1979 Turfgrass Soils Research Report: Nitrogen Carriers and Programs, Sulfur Effects on Soil pH and Core Cultivation

Paul E. Rieke and Richard A. Bay
Crop and Soil Sciences, M.S.U.

Several nitrogen carriers and experimental nitrogen sources were evaluated on Kentucky bluegrass at East Lansing and Traverse City during 1979. These data are given in Tables 1 and 2, respectively. At East Lansing the treatments were applied at the rate of 1.5 lbs of nitrogen per 1000 square feet on June 28. Several of the treatments included the use of Dwell (Olin-Matheson Co.) as an experimental nitrification inhibitor. In July the responses indicated there was no effect of Dwell on inhibiting nitrification inhibition from urea 1 month after application. However, 2 months after application in August there was a consistent improvement in quality ratings indicating that the nitrification process had been slowed by the application of Dwell. It was apparent that at least 1 lb of Dwell per acre was necessary to provide for this improvement in longevity of response. By October there were no differences between treatments receiving Dwell and no inhibitor application. When a 28% solution (half urea, half ammonium nitrate) was applied there was no advantage in using the Dwell. This may not be surprising since at least 25% of the nitrogen is applied in the nitrate form as ammonium nitrate form.

The Methylolurea from Georgia Pacific gave a somewhat slower response initially (1 month after application), but did not show any longevity advantage in terms of response. A similar observation was made for Formolene. In contrast, Folian showed a faster initial response and again no long-term advantage.

The Powder Blue ureaformaldehyde responded very slowly as has been observed in previous studies. The fine grade of IBDU responded somewhat more slowly than soluble materials but gave a long-term response, again as has been observed previously. This was particularly noticeable on the October 29 reading. The 18-5-9 from Lebanon gave typical responses - somewhat more slowly than the soluble urea but lasting a bit longer. The sulfur coated urea from Lakeshore responded somewhat slowly but gave longer-term quality improvement compared to the sulfur-coated urea from Canada. The Lakeshore material has a lower dissolution rate and therefore a slower and longer-term response.

The experimental fertilizers from Amway are composed of soluble nitrogen sources and tended to give a quick response which dissipated with time, similar to the s-luble nitrogen carriers.

The nitrogen carrier evaluations at Traverse City (Table 2) indicate similar responses were observed with the use of Dwell, although the responses were not as clear as at East Lansing. As at East Lansing, there seemed to be no difference in how the urea and Dwell were applied.

Other responses were very similar including the long-term response to IBDU observed in September, 4 months after application. Although the differences were small, it is apparent that these slower released materials gave longer-term responses into December.

Several studies were conducted on late fall nitrogen applications, two of which were on <u>Poa annua</u> fairways in the Lansing area. Table 3 gives the data for the responses to several carriers applied at 1 and 2 lbs of N in fall or spring applications. After a November 15 application at Walnut Hills Country Club, it was apparent that the more soluble sources tended to give a faster response than the more slowly available IBDU and Milorganite. The finer grades of IBDU give a faster response than the coarser grades as would be expected because of the higher surface area and faster dissolution of the nitorgen in IBDU. The use of Dwell as a nitrification inhibitor with urea showed small improvement in readings compared to urea alone particularly from the fall applications. Again, as was observed in the summer studies the sulfur-coated urea from CIL responded somewhat more rapidly than that from Lakeshore, especially with the spring applications.

The data from a similar study at the Country Club of Lansing (Table 4) are consistent with those observed at the Walnut Hills site. It is perhaps most striking that the nitrogen responses from the late fall applications carried through and were observable even into mid-July. With the reduced growth response observed from fall applications compared to spring applications, and with the relative longevity of response, even from soluble nitrogen sources (but particularly from those which contain some slow released nitrogen), it is apparent that spring applications of nitrogen can be delayed when a late season nitrogen program has been followed. The time of application in the late spring can be delayed as far as into June in some cases, depending on soil, turf and season.

The use of urea as a nitrogen source in fall and late fall applications was evaluated on Nugget Kentucky bluegrass at East Lansing in the fall of 1979. The fall turfgrass quality responses are shown in Table 5. As would be expected, in October a very quick response to the September application of urea was very apparent. Three weeks after the October 1 application, the response was not quite as great as to the September applications but was still very marked. Further, the October applications resulted in higher quality readings in mid-November than those applied in September. The nitrogen from the early September application was obviously becoming dissipated.

A companion study evaluating nitrogen sources applied at different times on Nugget Kentucky bluegrass is outlined in Table 6. As would be expected, those materials which are more readily available give the faster response than the more slowly available IBDU. This was especially apparent for those applications made later in the season when the soil is cooler and the response to the slowly available nitrogen source is more limited. Spring responses to these treatments applied as outlined in Tables 5 and 6 will be evaluated during the spring of 1980.

The lawn care industry is concerned about the potential for foliar burn from nitrogen fertilizer application. A study was initiated to evaluate the foliar burn potential of several nitrogen sources on September 19 at East Lansing (Table 7). The treatments were applied on Penncross creeping bentgrass which is quite susceptible to foliar injury. The plots were rated 5 days after application for foliar burn. It is interesting to note that urea applied as high as 1.5 lbs of nitrogen per 1000 square feet gave no detectable injury while at 3 lbs serious injury occurred. The product from the Ashland Company, Formolene, was apparently quite safe to use in that no injury occurred even at the 3 lb nitrogen rate. Folian from Allied did give significant foliar burn, however, at both 1.5 and 3 lb rates. The Amway fertilizer which is comprised of all soluble nitrogen sources, likewise gave very serious burn at both rates. The Methylolurea from Georgia Pacific was quite safe as well. Although we have not observed any long-term benefit of the use of the Methylolurea products, they are clerly saver to use and are less likely to cause foliar burn of the turf.

There have been reports of injury from the use of sulfur on various turfs when the sulfur is applied at rates high enough to reduce soil pH. A study was initiated in the fall of 1978 at Traverse City on the sandy soil at that site (Table 8). The sulfur sources used were powdered (flowers of sulfur) and a ground sulfur which was composed of relatively larger particles of crystalline sulfur. The pH change was quite marked, particularly for the powdered form, at all rates of application. It is apparent that the 20 lb application rate gave a very significant reduction in pH down to 4.6. As can be seen by turf quality readings, serious turf injury also occurred as observed in September, 11 months after application. Interestingly, the pH decreased even in the 4 to 6 inch depth indicating that the acid was being moved downward somewhat in the very sandy soil by leaching. In contrast, the pH effects from the ground sulfur applications were not as marked nor was there any injury apparent on the turf, even at the 20 lb application rate. Thus, it is very important to consider the type of sulfur being applied when determining the rate of application.

One should always use caution in applying the powdered form of sulfur. A maximum annual rate of 4 to 5 lbs per 1000 square feet is suggested when this is used. pH change on finer-textured soils or soils which have considerable amounts of free calcium carbonate and have pH as well above 7 would be much slower than observed here, of course. More sulfur would be needed to bring about a similar pH change so the treatment period would need to be extended over a period of years. As is clear, the ground sulfur which has larger particles gives much slower pH change but the effect would last longer. There are some products on the market which are granular in nature but when they are put in water, they break down to fine particles and give relatively quick pH change again. Let me stress the importance of using sulfur very carefully to reduce soil pH.

Studies on the effect of using core cultivation on soils have proven very interesting. Marty Petrovic completed his Ph.D. on this study in the past year and now is the turf specialist at Cornell University in New York. He utilized the Computerized Axial Tomography scanner (CAT Scanner) in the Medical School here at Michigan State University to evaluate the density of soil over very small distances. With this piece of equipment, he was able to determine that core cultivation does, in fact, cause zones of compaction both parallel to the sides of the tines and in the soil right at the bottom of the coring hole. Based on greenhouse studies, we feel that the compaction on the sides of the coring holes is minimal and with tiem these walls tend to sluff into the opening and in fact provide improvement in aeration and associated responses such as rooting. The bottom of the coring hole, however, presents a different problem. After several months of growing the cores in the greenhouse, the soil at the bottom of the coring hole still exhibited a marked increase in compaction as a result of the core cultivation. It is apparent that with continued use over a period of yers coring to the same depths can cause a type of coring pan, or compaction zone below the surface.

How serious is this problem? We really do not know the long-term detriment of this effect. Perhaps with freezing and thawing we may get improvement of the compaction layer such that it will not be noticeable. Should one consider not using core cultivation in the future? Definitely, we would say that core cultivation should be practiced where needed. If the surface compaction problem is such that core cultivation is necessary, this is an essential practice. But it might be well to consider coring to different depths to be sure there is not one depth that is reached with your coring tine every time this is practiced. Naturally, the coring depth will vary as there are changes in soil moisture content, the amount of sand in a particular green, how compacted the soil is for particular greens, and the length of the tines at the time the coring is done. It may be well to not always follow the same routine when starting with new tines. That is, do not core number 18 first and proceed in a set pattern. By varying the depth of coring, one then can vary the depth to which this compaction might occur.

The basic conclusion from these studies is not that we should cease coring operations, but that we should evaluate carefully the objectives for such practices and then determine that they are, in fact, giving us the improvement in turf conditions which is desired. If we just stop to think about it, anything that creates a hole where there was not one will have to cause compaction due to the downward motion. For example, spiking surely causes some compaction in the surface inch or so of soil under a green. Is spiking giving use the improvement in maintenance conditions desired? There are some clear advantages of spiking, but the potential for increased compaction in the surface cannot be overlooked.

Appreciation is expressed to the companies which donated products and to the superintendents and their associated golf courses on which we conducted the research studies: Ed Karcheski, Traverse City Country Club; Kurt Thuemmel, Walnut Hills Country Club; and Red Bell, Country Club of Lansing.

Table 1. 1979 N Carrier Evaluations on Kentucky bluegrass at East Lansing. Treatments applied at 1.5 lbs N/1000 square feet on June 28. Average for 3 replications.

Treatment		Turf Quality Rating (9 = best)		
Carrier	Dwell Rate lb/A	July 25	Aug 25	Oct 29
Urea[w]	-	8.3ac*	6.3fh*	4.2
Urea[w]	0.5	8.3ac	7.0cf	4.3
Urea[w]	1.0	8.2ad	7.5bd	4.7
Urea[w]	2.0	8.0ad	7.5bd	4.7
Urea[x]	-	8.2ad	6.2gh	4.2
Urea[x]	0.5	8.0ad	6.7eg	4.5
Urea[x]	1.0	7.8bd	7.0cf	4.7
Urea[x]	2.0	7.5d	7.2be	5.0
Urea[y]	0.5	8.2ad	7.5bd	4.5
Urea[y]	1.0	8.2ad	7.8b	4.7
Urea[z]	1.0	8.3ac	7.7bc	4.8
Urea[z]	2.0	8.3ac	7.5bd	5.0
28-0-0	-	8.3ab	6.8dg	4.0
28-0-0	1.0	8.0ad	6.7eg	4.5
28-0-0	2.0	8.0ad	7.5bd	4.5
Methylolurea (Georgia Pacific)	-	6.7e	6.8dg	4.0
Ureaform (Powder blue)	-	5.0g	5.8h	4.0
Sulfur coated urea (Lakeshore)	-	5.5fg	8.8a	5.7
Sulfur coated urea (CIL)	-	7.7cd	6.7eg	4.2
Amway 15-2-5 (KCL)	-	8.0ad	7.2be	4.3
Amway 15-2-5 (KNO_3)	-	8.0ad	7.2be	4.5
Amway (12-12-5)	-	7.7cd	7.5bd	4.8
Formolene (26% N) (Ashland)	-	6.8e	6.7eg	4.0
Folian (12% N) (Allied)	-	7.8bd	6.3fh	4.2
IBDU (fine)	-	5.3g	6.5eg	7.0
18-5-9 (Lebanon)	-	6.8e	7.0cf	4.2

*Numbers in columns followed by the same letter are not significantly different at the 5% level.

w - Urea applied dry, Dwell as solution; watered.

x - Urea and Dwell applied as solution; watered.

y - Dwell treated urea applied dry; watered.

z - Urea, Dwell and Unite applied as solution; watered.

Table 2. 1979 N Carrier Evaluation on Kentucky Bluegrass at Traverse City. Two pounds N applied per 1000 square feet on May 8. Average for 3 replications.

Treatment		Turfgrass Quality Ratings (9 = best)			
Carrier	Dwell Rate lbs/A	July 18	Aug 23	Sept 13	Dec 11
Urea[w]	-	9.0a*	6.7fh	5.3i	4.3df
Urea[w]	1.0	8.5ac	7.3cf	6.2ei	5.0cf
Urea[w]	2.0	8.7ab	7.5bf	6.5dh	4.7cf
Urea[x]	-	8.3ac	6.7fh	5.7gi	4.3df
Urea[x]	1.0	8.2bc	7.7ae	5.5hi	4.0ef
Urea[x]	2.0	8.3ac	7.5bf	6.5dh	4.0ef
Urea[y]	1.0	8.0bd	7.2dg	6.2ei	5.0cf
Urea[y]	2.0	8.2bc	7.5bf	6.7dg	4.7cf
Urea[z]	1.0	8.5ac	6.8eh	6.2ei	4.7cf
Urea[z]	2.0	8.5ac	7.0dg	6.5dh	4.7cf
28-0-0	-	8.0bd	6.7fh	5.7gi	3.7f
28-0-0	1.0	7.8ce	6.8eh	6.3ei	4.3df
28-0-0	2.0	8.0bd	7.5bf	6.7dg	4.0ef
Methylolurea (Georgia Pacific)	-	7.3df	6.0h	5.3i	3.7f
Methylolurea (Georgia Pacific)	1.0	7.0fh	6.3gh	5.5hi	4.3df
Milorganite	-	6.7fh	7.3cf	7.0cf	5.3bf
Milorganite	1.0	6.5gi	7.5bf	6.7dg	5.0cf
Amway 15-2-5 (KCL)	-	7.8ce	7.0dg	6.3ei	4.3df
Amway 15-2-5 (KNO_3)	-	7.8ce	7.0dg	6.0fi	4.7cf
Amway 12-12-5		-	6.0h	5.8gi	4.3df
Ureaform (Powder blue)	-	6.5gi	6.7fh	6.5dh	5.0cf
Sulfur coated urea (Lakeshore)	-	7.2eg	6.8eh	7.5bd	5.0cf
Sulfur coated urea (CIL)	-	8.2bc	7.8ad	8.0ac	5.7ac
IBDU (coarse)	-	5.7jk	8.3ab	9.0a	6.3ac
IBDU (fine)	-	5.8jk	8.2ac	8.7a	6.0ad
24-4-12 (Swift)	-	7.8ce	7.7ae	7.5bd	6.0ad
18-5-9 (Lebanon)	-	8.3ac	7.0dg	7.2be	5.3bf

*Numbers in columns followed by the same letter are not significantly different from each other at the 5% level.
w - Urea applied dry, Dwell applied as solution; watered.
x - Urea and Dwell applied together in solution; watered.
y - Dwell treated urea applied dry; watered.
z - Urea applied dry, Dwell applied as a solution; not watered.

Table 3. 1978-79 Late Fall N Study on a *Poa annua* fairway - Walnut Hills Country Club. Fall treatments applied November 15, 1978; spring treatments on April 10, 1979.

Treatment			Visual Quality Rating (9 - best)		
Carrier	N Rate lbs/1000	Date of application	April 10	May 1	June 6
None	1	Fall	3.7j*	4.2l	3.7j
IBDU (coarse)	1	Fall	4.7gh	5.2jk	7.0eh
IBDU (fine)	1	Fall	5.0g	5.7ij	6.8fi
IBDU (.5-1 mm)	1	Fall	5.7f	6.3gi	7.0eh
IBDU (.1-.2 mm)	1	Fall	5.8f	6.7eg	6.8fi
24-4-12 (Swift)	1	Fall	7.0d	7.2de	6.5hi
Urea	1	Fall	7.7bc	7.8cd	6.2i
Urea (1% Dwell)	1	Fall	7.0d	7.0ef	6.7gi
Sulfur coated urea (Lakeshore)	1	Fall	7.0d	6.7eg	7.2dh
Sulfur coated urea (CIL)	1	Fall	6.8de	7.0ef	6.8fi
Milorganite	1	Fall	6.2ef	6.2gi	6.8fi
18-5-9 (Lebanon)	1	Fall	7.3cd	7.3de	6.5hi
IBDU (coarse)	2	Fall	5.8f	5.7cj	8.2b
IBDU (fine)	2	Fall	6.3ef	6.7eg	8.0bc
IBDU (.5-1 mm)	2	Fall	6.7de	7.2de	7.3cg
IBDU (.1-.2 mm)	2	Fall	6.8de	7.3de	6.8fi
24-4-12 (Swift)	2	Fall	8.0b	8.2bc	7.3cg
Urea	2	Fall	8.7a	9.0a	6.7gi
Urea (1% Dwell)	2	Fall	8.3ab	8.5ab	7.3cg
Sulfur coated urea (Lakeshore)	2	Fall	8.0b	7.8cd	8.0bc
Sulfur coated urea (CIL)	2	Fall	8.0b	8.2bc	7.8bd
Milorganite	2	Fall	7.7bc	7.3de	7.7be
18-5-9 (Lebanon)	2	Fall	8.3ab	8.3bc	7.3cg
IBDU (coarse)	1	Spring	-	4.7kl	6.7gi
IBDU (fine)	1	Spring	-	5.0k	7.0eh
IBDU (.5-1 mm)	1	Spring	-	6.3gi	7.2dh
IBDU (.1-.2 mm)	1	Spring	-	6.3gi	7.0eh
24-4-12	1	Spring	-	6.8eg	6.8fi
Urea	1	Spring	-	8.2bc	7.3cg
Urea (1% Dwell)	1	Spring	-	7.7cd	7.2dh
Sulfur coated urea (Lakeshore)	1	Spring	-	6.2gi	6.7gi
Sulfur coated urea (CIL)	1	Spring	-	7.3de	7.7be
IBDU (coarse)	2	Spring	-	6.0hi	7.7be
IBDU (fine)	2	Spring	-	6.5fh	8.2b
IBDU (.5-1 mm)	2	Spring	-	7.8cd	7.8bd
IBDU (.1-.2 mm)	2	Spring	-	8.2bc	7.5bf
24-4-12	2	Spring	-	8.0bc	7.8bd
Urea	2	Spring	-	9.0a	8.0bc
Urea (1% Dwell)	2	Spring	-	8.5ab	8.0bc
Sulfur coated urea (Lakeshore)	2	Spring	-	7.0ef	7.7be
Sulfur coated urea (CIL)	2	Spring	-	8.3bc	9.0a

*Numbers in columns followed by the same letter are not significantly different at the 5% level.

Table 4. 1978-79 Late Fall N Study on a *Poa annua* fairway - Country Club of Lansing. Fall treatments applied November 16, 1978; spring treatments on April 13, 1979.

Treatment			Turfgrass Quality Rating (9 - best)				
Carrier	N Rate lbs/1000	Date of applic.	Mar 22	Apr 13	May 11	June 4	July 23
None	-	-	4.2j*	4.2i	3.0t	4.7p	4.0q
IBDU (coarse)	1	Fall	5.8i	5.0hi	4.5pr	6.7jm	6.3im
IBDU (fine)	1	Fall	5.8i	5.7gh	5.0nq	6.8im	6.2jo
IBDU (.5-1 mm)	1	Fall	6.5fh	6.2fg	5.5kn	6.8im	6.3im
IBDU (.1-.2 mm)	1	Fall	6.7eg	6.8df	5.2mp	6.8im	6.3im
24-4-12 (Swift)	1	Fall	7.3ce	7.0df	5.3lo	6.2mn	5.7mo
Urea	1	Fall	7.3ce	7.7bd	6.3gj	5.3op	4.8pq
Urea (1% Dwell)	1	Fall	7.5cd	7.2cf	6.2hk	6.2mn	6.2jo
Sulfur coated urea (Lakeshore)	1	Fall	6.0hi	6.5eg	5.8im	7.0hl	6.8fj
Sulfur coated urea (CIL)	1	Fall	7.2cf	7.0df	6.5fi	6.8im	6.7gk
Milorganite	1	Fall	6.2gi	6.5eg	5.3lo	6.3ln	6.3im
18-5-9 (Lebanon)	1	Fall	6.8dg	7.2cf	6.0il	6.7no	5.5np
IBDU (coarse)	2	Fall	6.5fh	6.3fg	5.8im	6.8cg	7.2dh
IBDU (fine)	2	Fall	7.0cf	7.0df	6.2hk	8.0bf	7.3cg
IBDU (.5-1 mm)	2	Fall	7.5cd	7.8ad	6.5fi	7.7dh	7.2dh
IBDU (.1-.2 mm)	2	Fall	7.7bc	8.2ac	5.8im	7.5ei	6.7gk
24-4-12 (Swift)	2	Fall	8.3ab	8.2ac	6.5fi	7.0hl	6.3im
Urea	2	Fall	8.3ab	8.8a	7.2df	6.5km	6.0ko
Urea (1% Dwell)	2	Fall	8.8a	8.3ab	7.0eg	7.3fj	6.8fj
Sulfur coated urea (Lakeshore)	2	Fall	7.0cf	7.5be	6.8eh	7.3fj	7.7be
Sulfur coated urea (CIL)	2	Fall	8.3ab	8.2ac	7.3de	7.7dh	7.5bf
Milorganite	2	Fall	7.0cf	7.8ad	5.8im	7.0hl	6.8fj
18-5-9 (Lebanon)	2	Fall	8.2ab	8.3ab	6.5fi	6.8im	7.0ei
IBDU (coarse)	1	Spring	-	-	4.0rs	6.8im	6.7gk
IBDU (fine)	1	Spring	-	-	4.7or	7.2gk	6.5hl
IBDU (.5-1 mm)	1	Spring	-	-	4.7or	7.2gk	6.8fj
IBDU (.1-.2 mm)	1	Spring	-	-	5.2mp	7.2gk	6.7gk
24-4-12 (Swift)	1	Spring	-	-	6.3gj	7.3fj	6.7gk
Urea	1	Spring	-	-	7.7cd	6.8im	5.8lo
Urea (1% Dwell)	1	Spring	-	-	7.2df	7.8cg	7.0ei
Sulfur coated urea (Lakeshore)	1	Spring	-	-	5.7jn	7.0hl	6.7gk
Sulfur coated urea (CIL)	1	Spring	-	-	6.5fi	7.8cg	7.5bf
Milorganite	1	Spring	-	-	4.7pr	7.3fj	6.5hl
18-5-9 (Lebanon)	1	Spring	-	-	6.8eh	7.5ei	6.5hl
IBDU (coarse)	2	Spring	-	-	4.3qr	8.3ad	8.2ab
IBDU (fine)	2	Spring	-	-	5.3lo	8.3ad	8.2ab
IBDU (.5-1 mm)	2	Spring	-	-	4.5pr	7.8cg	7.8bd
IBDU (.1-.2 mm)	2	Spring	-	-	5.0nq	8.2ae	7.7be
24-4-12 (Swift)	2	Spring	-	-	7.2df	8.5ac	7.3cg
Urea	2	Spring	-	-	9.0a	8.2ae	7.0ei
Urea (1% Dwell)	2	Spring	-	-	8.8ab	8.3ad	7.7be
Sulfur coated urea (Lakeshore)	2	Spring	-	-	6.5fi	8.0bf	8.0ac
Sulfur coated urea (CIL)	2	Spring	-	-	7.7cd	8.7ab	8.5a
Milorganite	2	Spring	-	-	5.8im	8.5ac	7.5bf
18-5-9 (Lebanon)	2	Spring	-	-	8.2bc	8.8a	7.3cg

*Numbers in a column are not significantly different from each other at the 5% level if followed by the same letter.

Table 5. 1979 - Time of Urea N application on Nugget Kentucky bluegrass. N applied at 2 lbs/1000 square feet at East Lansing. Average for 3 replications.

Date of Application	Turf Quality Rating (9 = best)		
	Oct 22	Nov 7	Nov 20
Sept 1	9.0a*	8.7a	7.7bd
Sept 15	9.0a	8.5ab	7.5cd
Oct 1	8.0ab	8.5ab	8.3ab
Oct 15	6.2ce	8.3ab	7.2de
Nov 1	-	6.5c	4.7ij
Nov 15	-	-	3.8kl

*Numbers in columns followed by the same letter are not significantly different at the 5% level.

Table 6. 1979 - Carrier and time of late fall application on Nugget Kentucky bluegrass. N applied at 1.5 lbs/1000 square feet in East Lansing. Average for 3 replications.

Treatment		Turf Quality Rating (9 = best)		
Carrier	Date of Application	Oct 22	Nov 7	Nov 20
IBDU (coarse)	Sept 15	7.0bd*	7.0de	6.5fg
	Oct 15	4.2h	5.8f	4.8ij
	Nov 15	-	-	3.5l
Methylolurea (Georgia Pacific)	Sept 15	8.0ab	7.0de	6.8ef
	Oct 15	6.0cf	8.0ab	7.5cd
	Nov 15	-	-	4.8ij
Urea (1% Dwell)	Sept 15	8.8a	8.2ab	8.0ac
	Oct 15	6.5cd	8.7a	7.3de
	Nov 15	-	-	4.3jk
Sulfur-coated urea (CIL)	Sept 15	8.0ab	8.7a	8.2ab
	Oct 15	5.0eh	7.0de	6.2fh
	Nov 15	-	-	4.5ij

*Numbers in columns followed by the same letters are not significantly different at the 5% level.

Table 7. Foliar burn effects of N fertilizers applied on Penncross bentgrass September 19, 1979 at East Lansing. Plots rated September 24. Average of 3 replications.

Treatment		
Carrier	N Rate lbs/1000	Foliar burn injury rating (9 = none)
None	-	9.0a*
Urea	1.5	8.8a
Urea (2 lbs Dwell/A)	1.5	8.8a
Urea	3.0	6.0c
Formolene (Ashland)	1.5	9.0a
Formolene	3.0	8.7a
Folian (Allied)	1.5	6.8bc
Folian	3.0	6.3c
Amway	1.5	7.3b
Amway	3.0	4.3d
Methylolurea (Ga. Pacific)	1.5	9.0a
Methylolurea	3.0	8.7a

*Numbers in columns followed by the same letter are not significantly different from each other at the 5% level.

Table 8. Sulfur effects on soil pH and Kentucky bluegrass injury. Treatments applied to Kalkaska sand in October, 1978. Ratings taken in 1979.

Treatment		Soil pH (11/79)		Turf Quality Rating (9 = best)	
Source	Rate lbs/1000	0-2 inch	4-6 inch	Sept 13/79	Dec 11/79
None	-	6.9	6.6	9.0a*	6.3a*
Powder	5	6.4	6.2	9.0a	7.0a
Powder	10	5.4	6.0	6.5b	5.7b
Powder	20	4.6	5.8	1.0c	2.0c
Ground (Chip)	5	6.5	6.3	9.0a	6.7ab
Ground (Chip)	10	6.6	6.6	9.0a	6.7ab
Ground (Chip)	20	6.0	6.2	9.0a	6.7ab

*Numbers in columns followed by the same letter are not significantly different from each other at the 5% level.