SOILS RESEARCH REPORT

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There is growing interest in liquid application of nitrogen fertilizers to turf. A study was initiated at Traverse City to compare ammonium nitrate and urea, rate of nitrogen application and rate of dilution of the fertilizer. Data on injury to Kentucky bluegrass are given in Table 1. The injury from the ammonium nitrate treatments was evident within a few minutes after application. The initial injury occurred as a darkening of the foliage and developed a somewhat "greasy" appearance within an hour. Three days later the typical foliar burn symptoms were evident. There was much more injury with ammonium nitrate than with urea, both short term (1 hour) and three days later. The injury was reduced slightly by using the higher rate of water (12 gallons water per 1000 square feet) but this higher rate of water is not normally practical especially for the slight benefit gained. It must be remembered that these treatments were applied under conditions where maximum potential for injury might occur - on a hot dry day in late July. But this points out the caution which must be exercised in applying soluble nitrogen sources during stress periods. Note also that there was much less injury apparent from comparable rates of these two nitrogen carriers when applied in dry form. There is the potential, however, that injury from a dry application could cause more damage to the crown of the turf plant and thus have a longer influence than the foliar injury experienced from a liquid application. The latter is more striking but the plant could grow out of the foliar injury condition faster.

Table 1. Nitrogen carrier, rate and method of application effects on injury to Kentucky bluegrass at Traverse City. Treatments applied July 30, 1975.

Averages of 3 replications.

Treatment			Relative injury rating (1=none; 10=severe)	
Carrier	N rate lbs/1000 sq ft	Method of application*	7/30/75	8/2/75
---	0	---	1.0	1.0
nitrate	1	3	6.8	6.3
urea	1	3	1.7	2.0
am. nitrate	1	12	5.3	4.3
urea	1	12	1.0	1.0
am. nitrate	2	3	8.7	8.0
urea	2	3	2.0	3.0
am. nitrate	2	12	7.0	6.3
urea	2	12	1.7	2.3
am. nitrate	1	Dry	1.0	2.0
am. nitrate	2	Dry	1.0	2.3
urea	2	Dry	1.0	1.0

*Gallons water per 1000 square feet applied with the nitrogen unless applied in dry form.

Higher nitrogen rates resulted in an increase in the incidence of stripe smut on Merion Kentucky bluegrass in June at Traverse City as suggested in Table 2. Plots receiving the highest nitrogen rate (12 pounds nitrogen annually, divided into 6 monthly applications) were especially susceptible. When extremely high nitrogen rates were applied in late April the incidence of stripe smut was also increased. Thus timing of nitrogen application is also a factor. The disease rating was lower on plots receiving nitrogen as sewage sludge (Milorganite) and ureaformaldehyde (38%) compared to ammonium nitrate. This is a further indication of the slower rate of nitrogen release from these organic nitrogen carriers compared to the soluble ammonium nitrate. Although these nitrogen rates are excessively high, these data do point out the importance of modest nitrogen fertilization in the spring of the year. Modest spring nitrogen rates are also suggested for reducing a susceptibility of Kentucky bluegrasses to Fusarium blight.

Table 2. Incidence of stripe smut on Merion Kentucky bluegrass at Traverse City in June as affected by nitrogen treatment.

Treatment			Stripe Smut Incidence
N rate lbs/1000 sq ft	Carrier	Time of application	(1=none; 10=severe)
0	---	---	0.5
4	ammonium nitrate	monthly	1.5
8	ammonium nitrate	monthly	3.5
12	ammonium nitrate	monthly	8.5
8	ammonium nitrate	Apr	4.5
8	ammonium nitrate	Apr, June, Aug	2.0
8	ammonium nitrate	Apr, Aug	2.5
8	Milorganite	Apr	3.0
8	ureaformaldehyde	Apr	2.5

Higher nitrogen rates resulted in an increase of *Poa annua* in a mixed Merion Kentucky bluegrass *Poa annua* turf (see Table 3). Plugs of *Poa annua* were planted into the Merion sod in 1971 and treatments initiated in 1972. The turf is mowed at 3/4 inch. The *Poa annua* has steadily increased in the turf since the initiation of the treatments. Higher rates of nitrogen in the spring have also tended to encourage the *Poa annua* encroachment rate into the turf. In this study the use of sewage sludge has also resulted in an increase of the *Poa annua* encroachment rate. Similar increases in *Poa annua* have been observed at Traverse City in a Pennlawn red fescue turf where *Poa annua* has encroached naturally in the irrigated turf.

Table 3. Effect of nitrogen treatment on the composition of a Merion Kentucky bluegrass-*Poa annua* polystand at East Lansing. Treatments were initiated in 1972. Averages of 3 replications. November, 1975.

Treatment			*Poa annua* in turf
N rate lbs/1000 sq ft	Carrier	Time of application	
0	---	---	47
2	ammonium nitrate	monthly	58
4	ammonium nitrate	monthly	63
6	ammonium nitrate	monthly	65
8	ammonium nitrate	monthly	73
12	ammonium nitrate	monthly	72
4	ammonium nitrate	Apr, May, Aug	55
4	ammonium nitrate	Apr, Aug, Sept	50
4	ammonium nitrate	May, July	38
4	ammonium nitrate	Apr	80
4	ammonium nitrate	Apr, Aug	67
4	milorganite	Apr	
8	milorganite	Apr	

Returning clippings to the turf is a good means of recyclying the nutrients contained in them. In a study of the effects of management practices on Merion Kentucky bluegrass initiated by James Beard in 1963 at East Lansing the return of clippings has resulted in an improvement in color of the turf compared to where the clippings have been removed. Table 4 shows data taken in November, 1975 to illustrate this point. The differences in color are most marked in spring and fall when cool soil temperatures limit organism activity and rate of nitrogen release in the soil. However, returning clippings has also resulted in an increase in the incidence of stripe smut. In June, 1975 there was considerable stripe smut evident on plots where clippings were returned. When clippings were removed there was no stripe smut apparent. In addition there has been encroachment of *Poa annua* when clippings are returned but only when the turf was mowed at 1 inch. At the 2-inch mowing height *Poa annua* has not apparently been competitive with the Merion.

Table 4. Management practices effects on color of Merion Kentucky bluegrass at East Lansing. Treatments initiated in 1963. Data taken November, 1975.

Annual N rate lbs/1000 sq ft	Mowing height	Visual turfgrass color rating (1=dark green; 9=yellow)			
		Return clippings		Remove clippings	
		1 inch	2 inches	1 inch	2 inches
4		2.7	2.2	6.1	5.5
6		2.4	1.8	5.8	5.0
8		2.5	1.4	5.0	3.9
10		2.3	1.4	4.6	3.8
12		2.1	1.1	4.0	2.8
14		1.8	1.2	3.9	2.8
Average		2.3	1.5	4.7	4.0

Table 5. Management practices effects on the encroachment of Poa annua into Merion Kentucky bluegrass at East Lansing. Treatments initiated in 1963. Data taken November, 1975.

Annual N rate lbs/1000 sq ft	Mowing height	Poa annua in turf, Percent			
		Return clippings		Remove clippings	
		1 inch	2 inches	1 inch	2 inches
4		18	0	1	0
6		19	0	0	0
8		23	0	0	0
10		20	0	0	0
12		16	0	1	0
14		25	0	0	0

Applying ferrous sulfate to bentgrass turf mowed at 1/4 inch resulted in improved turfgrass color (Table 6). The ferrous sulfate was applied at rates of 0,3,6, and 12 ounces per 1000 square feet at 2 week intervals. The higher ferrous sulfate rates resulted in some injury to the turf. In some cases the higher rates caused the turf to turn a blackish-green color. The injury appeared as a tip burn of some of the leaves.

From a distance the turf appeared uninjured but a close examination revealed the injury. The length of the color improvement from the treatments depended on the environmental conditions at the time of application and the growth rate of the grass following treatment. When the turf was actively growing the color dissipated in 2 to 3 days. When the turf was growing slowly the color influence was longer.

Table 6. Ferrous sulfate effects on putting green bentgrass. Ferrous sulfate was applied at 2 week intervals at East Lansing beginning July 3, 1975. Averages for 10 weeks.

Ferrous sulfate rate oz/1000 sq ft	Visual color rating (1=best; 10=poor)	Injury rating (1=none; 10=severe)
0	6.0	1.0
3	3.1	1.3
6	2.0	1.9
12	1.2	2.8

The rate of recovery from injury followed the same pattern. The use of ferrous sulfate to improve turf color is useful as a means of reducing nitrogen needs somewhat, especially during key stress periods. But care should be taken to prevent injury to the turf. Rates of 1-3 ounces per 1000 square feet are suggested with repeat applications as needed. Injury will tend to be more severe during stress periods.

On heavily irrigated sands such as are often found on greens, potassium needs may be higher than are called for by standard recommendations which are based on soil tests. At Traverse City rates of up to 6 pounds K_2O have been applied annually per 1000 square feet. The soil tests at Traverse City on the untreated plots were about 100 pounds per acre (see Table 7). At that level the recommendations would be 2 to 3 pounds K_2O per 1000 square feet. We would like to maintain potassium soil tests of 250 pounds per acre or higher for good turf. Even with the 6 pound treatment (divided equally into spring and fall applications) the potassium soil test levels were not above 200 pounds per acre. This points out the need to apply potash regularly on such soils where there is very little cation exchange capacity to hold the potassium cations in the soil. Under conditions of reduced irrigation rates and soils with more clay the loss of potassium by leaching is much lower. The use of potassium sulfate (K_2SO_4) resulted in somewhat higher soil potassium tests than did potassium chloride (KCl or muriate of potash). There was little difference in the visual quality of the turf regardless of potassium carrier.

The soil mix plots for greens at East Lansing on which Cohansey bentgrass was established in the early 1960's have developed a resistant strain of dollar spot. The plots were not sprayed for control of the dollar spot so the disease would become extensive enough for Joe Vargas to evaluate fungicide programs for control of the disease. One half of each of the soil mix plots is compacted with a roller compacter which we have developed. There are golf shoes on the roller drum. As a

result of the traffic the dollar spot development in early July was increased from 18% of the turf area infected on the uncompacted side to 54% on the compacted side. Apparently the golf shoes carried the inoculum from plot to plot.

Results of the use of wetting agents to rewet a hydrophobic sand at Boyne Highlands near Petoskey were consistent in 1975 with earlier studies. Coring treatments gave only short term improvement of turf. Hydro-Wet and Aqua-Gro proved the only consistently effective wetting agents among the nine which were applied in these studies. Hydro-Wet was somewhat more effective than Aqua-Gro under the conditions. The higher rates (32 ounces per 1000 square feet) gave longer improvement than 16 ounces from a one time application. In two years the effects of the wetting agent treatments have nearly dissipated. Repeat applications appear necessary to prevent the hydrophobic soil condition from redeveloping. Frequency and rate of reapplication will vary with the wetting agent, soil, and the degree to which the hydrophobic condition has developed. When the hydrophobic condition has become severe the rate of application of wetting agent may need to be higher, multiple treatments may be necessary and rate of turf improvement may be much slower than when treatments are applied at the first sign of a localized dry spot.

There is concern for the possibility of phytotoxicity to the grass from the use of wetting agents. No injury has been observed on the plots at Boyne Highlands even at rates up to 32 ounces per 1000 square feet. Injury has often been observed, however, even at lower rates of application, on turf. In a phytotoxicity study initiated at East Lansing in 1975 Aqua-Gro proved slightly more injurious than Hydro-Wet at comparable rates of application. But Aqua-Gro provided a day or two longer effect on suppression of dew formation on bentgrass than did Hydro-Wet. The use of more water when applying the wetting agents reduced the degree of injury observed as well. Watering the wetting agent into the turf after application will also reduce the potential for injury.

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