# TURFGRASS SOIL MANAGEMENT RESEARCH REPORT - 1985

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This report summarizes the turf soil management research conducted primarily at the Hancock Turfgrass Center in 1985 and which was supported financially in large part by the Michigan Turfgrass Foundation. We are most grateful for this support and encouragement.

## LONG TERM NITROGEN FERTILITY PROGRAM EFFECTS ON THREE CREEPING BENTGRASSES MAINTAINED UNDER GREENS CONDITIONS

The treatments outlined in Table 1 have been applied for 4 years to the blocks of Emerald, Penneagle and Penncross creeping bentgrasses. These grasses have been maintained under greens conditions and are growing on a modified loamy sand soil. Plot size was 4 feet by 6 feet with 3 replications. In previous years the Emerald plots tended to provide a very open turf, especially at the lower nitrogen rates. And the Emerald was highly susceptible to dollarspot as well. Quality ratings in 1985 (Table 1) indicated smaller differences between Emerald and Penneagle in particular, although some variability in data occurred. Frequently, Penncross had higher quality ratings for given month than the other grasses except for the August 23 rating date. There was no apparent cause for the low ratings on all grasses on that date. Some of the plots, particularly the Penncross plots and the Penneagle at higher nitrogen rates, are developing a significant thatch layer which will likely influence the turf quality in the future. Some evidence of scalping appeared in 1985 on these plots. Further, there was more wilting on the higher nitrogen plots on a few days earlier in the summer when there was more moisture stress.

## LONG RANGE NITROGEN CARRIER EFFECTS ON A PENNCROSS CREEPING BENTGRASS GREEN AND AN ANNUAL BLUEGRASS FAIRWAY TURF

This cooperative study with J. M. Vargas, Jr. was established in 1982 with revisions in some treatments in 1985. Treatments outlined in Table 2 were applied to a 5-year old Penncross creeping bentgrass green growing on a modified loamy sand soil and to an annual bluegrass turf growing on a loam soil and maintained under fairway conditions at the Hancock Turfgrass Research Center. Plot size was 6 feet by 6 feet with 3 replications. Treatments for April and May were initiated in early June because of a change of technical personnel. Further, the 1985 November applications outlined were not applied as scheduled so data for treatments 1, 3, 5, 7, 9 and 11 should not be compared for others for 1985. The sulfur-coated urea is a greens grade from CIL while the 18-4-10 is a greens fertilizer from the Lebanon Co. Although the treatments receive 1 pound of nitrogen during the summer months from several carriers (treatments 3, 4, 6, 8, 10 and 12) rated highly on many dates, we suggest summer applications (July and August) of nitrogen on greens or fairways should not normally exceed 1/2 pound per 1000 square feet at one time, with an upper rate of 3/4 pound in rare cases.

Data in Table 4 are quality ratings for the annual bluegrass plots. Interestingly, the Penncross green and the annual bluegrass fairway plots

Table 1. Effect of N fertilization program on turfgrass quality ratings of Emerald, Penneagle and Penncross creeping bentgrasses maintained under putting green conditions. Total nitrogen rates shown were divided in monthly applications and made in May, June, June, August and September except as noted. Averages of 3 replications.

| Treatment lbs N/1000 yr | Carrier | Turfgrass quality rating (9 = greenest) July 11 | Aug 2 | Aug 23 | Nov 27 |
|---|---|---|---|---|---|
| Emerald | | | | | |
| 1 | Urea | 5.5 de** | 5.3 d | 3.2 d | 5.7 d |
| 2 | Urea | 6.3 c | 5.8 d | 4.8 c | 6.2 bd |
| 3 | Urea | 6.2 cd | 6.5 c | 5.7 b | 6.7 ab |
| 4 | Urea | 6.5 bc | 7.2 b | 5.5 b | 6.7 ab |
| 6 | Urea | 7.2 ab | 7.7 ab | 7.3 a | 6.8 a |
| 8 | Urea | 7.2 ab | 7.7 ab | 6.8 a | 6.7 ab |
| 4* | Urea | 4.3 f | 6.0 cd | 5.7 b | 6.3 ac |
| 4* | Milorganite | 5.2 e | 5.7 d | 5.5 b | 6.0 cd |
| 4* | Am. Nit. | 7.3 a | 8.0 a | 7.0 a | 6.8 a |
| Penneagle | | | | | |
| 1 | Urea | 6.2 ab | 5.5 d | 3.0 e | 5.5 e |
| 2 | Urea | 6.7 ab | 6.2 cd | 4.2 d | 6.0 de |
| 3 | Urea | 7.3 a | 7.8 ab | 5.8 bc | 6.5 cd |
| 4 | Urea | 6.5 ab | 7.3 b | 5.0 cd | 7.2 ab |
| 6 | Urea | 6.5 ab | 8.0 ab | 7.0 a | 7.7 a |
| 8 | Urea | 7.0 ab | 8.5 a | 6.8 ab | 7.3 a |
| 4* | Urea | 4.7 c | 5.7 d | 5.0 cd | 6.3 cd |
| 4* | Milorganite | 6.0 b | 7.0 bc | 5.0 cd | 6.3 cd |
| 4* | Am. Nit. | 6.3 ab | 7.8 ab | 7.2 a | 6.7 bc |
| Penncross | | | | | |
| 1 | Urea | 6.2 de | 6.0 c | 2.8 d | 6.0 b |
| 2 | Urea | 7.2 ac | 6.3 c | 2.7 d | 6.8 ab |
| 3 | Urea | 6.3 cd | 7.4 b | 4.5 c | 6.5 ab |
| 4 | Urea | 6.7 cd | 7.5 b | 4.2 c | 7.3 a |
| 6 | Urea | 8.0 a | 8.2 a | 7.3 a | 7.5 a |
| 8 | Urea | 7.8 ab | 8.5 a | 7.0 ab | 7.0 ab |
| 4* | Urea | 4.7 f | 5.8 c | 4.0 c | 6.5 ab |
| 4* | Milorganite | 5.3 ef | 6.3 c | 4.2 c | 6.7 ab |
| 4* | Am. Nit. | 7.0 bd | 8.2 a | 6.5 b | 6.8 ab |

*Nitrogen program includes 1 pound N per 1000 sq. ft. applied on December 5.

**Means within columns with like letters do not differ significantly according to Duncan's Multiple Range Test (5%). Cultivars evaluated individually.

Table 2. Treatments applied in Penncross bentgrass green and Annual bluegrass fairway nitrogen carrier fertility study at the Hancock Turfgrass Research Center. Treatments initiated in 1982 and revised in 1985. Plot size is 6 feet by 6 feet. Four replications.

| Treatment | | Month of application | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | N Carrier | Nov | Apr | May | June | July | Aug | Sept | Total |
| | | ----------Pounds N per 1000 sq. ft. ---------- | | | | | | | |
| 1 | IBDU | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 2 | IBDU | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 3 | S. Urea | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 4 | S. Urea | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 5 | Urea | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 6 | Urea | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 7 | Am. Nitrate | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 8 | Am. Nitrate | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 9 | Milorganite | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 10 | Milorganite | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 11 | 18-4-10 | 1.0 | --- | --- | 0.5 | 0.5 | 0.5 | 1.0 | 3.5 |
| 12 | 18-4-10 | --- | 1.0 | 1.0 | 1.0 | --- | --- | 1.0 | 4.0 |
| 13 | 18-4-10 | --- | --- | 1.0 | --- | --- | --- | 1.0 | 2.0 |
| 14 | 18-4-10 | --- | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 1.0 | 4.0 |
| 15 | 18-4-10 | --- | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6.0 |
| 16 | Urea | --- | --- | 0.5 | --- | --- | --- | 0.5 | 1.0 |
| 17 | Urea | --- | --- | 1.0 | --- | --- | --- | 1.0 | 2.0 |
| 18 | Urea | --- | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 1.0 | 4.0 |
| 19 | Urea | --- | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6.0 |
| 20 | Urea | --- | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.5 | 7.5 |

Table 3. Effect of nitrogen carriers on quality of a Penncross creeping bentgrass green at the Hancock Turfgrass Research Center. Averages for four replications.

| Treatment* | | Turfgrass Quality Rating (9=best) | | | | | |
|---|---|---|---|---|---|---|---|
| No. | Carrier | June 30 | July 23 | Aug 6 | Aug 15 | Sept 25 | Nov 14 |
| 1 | IBDU | 1.0 d** | 6.4 cg | 5.8 df | 4.8 ik | 6.8 ae | 8.0 ad |
| 2 | IBDU | 6.0 ab | 7.6 ad | 8.1 ac | 7.5 ac | 6.6 af | 7.4 bf |
| 3 | S.C. Urea | 1.0 d | 4.5 h | 6.1 de | 3.5 l | 5.8 ef | 6.4 gh |
| 4 | S.C. Urea | 4.9 bc | 6.3 dg | 4.9 f | 6.5 df | 7.0 ad | 6.3 h |
| 5 | Urea | 1.0 d | 5.1 gh | 5.4 ef | 5.3 gj | 6.7 af | 7.4 bf |
| 6 | Urea | 6.5 a | 7.9 ac | 7.5 c | 6.8 ce | 6.7 af | 7.0 eh |
| 7 | Am. Nitrate | 1.0 d | 5.0 gh | 5.4 ef | 5.0 hk | 6.5 af | 7.6 bc |
| 8 | Am. Nitrate | 6.6 a | 8.0 ab | 7.6 c | 7.5 ac | 5.6 f | 7.0 eh |
| 9 | Milorganite | 1.3 d | 5.5 eh | 6.0 de | 5.4 gi | 6.3 bf | 6.9 eh |
| 10 | Milorganite | 4.5 bc | 7.9 ac | 7.5 c | 7.0 ce | 6.7 af | 6.8 eh |
| 11 | 18-4-10 | 1.3 d | 5.4 fh | 5.6 df | 4.4 jl | 7.4 ab | 7.1 dh |
| 12 | 18-4-10 | 6.0 ab | 8.4 a | 7.9 bc | 7.1 bd | 6.9 ae | 7.3 cg |
| 13 | 18-4-10 | 4.5 bc | 6.0 eh | 5.5 ef | 5.4 gi | 6.3 bf | 6.6 fh |
| 14 | 18-4-10 | 4.1 c | 6.8 bf | 6.5 d | 5.8 fh | 7.1 ac | 7.4 bf |
| 15 | 18-4-10 | 5.5 ac | 8.1 ab | 8.6 ab | 8.0 ab | 7.4 ab | 8.0 ad |
| 16 | Urea | 4.3 bc | 5.4 fh | 5.5 ef | 4.3 kl | 6.1 cf | 7.0 eh |
| 17 | Urea | 4.9 bc | 5.8 eh | 5.4 ef | 4.4 jl | 5.9 df | 7.3 cg |
| 18 | Urea | 4.6 bc | 6.9 af | 6.4 de | 6.1 eg | 7.2 ac | 8.1 ac |
| 19 | Urea | 6.9 a | 7.7 ad | 8.9 a | 8.4 a | 7.5 a | 8.3 ab |
| 20 | Urea | 4.7 bc | 7.0 ae | 8.7 ab | 8.0 ab | 7.3 ab | 8.8 a |

*For treatment details see Table 2.

**Means within columns with like letters do not differ significantly according to Duncan's Multiple Range Test (5%).

Table 4. Effect of nitrogen carriers on turf color of annual bluegrass fairway turf at the Hancock Turfgrass Research Center. Averages for four replications.

| Treatment* | | Turfgrass Color Rating (9=Darkest Green) | | | | | |
|---|---|---|---|---|---|---|---|
| No. | Carrier | June 30 | July 22 | Aug 6 | Aug 28 | Sept 25 | Nov 27 |
| 1 | IBDU | 4.3 fg** | 6.0 ef | 6.2 de | 6.1 ac | 6.1 c | 7.0 be |
| 2 | IBDU | 5.3 df | 7.8 ab | 7.1 ab | 5.4 cf | 6.3 c | 7.5 ab |
| 3 | S.C. Urea | 4.5 fg | 6.8 ce | 6.7 ac | 6.3 ab | 6.5 ac | 7.4 ac |
| 4 | S.C. Urea | 7.1 bc | 7.5 ac | 6.7 ae | 5.7 bf | 6.3 c | 7.2 ad |
| 5 | Urea | 4.6 fg | 6.5 df | 6.9 ad | 6.1 ac | 6.9 ab | 7.0 be |
| 6 | Urea | 8.0 ab | 7.3 bd | 6.2 de | 5.2 df | 6.3 c | 6.8 be |
| 7 | Am. Nitrate | 5.0 eg | 6.5 df | 6.4 ce | 6.0 ad | 6.5 ac | 6.9 be |
| 8 | Am. Nitrate | 7.8 ab | 7.5 ac | 6.2 de | 5.0 f | 6.4 bc | 6.5 de |
| 9 | Milorganite | 4.9 eg | 6.6 df | 7.1 ab | 6.6 a | 7.0 a | 7.2 ad |
| 10 | Milorganite | 6.4 cd | 8.3 a | 7.3 a | 5.9 ae | 6.4 bc | 7.0 be |
| 11 | 18-4-10 | 3.8 g | 6.3 ef | 6.5 be | 6.0 ad | 6.5 ac | 6.5 de |
| 12 | 18-4-10 | 7.3 ac | 7.1 bd | 6.0 e | 5.7 bf | 7.0 a | 6.4 e |
| 13 | 18-4-10 | 6.1 ce | 5.9 f | 6.7 ae | 5.6 bf | 6.9 ab | 6.5 de |
| 14 | 18-4-10 | 6.6 bc | 6.6 df | 6.7 ae | 5.6 bf | 6.7 ac | 6.5 de |
| 15 | 18-4-10 | 6.4 cd | 7.3 bd | 7.1 ab | 5.6 bf | 6.7 ac | 6.6 ce |
| 16 | Urea | 6.0 ce | 6.1 ef | 6.2 de | 5.5 bf | 6.1 c | 6.4 e |
| 17 | Urea | 7.0 bc | 6.6 df | 6.2 de | 5.1 ef | 6.5 ac | 6.9 be |
| 18 | Urea | 7.9 ab | 7.3 bd | 6.9 ad | 6.0 ad | 6.5 ac | 6.9 be |
| 19 | Urea | 8.0 ab | 7.5 ac | 7.3 a | 5.6 bf | 6.3 c | 7.4 ac |
| 20 | Urea | 8.5 a | 7.1 bd | 7.0 ac | 6.0 ad | 6.3 c | 7.9 a |

*For treatment details, see table 2.

**Means within columns with like letters do not differ significantly according to Duncan's Multiple Range Test (5%).

receive the same treatments, but the nitrogen responses on the annual bluegrass are not as clearly defined and do not appear to last as long as on the Penncross. Some of this difference may be due to the higher clay content soil (loam) where the annual bluegrass is grown while greater leaching would occur on the loamy sand. But even with slow release materials which would not be as susceptible to leaching (such as IBDU or Milorganite) the responses are not as marked on the annual bluegrass site.

## EFFECT OF NITROGEN, COPPER AND SULFUR ON ALGAE ON A PENNCROSS CREEPING BENTGRASS GREEN

A rather serious algae condition developed in 1985 on a Penncross creeping bentgrass green growing on a sand/peat soil at the Hancock Turfgrass Research Center. The turf had received less than 2 pounds of nitrogen per 1000 square feet in 1984 while none had been applied in 1985 until the study was initiated in July. Treatments applied are outlined in Table 5. The annual nitrogen treatments were divided into 2 applications, while the copper and sulfur treatments were applied at the beginning of the study in July. Plot size was 3 feet by 6 feet with 3 replications. Because the turf was so weak there was no untreated check included in the study. It is obvious that the algae intrusion into the turf is occurring on turf which was fertilized at very low nitrogen rates in the past. In an attempt to increase ball roll and to reduce other turf management problems we may be using such low nitrogen rates that algae competition is encouraged because of the limited density of the turf. And sand topdressing and the use of high sand content soils in the construction of greens which have little organic matter and water holding capacity may enhance susceptibility to the algae problem. Susceptibility will vary with the kind of grass you have, nitrogen rate, nitrogen carrier, other auxiliary practices such as verticutting, topdressing, cultivation, specific site conditions, traffic and other management practices. Of course an algicide can be used to reduce the magnitude of the problem.

## EFFECT OF TOPDRESSING PROGRAM AND NITROGEN FERTILITY PROGRAM ON A PENNEAGLE CREEPING BENTGRASS GREEN

The study outlined in Table 6 was initiated in 1982 on Penneagle creeping bentgrass growing on a modified loamy sand. The soil mix used in the study was prepared to match the texture of the soil utilized in the original construction. Turf quality ratings were taken twice in 1985 as shown in Table 6. Plots receiving the higher nitrogen rates ranked higher but in some cases were too succulent. Those plots receiving the 6 pounds annual rate of nitrogen per 1000 square feet were more susceptible to wilt, consistent with observations on other plots. There was also a tendency for plots receiving sand topdressing treatment at the high nitrogen rate to wilt before those receiving soil mix topdressing although no data were taken.

Stimpmeter readings taken in August (Table 7) indicate that shorter roll occurred on all plots receiving higher nitrogen consistent with observations reported by others. There was no difference observed due to topdressing treatment on that date.

Table 5. Effect of nitrogen fertility and simple algicides for algae reduction on Penncross creeping bentgrass maintained on a sand/peat mix under putting green conditions. Treated July 9, 1985. Averages for 3 replications.

| No. | Treatment Material | Rate/1000 sq. ft. | | Algae Occurrence (9=greatest occurrence) Aug 13 | Sept 30 |
|---|---|---|---|---|---|
| | | Annual N | Algicide/App. | | |
| 1 | Urea | 1 lb. | 0 | 5.2 b* | 6.7 c |
| 2 | Urea | 2 lb. | 0 | 3.3 ab | 2.7 b |
| 3 | Urea | 4 lb. | 0 | 1.5 a | 1.0 a |
| 4 | Urea | 6 lb. | 0 | 1.7 a | 1.0 a |
| 5 | Urea<br>$CuSO_4$ | 2 lb. | 1 oz. | 3.0 ab | 1.3 ab |
| 6 | Urea<br>$CuSO_4$ | 4 lb. | 1 oz. | 2.5 ab | 1.2 a |
| 7 | Urea<br>$CuSO_4$ | 2 lb. | 2 oz. | 3.2 ab | 1.3 ab |
| 8 | Urea<br>$CuSO_4$ | 4 lb. | 2 oz. | 2.8 ab | 1.0 a |
| 9 | Urea<br>Flowable Sulfur | 2 lb. | 1 lb. | 3.0 ab | 2.0 ab |
| 10 | Urea<br>Flowable Sulfur | 4 lb. | 1 lb. | 2.0 a | 1.0 a |
| 11 | Urea<br>Flowable Sulfur | 2 lb. | 5 lb. | 3.2 ab | 1.8 ab |
| 12 | Urea<br>Flowable Sulfur | 4 lb. | 5 lb. | 2.2 a | 1.0 a |

*Means within columns with like letters do not differ significantly according to Duncan's Multiple Range Test (5%).

Table 6. Effect of Nitrogen fertility and topdressing on quality of Penneagle creeping bentgrass green at Hancock Turfgrass Research Center. Averages from three replications.

| Treatment No. | Topdressing | lbs N 1000 ft.$^2$ | Quality Rating (9=best) Aug 2 | Aug 29 |
|---|---|---|---|---|
| 1 | 12 cu. ft. Soil Mix Spring/Fall | 3 | 7.7 bd* | 6.2 cd |
| 2 | 12 cu. ft. Dune Sand Spring/Fall | 3 | 8.0 ad | 6.0 cd |
| 3 | 3 cu. ft. Dune Sand 3 weeks, 8 app./yr | 3 | 7.0 d | 6.5 bd |
| 4 | 6 cu. ft. Dune Sand 6 weeks, 4 app./yr | 3 | 7.2 cd | 6.5 bd |
| 5 | Check | 3 | 7.2 cd | 5.5 d |
| 6 | 12 cu. ft. Soil Mix Spring/Fall | 6 | 9.0 a | 8.2 a |
| 7 | 12 cu. ft. Dune Sand Spring/Fall | 6 | 8.2 ac | 7.8 ab |
| 8 | 3 cu. ft. Dune Sand 3 weeks, 8 app./yr | 6 | 8.3 ab | 8.0 ab |
| 9 | 6 cu. ft. Dune Sand 6 weeks, 4 app./yr | 6 | 8.8 b | 7.3 ac |
| 10 | Check | 6 | 8.2 ac | 7.0 ad |

*Means within columns with like letters do not differ significantly according to Duncan's Multiple Range Test (5%).

Table 7. Ball speed as affected by nitrogen fertility and topdressing program on Penneagle bentgrass at the Hancock Turfgrass Research Center. Stimpmeter readings, average of four rolls, three replications.

| Treatment No. | Topdressing | lbs N/1000 $ft^2$ | Average distance of ball travel (in inches) |
|---|---|---|---|
| 1 | 12 cu. ft. Soil Mix Spring/Fall | 3 | 84.9 a* |
| 2 | 12 cu. ft. Dune Sand Spring/Fall | 3 | 84.4 a |
| 3 | 3 cu. ft. Dune Sand 3 weeks, 8 app./yr | 3 | 85.9 a |
| 4 | 6 cu. ft. Dune Sand 6 weeks, 4 app./yr | 3 | 88.0 a |
| 5 | Check | 3 | 82.6 a |
| 6 | 12 cu. ft. Soil Mix Spring/Fall | 6 | 72.3 b |
| 7 | 12 cu. ft. Dune Sand Spring/Fall | 6 | 74.0 b |
| 8 | 3 cu. ft. Dune Sand 3 weeks, 8 app./yr | 6 | 73.4 b |
| 9 | 6 cu. ft. Dune Sand 6 weeks, 4 app./yr | 6 | 74.4 b |
| 10 | Check | 6 | 73.9 b |

*Means in columns with like letters do not differ significantly according to Duncan's Multiple Range Text (5%).

## FERTILIZER TREATMENT EFFECTS ON YELLOW ANNUAL BLUEGRASS

In late August areas of the annual bluegrass fairway plots at the Hancock Turf Research Center developed a condition often observed in Michigan: random plants in the turf growing faster than adjacent plots which developed distinctly yellow leaves. In an attempt to document nutritional responses of the grass in this condition, the treatments outlined in Table 8 were applied August 30, 1985. Plot size was 4 feet by 6 feet. All treatments were applied foliarly except for the 0-46-0 (superphosphate). Five days later turf quality ratings taken indicated that the ferrous sulfate ($FeSO_4$) treatment gave the only significant response compared to the untreated check. By September 23 this difference had dissipated as would be expected. The response to foliarly applied iron will usually disappear within a week depending on growth rate and growing conditions. There was some discoloration caused by certain of the treatments, most noticeably from manganese sulfate. The cause of the etiolated growth of the annual bluegrass is not clear at this time, but it appears that the yellowing can be masked with foliar application of iron.

## WETTING AGENT EFFECT ON TURFGRASSES

Wetting agent treatments outlined in Table 9 were applied to a Penncross creeping bentgrass green growing on a modified loamy sand soil. Two irrigation programs were utilized: low (approximately 1/3 inch of water per week) applied: and moderate (2/3 inch per week). The objective was to determine the effect of wetting agent treatments on development of localized dry spots. Subsequent to treatment rainfall patterns prevent any development of localized dry spots so no treatment effects appeared. As observed in past years, turf discoloration caused by wetting agent phytotoxicity resulted from some treatments as these treatments were not watered in. Lescowet and Aqua-Gro exhibited the greatest phytotoxicity. Peneturf also caused some injury. Based on past observations on plots, watering the area after application would have resulted in no injury. Further, the rates of wetting agents applied in this study were very high for application at this time of year. Judicious application of wetting agents available at present should be safe for turf if watered in appropriately.

A study of wetting agent responses was also established on tees at the Crystal Mountain Golf Resort. No differences in response were observed and no localized dry spots developed.

## COMPARISON OF SEVERAL AERIFIERS ON GENERAL TURFS

In the fall of 1985 several different aerifiers were used on perennial ryegrass turfs growing on two different sites, a soil with limited topsoil but in a "normal" state of compaction while the second site was a heavily compacted, predominantly subsoil loam. The aerifiers evaluated were: 1) a Dedoes walk behind with a "standard" tine spacing or with part of the tines removed creating a diamond spacing (7 inches by 8 inches); 2) a Ryan's Ride-Aire; 3) an Aer-Way aerifier which has triangular-shaped tines and 4) the Verti-Drain aerifier. The Verti-Drain aerifier has both solid (deep) and hollow tines and has two different speeds resulting in holes 4 inches apart linearly or 2.5 inches apart.

Table 8. Effect of fertilizer treatments on yellow annual bluegrass. Hancock Turfgrass Research Center. Treatments applied August 30, 1985. Averages for 3 replications.

| Treatment, lbs/1000 sq. ft. | | | | Micronutrients | Quality Ratings (9=darkest green) | | Injury rating (9=none) |
|---|---|---|---|---|---|---|---|
| N | P | K | Carrier | oz/1000 | Sept 4 | Sept 23 | Sept 4 |
| 1/2 | 0 | 0 | urea | 0 | 4.8 b* | 7.0 b | 8.8 a |
| 1 | 0 | 0 | urea | 0 | 5.5 b | 7.0 b | 8.2 ab |
| 1/2 | 0 | 1 | 33-0-0<br>13-0-44 | 0 | 4.3 b | 8.0 b | 8.8 a |
| 1 | 0 | 1 | 33-0-0<br>13-0-44 | 0 | 4.5 bc | 7.7 ab | 6.3 c |
| 1 | 0 | 1 | 33-0-0<br>13-0-44 | 3-$FeSO_4$ | 8.3 a | 8.5 a | 7.3 b |
| 1 | 0 | 1 | 33-0-0<br>13-0-44 | 3-$MnSO_4$ | 4.2 bc | 7.5 ab | 5.8 c |
| 0 | 1 | 0 | 0-46-0 | 0 | 4.0 c | 7.8 ab | 9.0 a |
| 0 | 0 | 0 | ---- | 0 | 4.2 bc | 8.0 ab | 9.0 a |

*Means in columns followed by different letters are significantly different at the 5% level using Duncans Multiple Range Test.

Table 9. Effect of several wetting agent materials on turf discoloration of Penncross creeping bentgrass maintained under putting green conditions with moderate and low irrigation regimes. Treatments were applied August 14, 1985 and were not watered in following application. Averages for 3 replications.

| Treatment | | Turf Discoloration (9=greatest discoloration) 15 days after treatment | |
|---|---|---|---|
| Material | Rate | Moderate Irrigation | Low Irrigation |
| | oz/1000 | | |
| Check | - | 1.0 a | 1.3 ab |
| Lescowet | 8 | 4.8 d | 4.2 e |
| Lescowet | 16 | 7.3 f | 7.3 g |
| Aquagro | 8 | 2.2 b | 2.2 cd |
| Aquagro | 16 | 6.3 e | 6.5 f |
| Hydrowet | 8 | 1.7 ab | 1.7 ac |
| Hydrowet | 16 | 2.2 b | 1.8 bc |
| Basic H | 8 | 1.2 a | 1.2 ab |
| Basic H | 16 | 2.2 b | 1.7 ac |
| Aquagro | 3.5 lbs dry | 1.2 a | 1.7 ac |
| Aquagro | 7.0 lbs dry | 1.7 ab | 2.2 cd |
| Peneturf | 8 | 1.7 ab | 1.5 ac |
| Peneturf | 16 | 3.5 c | 2.8 d |
| NAIAD | 1 | 1.2 a | 1.2 ab |
| NAIAD | 4 | 1.2 a | 1.3 ab |
| Superwet | 8 | 1.0 a | 1.3 ab |
| Superwet | 16 | 1.2 a | 1.0 a |
| Soil Rebuilder | 21.3 | 1.2 a | 1.3 ab |
| Soil Rebuilder | 42.6 | 1.0 a | 1.0 a |

*Means with columns within like letters do not differ significantly according to Duncan's Multiple Range Test (5%).

Data on the depth of penetration of the various tines are given in Table 10. With many aerifiers the weight needed to penetrate soil effectively varies with the unit and soil condition. In dry and highly compacted soils some units do not penetrate well. Although the data have not been analyzed statistically, the depth of penetration was not dramatically reduced on the more compacted sites for the aerifiers utilized. By removing some of the tines from the Dedoes unit the depth of penetration was increased slightly on both sites (2.0 vs 2.8 inches on the "normal" soil and 1.8 vs 2.7 inches on the "compacted" site). When greater penetration is desired an alternative is to selectively remove some of the tines, more weight or wait until the soil has a higher moisture content. Of course, aerifying should not normally be practiced when the soil is very wet.

The Ride-Aire does not penetrate as deeply as other units as might be expected. The Aer-Way unit leaves a hole that is triangular in shape. Average figures were 5.0 inches deep by 6.9 inches long. The width was 1/4 to 3/8 inch wide. The Verti-Drain is a much larger unit which makes a deeper hole (9 inches average with the solid tines) on the "normal" site compared to other units. On the "compacted" site the average depth was reduced to 8.5 inches with the 4 inch linear spacing between holes. When the hollow tines were utilized the average depth was 6.2 inches with the 4 inch linear spacing on "normal" soil and reduced to 5.9 inches on "compacted" soil.

As might be expected the deeper and larger tines remove more soil when using hollow tines. The closer spacing of the Dedoes "standard" setup removes more soil, but doesn't go as deep compared to the less intense "diamond" spacing. These figures are based on dry weights of soil cores removed from a 4 square foot area and represents an average of 4 areas sampled for each treatment. The Ride-Aire removed the least soil among the units studied and the Verti-Drain removed the greatest amount at the 2.5 inch linear spacing as would be expected.

These observations are based on physical measurements only. No data were taken with regard to rooting responses, turf quality or effects on soil properties, partly because the treatments were applied late in the season when equipment was available. Determination of which unit(s) is most effective would depend on the depth of penetration desired; whether soil cores need to be removed from the site or deposited back into the thatch; cost of the equipment; speed of operation; durability of the equipment and soil conditions, among other factors.

## EFFECT OF SAND AID AND TOPDRESSING PROGRAM ON A PENNCROSS CREEPING BENTGRASS GREEN

A long term study was initiated in May, 1985 at the Hancock Turfgrass Research Center to evaluate the effects of the use of Sand Aid as an amendment in topdressing and core cultivation programs for putting greens. The treatments outlined in Tables 11 and 12 were applied to a Purr-Wick green (dune sand) and on a "USGA~ green, respectively. A third study was conducted on a green growing on fine sandy loam soil with treatments 1) 15 pounds Sand Aid after coring; 2) 30 pounds Sand Aid after coring; and 3) coring only. Coring treatments were applied in May, June and September on all cored plots using a Ryan's Green Aire with 1/2 inch hollow tines. Plot size was 4 feet by

Table 10. Depth of aerifier tine penetration on loam soil. Perennial ryegrass turf. October, 1985. Hancock Turfgrass Research Center. Averages for a minimum of 24 measurements.

| Aerifier | Depth, inches "Normal" Soil | Depth, inches "Compacted" Soil | Soil wt, gms 4 sq. ft. |
|---|---|---|---|
| Dedues - standard spacing | 2.0 | 1.8 | 418 |
| - diamond spacing | 2.8 | 2.7 | 643 |
| Ryan Ride Aire | 1.8 | 1.5 | 270 |
| Air Way | 5.0 | --- | --- |
| Verti Drain - 4" solid | 9.0 | 8.5 | --- |
| 2.5" solid | 8.9 | --- | --- |
| 4" hollow | 6.2 | 5.9 | --- |
| 2.5" hollow | 6.1 | --- | 1647 |

Table 11. Effect of Sand-Aid and Topdressing treatment on quality of Penncross creeping bentgrass turf grown on a Purwick green (dune sand). Treatments initiated May 23, 1985. Hancock Turfgrass Research Center. Averages for 3 replications.

| Treatment | | | Turf Quality Ratings (9=darkest green) | | | | |
|---|---|---|---|---|---|---|---|
| Sand Aid | Auxiliary | Frequency | May 25 | July 30 | Sep 8 | Sep 22 | Sep 28 |
| 30 lbs/M | After coring | May, June, Sept | 7.0 b | 7.3 ac | 8.3 a | 8.0 a | 8.0 a |
| 15 lbs/M | Ater coring | May, June, Sept | 7.0 b | 7.2 bc | 7.7 ab | 7.8 a | 7.8 ab |
| None | Coring only | May, June, Sept | 6.0 c | 7.0 c | 7.8 ab | 7.8 a | 7.8 ab |
| 5% volume | Sand T.D. | every 3 weeks | 8.0 a | 7.8 ab | 7.5 b | 7.7 a | 7.5 bc |
| 10% volume | Sand T.D. | every 3 weeks | 7.0 b | 7.5 ac | 7.5 b | 7.8 a | 7.5 bc |
| None | Sand T.D. | every 3 weeks | 7.0 b | 8.0 a | 7.2 b | 6.5 b | 7.2 c |
| None | None | ---- | 7.0 b | 7.5 ac | 7.5 b | 7.0 ab | 7.5 bc |

Table 12. Effect of Sand-Aid and topdressing treatment on quality of Penncross creeping bentgrass turf grown on a "USGA" soil. Treatments initiated May 24, 1985. Averages for 3 replications. Hancock Turfgrass Research Center.

| Treatment | | | Turf Quality Rating (9=darkest green) | | | | |
|---|---|---|---|---|---|---|---|
| Sand Aid | Auxiliary | Frequency | Jun 25 | July 30 | Aug 25 | Sept 8 | Sept 22 |
| 30 lbs/M | After coring | May,Jun,Sep | 8.0 a | 7.7 a | no | 8.0 a | 6.7 ac |
| 15 lbs/M | After coring | May,Jun,Sep | 8.0 a | 7.2 a | differ- | 8.0 a | 6.3 bc |
| None | Coring only | May,Jun,Sep | 7.0 b | 7.2 a | ences | 7.5 ab | 6.0 c |
| 5% volume | Sand T.D. | every 3 wks | 7.0 b | 7.3 a | ob- | 7.7 a | 7.5 a |
| 10% volume | Sand T.D. | every 3 wks | 7.0 b | 7.6 a | served | 7.0 ab | 6.3 bc |
| None | Sand T.D. | every 3 wks | 7.0 b | 7.2 a | | 7.5 ab | 7.2 ab |
| None | None | ---- | 7.0 b | 7.3 a | | 6.5 b | 6.5 ac |

6 feet with 3 replications. Financial support for this project from the Emerald Isle Corporation is gratefully acknowledged.

Data in Tables 11 and 12 suggest there were no consistent differences in turfgrass quality ratings during 1985. On some dates plots receiving Sand Aid did rank higher than certain untreated plots, but the trend was not consistent across all dates. There were no differences observed at any time during the year on the plots on the soil green. Our hypothesis is that any consistent differences observed will likely occur over a period of time (perhaps 2 to 3 years) and that the greatest benefit will occur on greens high in sand content or which have been sand topdressed. This study will be continued.

## OTHER STUDIES

Several other long term studies are being continued although no data are being reported here. This includes the pH control study comparing lime and sulfur treatments on soil pH and changes which occur with time. The wear simulator which was utilized in research extensively by James Beard and his students here at MSU was utilized in a study to evaluate the effects of different fertilizers and nutrient rates on wear tolerance of perennial ryegrass and Kentucky bluegrass. Variability in data was high enough that we felt it was best not to report results yet. We are taking steps to improve the wear simulator for our studies.

The nitrogen-potassium balance study on the irrigation green is continuing. No unusual differences occurred this year.

Two out state sites were selected to evaluate turf responses to very low soil phosphorus levels. One on a condominium site in Novi, the other on a golf course fairway at Crystal Mountain. Treatments were applied during the summer. Soil samples will be taken in 1986 for testing purposes and turf responses will be evaluated. There are many turf sites in Michigan which have very high soil phosphorus levels while there are others which have very low soil phosphorus levels. We cannot afford to have phosphorus limiting considering the cost of other materials. It is preferable to use soil tests as the base to determine phosphorus needs, but without soil tests it would be wise to use a low rate (such as 1/2 pound $P_2O_5$ per 1000 square feet annually) on sites where there is no topsoil and the turf was established on a compacted subsoil. We do strongly recommend the use of soil tests to determine the need for phosphorus on turfs along lakes and streams. Use phosphorus very sparingly on such sites.