.3 be	6.0 be
41-0-0 (Scotts)	4.0 ef	4.7 e	4.7 fh	5.7 de	6.2 be	6.0 be
Milorganite	2.7 ij	2.7 gi	4.0 hi	5.2 ef	6.2 be	5.7 cf
Urea	5.7 bd	6.3 bc	6.0 bd	6.7 bd	6.5 bd	6.7 bc
Ammonium Nitrate	5.3 cd	6.3 bc	6.3 bc	6.7 bd	6.7 bc	6.8 bc
IBDU-Fine (Estech)	2.3 h	2.0 i	2.0 1	2.7 hi	4.7 ei	4.8 dg
Oxamide (Estech)	2.0 h	2.0 i	2.3 kl	2.7 hi	4.2 gi	4.7 dg
S. Coated Urea (CIL)	2.0 h	3.7 f	4.7 fh	5.5 e	6.7 bc	6.8 bc
14-0-0+Fe (Scotts)	3.0 gh	7.0 b	6.7 b	7.7 b	7.0 bc	7.0 bc
Powder Blue (BFC Chem)	2.7 gh	3.0 fh	3.0 jk	3.3 gh	4.3 fi	4.5 fg
Powder Blue + Urea	2.7 gh	5.0 de	5.0 eg	5.3 e	5.7 cg	5.8 cf
FLUF (Cleary)	4.7 df	5.0 de	5.3 df	5.7 de	6.0 be	6.2 bd
20-0-2 (Agrochem)	4.7 df	6.3 bc	6.0 bd	7.0 bc	7.5 b	7.0 bc
Strengthen & Restore (Agrochem)	7.0 a	6.3 bc	6.0 bd	7.0 bc	6.7 bc	7.3 b
20-0-0 (FAN-Cleary)	6.3 ac	5.7 cd	5.7 ce	6.7 bd	6.7 bc	7.3 b
16-2-4 (Cleary)	5.7 bd	5.0 de	5.0 eg	5.7 de	5.7 cg	5.7 cf
S. Coated Urea (Lakeshore)	4.7 df	3.0 fh	4.0 hi	4.0 g	4.8 dh	4.5 fg
24-4-12 (IBDU-Estech)	2.7 gh	3.3 fg	3.7 ij	4.3 fg	5.8 bf	6.0 be
Ureaformaldehyde	2.3 h	2.0 i	3.0 jk	3.3 gh	3.2 ik	3.8 gh
31-3-10 (Scotts)	4.7 df	5.0 de	5.0 eg	6.0 cde	6.3 be	6.3 bc
Check	2.7 gh	2.0 i	2.0 1	2.3 hi	2.2 jk	2.5 hi

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Table 6. Nitrogen carrier study on a Penneagle creeping bentgrass green. 1983. Hancock Turfgrass Research Center. Averages for 3 replications.

Carrier	N treatment, lbs/M			Quality Rating	
	Aug 1	Aug 24	Sept 16	Sept 9	Nov 10
25-0-25 (TCI)	1.50	1.50	1.00	8.2 a[x]	7.2 a
25-0-25 (TCI)	.75	.75	.50	4.5 b	3.2 d
13-0-44 (TCI)	1.50	1.50	1.00	8.0 a	6.7 b
13-0-44 (TCI)	.75	.75	.50	4.3 b	2.7 de
32-0-16 (TCI)	1.50	1.50	1.00	7.8 a	7.3 a
32-0-16 (TCI)	.75	.75	.50	4.8 b	3.0 de
22-4-10 (Lebanon)	1.50	1.50	1.00	7.8 a	7.2 ab
22-4-10 (Lebanon)	.75	.75	.50	4.8 b	3.0 de
22-0-16 (Scott's)	1.50	1.50	1.00	7.8 a	5.0 c
22-0-16 (Scott's)	.75	.75	.75	5.0 b	2.8 de
Urea	1.50	1.50	1.00	7.5 a	7.0 ab
Urea	.75	.75	.50	4.8 b	2.5 e

[x] Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Soil pH control study

The soil pH control study was initiated in 1981 on sandy loam soil. Soil pH values for 1982 and 1983 are given in Table 7. Of particular interest is the marked increase in pH of the 0-2 inch depth between 1982 and 1983 for plots which were acid in 1982. The higher sulfur plots increased from pH 3.4 to 4.3; the lower sulfur treatment increased from 4.1 to 4.8 and the untreated check increased from 6.0 to 6.4. This was likely caused by the free lime in the irrigation water. An increase in pH is frequently observed where the turf is irrigated regularly with water drawn from a limestone acquifer. We have seen this previously on other plots.

The effects of pH modification on available nutrient soil tests are given in Table 8. Acidifying the soil increased phosphorus tests although there was too much variability for statistically significant differences. There was no pH effect on potassium soil tests, but acidifying the soils resulted in highly significant losses in both calcium and magnesium. These data confirm the importance of monitoring available magnesium soil tests on acid soils. The test result of 34 pounds available magnesium in the 2-4 inch depth for the higher sulfur treatment would be considered deficient for most plants. There is sufficient magnesium in the 0-2 inch depth to provide for the magnesium needs of the turf.

In spite of the range of soil tests on these plots there is no apparent difference in growth of three grasses established on these plots - Baron Kentucky bluegrass, Pennlawn red fescue and Manhattan perennial ryegrass.

Responses of Penncross creeping bentgrass to phosphorus and postassium

The Penncross creeping bentgrass growing on dune sand (Purr-Wick Green) ciency with the typical symptoms of very slow growth and a dark purplish-green color. Phosphorus applications resulted in turf responses as indicated in Table 9, although soil tests indicated there was little phosphorus left in August from the spring application of phosphorus.

A study to evaluate soil test responses was initiated on September 30. Soil tests a month later point out the increases in soil tests in response to application of phosphorus (Table 10) and potash (Table 11) on three soils. There was no apparent turf response to these nutrient treatments in spite of the low tests, although these plots were not subjected to severe stress.

Table 7. Soil pH control study on sandy loam at the Hancock Turfgrass Research Center. Treatments applied August, 1981. Averages for 3 replications. Sampled in August each year.

Treatment		Depth of sampling, inches			
Chemical	Rate, tons/A	0-2		2-4	
		1982	1983	1982	1983
Limestone	6.0	7.5a[x]	7.6a	7.0ab	7.3a
Limestone	3.0	7.6a	7.3ab	6.6bcc	6.7b
Limestone	1.5	7.0ab	7.0b	6.1cd	6.5b
Check	---	6.0cd	6.4c	5.5d	5.8c
Sulfur	0.5	4.1ef	4.8d	4.6c	4.6d
Sulfur	1.0	3.4g	4.3e	3.8fg	4.1d

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Table 8. Effect of sulfur and dolomitic limestone applications on soil tests. Treatments applied August, 1981 at the Hancock Turfgrass Research Center.on a sandy loam soil. Sampled August, 1983.

Treatment		Sample	pH[y]	Available[y] soil test levels, pounds/A			
Material	Rate Tons/A	depth inches		P	K	Ca	Mg
Limestone	6.0	0-2	7.6a[x]	64ns	187a	3933a	441b
		2-4	7.3ab	69	107d	1706cd	507a
Limestone	3.0	0-2	7.3ab	84	187a	2595b	349c
		2-4	6.7cd	90	121cd	1493cd	356c
Limestone	1.5	0-2	7.0be	77	173ab	1920c	270d
		2-4	6.5d	88	126bd	1387de	273d
Check	---	0-2	6.4d		187a	1742cd	260d
		204	5.8e		129bd	1422ce	185e
Sulfur	0.5	0-2	4.8f	93	171ac	960ef	178e
		204	4.6fg	108	141ad	853fg	134e
Sulfur	1.0	0-2	4.3gh	125	174ab	676fg	136e
		204	4.1h	130	136ad	427g	38f

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Table 9. Phosphorus response of a Penncross creeping bentgrass green growing on dune sand. Study initiated June, 1983. Averages for 3 replications.

Treatment			Quality Rating (9=greenest)			
P_2O_5 lbs/1000 sq. ft./yr.	Date of application	Available[x] P, lbs/A 8/14/83	July 29	Aug 24	Sept 29	Nov 10
0	--	14[y]	2.0 b[y]	2.5 c	2.5 b	2.0 d
1	spring	13	3.3 a	4.0 ab	3.8 a	3.7 c
2	spring, fall	13	3.3 a	3.8 a	3.8 a	4.3 b
4	spring, fall	18 ns	3.8 a	4.3 a	4.0 a	4.8 a

[x] Available phosphorus (P) determined with Bray P_1

[y] Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Table 10. Phosphorus soil test[x] responses on Penncross creeping bentgrass greens growing on 3 soils. Hancock Turfgrass Research Center. Average of 3 replications. Study initiated September 30, 1983, samples taken October 24, 1983.

P_2O_5 applied	Dune sand		sand/peat	Topsoil
lbs/1000 sq. ft.	0-3"	3-6"	0-3	0-3
0	37 cd[y]	14 e	36 b	117 b
0.5	47 bc	19 e	36 b	131 b
1.0	59 b	22 de	46 b	145 b
2.0	76 a	22 de	83 a	187 a

[x] Available phosphorus (P) determined with Brag P_1.

[y] Means in columns followed by the same letter are not significantly different than each other at the 5% level using Duncan's Multiple Range Test.

Table 11. Potassium soil test[x] responses on Penncross creeping bentgrass greens growing on 3 soils. Hancock Turfgrass Research Center. Averages for 3 replications. Studies initiated September 30, 1984. Samples taken October 24, 1983.

K_2O applied	Dune sand		Sand/peat	Topsoil
lbs/1000 sq. ft.	0-3"	3-6"	0-3"	0-3"
0	35 cd[y]	10 c	86 c	124 b
0.5	51 bc	13 c	114 bc	124 b
1.0	66 ab	25 de	149 b	176 ab
2.0	84 a	46 bd	250 a	260 a

[x]Available Potassium (K) determined with neutral normal ammonium acetate.

[y]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

Effect of topdressing program and nitrogen fertilization on Penncross creeping bentgrass turf

This study, with the treatments outlined in Table 12, was initiated in 1982. Simpmeter readings were taken in November, 1983 with small differences recorded. The thickness of the combined thatch and topdressing layer was greater for topdressed plots than where no topdressing was applied as would be expected. This layer had a higher percent of organic matter in the plots receiving no topdressing than when topdressing was applied. The plots receiving sand topdressing on infrequent intervals developed alternate layers of sand and thatch, which will surely lead to management difficulties at some time in the future. Golf course superintendents are strongly urged to utilize light and frequent rates of topdressing if a sand topdressing program has been started. Missing even one application date could result in the development of a layer of thatch which could ultimately have a detrimental effect, particularly on rooting, and maybe on water movement. Once on a sand topdressing program, always on it!

Turf cultivation studies

A comparison of half-inch solid tines and half-inch hollow tines in cultivating a green with the Ryans Greensaire was initiated during summer, 1983. This research was conducted by James Murphy, graduate student. The holes left by the use of the solid tines grew back over more rapidly than when the hollow tines were used. Cutworm activity (Table 13) was greater in plots treated with hollow tines because these holes stayed open longer, providing a haven for the cutworms. Examination of the coring holes revealed that when the solid tines are used the holes tend to close back up rapidly while those from the use of open tines stay open longer. This is reasonable since soil is removed from these holes. There was no difference in rooting in plugs (4 inches diameter and 3 inches deep) removed from these plots.

When these cultivation treatments were applied to moist loamy sand there was no lifting of the soil on plots receiving either treatment. But when treatments were applied on a dry, compacted sandy loam there was some lifting of the soil around the aerifying holes with the solid tines. These preliminary observations would suggest that the use of solid tines may have greater potential if the soil is dry, although considerably more research is needed to evaluate this technique.

Evaluation of winter protective covers for greens

Eight winter protective covers were placed on a Penncross creeping bentgrass green in December, 1982. Covers were removed in March, 1983 after snow melt. The excelsior mat resulted in the greenest turf after removal (Table 14). The microfoam mat with 2 layers of thickness also gave good results. The excelsior mat was messy, especially at time of removal. Within one week of cover removal a hard freeze masked all differences. No further differences were apparent thereafter.

Table 12. Topdressing management on a Penncross bentgrass putting green. 1983. Hancock Turfgrass Research Center. Averages for 3 replications.

Topdressing treatment			N Rate	Stimpmeter[y]	Thatch	
Material	Rate cu. ft.	Frequency	lbs/M	feet	depth[z] mm	organic matter %
Sand	3	3 weeks	3	6.14 ab[x]	18.9 ac	9.4 d
Sand	3	3 weeks	6	5.81 ad	19.1 ac	10.1 cd
Sand	6	6 weeks	3	5.87 ad	19.8 ab	8.6 d
Sand	6	6 weeks	6	5.91 ad	21.2 a	8.6 d
Sand	12	spring, fall	3	6.10 ab	19.6 ab	9.2 b
Sand	12	spring, fall	6	5.71 bd	19.3 ac	10.1 cd
Soil mix	12	spring, fall	3	6.07 ac	17.5 cd	11.5 e
Soil mix	12	spring, fall	6	5.68 cd	18.6 bd	10.0 cd
Check	--	--	3	6.17 a	14.9 e	17.4 a
Check	--	--	6	5.58 d	16.3 d	14.3 b

[x]Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test.

[y]Stimpmeter readings taken November 7; 4 readings per plot

[z]Thatch depth with 0.3 p.s.i. pressure

Table 13. Effect of cultivation treatment on a Penncross creeping bentgrass green. Hancock Turfgrass Research Center. 1983. Averages for 3 replications.

Cultivation treatment	Cutworm sites per plot	Root weights for 2x2x4 sample
	no.	gm
Check	0 a[x]	.30 ns
Solid tines	27 b	.30 ns
Hollow tines	121 c	.33 ns

[x] Means in columns followed by the same letter are not significantly different from each other at the 5% level using Duncan's Multiple Range Test. ns indicates no significant differences occurred.

Table 14. Winter protective cover study on Penncross creeping bentgrass. Covers removed and evaluations made March 19, 1983. Averages for 3 replications.

Cover treatment	Color rating (9=greenest)
Microfoam - 1 layer	4.5 c[x]
Microfoam - 2 layers	5.3 b
Microfoam - 3 layers	4.2 c
Excelsior mat	6.7 a
White polyethylene	3.2 d
Clear polyethylene (punctured)	3.3 d
Saran cloth (75-90% shade)	3.0 d
Amoco filter	4.5 c
Check	2.2 e

[x] Means in columns followed by the same letter are not significnatly different from each other at the 5% level using Duncan's Multiple Range Test.