TURFGRASS SOIL MANAGEMENT RESEARCH-1998

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Irrigation Study on Kentucky Bluegrass

A Kentucky bluegrass management irrigation study was initiated on a sodded Kentucky bluegrass site during the summer of 1996. The soil is a native sandy loam/sandy clay loam. Three irrigation treatments were included in the study: .1 inch daily; 1.0 inch irrigation upon the appearance of wilt; and no irrigation.. The irrigation blocks were 40' x 40' with three replications of each treatment. Within each irrigation block were a series of nitrogen, herbicide, insecticide, and fungicide treatments as given in Table 1.

Broad leaf weeds counts were taken on several dates during the 1998 season. Most weeds were dandelions with some plantain. Clover had not been observed on the plots. In Table 1 all plots receiving herbicide applications had few to no broadleaf weeds and there were no statistical differences regardless of irrigation treatment. The daily irrigated plots with no nitrogen had significantly greater numbers of weeds than the other treatments for both dates reported. There was no difference in weed numbers on either date between the non-irrigated and irrigation upon the appearance of wilt plots. These data reflect the importance of proper irrigation techniques. On Kentucky bluegrass lawns susceptible to necrotic ring spot (NRS) it is recommended that light daily irrigation coupled with monthly applications of slow release fertilizers are important for an integrated approach for management of NRS. On these plots, however, there were greater weed numbers on plots receiving daily irrigation. It may be that providing daily irrigation provides ideal conditions for germination of weeds. This may be counteracted on many lawns by higher turf density due to adequate moisture provided by daily irrigation that could reduce weed numbers. On several occasions over the years unirrigated turfs that go dormant due to lack of moisture have had significant weed numbers after a good rainfall. Turf density was low due to dormancy so there was space for the weeds to germinate.

Also of interest in Table 1 is the 16 September data regarding the three fertilizer carrier treatments that had no herbicide application. The urea had statistically fewer weeds than the Milorganite and Ringer's products. This could have been due to the quick release of nitrogen from urea that may result in a denser turfgrass canopy.

In Table 2 turfgrass ratings for this study are given. These are means for all treatments. Note that on 10 June is the only date that the wilt plots received a rating that was not acceptable for a Kentucky bluegrass lawn. This indicates that at some times waiting for wilt symptoms as a basis for determining when to irrigate a home lawn is too stressful for consistently maintaining a high quality lawn. The data from 24 November in Table 2 are interesting in that the irrigation on wilt and non-irrigated treatments received higher quality ratings than the daily irrigated plots. This was likely due to the greater amount of weeds on the daily irrigated plots.

Table 1. Broadleaf Weed Counts. Kentucky bluegrass mamagement study.

			April 27, 1998 Irrigation Timing			September 16, 1998 Irrigation Timing		
N Source[1]	**N Rate[2]**	**Herbicide[3]**	**Daily***	**Wilt****	**None**	**Daily***	**Wilt****	**None**
none	——	none	20 a	12 bc	10 cd	70 a	22 cd	18 d
Urea	0.5 lb.	biannual	3 e	0 e	0 e	4 e	0 e	0 e
Urea	1.0 lb.	biannual	1 e	0 e	0 e	3 e	0 e	1 e
Urea[4]	1.0 lb.	biannual	0 e	0 e	0 e	2 e	0 e	0 e
Urea[5]	1.0 lb.	biannual	0 e	0 e	0 e	0 e	0 e	0 e
Urea[4,5]	1.0 lb.	biannual	0 e	0 e	0 e	0 e	0 e	0 e
Urea	1.0 lb.	none	12 bc	0 e	1 e	16 d	1 e	1 e
Milorganite	1.0 lb.	none	18 ab	3 de	3 e	35 b	7 e	4 e
Ringer's	1.0 lb.	none	14 abc	0 e	1 e	31 bc	1 e	3 e
Probability				0.02			0.00	
LSD at 0.05				6.9			7.7	

Means for the same date followed by the same letter are not significantly different using the LSD mean separation test.

1. Nitrogen applications were applied 23 April, 12 June, 23 July, 9 September, and 24 November.
2. Pounds of nitrogen per 1000 sq. ft. per application.
3. Pendimethalin applied on 1 June and Trimec applied on 30 July at their highest labeled rate.
4. Dursban applied on 29 July at highest labeled rate.
5. Chipco 26019 applied on 28 July at highest labeled rate.

* Approximately 1/10 inch of water per day from May through October at 4:00 a.m.

** Approximately 1 inch of water applied at the onset of wilt.

Table 2. Irrigation Timing Effects on Quality Ratings (9= excellent, 6 and above is acceptable, 1 = chlorotic or brown.)

Irrigation Treatment	24 April	10 June	21 July	24 November***
.1 " Daily	6.4	6.7 a	6.9 a	5.3 b
Onset of Wilt	6.4	4.7 b	6.2 b	6.2 a
None	6.6	4.3 c	5.4 c	6.4 a
probability	n.s.	0.00	0.00	0.00
LSD @ 0.05	——	0.3	0.4	0.2

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

*** An interaction exists with fertility treatments on this day.

Bentgrass Green High Potassium Study

A study evaluating high annual rates of potash on creeping bentgrass that was initiated in 1990 was concluded in 1997. The study was located on a sandy loam/loamy sand putting green. There were four replications of each treatment. Plot size was 5 feet by 7 feet. All applications during the season were made at the rate of 2 lbs. K_2O / 1000 sq. ft. per application. The soil tests reported in Table 3 are for samples taken in November of 1997 and were not available at the time of printing the 1997 reports. Potassium tests are typically higher in the thatch layer than in the soil. This is due to the lower density of thatch. Potassium levels in the 0-3 and 3-6 inch layers are similar to those found in previous years, reflecting the increase in soil potassium levels with increasing potash applications. In spite of the very high potassium applications (12 lbs. potash per 1000 sq. ft. annually) there is a maximum amount of potassium this soil will hold. Further, even though the soil potassium levels are low, there has never been any appearance of potassium deficiency symptoms. These plots have not been subjected to intense traffic or other stresses, however.

There was no influence of potassium rate on calcium tests. However, magnesium tests were in the 0-3 inch depth was reduced by the high potash levels. This effect of reducing exchangeable magnesium is marginal on these plots, likely because the irrigation water contains both calcium and magnesium. For this reason, it is important to take soil samples annually from sandy putting greens to monitor all nutrients including calcium and magnesium.

Table 3. Bentgrass Potassium Study. Initiated 1990 Soil test data from November 1997

	Potassium lbs./A			Calcium lbs./ A			Magnesium lbs./A		
Treatments and Rate	**Thatch**	**0-3"**	**3-6"**	**Thatch**	**0-3"**	**3-6"**	**Thatch**	**0-3"**	**3-6"**
Check Plot	223 c	67 d	33 d	1994	1350	925	219	199 a	160
Soil Test Recommendation	349 b	199 c	132 c	2142	1300	1000	210	178 ab	283
4 lbs. KCl / M annual	381 b	174 c	120 c	2119	1125	950	215	144 c	124
8 lbs. KCl / M annual	397 b	255 b	194 b	2262	1325	825	232	173 b	110
12 lbs. KCl / M annual	490 a	310 a	258 a	2070	1350	850	205	162 bc	107
12 lbs. K_2SO_4 / M annual	420 ab	343 a	263 a	1945	1325	850	212	172 b	116
Probability	0.00	0.00	0.00	0.52	0.19	0.15	0.81	0.00	0.37
LSD at 0.05	72.3	50.0	21.8	ns	ns	ns	ns	21.0	ns

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

Phosphorous Soil Test Correlation's on Sand: Peat Green

A study was established in 1993 on a an 85% sand, 15% peat green built to U.S.G.A. specifications. The grass was Penncross creeping bentgrass mowed at 3/16 inch. Not long after establishment a serious phosphorus deficiency developed with the typical purplish/gray green appearance and the turf had very little growth. The Bray P phosphorus soil test was 4 lbs. of phosphorus per acre. At the initiation of the study treatment 1 received no phosphorus; treatment 2 received 1 lb. P_2O_5 / 1000 sq. ft annually; treatment 3 received 2 lb. P_2O_5 / 1000 sq. ft annually; treatment 4 received 4 lb. P_2O_5 / 1000 sq. ft annually; treatment 5 received 4 lb. P_2O_5 / 1000 sq. ft in 1993 with no further applications; treatment 6 was treated annually at the rate recommended by the Bray P1 phosphorous soil test; and treatment 7 was treated annually at the rate recommended by the Olsen phosphorous test. Plot size was 4 ft. by 12 ft. with 3 replications of each treatment. In 1996 the plots inadvertently received 0.2 lb. phosphate per 1000 sq. ft. as part of a complete fertilizer. With that exception no phosphate has been applied since 1995 when all treatments were ceased. Interestingly, the phosphorus soil test values in Table 4 are similar to those reported in 1997.

The plots receiving no phosphorus have exhibited typical deficiency symptoms, particularly during spring and fall. Some symptoms have been evident at times on the plots that had received 1 or 2 lbs. phosphate annually. In spite of deficiency symptoms being evident on the check plot there was no difference in clipping weights taken in June. We have observed that as soils warm the symptoms tend to disappear. Perhaps the early warm year in 1998 resulted some release of phosphorus from soil organic matter, causing no differences in growth in June. The phosphorus content in clippings in the June sampling reflect the low soil phosphorus tests. Only treatments treated with phosphorus through 1995 have at least .4 % phosphorus. Most agronomists suggest phosphorus levels in clippings should be above .3-.4%.

Table 4. Sand/peat Root-Zone Phosphorous Study. Data Collected June 23, 1998

Treatment lbs P_2O_5/1000 sq. ft.	**Clipping Weights in grams**	**% P from clippings**	**Lbs. P/A soil test**	**Lbs. P/1000 sq. ft. Recommended***
1) No Phosphorus since 1992	38.9	0.19 c	7 b	4.0
2) 1 in 1995	33.9	0.20 c	10 b	4.0
3) 2 in 1995	48.9	0.29 b	12 b	3.5
4) 4 in 1995	53.5	0.43 a	27 a	3.0
5) 4 in 1993	41.8	0.19 c	10 b	4.0
6) 3 in 1995[Y]	48.0	0.45 a	26 a	3.0
7) 3 in 1995[Z]	48.1	0.45 a	37 a	2.0
Probability	0.12	0.00	0.00	
LSD at 0.05	ns	0.03	12.9	

Means in columns followed by the same letter are not significantly different using the LSD mean separation test.

Y-Based upon Bray Soil Test Recommendations

Z-Based upon Olsen Soil Test Recommendations

* Annual phosphate recommended bases on soil P test (Bray P_1 extractable) at the Michigan State University Soil Testing Laboratory.

Putting Green Root-Zone Mix Fertility Study

In the late summer of 1996 a fertilization study was initiated on greens constructed with three different root-zone mixes: 1) an 85% sand, 15% peat green built to U.S.G.A. specifications; 2) an 80% sand, 10% peat, 10% soil green with a perched water table; and 3) a native soil push-up green (sandy clay loam) with no perched water table. There are three replications of each soil treatment. Each soil block measured 40 feet by 40 feet. The grass was Penncross creeping bentgrass and it was mowed on the average of six times per week throughout the growing season at 5/32 inch.

Nitrogen treatments were applied at 3 and 6 pounds of nitrogen per 1000 sq. ft. annually. Potassium treatments included no potash, 4, and 8 lbs. of potash per 1000 sq. ft. annually. The initial and final nitrogen applications were applied as urea. The other nitrogen treatments were applied as methylene urea. All potash treatments were applied as sulfate of potash. In Tables 5, 6, and 7 give the soil sample test results for samples collected in October, 1998. Phosphorous, potassium, calcium, and magnesium are reported in Table 5. In all cases the sandy clay loam had higher soil test values. The 80:10:10 mix retained more phosphorus and potassium than did the 80:15 mix as expected because of the additional clay present. In regard to soil potassium tests, there was a statistical interaction between root-zone and potassium rate. These data are reported in Table 6. In every case the higher K application resulted in higher soil tests as would be expected.

Table 5. Putting Green Root-Zone Mix Fertility Study Soil sample test results from October 1998

Soil Type	Phosphorous	Potassium*	Calcium	Magnesium
		------------------- lb/A -------------------		
85% sand 15% peat	26 c	40 c	2601 b	253 b
80% sand 10% peat 10% soil	56 b	60 b	2836 b	236 b
Sandy Clay Loam	87 a	192 a	3129 a	519 a
probability	0.03	0.00	0.04	0.00
LSD @ 0.05	28	14	272	59

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.
*An interaction exists between soil type and potassium rate. See next table.

Table 6. Putting Green Root-Zone Mix Fertility Study Soil sample test results from October 1998 regarding potassium rate and green root-zone mix.

Root-Zone Mix	1998 Potassium Rate lbs. / 1000 sq. ft.	Pounds of Potassium /Acre	Annual K_2O Recommendation*
85% sand 15% peat	**none**	27 g	6.0 lbs.
85% sand 15% peat	**4 lbs.**	37 fg	6.0 lbs.
85% sand 15% peat	**8 lbs.**	57 e	6.0 lbs.
80% sand 10% peat 10% soil	**none**	40 f	6.0 lbs.
80% sand 10% peat 10% soil	**4 lbs.**	53 e	6.0 lbs.
80% sand 10% peat 10% soil	**8 lbs.**	87 d	5.5 lbs.
Sandy Clay Loam	**none**	147 c	4.5 lbs.
Sandy Clay Loam	**4 lbs.**	176 b	3.5 lbs.
Sandy Clay Loam	**8 lbs.**	251 a	2.0 lbs.
probability		0.00	
LSD @ 0.05		11.6	

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test
* Rates are in lbs. / 1000 sq. ft. For greens, tees, athletic fields, and establishment based on soil K test (neutral normal ammonium acetate extractable) at the Michigan State University Soil Testing Laboratory.

The importance of proper nutrient balance for sand based greens is evident in Table 7. Soils higher in sand content hold less potassium because of lower cation exchange capacities as expected. There was an interaction between nitrogen and potassium rates on these soils. Higher nitrogen resulted in lower soil potassium tests on the soils having some clay. The 85% sand tests are not affected by N rate because the tests are so low (39 and 41 lbs. per acre). This effect of higher nitrogen rates on reducing soil potassium tests is probably caused by two factors. First, with higher nitrogen there is more growth so more potassium is removed in the clippings. Second, the higher nitrogen rate likely results in more cations, probably from the production of hydrogen ions through nitrification. These hydrogen ions can replace the weakly held potassium ions increasing the potential to leach the potassium. This further supports the importance of regular soil testing and the light, frequent applications of potash on sand greens. The 8 lb. nitrogen rate is higher than recommended even for sand greens, but it is clear that higher N rates are needed on sand greens than for those having any appreciable amount of silt and clay.

Table 7. Putting Green Root-Zone Mix Fertility Study Soil sample test results from October 1998 regarding nitrogen rate and green root-zone mix.

Root-Zone Mix	1998 Nitrogen Rate	Pounds of Potassium per Acre	Annual K_2O Recommendation*
85% sand 15% peat	**6 lbs.**	39 e	6.0 lbs.
85% sand 15% peat	**3 lbs.**	41 e	6.0 lbs. .
80% sand 10% peat 10% soil	**6 lbs.**	53 d	6.0 lbs.
80% sand 10% peat 10% soil	**3 lbs.**	66 c	6.0 lbs.
Sandy Clay Loam	**6 lbs.**	175 b	4.0 lbs. .
Sandy Clay Loam	**3 lbs.**	208 a	3.0 lbs.
probability		0.00	
LSD @ 0.05		9.47	

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

* Rates are in lbs. / 1000 sq. ft. For greens, tees, athletic fields, and establishment based on soil K test(neutral normal ammonium acetate extractable) at the Michigan State University Soil Testing Laboratory.

Table 8. Putting Green Root-Zone Mix Fertility Study Clipping weights in grams from 5 May 1998 regarding nitrogen rate and green root-zone mix.

Root-Zone Mix	1998 Nitrogen Rate (lbs/1000 sq. ft.)	Clipping Weights
85% sand 15% peat	**6 lbs.**	22.76 a
85% sand 15% peat	**3 lbs.**	14.22 d
80% sand 10% peat 10% soil	**6 lbs.**	22.91 a
80% sand 10% peat 10% soil	**3 lbs.**	16.46 c
Sandy Clay Loam	**6 lbs.**	23.55 a
Sandy Clay Loam	**3 lbs.**	18.15 b
probability		0.01
LSD @ 0.05		1.54

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

Clippings were collected on 4 dates during the growing season. There were no significant differences among soils. However, there was an interaction between soil mix and nitrogen level on May 5 (Table 8). There was no significance in the amount of clippings on the greens that received 6 lbs. N annually. However, at 3 lbs. N annually there were differences among the three root-zones. These data suggest that 3 lbs. of nitrogen is not adequate for the 85:15 and 80:10:10 mixes while the native soil green has adequate levels of natural organic matter that provided some additional nitrogen. Likewise, the soil in the 80:10:10 mix provided a small amount of nitrogen that resulted release of a small amount of nitrogen compared to the 85:15 mix.

Sand Topdressing On Greens Constructed With Three Different Root-Zone Mixes

In the spring of 1995 a sand-topdressing study was initiated on greens constructed with the three different root-zone mixes described above: an 85% sand, 15% peat green built to U.S.G.A. specifications; an 80% sand, 10% peat, 10% soil green with a perched water table; and a native soil push-up green (sandy clay loam) with no perched water table. There are three replications of each soil treatment. Each soil type measures 40 feet by 40 feet. The grass was Penncross creeping bentgrass and it was mowed on the average of six times per week throughout the growing season at 5/32 inch. The plots have been topdressed every two to three weeks throughout the growing season..

Light-frequent sand-topdressing of putting greens has become a widely adopted practice. One major objective was to smooth the putting surface as mowing heights decreased. One of the stated objectives in the early years was a potential decrease in disease based on the theory that the surface would be dryer as the sand layer accumulated. In 1995 before the fertility was initiated, data were collected that concluded that with higher sand content in the root-zone mix there was more dollar spot. Inversely, there was more yellow tuft disease in the soil green. This seemed logical as dollarspot will be more active when there is less nitrogen available, and yellow tuft will be more active in wet soils. Additional statistically significant data collected in 1998 indicate the same trends are evident. There is more dollarspot on the sand green and more yellow tuft on the natural soil green in spite of a sand topdressing layer of about 1.25 inches that has accumulated since 1995. Furthermore, from root data collected in June of 1998 approximately 54% of the roots were growing in that topdressing layer, regardless of the original green root-zone mix. This study will continue through the year 2000.

Other Studies

The Alternative Golf Spike Study is a project that was a team effort in the summer of 1998. Thom Nikolai initiated this work beginning in 1995. Research efforts have continued as more shoe and spike companies have become involved. In 1998, with the collaboration of Dr. John Rogers III and his staff, the 1998 Traveling Golf Spike Study was held at six different golf courses. Data analysis was done by Doug Karcher. The report for this work appears elsewhere in these proceedings (see Rogers report). Thom will be less involved in this project in the future as he pursues completion of his Ph.D.

Two leaf mulch studies were also continued in 1998. Soil samples have been collected and are yet to be analyzed. Results continue to be positive as reported in the past. More thorough analyses are planned in 1999 as we prepare an article for publication in a scientific journal. The light-weight greens rolling study also continued in 1998 with results consistent with previous observations.

A study to compare irrigation and fertilization effects on three species of grass was initiated in 1998. Irrigation treatments were begun in late summer; nitrogen treatments in November. The grasses are Kentucky bluegrass, perennial ryegrass, and tall fescue. The study is located in open sun at the Hancock Center. The three irrigation regimes were: 0.1 inch per day; irrigation upon the appearance of wilt, and no irrigation. This study is in cooperation with David Gilstrap. During the fall, dry weather was conducive to development of rust disease. As expected, the perennial ryegrass plots had more rust than the other two species. However, plots receiving daily irrigation had little rust compared to the other treatments. This suggests that during a dry fall, some irrigation will reduce susceptibility to rust disease. Adequate nitrogen will also reduce rust symptoms as well, of course.