TURFGRASS SOIL MANAGEMENT RESEARCH REPORT

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During 1992 several new soil management projects were established as well as having several projects continued from 1991. Results will be addressed by general topic in this report.

NITROGEN CARRIER EVALUATIONS

Description of studies: Two studies were initiated at the Hancock Turfgrass Research Center during the year designed to provide information on evaluation of some new nitrogen carriers as compared to some traditional fertilizers. One study was initiated on an annual bluegrass fairway turf which had been seeded in 1991. Plots were mowed at 5/8 inch and irrigated to prevent wilt. Plot size was 4 feet by 12 feet and there were 4 replications for each of the 13 treatments.

A second study was initiated on a tall fescue turf which had been seeded in 1991. The mowing height was 2 inches. Plot sizes and replications were the same as for the annual bluegrass carrier study. Both these studies were established on new plots in the expanded research area at the Hancock Center. The soil for both studies was a loam.

In the annual bluegrass carrier study, nitrogen was applied at the rate of 1 lb. N per 1000 sq. ft. on June 12, July 16 and August 31. Turfgrass quality ratings were taken on 12 different dates during the season. Clipping weights were obtained from an area 21 inches wide by 10.25 feet long and are reported in dry clipping weights per plot. There were 2 clipping sampling dates for the annual bluegrass study.

On the tall fescue study, nitrogen was applied at the rate of 1.5 lbs. N per 1000 sq. ft. on July 5 and September 14. Turfgrass quality ratings and clipping weights (3 dates) were obtained as described for the annual bluegrass study.

The nitrogen carriers evaluated are listed in Tables 1 and 2 for the annual bluegrass and tall fescue studies, respectively. The Scotts fertilizers are experimental polymer–coated urea products; SCU is sulfur–coated urea from The Anderson's; Herbruck's fertilizers are experimental poultry manure–based carriers from the Herbruck's Co. in Michigan; Nutralene is from the Nor–Am Co.; Once is a polymer–coated fertilizer from the Sierra Co.; Terrene is an organic sludge–based material; Milorganite is from the Milwaukee Sewerage Commission; Ringer's is from the Ringer Corp.; and Sustane is a poultry manure–based product from the Sustane Corp.

Results: The annual bluegrass plots provided excellent differentials in response to nitrogen carriers although the responses tended to be of short duration. On several dates, response to the nitrogen was depleted before the next nitrogen application, resulting in many plots exhibiting a light yellow-green color and low quality ratings. A quality rating of 6.0 to 6.5 is considered minimum on annual bluegrass. The excessive rainfall during the summer apparently contributed to rapid depletion of the applied nitrogen on the annual bluegrass plots. This rapid loss of response to these nitrogen carriers was not evident on the tall fescue plots. There was serious dollarspot incidence on the annual bluegrass plots during late summer. This contributed to the very low quality ratings observed on some dates. Dollarspot disease severity ratings were taken, but no significant differences were observed.

Most of the carriers resulted in a spotty response on the annual bluegrass. This spotty condition made the plots difficult to rate, with ratings which were not considered acceptable on several dates. The spotty response was not evident on the tall fescue turf. Grasses maintained at a short mowing height are more susceptible to such spotty responses. We have seen this on bentgrass greens in the past even with water soluble carriers such as urea or ammonium nitrate when applied in the dry form. High analysis fertilizers do not permit a high enough density of particle placement resulting in the particles being far apart. The nitrogen is released from these particles and does not move very far laterally, giving the spotty response observed. However, most fertilizers designed for greens and fairways have smaller particle sizes and lower analyses than was the case for most of the fertilizers utilized in this study.

As a fast-acting carrier, urea gave typical responses on the annual bluegrass (Table 1) which were very quick, but did not last as long as some other carriers. The first date of evaluation (July 29, 17 days after application) is a prime example with urea ranking best among all carriers. The effect of polymer coating thickness is evident on that first date of evaluation as well. Among the 3 Scott's experimental carriers, the 40-0-0 has the thinnest polymer coating, making it the fastest acting of the 3, while the 38.5-0-0 has the thickest coating, giving the slowest response while the length of response is generally longer. Another polymer-coated fertilizer, Once, exhibits similar long term response as does sulfur-coated urea. The natural organic carriers gave adequate responses on many dates, but did not provide as good long-term response in this study as did the polymer-coated sources.

When evaluating such data in these tables the reader is reminded that any number followed by the same letter in a columnn is not significantly different on a statistical basis from any other number followed by the same letter. This is true even though there may be a large difference among several numbers followed by the same letter. On the other hand, some times the numbers are different statistically (followed by different letters), but practically it is not reasonable to say the difference is meaningful. Usually, when comparing quality ratings a number difference of greater than 1 is needed for a difference to be somewhat practical. For a major effect, a rating difference of 2 or more is usually needed, depending on the turf and the person doing the rating.

Table 1

Evaluation of Nitrogen Carrier Affects on Annual Bluegrass Fairways

Quality Ratings, 1 = poor 9 = excellent

Treatments were applied June 12, July 16, and August 31, 1992 at the rate of 1 pound of nitrogen per 1000 sq. feet.

TREATMENT	JUN 29	JUL 22	AUG 6	AUG 18	AUG 26	SEP 8	SEP 10	SEP 17	OCT 7	OCT 14	OCT 22	OCT 27
Scotts 40-0-0	5.8 d	4.5 bcd	4.0 bcde	3.9 cd	5.1 a	6.9 b	7.4 bc	5.5 a	3.6 cd	6.5 b	5.8 a	6.1 bcd
Scotts 39-0-0	5.3 f	4.4 cde	3.9 bcde	3.8 d	5.1 a	6.8 bc	7.5 ab	5.5 a	4.0 abc	6.5 b	6.0 a	5.9 cd
Scotts 38.5-0-0	4.6 g	4.0 ef	4.0 bcde	3.5 d	5.3 a	6.9 b	7.3 bcd	5.5 a	3.9 abc	6.9 ab	5.9 a	6.6 ab
SCU 32-0-0	6.3 c	4.8 bc	4.6 ab	5.1 a	5.4 a	7.1 ab	7.6 ab	5.5 a	4.5 ab	6.6 b	6.0 a	6.4 abc
Herbruck's 6-2-4	5.6 de	3.6 f	4.4 abc	4.4 abcd	5.4 a	6.4 cd	6.8 e	5.5 a	3.9 abc	5.6 cd	5.4 b	5.6 de
Herbruck's 10-3-4	7.4 b	4.9 ab	4.6 ab	4.4 abcd	5.3 a	7.0 ab	7.5 ab	5.5 a	3.8 bcd	5.1 de	5.3 bc	5.0 f
Nutralene 40-0-0	4.8 g	3.8 f	4.1 bcd	4.8 abc	5.4 a	7.0 ab	7.6 ab	5.5 a	4.1 abc	5.9 c	5.4 b	5.1 ef
Terrene 6-2-0	4.3 h	3.1 g	3.6 cde	4.0 cd	5.3 a	6.1 d	6.6 e	5.5 a	3.0 d	4.8 e	5.0 c	5.0 f
Milorganite 6-2-0	4.6 g	3.0 g	3.1 e	4.1 bcd	5.3 a	6.1 d	6.6 e	5.5 a	3.5 cd	5.4 cd	5.4 b	5.1 ef
Once 35-0-6	4.5 gh	4.3 de	4.0 bcde	4.1 bcd	5.4 a	6.9 b	7.3 bcd	5.5 a	4.6 a	7.3 a	6.0 a	6.9 a
Urea 46-0-0	8.4 a	5.3 a	5.1 a	5.0 ab	5.4 a	7.4 a	7.9 a	5.5 a	3.9 abc	5.8 c	5.4 b	5.0 f
Ringer 10-2-6	5.6 de	3.0 g	4.3 abcd	5.0 ab	5.4 a	6.1 d	7.0 cde	5.4 b	3.6 cd	5.1 de	5.4 b	5.3 ef
Sustane 5-2-4	5.4 ef	3.6 f	3.4 de	3.8 d	5.1 a	6.1 d	6.9 de	5.5 a	3.5 cd	5.4 cd	5.3 bc	5.1 ef

Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

The nitrogen carrier study on tall fescue (Table 2) gave responses typically observed in the past on Kentucky bluegrass and perennial ryegrass. Generally, the relative responses among carriers was similar to those observed on annual bluegrass, but the responses lasted longer and differences were smaller on the tall fescue. This was due in part to the higher rate of nitrogen applied per application (1.5 lbs N per 1000 sq ft). And, as in past studies we have observed that grasses which are mowed higher tend to hold nitrogen responses longer than do those mowed short. This was likely the case in these studies even though both grasses were growing on similar soils.

Clipping weight data (Table 3 for annual bluegrass and Table 4 for tall fescue) suggest growth rates in response to the nitrogen carriers was generally consistent with quality rating responses, depending on carrier and time of sampling after application.

TIMING OF NITROGEN ON ANNUAL BLUEGRASS

A study to evaluate timing of nitrogen application on annual bluegrass fairway turf was initiated in 1992 on the new plot area. Nitrogen was applied as urea according to the schedule shown in Table 5. The dates of application are approximately the 15th of each month. Plot size was 4 feet by 14 feet with 4 replications. The plots were mowed at 5/8 inch. Irrigation was applied to prevent wilt.

Turf quality ratings for these plots are given in Table 7 and clipping weight data for 3 dates are given in Table 6. There were no unusual responses this first growing season. The untreated check had very low quality ratings throughout the season with significant dollarspot at times. Those plots receiving 1 and 2 lbs N per 1000 sq ft often had low ratings as well. The objective of this study is to determine if very low nitrogen rates or if timing of application of nitrogen will have an impact on turf quality and susceptibility to stress.

Table 2

Evaluation of Nitrogen Carrier Affects on a Tall Fescue Lawn
Quality Ratings, 1 = poor 9 = excellent
Treatments were applied July 5 and September 14, 1992 at the rate of 1.5 pounds of nitrogen per 1000 sq. feet

TREATMENT	JUL 16	AUG 6	AUG 26	SEP 8	SEP 17	SEP 21	SEP 22	SEP 29	OCT 6	OCT 14	OCT 22	OCT 27
Scotts 40-0-0	7.1 bcde	7.4 ab	7.0 abc	7.8 abc	7.3 bc	7.5 b	8.0 b	7.1 ab	7.6 abc	7.9 a	7.8 ab	7.3 ab
Scotts 39-0-0	7.0 cdef	7.6 a	7.4 a	8.0 a	7.3 bc	7.5 b	8.0 b	7.0 abc	7.8 abc	7.9 a	7.9 a	7.6 a
Scotts 38.5-0-0	6.6 efg	7.4 ab	7.4 a	8.0 a	7.1 cd	7.4 bc	7.9 b	7.1 ab	7.8 abc	7.9 a	7.6 ab	7.0 ab
SCU 32-0-0	7.4 abc	7.1 bcd	7.3 a	7.9 ab	7.3 bc	7.5 b	8.1 ab	7.3 a	7.9 ab	7.5 abc	7.8 ab	7.1 ab
Herbruck's 6-2-4	6.4 gh	7.4 ab	7.1 ab	7.8 abc	6.5 e	6.5 d	7.0 c	6.8 cd	7.5 bcd	7.5 abc	7.8 ab	7.0 ab
Herbruck's 10-3-4	7.8 a	7.0 cd	6.8 bcd	7.5 c	7.4 ab	7.9 a	8.3 ab	7.3 a	7.8 abc	7.9 a	7.8 ab	7.3 ab
Nutralene 40-0-0	7.3 abcd	7.0 cd	7.0 abc	7.6 bc	7.0 d	7.1 c	7.9 b	7.0 abc	7.6 abc	7.6 abc	7.8 ab	7.1 ab
Once 35-0-6	6.6 efg	7.4 ab	7.3 a	8.0 a	7.1 cd	7.3 bc	7.9 b	7.0 abc	7.5 bcd	7.8 ab	7.9 a	7.4 ab
Urea 46-0-0	7.6 ab	7.3 bc	6.8 bcd	7.5 c	7.5 a	7.9 a	8.5 a	7.3 a	8.0 a	7.9 a	7.8 ab	7.3 ab
Terrene 6-2-0	6.5 fg	7.0 cd	6.6 cd	7.5 c	6.5 e	6.4 d	6.8 c	6.6 d	7.1 d	7.3 c	7.4 b	6.6 b
Milorganite 6-2-0	5.9 h	6.9 d	7.0 abc	7.6 bc	6.5 e	6.4 d	6.6 c	6.8 cd	7.1 d	7.4 bc	7.5 ab	7.0 ab
Ringer 10-2-6	6.8 defg	7.4 ab	7.0 abc	7.8 abc	6.5 e	6.4 d	6.8 c	7.0 abc	7.8 abc	7.8 ab	7.6 ab	6.9 ab
Sustane 5-2-4	6.6 efg	7.1 bcd	6.5 d	7.5 c	6.5 e	6.5 d	7.0 c	6.9 bcd	7.4 cd	7.4 bc	7.6 ab	6.8 ab

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 3. Annual Bluegrass Nitrogen Carrier Study 1992
Clipping Weights in grams

Treatments applied June 12, July 16, and August 31, 1992
Each treatment 1 pound of nitrogen per 1000 sq. ft.

TREATMENTS	JULY 7	AUGUST 4
Scotts 40-0-0	25.85 abc	13.10 abc
Scotts 39-0-0	18.35 cd	10.30 abc
Scotts 38.5-0-0	21.35 bcd	11.78 abc
SCU 32-0-0	29.10 a	10.78 abc
Herbruck 6-2-4	16.20 d	9.32 abc
Herbruck 10-3-4	27.23 ab	12.91 abc
Nutralene 40-0-0	19.00 cd	6.20 abc
Terrene 6-2-0	14.75 d	6.05 bc
Milorganite 6-2-0	18.73 cd	9.07 abc
Once 35-0-6	21.45 bcd	10.44 abc
Urea 46-0-0	28.92 ab	15.84 a
Ringer 10-2-6	19.33 cd	4.58 c
Sustane 5-2-4	25.88 abc	14.46 ab

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 4

Tall Fescue Nitrogen Carrier Study 1992
Clipping weights in grams

Treatments applied July 5 and September 14, 1992
Each treatment 1.5 pounds of nitrogen per 1000 sq. ft.

TREATMENT	JULY 22	AUGUST 10	SEPTEMBER 30
Scotts 40-0-0	15.4 bc	28.1 a	26.7 ab
Scotts 39-0-0	12.8 cde	29.0 a	27.5 ab
Scotts 38.5-0-0	8.2 ef	27.2 a	27.8 ab
SCU 32-0-0	16.2 bc	25.3 ab	27.2 ab
Herbruck's 6-2-4	9.0 def	27.4 a	16.8 cd
Herbruck's 10-3-4	19.4 ab	25.1 ab	21.8 bcd
Nutralene 40-0-0	14.3 bcd	25.3 ab	22.6 bcd
Once 35-0-6	9.03 def	29.1 a	24.5 abc
Urea 46-0-0	23.9 a	26.6 a	31.7 a
Terrene 6-2-0	7.01 ef	19.4 b	14.3 d
Milorganite 6-2-0	6.0 f	27.1 a	14.1 d
Ringer 10-2-6	15.5 bc	24.3 ab	16.3 cd
Sustane 5-2-4	10.9 cdef	24.28 bc	14.2 d

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 5. Timing and Rate of Urea Applications - Annual Bluegrass Timing Study - 1992

TREATMENT	ANNUAL NITROGEN PER 1000 SQ. FT.	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	NOVEM-BER
1	1	0	.5	0	0	0	.5	0
2	2	0	1	0	0	0	1	0
3	4	1	1	1	0	1	1	0
4	6	1	1	1	1	1	1	0
5	4	1	1	1	0	0	1	0
6	4	0	0	1	.5	.5	1	1
7	4	0	0	1	1	1	1	0
8	4	0	0	.5	.5	.5	.5	2
9	0	0	0	0	0	0	0	0
10	4	0	1	1	0	1	1	0
11	4	0	1	1	0	1	1	0
12	4	0	1	1	0	1	1	0
13	4	0	1	1	0	1	1	0
14	4	0	1	1	0	1	1	0

Table 6

Evaluation of Urea Treatments on an Annual Bluegrass Fairway
Quality Ratings, 1 = poor 9 = excellent
Treatments were applied at various times and rates throughout the season.

Treatment	JUN 13	JUL 16	AUG 6	AUG 18	AUG 19	AUG 26	SEPT 29	OCT 6	OCT 9	OCT 14	OCT 22	OCT 27	NOV 9
1	5.4 c	4.8 fg	4.1 d	3.5 d	3.6 e	4.0 d	6.3 c	6.1 cd	5.4 cd	5.6 d	5.8 d	5.1 c	5.3 d
2	6.4 b	5.1 f	4.0 d	3.6 d	4.1 d	3.8 d	6.8 abc	7.1 abc	7.0 ab	6.9 abc	6.9 ab	6.0 abc	5.6 bcd
3	6.1 b	6.8 bcd	5.0 ab	8.0 a	8.0 a	7.1 a	6.4 bc	6.4 bc	6.6 ab	6.9 abc	6.8 ab	6.1 ab	5.6 bcd
4	7.8 a	7.3 ab	4.8 bc	8.0 a	8.0 a	7.3 a	7.1 a	7.5 a	7.6 a	7.4 ab	7.4 ab	6.9 a	6.1 a
5	7.9 a	7.6 a	5.3 a	5.3 c	4.8 c	5.0 c	6.4 bc	6.6 abc	7.0 ab	6.8 bc	6.6 bc	6.4 ab	5.4 d
6	4.4 d	6.5 cd	4.8 bc	7.0 b	7.3 b	5.8 b	6.9 ab	7.4 ab	7.4 a	7.5 ab	7.3 ab	6.6 ab	5.9 abc
7	4.3 d	6.4 de	4.4 cd	7.6 a	8.0 a	7.3 a	6.9 ab	7.4 ab	7.5 a	6.9 abc	7.4 ab	6.5 ab	6.0 ab
8	4.4 d	5.9 e	4.4 cd	7.0 b	7.5 b	5.8 b	6.5 bc	6.5 abc	6.0 bc	6.1 cd	5.9 cd	5.9 bc	5.5 cd
9	4.1 d	4.5 g	4.8 bc	3.8 d	3.8 e	3.8 d	5.3 d	5.3 d	4.4 d	4.4 e	5.1 d	3.6 d	4.5 e
10	6.1 b	7.3 ab	5.4 a	8.0 a	8.0 a	7.1 a	6.8 abc	7.4 ab	7.4 a	7.6 ab	7.5 a	6.8 ab	6.0 ab
11	6.3 b	7.0 bc	5.3 a	7.9 a	7.9 a	7.3 a	6.8 abc	7.3 ab	7.3 a	7.5 ab	7.1 ab	6.3 ab	6.0 ab
12	6.3 b	7.0 bc	5.1 ab	8.0 a	8.0 a	7.0 a	6.8 abc	7.3 ab	7.5 a	7.8 a	7.5 a	6.8 ab	6.0 ab
13	6.1 b	7.0 bc	5.3 a	8.0 a	8.0 a	7.1 a	6.8 abc	7.4 ab	7.5 a	7.8 a	7.4 ab	6.8 ab	6.0 ab
14	6.4 b	7.1 ab	5.4 a	8.0 a	8.0 a	7.1 a	6.8 abc	7.3 ab	7.1 ab	7.3 ab	7.3 ab	6.6 ab	6.0 ab

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 7. Annual Bluegrass Urea Timing Study 1992 Clipping weights in grams			
TREATMENT	JULY 20	AUGUST 11	SEPTEMBER 4
1	8.09 de	4.89 cd	5.61 e
2	10.32 cde	4.32 d	4.36 e
3	16.30 abc	6.58 bcd	18.49 bc
4	16.48 abc	9.51 ab	27.37 a
5	21.05 a	12.51 a	10.29 de
6	14.61 abcd	6.22 bcd	10.47 de
7	15.66 abc	9.07 abc	19.75 b
8	12.58 bcde	5.40 bcd	10.04 de
9	7.71 e	5.82 bcd	4.13 e
10	18.98 ab	5.82 bcd	15.94 bcd
11	12.26 bcde	5.74 bcd	15.14 bcd
12	13.90 bcde	6.16 bcd	12.85 cd
13	14.12 bcde	6.22 bcd	12.23 cd
14	13.18 bcde	6.02 bcd	14.38 bcd
Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.			

HIGH POTASSIUM APPLICATIONS

There is widespread interest in use of high rates of potash on turfs to improve wear and stress tolerance. Some turf managers are using very high rates of application. In a cooperative study with John N. Rogers III established in 1990, we have applied up to 12 lbs K20 per 1000 sq. ft. annually to a creeping bentgrass green, an annual bluegrass fairway turf and a Kentucky bluegrass turf. All plots are 5 feet by 7 feet with 4 replications. The annual bluegrass and Kentucky bluegrass are growing on loam soils while the creeping bentgrass is growing on a modified loamy sand. We intended to subject these plots to dry down stress conditions in 1992, but the regularity of rainfall prevented effective use of dry down moisture stress during the growing season.

The soil tests for available K, Ca and Mg are given in Tables 8, 9 and 10 for the creeping bentgrass, annual bluegrass and Kentucky bluegrass, respectively. In all cases the application of potash has increased soil K tests as would be expected. With continued use the higher rates are resulting in saturation of the cation exchange capacity in the surface layer. The K then moves down in the profile. The sandy soil in the green does not hold as much K compared to the loam because of the lower cation exchange capacity. The maximum K tests in the 0–3 inch depth in the green soil are less than 250 lbs K per acre while in the loam soil, K tests range up over 600 lbs per acre and higher at the highest rate of application. It is also clear that the K test in the 3–6 inch depth of the green is very low (38 lbs per acre), a level that is probably deficient. With continued growth, roots which reach deeper into the soil will extract K and other nutrients. It is possible to remove so much of a given nutrient that it could become deficient at that depth. Of course, removing clippings results in significant removal of nutrients as well which could partially explain the lower K tests in the green. In spite of the very low K tests deeper in the soil we have seen no evidence of any deficiency response, however, likely because the K levels in the thatch and surface layer are adequate for these turf conditions where there is little stress.

There has been a report from Georgia that K levels lower than the maximum applied in this study resulted in some loss of turf quality due to the high level of salts applied with the potash, particularly with potassium chloride (muriate of potash, 0–0–60). We have seen no evidence of this on these plots to date. Still it wise to apply potash in modest amounts, particularly during the stress periods. If applied every month there should be no reason to apply more than 6 lbs K20 per 1000 sq. ft. annually in our climate even on sandy soils. The key on sandy soils is to apply the potash regularly throughout the growing season.

Table 8

High Potassium Study on Bentgrass 1992.
Initiated in 1990

TREATMENT K_2O in lbs/M/year	POTASSIUM LEVELS LBS/ACRE			CALCIUM LEVELS LBS/ACRE			MAGNESIUM LEVELS LBS/ACRE		
	THATCH	0-3 INCHES	3-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES
NONE	244.8 cde	62.00 hi	38.25 i	1987. ab	1049. d	790.5 defg	338.8 a	200.0 cde	143.0 efgh
SOIL TEST KCl carrier	254.3 cde	108.3 ghi	78.00 hi	1744. bc	1061. d	818.3 defg	297.5 ab	204.0 cd	155.8 defgh
4 lbs Kcl carrier	327.8 bc	136.5 fgh	73.75 hi	2052. a	1018. de	691.0 g	327.8 a	158.5 defg	118.0 fgh
8 lbs. Kcl carrier	281.8 cd	212.5 def	176.5 efg	1565. c	993.0 def	706.5 fg	250.0 bc	172.5 def	98.75 h
12 lbs. Kcl carrier	466.3 a	218.5 def	177.8 efg	2139. a	1035. de	752.5 efg	341.3 a	155.5 defgh	112.8 gh
12 lbs. K_2SO_4 carrier	410.0 ab	234.8 cde	195.5 defg	2063. a	1029. de	790.5 defg	342.5 a	132.3 fgh	104.0 gh

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 9

High Potassium Study on Annual Bluegrass 1992.
Initiated in April 1990.

TREATMENT K_2O in lbs/M/year	POTASSIUM LEVELS LBS/ACRE			CALCIUM LEVELS LBS/ACRE			MAGNESIUM LEVELS LBS/ACRE		
	THATCH	0-3 INCHES	3-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES
NONE	747.8 c	128.0 hi	71.75 i	2240.0 a	1660.0 bcde	1456.0 de	457.8 a	395.0 cde	316.3 ghij
SOIL TEST Kcl carrier	747.3 c	474.0 defg	233.5 ghi	1790.0 b	1760.0 bc	1487.0 cde	371.0 def	349.8 fgh	300.0 ijk
4 lbs Kcl carrier	992.0 b	315.5 fghi	192.5 hi	2260.0 a	1680.0 bcd	1458.0 de	420.3 abc	358.3 efg	308.0 hijk
8 lbs. Kcl carrier	1317.0 a	553.5 cdef	332.0 efgh	2460.0 a	1720.0 bcd	1385.0 e	441.8 ab	332.3 fghi	278.0 jk
12 lbs. Kcl carrier	1348.0 a	570.0 cde	517.5 cdef	2325.0 a	1741.0 bc	1441.0 de	412.5 bcd	353.5 efg	274.0 jk
12 lbs. K_2SO_4 carrier	1459.0 a	632.3 cd	460.8 defg	2360.0 a	1683.0 bcd	1458.0 de	439.5 ab	343.3 fghi	270.0 k

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 10

High Potassium Study on Kentucky Bluegrass 1992
Initiated in April 1990

TREATMENT K_2O in lbs/M/year	POTASSIUM LEVELS LBS/ACRE			CALCIUM LEVELS LBS/ACRE			MAGNESIUM LEVELS LBS/ACRE		
	THATCH	0-3 INCHES	33-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES	THATCH	0-3 INCHES	3-6 INCHES
NONE	396.0 de	134.8 gh	75.8 h	2160.0 a	1720.0 cd	1283.0 fgh	427.5 a	352.5 b	280.0 de
SOIL TEST Kcl carrier	434.0 de	208.3 fgh	145.3 gh	2000.0 ab	1531.0 def	1146.0 h	403.8 a	339.0 b	240.0 ef
4 lbs Kcl carrier	649.5 c	342.0 ef	229.3 fg	2140.0 a	1786.0 bcd	1344.0 fgh	407.3 a	347.8 b	258.0 def
8 lbs. KCl carrier	1032.0 b	506.3 d	340.0 ef	1961.0 abc	1455.0 efg	1182.0 h	342.0 b	284.0 cd	216.0 f
12 lbs. KCl carrier	973.0 b	738.8 c	450.0 de	1920.0 abc	1765.0 bcd	1253.0 gh	340.0 b	325.3 bc	232.0 f
12 lbs. K_2SO_4 carrier	1206.0 a	672.5 c	506.3 d	1960.0 abc	1602.0 de	1251.0 gh	346.3 b	278.0 de	222.0 f

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

GREENS TOPDRESSING RESEARCH

Topdressing programs outlined in Table 11 have been applied since 1986 to a Penncross creeping bentgrass green at the Hancock Turfgrass Research Center. Plot size is 4 feet by 12 feet with 3 replications. The straight sand treatments are applied either on a light, frequent program with 3 cubic feet of sand per 1000 sq. ft. applied every 3 weeks during the growing season or twice annually (spring and fall) at the rate of 12 cubic feet. The 80:20 mix is composed of 80% sand and 20% peat on a volume basis. The 60:20:20 mix is sand:peat:sandy loam soil. The "Sand aerified" plot is aerified with a Greensaire aerifier both spring and fall using 1/2-inch hollow tines followed by topdressing with 12 cubic feet of sand each time.

The depth of the layer composed of topdressing material and/or thatch is shown in Table 11. Note that there is no difference in depth of the topdressing layer among all plots receiving topdressing (4.7 to 5.0 cm), regardless of whether straight sand or a mix was applied. All the topdressed plots had a layer about 3 times thicker than the thatch layer (1.6 cm) on the non-topdressed check plot. Interestingly, based strictly on calculations the depth of sand applied during the 7 years of the study should amount to about 5 cm (2 inches).

Samples were collected from each plot and taken to the laboratory for physical analyses. The amount of organic matter found in each plot is given in Table 11. Plots topdressed with the 60:20:20 mix resulted in more organic matter than those topdressed with sand alone. There was no difference in organic matter present among plots treated with sand alone or that were untreated (check). One reason for the soil based mix producing slightly more organic matter could be that having more soil in the topdressing layer may have enhanced growth sufficiently to increase the amount of thatch produced.

During 1992, the 4 feet by 12 feet plots were split in (4 feet by 6 feet) half with one half of the plots receiving 5 lbs. K20 per 1000 sq. ft. applied as 0-0-60 in 5 separate applications during the growing season. The plots were sampled in October and analyzed for available soil K, Ca and Mg levels. Samples were separated into either the topdressing/thatch layer; or the 0-3 inch soil depth just beneath the topdressing/thatch layer.

The soil tests from these plots are given in Table 12. Plots treated with K had higher soil K tests as would be expected. Plots topdressed with the 60:20:20 mix which contains 20% topsoil tended to have higher soil K tests that those without topsoil, although differences were not often statistically significant. Soil tests in the topdressed/thatch layer tended to be higher than in the underlying soil. This probably occurred for two reasons. The potash was applied to the surface and was placed in the topdressed/thatch layer, so it would show up there first.

Table 11

Great Lakes Topdressing Study Organic Matter Data 1992 Initiated 1986		
TREATMENT	**DEPTH OF TOPDRESSING LAYER** (cm)	**AMOUNT OF ORGANIC MATTER** (grams)
SAND 3 cu ft/1000 every 3 weeks	5.0 a	5.7 cd
SAND spring & fall 12 cu ft/1000	4.7 a	6.3 bcd
80:20 mix every 3 weeks 3 cu ft/1000	4.8 a	7.8 abc
80:20 mix spring & fall 12 cu ft/1000	4.7 a	7.5 abc
60:20:20 mix every 3 weeks 3 cu ft/1000	5.0 a	8.8 a
60:20:20 mix spring & fall 12 cu ft/1000	4.9 a	8.4 ab
CHECK PLOT	1.6 b	4.5 d
SAND AERIFIED spring & fall 12 cu ft/1000	5.0 a	5.8 cd
Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.		

Table 12

Great Lakes Topdressing Study 1992

+K treatments received 5 pounds of potassium in 5 equal applications.
-K treatments received no potassium for the season.

TREATMENT	POTASSIUM LEVELS				CALCIUM LEVELS				MAGNESIUM LEVELS			
	Topdressing		0-3 inches		Topdressing		0-3 inches		Topdressing		0-3 inches	
	- K	+K	-K	+K	-K	+K	-K	+K	-K	+K	-K	+K
SAND every 3 weeks 3 cu ft/1000	67.7 g	154.3 cd	53.0 d	124.7 bc	1187.0 e	1110.0 e	977.0 cdef	959.3 def	167.0 e	168.0 e	170.0 bc	135.3 c
SAND spring & fall 12 cu ft/1000	59.0 g	152.7 cde	45.3 d	121.7 c	987.0 e	983.7 e	1082.0 bcdef	931.7 ef	138.0 e	133.7 e	188.3 ab	140.0 c
80:20 mix every 3 weeks 3 cu ft/1000	99.3 efg	162.3 bc	45.3 d	159.3 a	1703.0 d	1879.0 bcd	1283.0 ab	1380.0 a	251.7 d	281.7 bcd	226.0 a	205.3 ab
80:20 mix spring & fall 12 cu ft/1000	96.3 g	181.3 bc	47.3 d	149.3 a	1654.0 d	1658.0 d	1214.0 abc	1181.0 abcd	280.7 cd	260.0 d	197.7 ab	195.3 ab
60:20:20 mix every 3 weeks 3 cu ft/1000	98.3 fg	197.3 bc	44.3 d	145.3 ab	2152.0 a	2039.0 abc	1191.0 abcd	1248.0 ab	328.0 abc	328.3 abc	205.7 ab	222.3 a
60:20:20: mix spring & fall 12 cu ft/1000	103.7 defg	210.7 ab	41.3 d	153.7 a	2027.0 abc	2090.0 ab	1163.0 abcde	1188.0 abcd	338.7 a	318.0 abc	206.7 ab	193.0 ab
CHECK PLOT	152.0 cdef	267.0 a	44.3 d	139.3 abc	1806.0 cd	1672.0 d	1121.0 bcdef	933.0 ef	331.3 ab	313.0 abc	184.3 ab	170.7 bc
SAND AERIFIED spring & fall 12 cu ft/1000	71.7 g	169.0 bc	47.0 d	145.0 ab	1102.0 e	1126.0 e	1118.0 bcdef	907.3 f	181.3 e	167.7 e	163.3 bc	138.7 c

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Secondly, the organic matter in that layer tends to reduce the weight of the soil sample. Thus the K soil tests would read higher than in the underlying soil since most soil testing labs use a volume sampling procedure rather than taking a sample based on weight. In the underlying 0–3 inch soil depth, the soil K tests tended to be higher in plots treated with the 60:20:20 mix than in sand topdressed plots, but differences were generally small. Perhaps K present in the soil mix (60:20:20) contributed to these higher soil K tests.

The soil Ca tests in the topdressed/thatch layer pointed out the additional cation exchange capacity in the soil–based (60:20:20) topdressed plots with much higher soil Ca tests than in sand topdressed plots. This was evident in both K treated plots and those receiving no K. A similar response was observed for soil Mg tests.

LONG TERM CULTIVATION STUDIES

The effect of long term cultivation treatments on a Ram I Kentucky bluegrass turf at the Hancock Turfgrass Research Center was established in 1987. Cultivation treatments are shown in Table 13. The Toro treatment is a Toro greens aerifier with 1/2 inch tines, applied once per year in the fall (1X), spring and fall (2X) or spring, summer and fall (3X). The Core Master Full treatment utilizes 1/2 inch tines to a full depth (approximately 3 inches) while the Core Master Shallow treatment is set to penetrate only 1 inch. The Core Master was used for this particular treatment to simulate the effect of an aerifier which does not penetrate deeply into the soil as is the case for some relatively ineffective aerifiers. The use of the Core Master unit for this treatment should not be construed as an indication this aerifier will not penetrate adequately into the soil. The flexibility of being able to vary the depth of penetration of aerifier tines could be a distinct advantage under some turf conditions. The Verti–Drain was used with hollow and solid tines. Soil and thatch samples were taken from these plots in September, 1992 for evaluation of the amount of thatch found.

Data in Table 13 point out that there was no difference in the thickness of thatch found among any of the treatments. It was apparent that the plots which had significant amounts of soil brought to the surface by aerification had the soil mixed rather uniformly with the thatch layer, but the thickness of the layer of thatch or thatch and soil was not different among treatments. Further, there was no difference in the weight of organic matter found in plugs taken from these plots (Table 13), regardless of treatment. It is thus clear that cultivation and returning the soil cores to the turf has not influenced the amount of organic matter found in the thatch layer. Either thatch degradation is not taking place in spite of mixing soil with the thatch layer or the rate of thatch development is equal to the rate of thatch degradation. This is in opposition to the generally held theory that cultivation enhances thatch degradation. A more proper terminology may be thatch control, a situation where mixing soil from the cultivation cores is mixed with the thatch layer. This keeps the thatch under control and provides a more uniform rooting medium in contrast to the solid thatch layer observed on the check plots or those which receive only very shallow cultivation in this study. Because of the presence of so many stones in this plot area, evaluation of soil compaction and pore size distribution could not be carried out as planned.

RAM 1 CULTIVATION STUDY 1992 RESULTS Initiated September 2, 1987.		
TREATMENT	DEPTH OF THATCH in centimeters	ORGANIC MATTER WEIGHT in grams
TORO 1X	3.5 a	4.6 a
TORO 2X	3.3 a	4.7 a
TORO 3X	3.2 a	4.8 a
CORE MASTER FULL	3.4 a	5.2 a
CORE MASTER SHALLOW	3.4 a	5.2 a
VERTI DRAIN HOLLOW	3.2 a	4.8 a
VERTI DRAIN SOLID	3.4 a	5.4 a
CHECK	3.5 a	5.4 a
Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.		

WETTING AGENT STUDIES

In 1991, we had a study on the effect of wetting agents on water use rates of bentgrass turf. There was some indication that wetting agent influenced the water use rate. A new study was initiated during summer, 1992. Wetting agents applied included Hydro Wet and Real Kleen at 8 and 16 ounces per 1000 sq. ft. on August 18. No differences in water use rate of the bentgrass was observed in during a period from August 20 through September 4.

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HYDROJECT CULTIVATION AND INJECTION RESEARCH

While the ongoing research with the HydroJect is not supported by the Michigan Turfgrass Foundation, a brief report may be of interest to some members. Three studies will be reported here. The first was to evaluate the effect of HydroJect treatments on soil and turf conditions in Beal Gardens on campus. The Beal Gardens receive intensive traffic throughout the growing season and often have weak turf at the end of the summer. Two areas were studied: a native loam flood plain soil and the same soil modified by mixing in sand. The following treatments were applied every two weeks from the end of June to the end of August: 1 pass with the HydroJect; 2 passes; and an untreated check. There was no difference in turf quality ratings on the plots during the course of this study. However, the depth of holes from treatments was consistently deeper (40% in the native loam and over 60% in the modified soil) on plots receiving 2 passes compared to one. The holes in the native loam soil were about 40% deeper than in the sand modified soil, a result of the greater soil strength contributed by the sand grains. Surface hardness measurements taken with the Clegg impact tester showed that the treated plots had a consistently softer surface than the check. This is generally consistent with observations on other research plots evaluating the effects of the use of the HydroJect.

A second study was initiated in summer, 1991 on the practice putting green at Forest Akers East Golf Course on campus. This was continued in 1992. Treatments were 1 or 2 passes monthly with the HydroJect and a check. There were few differences in turf quality ratings. Generally, 2 passes with the HydroJect were needed to provide a consistently softer surface than was found on the check.

The HydroJect continues to prove effective for injecting phosphorus and potassium into the soil. In on-going studies, both nutrients can be found deeper in the soil on injected plots compared to surface applications at the same or even higher rates.

Studies on wetting agent injection with the HydroJect were conducted on a putting green at the Hancock Turfgrass Research Center. Because of the frequent rainfall during 1992 few differences were observed.