on August 15 and September 1 were considerably higher for the unrolled plots. In a traffic study done several years ago, the use of a heavy vibrating roller (with golf shoe soles and spikes attached) caused significant increases in dollar spot. The interpretation was that the roller was spreading the dollar spot organism from one plot to another. Perhaps there was injury caused by the roller, making the grass more susceptible to infection. But in this study there was no significant effect of rolling on dollar spot.

There was some tendency for more dollar spot on the U.S.G.A. soil than on the other soils (Table 9), with significant differences on June 7 and September 1. Although the data were not statistically different on July 27 and August 15, there were much higher numbers on both dates for the sand:peat green. The 80:10:10 soil had a few more dollar spots that the native soil, but differences were not significant. The greater number of dollar spots on the sandier soil most likely reflects a lower amount of nitrogen available to the turf. There was no yellow tuft on the sand:peat green, while a few spots were present on the other soils.

GOLF SPIKE STUDY

On August 1 a demonstration was initiated for visitors of the August 17th Field Day to observe the impact that three different golf shoe spikes had on the greens described above. Soft Spikes and Green Spikes were donated by the prospective companies and the MTF donated money for the purchase of three identical pairs of golf shoes. Soft Spikes were screwed into one pair of shoes, Green Spikes in another, and metal spikes remained in the third pair. For 17 straight days an individual made the same amount of passes(20 to 40 passes daily) on each 1' x 15' plot with the appropriate shoe. We never anticipated collecting data from these plots as they were initiated for demonstration purposes. However, Field Day was literally awash in 1995 when flooding was caused by the 1.4 inches of rain that fell that morning. So on August 18 ball roll data was taken on all 54 plots using a Stimpmeter so the time and effort put into the study was not a complete waste of time.

Data are given in Table 10. Numbers reflect the averages for the golf spike data the soil types data and the rolling data. The data cannot be analyzed statistically by traditional methods because complexity of the design. As has been determined in other studies around the country the metal spikes gave lower ball roll distances than the Soft Spikes and Green Spikes. Visually, the steel spikes resulted in more surface disruption of the green with spike marks and lifting of bentgrass stolons. It was interesting to note that on August 18 the USGA green was approximately a foot faster than the other two soil type greens. This differed from the greens rolling study for which no differences existed in green speed among soil types. However, no traffic was applied to that study in 1995. It was determined to run the demonstration again to see if we could duplicate the results. The Stimpmeter readings taken in September fluctuated more with inconclusive results although the USGA green gave the highest readings.

PHOSPHORUS SOIL TEST CORRELATION ON A SAND:PEAT GREEN

This study was established in 1993 on the 85% sand, 15% peat green built to U.S.G.A. specifications described above. The grass is Penncross creeping bentgrass mowed at 3/16 inch. When the study began there was serious phosphorus deficiency evident and Bray P_1 phosphorus tests of about 4 lbs per acre. Treatment 1 receives no phosphorus; treatment 2 receives 1 lb. P_2O_5 per 1000 sq. ft. annually; treatment 3, 2 lbs. annually; treatment 4, 4 lbs. annually; treatment 5, 4 lbs. P O_2 $_5$ in 1993 only with no further applications; treatment 6 is treated annually at the rate recommended by the Bray P_1 phosphorus soil test; treatment 7 is treated annually at the rate recommended by the Olsen phosphorus test. Plot size is 4 ft. by 12 ft. with 3 replications.

Table 11 gives the treatments, the Bray soil tests at the end of each season, the amount of phosphate applied each year, the Olsen soil tests for 1995, and the phosphate recommended for 1996. The check plot has shown no change in phosphorus test over the three years (4 to 5 lbs P per acre). Applying 1 lb. P_2O_5 annually increased the test from 4 to about 9. With 2 lbs. applied annually, the test increased to about 28 lbs. P. When 4 lbs. are applied annually, the test increased to 12 lbs. after one year, 32 lbs. after two years, and 62 lbs. at the end of 1995. The recommendation for next year is only 0.5 for 1996. When the Bray and Olsen tests are used for recommendations the soil tests have increased gradually, with both having recommended the same amount of phosphate for a total of 10 lbs. over the three years. Comparing this to the 4 lbs. P_2O_5 annual treatment which received a total of 12 lbs. over the three years, the soil tests are at 62 for this treatment and 47 for the two soil test treatments. These data are remarkably consistent and give us confidence that the soil test recommendations based on these two tests are giving dependable results. Although the Bray and Olsen tests have not increased the P soil tests as fast as might be preferred.

Turf color and quality ratings are given in Table 12. The check plot has serious phosphorus deficiency throughout the season. The 1 lb. annual treatment has less serious deficiency symptoms than the check as would be expected, but turf quality is generally unacceptable. When 2 lbs. are applied annually, turf quality was acceptable although the soil tests were still moderately low. It may be that 28 lbs. P per acre is adequate for greens turfs based on turf quality ratings, but there could be stress or disease relationships which would require higher P rates. The plots that were treated with 4 lbs. phosphate at the beginning of the study in 1993 have continued to exhibit phosphorus deficiency symptoms quite often. As

has been observed previously, the deficiency symptoms are most evident early in the year but disappear later in the summer. This occurred in 1995 as well.

TOPDRESSING/HYDROJECT TREATMENT STUDY

The long-term greens topdressing study was continued in 1995. Treatments outlined in Table 13 were applied as in the past. The topdressing materials utilized were straight sand; 80% sand, 20% peat; and 60% sand, 20% peat, 20% soil. Treatments are 3 cu. ft. of topdressing material per 1000 sq. ft. applied at 3 week intervals; 12 cu. ft. applied in spring and fall; an untreated check; and the 12 cu. ft. applied in spring and fall after cultivation with a vertical operating aerifier having 1/2 inch tines and a 2-inch by 2-inch spacing. Plot size was 4 ft. by 12 ft. These treatments have been applied since 1986. In 1993, the plots were split with one-half treated weekly with the Hydroject. This was continued in 1995.

Quality rating data were collected in 1995 with numbers similar to those reported in the past. In 1994, there were fewer localized dry spots on the Hyrdoject treated plots. To substantiate this, no irrigation was applied to these plots for extended periods in 1995. Visual estimates of localized dry spots were taken in July, August, and September (Table 13). During July and early August, the extensive wet weather prevented the development of localized dry spots. But in late August and through September, the lack of rainfall permitted drying of the plots. The plots treated with the Hydroject had significantly less localized dry spot development with the greatest differences occurring in September. These numbers are summarized in Table 14. Certainly the Hydroject provides some water to the treated plots, but not nearly enough to meet the evapotranspiration needs of the turf during this period. Our conclusion is that the Hydroject reduces the tendency for development of localized dry spots. We have seen this in some earlier studies. Golf course superintendents have reported less susceptibility to localized dry spots on greens when treated regularly with the Hydroject. In addition, plots which have been topdressed with sand were somewhat more susceptible to localized dry spots than those which received some peat or soil in the topdressing.

Additional data taken included dollar spot counts, dew ratings, and soil moisture content and are reported in Table 15. The soil moisture measurements were done on soil samples taken to a depth of 3 inches with moisture content determined gravimetrically. There was no difference in the dollar spot counts. The dew ratings were not significantly different in the overall study on July 15, but the differences were significant on July 24. On July 21 the Hydroject treated plots had 15.9% moisture and the non-treated plots had 9.1%. On Sept. 19 the % moisture was 19.4% and 12.2%, respectively.

LATE FALL NITROGEN APPLICATIONS ON ANNUAL BLUEGRASS

In Fall, 1994 a study was initiated by two undergraduate students, Marc McMullen and Ed Borst, to evaluate the effect of application of several experimental nitrogen fertilizers on an annual bluegrass fairway turf. The carriers utilized are listed in Table 16. Other than urea, all carriers are experimental nitrogen carriers from the following companies: Lesco, Anderson, and Sherritt. The Sherritt Org. is an organic carrier. These materials were applied at the rate of 1 lb. N per 1000 sq. ft. on the dates shown in Table 16.

Conclusions from this study are consistent with results from studies conducted several years ago. When nitrogen is applied as early as October 15, there is little residual effect the following spring. Applications in early November give somewhat more response the following spring, while when applied in mid-November the spring response is much longer. This is particularly true for the water soluble urea. When soluble N sources are utilized, the N should be applied later in the fall to achieve a good residual color the next spring.

If the nitrogen is applied about the time growth ceases, soluble nitrogen is taken up by the turf without causing any significant increase in growth (and mowing). This usually occurs in early to mid-November, but varies with the year and location in the state. With more nitrogen in the plant, this increases the potential for photosynthesis during sunny days in November. This should result in an accumulation of carbohydrates since growth has ceased. The greater levels of carbohydrates will be available for the plant the next spring. We are still of the opinion that the N should be predominantly soluble N with no more that 25% slow release N. The objective is to get nitrogen into the plant soon after application. Since winter arrived early in 1995 there may not be as much benefit in increased carbohydrates from late fall N applications in the spring of 1996.

OTHER STUDIES

Several other studies were conducted in 1995. The long-term cultivation study on an annual bluegrass fairway turf had minor differences during the growing season, but nothing of major importance.

Table 11.

USGA Green Phosphorus Correlation Study										
	1993		1994	1994		1995	1995		1995	1996
Treatment	P_2O_5[X] Applied lbs/1000	**Bray Soil Test lbs/acre**	P_2O_5 Recommended lbs/1000	P_2O_5 Applied lbs/1000	**Bray Soil Test lbs/acre**	P_2O_5 Recommended lbs/1000	P_2O_5 Applied lbs/1000	**Bray Soil Test lbs/acre**	Olsen Soil Test lbs/acre	P_2O_5 Recommended lbs/1000
1	0	**3.7 b**	4.0	0	**4.0 b**	4.0	0	**5.0 d**	6.0 c	4.0
2	1	**4.0 b**	4.0	1	**3.3 b**	4.0	1	**9.3 cd**	8.0 bc	4.0
3	2	**5.0 b**	4.0	2	**8.3 b**	4.0	2	**28.3 bc**	16.0 b	3.0
4	4	**12.3 a**	4.0	4	**32.3 a**	2.5	4	**62.0 a**	33.0 a	0.5
5	4	**14.7 a**	3.5	0	**9.3 b**	4.0	0	**10.7 cd**	8.0 bc	3.5
6	3.5[Y]	**14.7 a**	3.5	3.5	**26.3 a**	3.0	3	**46.7 ab**	30.0 a	1.0
7	3.5[Z]	**11.7 a**	3.5	3.5	**29.3 a**	3.0	3	**47.0 ab**	29.0 a	1.5
Means in columns followed by the same letter are not significantly different at the 5% level using the LSD range test.*										

X - Annual application
Y - Bray recommendation
Z - Olsen recommendation

Table 12.

USGA Green Phosphorus Correlation Study, 1995 Color & Quality Ratings						
P_2O_5 Applied lbs/1000	Quality Ratings (9 = Best)					
	May 1	June 1	July 1	Aug. 1	Sept. 1	Season Average
0# / Year	1.17 e	1.00 d	1.50 c	1.67 b	2.50 b	1.57 c
1# / Year	4.83 d	4.50 c	6.50 ab	7.00 a	6.67 a	5.90 b
2# / Year	6.17 ab	6.50 a	7.00 a	7.17 a	6.83 a	6.73 a
4# / Year	6.17 ab	6.50 a	7.00 a	7.33 a	6.83 a	6.77 a
4# in 1993 only	5.33 c	5.67 b	5.83 b	7.00 a	6.50 a	6.07 b
Bray Soil Test	5.83 b	6.50 a	7.00 a	7.50 a	7.00 a	6.77 a
Olsen Soil Test	6.33 a	6.50 a	7.00 a	7.33 a	6.83 a	6.80 a
Means in columns followed by the same letter are not significantly different at the 5% level using the LSD range test.*						

Table 13.

Great Lakes Topdressing Study Percent Localized Dry Spot												
Treatment	Rate	Frequency	Hydro-ject	July 15	July 18	July 20	July 28	Aug. 1	Aug. 28	Sept. 5	Sept. 14	Sept. 28
Sand	$3ft^2$	3 weeks	yes	0	1	1	11.7	18.5	4	5.7	3 d	4.3 d
Sand	$3ft^2$	3 weeks	no	25	15	16.7	30	18.5	10.7	38.3	66.7 ab	71.7 a
Sand	$12ft^2$	Spr./Fall	yes	0	2.7	1.7	16.7	13.8	3	15.7	7 cd	7.7 d
Sand	$12ft^2$	Spr./Fall	no	25	14.3	20	27	8	30	58.3	85 a	73.3 a
80sand:20peat	$3ft^2$	3 weeks	yes	0	0	1	3.3	7.3	2	1	3.3 d	2 d
80sand:20peat	$3ft^2$	3 weeks	no	0	10	11	25	16.8	6.3	25.7	60 b	65 abc
80sand:20peat	$12ft^2$	Spr./Fall	yes	0	0	0	5	0.8	1.3	2	3 d	1 d
80sand:20peat	$12ft^2$	Spr./Fall	no	0	6.7	6.7	27.7	19.3	4.7	23	55 b	53.3 c
60sand:20peat :20soil	$3ft^2$	3 weeks	yes	0	0	0	3.3	5.9	1	2	4.3 d	1.3 d
60sand:20peat :20soil	$3ft^2$	3 weeks	no	0	0	1	29.7	7.5	2	10	28.3 c	55 bc
60sand:20peat :20soil	$12ft^2$	Spr./Fall	yes	0	1	1	11	28.1	2.7	5.3	6.7 cd	8.3 d
60sand:20peat :20soil	$12ft^2$	Spr./Fall	no	21	10	14.3	40	10.4	23.3	22.7	65 ab	71.7 a
Check	-----	---------	yes	0	0	0	0	23	0	0	0 d	0 d
Check	-----	---------	no	0	0	0	2.7	8.3	0	13.3	18.3 cd	13.7 d