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.

The high potassium studies which initiated in 1990 were continued in 1995. Rates of application range from none to 12 lbs. K_2O per 1000 sq. ft. annually. These treatments have been applied to Kentucky bluegrass, annual bluegrass fairway or creeping bentgrass greens turfs. Because of the early cold weather, soil samples were not collected in November, 1995. There were no visual responses of these grasses to the potassium treatments. The plots were subjected to two different dry down cycles, one in July, the second in late August and early September. While some differences in wilting and localized dry spots became evident on the bentgrass plots, there was no apparent relationship to treatment.

The irrigation program modeling study being conducted by Charles Kome for his Ph.D. was completed this year. Although this project was not funded by the M.T.F., the work was done on the plots with the time domain reflectometry (TDR) installation that was part of the study conducted by Mike Saffel which the M.T.F. supported. Kome measured soil moisture with the TDR over three seasons, 1992-1994. The irrigation treatments were: 1) applying .1 inch water daily, regardless of rainfall; 2) returning the soil to field capacity (maximum available water) on a daily basis; and 3) irrigating with 1 inch of water on the appearance of wilt. The soil is a sandy loam, approaching a sandy clay loam. He evaluated two irrigation models currently used for field crops, SCHEDULER from the Soil Conservation Service and modified by Dr. V. F. Bralts and co-workers in the Agricultural Engineering Department at M.S.U., and SALUS which is used by Dr. J. T. Ritchie of the Crop and Soil Sciences Department at M.S.U.

Kome concluded that the TDR is a useful tool to measure soil moisture, consistent with that of Saffel. Both models predicted that both daily irrigation treatments applied too much water, resulting in conditions which would lead to excessive water use and leaching during wet periods. This occurred because in all three years there was greater than normal rainfall. This could be solved for the daily application of .1 inch water by not irrigating during wet periods. During the few extended dry periods, this treatment did not apply enough water to keep the soil moisture in the desired range. By returning the soil to field capacity on a daily basis, the soil was kept near the maximum available water holding capacity on a regular basis. When rainfall occurred, this resulted in excess water conditions. In retrospect, it would have been better to have returned the soil to a lower moisture content, perhaps 80% of field capacity. By doing this, rainfall would not have resulted in the excess water condition unless a heavy rainfall occurred. This research points out the importance of understanding how much water the soil can hold in the root zone and how much water can be expected to be lost by evapotranspiration in order to know how much water should be applied for good water management.

Table 1.

Greens Rolling Study-Stimpmeter Readings, Feet-1995
Day Rolled

Treatment	June 5	June 12	June 14	July 7	July 10	July 12	July 19	July 24	July 26	July 31	Aug. 18	Aug. 23	Season Average
Rolled	8.1 a	7.9 a	9.1 a	10.9 a	10.1 a	11.3 a	10.7 a	10.5 a	9.8 a	8.9 a	9.7 a	10.4 a	9.7 a
Not Rolled	6.9 b	6.7 b	7.9 b	9.9 b	9.3 b	9.9 b	9.3 b	9.4 b	8.5 b	8.2 b	8.6 b	9.12 b	8.67 b

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

Table 2.

Greens Rolling Study-Stimpmeter Readings, Feet-1995
One Day After Rolling

Treatment	June 13	July 25	July 27	Aug. 15	Aug. 24	Season Average
Rolled	7.9	8.5 a	8.8 a	8.2	9.9 a	8.70 a
Not Rolled	7.4	8.2 b	8.2 b	8.1	9.2 b	8.24 b

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