TURFGRASS SOIL MANAGEMENT RESEARCH REPORT-1997

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Golf Spike Survey

The number of golf courses that have banned metal spikes worldwide continues to grow. Table 1 gives a timeline of courses adopting a non-metal policy. The majority of the golf courses are located in the United States as the non-metal invasion is just beginning in Europe. Some of the reported golf courses simply suggest their members wear alternative spikes. In this scenario most members comply.

Table 1.
Number of golf courses that have banned metal spikes.*

January 1995	January 1996	January 1997	January 1998
55	185	1300	3000+

* Information provided by *Soft*spikes®

In the spring of 1997 the Golf Association of Michigan(GAM) adopted an alternative spike policy for their events. The GAM hosts a number of amateur golf events on courses throughout Michigan. However, there was growing concern that some alternative spikes might also cause damage to putting surfaces. In response to the interest expressed by the GAM it was decided to conduct a golf spike/sole survey at the Annual Michigan Turfgrass Foundation/MSU Turfgrass Field Day.

Putting The Green

The survey was conducted at the Hancock Turfgrass Research Center on a two year old Penncross creeping bentgrass putting green. The site was divided into 20 greens, each measuring 6' x 15'. Beginning in May they were mowed five times per week at 5/32" with a walk behind mower. One foot wide collars, mowed bi-weekly at 3/16", separated the greens. They were put on a light frequent sand topdressing program. On August 27, the day before Turfgrass Field Day, cups were set in the middle of each green. Early the next morning the greens were mowed. Nineteen of the twenty greens had a pair of golf shoes designated for play on that particular green. The remaining green was a check plot that received no play.

All golf shoes were size 11. Sixteen pairs were Foot-Joy® DryJoys®. Each pair had a different type of golf spike inserted into them. The remaining three pairs were Etonic® Stabilites™, Etonic® Difference® with DSS-1™ Spikes, and NIKE® Zoom Air™ with the NIKE® waffle spike.

Eight individuals trafficked each green by lacing on the appropriate shoe and putting into the cup a predetermined amount of times. One hundred twenty putting rounds were simulated by the time the survey began.

The Survey

Participants in the Field Day were asked to rate the wear on the greens from the different spikes/ shoes. The rating scale used was:

5 = No visible foot traffic.
4 = Indistinct foot traffic (very hard to see the foot traffic).
3 = Visible foot traffic, but acceptable wear.
2 = Apparent foot traffic that appears damaging.
1 = Would recommend banning these from the golf course.

Results of the survey are given in Table 2. Among the evaluators who did the ratings were 56 golf course superintendents, 45 assistant golf course superintendents, 34 golf course crew members, and 52 other (turf supply distributors, green committee chairs, etc.) for a total of 187 participants. The overall mean

appears in the "Combined" column. Product names are presented in descending order as the means appear in the "Combined" column. Few differences in evaluations occurred among the occupation of the evaluators and most of the differences were minimal.

Table 2. **Survey of evaluations of golf spikes/soles.**

	G.C. Super	Assistant	G.C. Crew	Other	Combined
Check	4.6	4.8	4.4	4.6	4.6
Etonic® Stabilities™	3.9	3.6	3.7	3.9	3.8
Green KEEPERS™	3.8	3.6	3.6	3.8	3.7
Turfmates™	3.6	3.5	3.6	3.5	3.6
Gripper™	3.5	3.4	3.5	3.4	3.5
*FLAT*SPIKES™	3.3	3.5	3.4	3.4	3.4
NIKE® Zoom Air™ Waffle Spike	3.3	3.1	3.5	3.3	3.3
FLEXI-GRIP™	3.2	3.3	3.2	3.1	3.2
*Soft*Spikes® XP™	3.2	3.1	3.2	3.2	3.2
TRED-LITE™ SP	3.1	3.2	3.1	3.3	3.2
Turfmates™ Plus	3.2	3.5	3.1	3.1	3.2
SOFTWALK™	3.1	3.2	3.1	3.1	3.1
Greenspike®	3.2	3.2	3.0	3.1	3.1
*Soft*Spikes® XT™	3.0	2.8	3.1	2.9	3.0
TRED-LITE™ MT	2.9	3.1	3.2	3.0	3.0
Etonic® Difference® DSS-1™ Spike	2.8	2.9	3.0	3.0	2.9
*Soft*Spikes®	2.5	2.7	2.8	2.7	2.7
SmartspikeS™	2.3	2.4	2.6	2.4	2.4
6 mm metal	2.0	2.0	2.1	1.8	2.0
8 mm metal	1.2	1.2	1.3	1.3	1.2
number	56	45	34	52	187

Results

As one might expect the check plot received the highest rating (least perceived injury). In this survey the only treatment with an average considered low enough to suggest the shoe/sole not be used was the 8 mm spike. The Etonic® Stabilities™ had the lowest noticeable wear evaluation (highest number in the table) among the trafficked greens. Alternative spikes in the survey with a metal component include **Turf**mates Plus™ and SOFTWALK™. Both had averages greater than "3" and even the all-metal 6 mm spike earned an overall average of "2". Many golf clubs currently have a non-metal policy. This policy impacted SOFTWALK™'s recent decision to replace its metal retractable spike with a ceramic one.

There are several interesting points from the survey results. The first point is that most alternative spike manufacturers are continually attempting to improve their product(s). This is reflected in the survey with the *Soft*spikes® products. Three *Soft*spikes® products(*Soft*spikes®, *Soft*spikes® XT™ , and *Soft*spikes® XP™) were included in the survey. *Soft*spikes® was the original product and *Soft*spikes® XP™ is the newest addition to their line. Note that with each new design the product earned a higher average on the putting surface.

Another point of interest regards the product design. Notice that had the averages been rounded-off the only non-metal spike averaging a number less than "3" would have been SmartspikeS™ . It is noteworthy that SmartspikeS™ is primarily designed for traction equal to metal spikes. Damage to infrastructure (bridges, decks, carpeting, golf carts, etc.) was also a primary concern in the design of this and other alternative spike products. While SmartspikeS™ ended up with the lowest alternative spike average the scale reflects it was not worthy of banishment from the golf course.

An alternative spike traction survey is ongoing with the MSU men's and women's golf teams. The traction survey was initiated in the fall and will conclude in the spring. The participants are rating traction on various surfaces under various weather conditions as they go through their practice rounds. The result of all

three surveys will be combined and reported in the summer/fall of 1998.

GREEN SOIL MIX CULTURAL PRACTICES STUDY

During his/her career the golf course superintendent may have to maintain greens constructed with different soil types or that have received differing topdressing programs. There is a lack of data on the effect of long-term management of putting greens growing on different soils in a situation where comparisons can be made. The objective of this research is to evaluate the effects of turf management programs on turf quality and responses for greens growing on three different soils.

The study was conducted on plots established with funding from the Michigan Turfgrass Foundation in 1993. The three greens mixes are : 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 loam-sandy clay loam) with no perched water table. There are three replications of each soil type. Each soil type section measures 60 feet by 60 feet. Furthermore, each section was split to accommodate two greens giving us a total of 18 greens. One of the two greens in each section was rolled three times/week with an Olathe roller and the other green was utilized as a check (i.e. not rolled). The grass is Penncross creeping bentgrass.

The area was mowed six times a week with a walk behind mower at a cutting height of .157 inch. Topdressing of the entire area with sand was accomplished on a light-frequent basis throughout the growing seasons. Thickness of the sand topdressing/mat layer as measured in the last 3 years is reported in Table 3. Irrigation was applied on a daily light-frequent practice with the exception of dry down periods to permit collecting data on development of localized dry spot. Pesticides were only applied on a curative basis to collecting data on any differences in disease, insect, or weed activity.

Table 3.
Thickness of Sand-Topdressing Layer

August 1995	October 1996	October 1997
14 mm	21 mm	27.5 mm

Traffic to simulate typical wear on putting greens was applied to the plots six times per week with a triplex greens-mower modified with spiked rollers in lieu of reel units. The rollers are 60 cm long and 20 cm in diameter. Six mm spikes are spaced at 2.5 cm intervals on the rollers. Front and rear (5 cm) rollers level each of the three traffic simulator units.

Statistically significant differences in disease pressure, insect activity, and moss and algae growth have been observed. Other interesting trends include development of localized dry spots and the appearance of black layer. The USGA constructed green has had the most dollar spot. However, data presented in Tables 4, 5, and 6 indicate the difference in dollar spot activity between the USGA and 80:10:10 mix is diminishing on non-rolled plots. In 1995 (Table 4) for rolled plots the USGA plots had more dollar spots than the 80:10:10 mix while the native soil had by far the least. On the unrolled plots the trends were similar except for the rating on September 1. In 1996 (Table 5) the same trends continued with the number of dollar spots on the 80:10:10 mix approaching those found on the USGA green only for the late season rating on August 22 when dollarspot activity was very high. This trend continued in 1997 (Table 6) with the exception of June rating when the 80:10:10 non-rolled green produced the greatest dollar spot activity. The number of dollar spots on the 80:10:10 unrolled plots approached those on the USGA green on other rating dates. Only the USGA green had high numbers of dollar spots on the rolled plots, however.

The likely reason for the higher dollar spot activity on the USGA green is the lower organic matter levels in this mix of 85% sand, 15% peat. Both sand and peat have very low nitrogen contents and would provide little nitrogen for the turf, making it more susceptible to dollar spot. The 80:10:10 mix has 10% native soil which would provide some nitrogen. The native soil green had very little dollarspot on most evaluation dates, particularly on the rolled plots.

It is hypothesized that the tendency for smaller differences in dollar spot activity between the USGA

and 80:10:10 non-rolled greens is the result of the light-frequent sand-topdressing program. As a sand layer is built up the turf is growing primarily in a layer of sand that will provide and hold less nitrogen than when some soil is present. It is anticipated that differences among all three root zone mixes will continue to diminish in regard to this disease as the study continues. After three years of topdressing the layer of sand and thatch (mat) is at 27.5 mm (about 1 inch). When most of the roots are found in this layer, fertilization programs must be based on managing a sand green rather than a native soil green. This has been apparent in potassium fertilization studies as well.

Table 4.

Dollar Spot Data 1995

Soil Type	June 17		August 15		September 1	
	rolled	check	rolled	check	rolled	check
USGA	54	54	130	197	486	594
80:10:10	8	11	17	83	88	478
Native	3	3	2	2	30	17

Table 5.

Soil Type	June 14		June 24		August 2		August 22	
	rolled	check	rolled	check	rolled	check	rolled	check
USGA	20.3	41.3	100	152	24	56	201	467
80:10:10	0.3	14.0	3	75	2	23	27	329
Native	0.3	1.7	2	11	1	3	24	73

Table 6.

Dollar Spot Data 1997

Soil Type	June 24		July 23		August 20	
	rolled	check	rolled	check	rolled	check
USGA	28	63	47	111	60	100
80:10:10	4	72	9	97	4	69
Native	6	11	5	11	2	1

The comparison of rolling on differently constructed greens that are sand topdressed is vital, particularly in light of the number of courses having more than one type of green construction present. One half of each plot was rolled with an Olathe roller 3 times per week during the growing season. The impact of lightweight greens rolling caused a major reduction in dollar spot. There is no obvious reason for this response. Rolling firms the surface and reduces the tendency for puffy growth. Other soil measurements (thatch level and composition) may provide further insight into this response. It is clear that rolling has more to offer than increases in green speed.

Few color and quality differences occurred between rolled and non-rolled plots with acceptable ratings being recorded on most dates. Color and quality ratings for 1997 are reported in Tables 7 and 8. However, in September of 1996 it was observed that one of the 80:10:10 greens that was rolled 3 times per week began to discolor. Black layer was found on this plot area. For this reason core cultivation planned for the fall of 1996 was canceled to observe if the black layer would form on other plots in 1997. During the summer of 1997 all replications of the 80:10:10 rolled plots formed the black layer. The lower quality ratings on October 10 is associated with the presence of black layer. Quality ratings were often slightly lower on check plots because the rolled plots always displayed less dollar spot and localized dry spot. The reason

that black layer appeared on the 80:10:10 plots and not on the USGA plots in not clear.

Table 7.

Color Ratings 1997 9=excellent, 6 and above is regarded as acceptable.

Soil Type	May 30		June 13		July 11		August 10		October 10	
	rolled	check	rolled	check	rolled	check	rolled	check	rolled	check
USGA	6.9	6.6	7.1	7.0	7.5	7.6	8.0	7.2	7.1	7.2
80:10:10	7.2	7.0	7.5	7.4	7.0	7.5	7.8	7.0	5.9	7.2
Native	7.6	7.6	7.7	7.6	7.6	7.6	8.0	7.4	6.8	6.8

Table 8.

Quality Ratings 1997 9 = excellent, 6 and above is acceptable.

Soil Type	May 30		June 13		July 11		August 10		October 10	
	rolled	check	rolled	check	rolled	check	rolled	check	rolled	check
USGA	6.2	5.8	6.6	6.3	7.8	6.8	7.8	6.9	6.7	6.7
80:10:10	6.9	6.6	7.2	7.0	7.4	6.8	7.5	6.5	5.1	7.1
Native	7.1	7.4	7.3	7.0	7.6	7.1	8.0	7.3	6.4	6.2

Fertilizer studies

Six different fertility programs have been evaluated on these plots. The fertility program design was a 2x3 factorial with two levels of nitrogen (3 or 6 lbs. N/1000 ft^2/ year) and three levels of potassium (soil test recommendations, 4, or 8 lb. K2O/1000 ft^2/ year). The seasons initial and final nitrogen applications were applied as urea. The other nitrogen treatments are made with granular applications of methylene urea. All potassium treatments are applied as sulfate of potash. Data collection from this study included color and quality ratings, annual soil tests, clipping analysis, Stimpmeter ratings, disease counts, and turfgrass rooting. This portion of the study was initiated in August of 1996, thus 1997 has been the first full year of the fertility regime. Fertilizer application dates are reported in Table 9.

Table 9.

Fertilizer Application Dates 1997

Date applied	Pounds of Nitrogen/ft^2		Pounds of Potassium/ft^2		
Annually	6.0 lbs.	3.0 lbs	8.0 lbs.	4.0 lbs.	soil test
May 16th			2.0 lb./ft^2	1.0 lb./ft^2	
May 20th	1.0 lb./ft^2	0.5 lb./ft^2			
June 24th	1.0 lb./ft^2	0.5 lb./ft^2			
July 3rd			1.0 lb./ft^2		1.0 lb./ft^2
July 30th	1.0 lb./ft^2	0.5 lb./ft^2	1.0 lb./ft^2	1.0 lb./ft^2	1.0 lb./ft^2
August22nd	1.0 lb./ft^2	0.5 lb./ft^2			
September 12th			1.0 lb./ft^2		*
October 8th	1.0 lb./ft^2	0.5 lb./ft^2	1.0 lb./ft^2	1.0 lb./ft^2	*
November 26th	1.0 lb./ft^2	0.5 lb./ft^2	2.0 lb./ft^2	1.0 lb./ft^2	*

* Rate varied for each plot depending upon the soil test results from October 1996.

Results

On August 20, 1997 an interaction between soil type, nitrogen level, and light-weight green rolling was observed regarding dollar spot activity. The data is presented in Table 10. A pattern exists regarding soil type, nitrogen rate, and rolling. Not surprisingly, nitrogen rate reduced dollar spot numbers. It is interesting that light weight green rolling had a greater impact on reducing dollar spot than did nitrogen rate.

Table 11.

Nitrogen and Rolling Effects on Dollar Spot Counts - August 20, 1997

Soil Type	Rolled 3x/week		Non-rolled plots	
	0.5 lbs. N/app.	1.0 lbs. N/app.	0.5 lbs. N/app.	1.0 lbs. N/app.
USGA	60 c	60 c	116 a	83 b
80:10:10	5 d	4 d	71 bc	67 c
Native	2 d	2 d	2 d	2 d
probability @ 0.05	0.04			

On June 24 an interaction was recorded regarding potassium rate and green rolling. Data is reported in Table 12. There was no effect of potash on the number of dollar spots on the rolled plots. However, for unrolled plots, the highest rate of potash has more dollar spots that did the lower rates..

Table 12.

Dollar Spot Observations - June 24, 1997

Annual Potassium Rate	Rolled 3x/week	None rolled plots
8 lbs.	11 c	63 a
4 lbs.	13 c	36 b
Soil Test	15 c	47 b
probability @ 0.05	0.03	

Stimpmeter data collected on the fertilized plots is reported in Table 13. For all dates light weight green rolling had a greater impact on green speed than did nitrogen treatment.

Table 13.

Stimp Meter Data - 1997 Data reported in feet.

Soil Type	Rolled 3x/week		Non- rolled	
	June 4, 1997			
	0.5 lbs. N/app.	1.0 lbs. N/app.	0.5 lbs. N/app.	1.0 lbs. N/app.
USGA	10.3	9.9	9.0	8.6
80:10:10	10.2	10.2	8.8	8.4
Native	9.9	9.6	8.7	8.4
	June 20, 1997			
USGA	9.6	9.4	8.1	8.1
80:10:10	9.6	9.8	8.1	8.3
Native	9.3	9.6	8.0	8.3
	July 11, 1997			
USGA	11.5	11.3	10.3	10.4
80:10:10	11.6	11.7	9.8	9.9
Native	10.9	11.2	10.0	10.3

PHOSPHOROUS SOIL TEST CORRELATION ON SAND:PEAT GREEN

This study was established in 1993 on an 85% sand, 15% peat green built to U.S.G.A. specifications. The grass is 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 turf had very little growth. The Bray P[1] phosphorus soil test was 4 lbs of phosphorus per acre. A number of golf course superintendents present at the Turfgrass Field Day have recognized these deficiency symptoms.

Treatment 1 received no phosphorus; treatment 2 received 1 lb. P_2O_5 per 1000 sq. ft. annually;

treatment 3 received 2 lbs. P_2O_5 per 1000 sq. ft. annually, treatment 4 received 4 lbs. P_2O_5 per 1000 sq. ft. annually; treatment 5 received 4 lbs. P_2O_5 per 1000 sq. ft. in 1993 with no further applications; treatment 6 was treated annually at the rate recommended by the Bray P1 phosphorus soil test; and treatment 7 was treated annually at the rate recommended by the Olsen phosphorus test. Plot size was 4 ft. by 12 ft. with 3 replications. In 1996 the plots inadvertently received 0.2 lb. phosphate per 1000 sq. ft. so no further phosphorus was applied that year. No further phosphorus has been applied.

In October of 1997 the soil samples were collected for analysis. Table 14 gives the annual phosphate recommendations based on soil P tests from the MSU Soil Testing Laboratory.

Table 14.

Annual phosphate (P_2O_5) recommendations based on soil P test (Bray P_1 extractable) at the Michigan State University Soil Testing Laboratory.

Soil test, lbs. P/acre ...	....Apply the following rates in pounds per 1000 sq. ft. under the following conditions.	
	Lawns, general grounds, and fairway	Greens, Tees, Athletic Fields, and Establishment
10 or less	3.0	4.0
11-15	3.0	3.5
16-20	2.5	3.5
21-25	2.0	3.0
26-30	1.0	3.0
31-35	0.5	2.5
36-40	0.5	2.0
41-45	0	1.5
46-50	0	1.0
51-55	0	1.0
56-60	0	0.5
61-66	0	0.5
66-70	0	0

In Table 15 are given the P treatments, the Bray soil tests at the end of each season, and the recommended amount of phosphate to apply each season. In 1995, 0.2 lbs. P/M^2 was applied on all plots in a complete fertilizer and in 1997 no P was applied. Soil tests reveal the importance of annual phosphorous on sand based greens, tees, and other intensively maintained turfs. The P tests in October, 1997 indicate that phosphorus levels have decreased compared to 1995 tests on all plots that had reasonably high P soil tests. This reflects removal of phosphorus in the clippings removed from the green. Since there was little growth on the low P plots there was little removal of phosphorus.

Table 15.

USGA Green Phosphorus Correlation Study

	1995		**1997**	
Treatment	P_2O_5 applied lbs./M^2	Soil Test results in lbs./A	P_2O_5 applied lbs./M^2	Soil Test results in lbs./A
1	0	5.0 d	4.3 c	4.0
2	1	9.3 cd	9.3 bc	4.0
3	2	28.3 bc	17.0 b	3.5
4	4	62.0 a	41.3 a	1.5
5	0	10.7 cd	9.3 bc	4.0
6	3*	46.7 ab	37.7 a	2.0
7	3**	47.0 ab	38.3 a	2.0

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

* Based on Bray soil test recommendations.

** Based on Olsen soil test recommendations.

NITROGEN EFFECTS ON WEEDS IN KENTUCKY BLUEGRASS

A study was initiated in 1991 to evaluate the effects of mulching either oak or maple leaves into a "Midnight" Kentucky bluegrass turf at the rate of 100 lbs of dry leaves per 1000 sq. ft. (approximately ankle height in depth). Check plots receiving no mulched tree leaves were included. A nitrogen variable was included in the study to observe if nitrogen would enhance the degradation of the tree leaves. All cool season grasses require some nitrogen to provide enough growth and density to compete with weedy species. Nitrogen was applied at 4 lbs. N per 1000 sq. ft. annually with either a spring or fall emphasis. Spring emphasis applications were applied in April, May, July, and August (1 lb. N per month) while the fall program received nitrogen in June, July, September, and October. A check plot with no nitrogen was also included. There were three replications of each treatment. Plots measured 4 feet by 12 feet. The leaf mulching portion of this study is reported by Thom Nikolai elsewhere in this proceedings. Tables 16 and 17 focus on the nitrogen variables included in the study.

August of 1995 was the last time the plots received a herbicide application. Broadleaf weed counts from 1997 are reported in Table 16. On May 22 flowering dandelions were counted on each plot. The no nitrogen plots had far greater dandelion counts than either nitrogen timing applications. Dandelions are biennials that flower during the second year. On May 23, July 15, and August 25 total broadleaf weed counts were taken. The no nitrogen plots always had the highest number. The timing of nitrogen applications had no impact on the weed population.

Table 16.

Effects of Nitrogen on Weed Populations on a "Midnight" Kentucky Bluegrass Turf - 1997

	Number of dandelion flowers.	Number of broadleaf weeds per plot		
	May 22	May 23	July 15	August 25
No nitrogen	59 a	10 a	16 a	25 a
Spring*	5 b	2 b	1 b	3 b
Fall*	3 b	1 b	1 b	3 b
lsd @ 0.05	19.0	3.7	6.6	11.5
Probability	0.00	0.00	0.00	0.00

Soil test results on these plots from May of 1997 are reported in Table 17. Applying nitrogen resulted in significant decreases in both phosphorus and potassium in spite of the fact that clippings are returned to these plots. This points out the benefit of monitoring soil tests even when clippings are returned. There was no effect on either calcium or magnesium tests, however.

Table 17.

Effects of Nitrogen on soil test results in the 0-3" depth after 6 years of treatments.

	Results from May of 1997				
	pH	Phosphorous	Potassium	Calcium	Magnesium
No nitrogen	7.5	33 a	104 a	1736	351
Spring*	7.5	22 b	60 b	1736	367
Fall*	7.4	22 b	72 b	1788	366
lsd @ 0.05	—	3.6	13.6	———	——-
Probability	n.s.	0.00	0.00	n.s.	n.s.

Means in the same columns followed by the same letter are not significantly different at the 5% level. Using the lsd range test.

BENTGRASS GREEN HIGH POTASSIUM STUDY

Studies evaluating high annual rates of potash on creeping bentgrass that were initiated in 1990 were continued in 1997. The study is located on a sandy loam to loamy sand green. There were four replications of six different treatments in the study. Plot size was 5 feet by 7 feet. All applications during the season were

made at the rate of 2 lbs. K_2O per 1000 sq. ft. per application. The soil samples reported are from October of 1996 because soil test results were not available at the time of printing the 1996 reports. Potassium and calcium soil tests are reported in Table 18. Potassium and calcium are both cations that compete for exchange sites. As observed in the past there was an increase in potassium soil tests with increasing K rates. And regardless of applying higher rates of potash there is no increase in potassium test beyond 4 lbs. potash per year. Calcium levels tend to decrease with higher potash applications, but there is some variability in the data. The final column in Table 18 gives the recommended amount of K_2O that should be applied per 1000 sq. ft. due to the soil tests results. Note there is little difference in the recommended amount of potash to apply after applying 4 or 12 lbs of potash on this sandy loam.

Table 18.

Bentgrass Green High Potassium Study. Soil K Tests Results from 0-3 Inch depth - October 1996.

Treatments	Potassium lbs/A	Calcium lbs/A	Recommended annual K_2O from soil test results.
Check (no potash applied)	64 d	1639 a	6.0
Soil Test Recommendations	101 c	1389 ab	5.5
4 lbs. KCl / M / Year	144 b	1625 a	4.5
8 lbs. KCl / M / Year	184 a	1481 ab	3.5
12 lbs. KCl / M / Year	171 a	1239 b	4.0
12 lbs. K_2SO_4 / M / Year	179 a	1556 a	3.5
Probability	0.00	0.04	
lsd @ 0.05	22.7	261.3	

OTHER STUDIES

Several other studies were conducted in 1997. The project to evaluate management practices to maintain sod grown on subsoil was continued during 1997. There are nine blocks in this study with three irrigation treatments and three replications. Kentucky bluegrass sod was laid on these plots in 1995. Treatments include: nitrogen rates of 0, 2, 4, and 6 lbs. per 1000 sq. ft. annually; core cultivation treatments applied 0,1, or 2 times annually or HydroJect treatments applied 0,1, or 3 times per year; and organic nitrogen or urea as the nitrogen source. The unirrigated plots had significant wilt on a few dates in 1997. Higher nitrogen plots tended to wilt more quickly than lower nitrogen plots. Samples have been collected to evaluate physical properties of the soil on these suhsoil plots. Rooting data are also being analyzed. Some of these analyses are yet to be completed.

In 1999, the Sod Producers International will be held on the M.S.U. campus and will be cohosted by M.S.U. and the Sod Growers Association of Michigan. The land immediately west of the Hancock Center across Farm Lane will be the site for the equipment show and demonstrations. In cooperation with sod growers and companies that serve the sod industry in Michigan, Mark Collins seeded the site with Kentucky bluegrass this past August. It will be maintained as sod in preparation for that event. We are proud to be cohosting their annual Field Day.