

Soils Research Report: Late Season Nitrogen Fertilization,
Nitrogen Carrier Evaluations, and Plot Establishment

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Major efforts in 1981 were placed on completing the soil modification for greens establishment at the Hancock Turfgrass Research Center. The plots to be used for greens irrigation research were constructed essentially according to the specifications designed by the U.S.G.A. including tile, pea gravel layer and topsoil mix. There was no sand layer included between the topsoil mix and the pea gravel. The plot areas drain well, but the border areas tend to pond water for a period of time where subsoil was brought to the surface during installation of the irrigation system. This subsoil material caused the soil surface to be sealed and limits infiltration rate. In normal construction this should not present a problem, since irrigation installation would occur on the perimeter of the green. An exception might be a football field or other large turf area in which irrigation lines and heads will be found in the middle of the field and where sandy soil mixes are used.

Three other greens were established on different soils. One was directly on the sandy loam topsoil existing on the site. Another was on 2NS (coarse mix) sand with peat worked into the upper 4-6 inches, and the third was built as a Purr-wick green with dune sand (predominantly medium and fine sands) with the plastic liner and tile drainage. Establishment rate of seeded Penncross creeping bentgrass was fastest on the topsoil followed by the U.S.G.A. mix. The establishment rate was much slower on the two sand greens, especially on the Purr-wick sand. This was likely due to lower nitrogen availability caused by leaching from the sands and no topsoil in the mix to provide some nitrogen and cation exchange capacity. We do not think that irrigation was a factor as the plots were irrigated independently. Clearly more frequent nitrogen fertilization will be needed on these sandy soils.

Appreciation is gratefully acknowledged to the Standard Sand Corporation which donated all the sand used in modifying the soils for the greens; the Michigan Turfgrass Foundation which paid for transportation of the sand, and much of the labor cost; irrigation companies who provided irrigation equipment and some of the labor for installation; and many individual members of the Michigan Turfgrass Foundation who donated use of equipment and/or personal labor. Special thanks to Ron Foote, superintendent at Forest Akers Golf Course, M.S.U., for loaning use of the soil shredder used for mixing all the soil, and for helpful advice given willingly. Without this kind of widespread support, we could not have the quality plots on which we will be conducting turf research for many years.

Late season nitrogen fertilization and nitrogen carrier evaluation

A large late season (or dormant nitrogen fertilization) study was initiated in October, 1980 on a Penncross creeping bentgrass putting green at the Soils Research Farm in East Lansing. Treatments are shown in Table 1. Plot size was 3 feet by 6 feet. All treatments were applied by hand. Turf responses were typical of those observed in earlier studies and in other studies given later in this report. One observation which was very apparent was that those plots fertilized with the completely soluble N sources (ammonium nitrate and urea) at the 2 pound rate gave very quick response to the October 15 fertilization as might be expected. The grass became very green and succulent. There was a period of several weeks before there was a hard freeze. When the hard freeze came in late November, significant injury to the leaf tissue occurred on these plots. The

Table 1. 1980-81 Fall Nitrogen Responses on a Penncross bentgrass green at East Lansing. Averages for 3 replications.

Carrier	Treatment		Evaluation date (9-1;9=dark green)			
	N rate lbs/M	Date of application	11/20/80	12/17/80	4/8/81	5/13/81
Milorganite	1	Oct 15	3.5mp#	3.5ru	3.0uw	4.0qr
Milorganite	1	Nov 1	3.3np	2.7wx	2.7wx	3.8rs
Milorganite	1	Nov 15	3.2op	2.7wx	2.3xy	3.5s
Milorganite	2	Oct 15	4.3kl	4.3oq	4.3pq	6.7h
Milorganite	2	Nov 1	3.8lo	3.7rt	4.2pr	6.3hi
Milorganite	2	Nov 15	3.3np	2.8vx	3.5su	6.0ij
10-1-8*	1	Oct 15	5.8gh	5.3jl	5.3lm	5.0o
10-1-8	1	Nov 1	4.3kl	4.3oq	5.0mo	5.3mo
10-1-8	1	Nov 15	3.0p	3.2tw	5.0mo	5.2no
10-1-8	2	Oct 15	7.3bd	7.2df	7.5bd	8.0de
10-1-8	2	Nov 1	5.5hi	5.8hj	7.3ce	8.3bd
10-1-8	2	Nov 15	3.5mp	3.7rt	6.5gi	8.0de
Urea	1	Oct 15	6.3eg	5.8hj	5.0mo	5.0o
Urea	1	Nov 1	4.7jk	4.8lo	5.2mn	5.0o
Urea	1	Nov 15	3.5mp	3.7rt	5.2mn	5.7km
Urea	2	Oct 15	7.8eg	7.5de	7.2cf	7.5fg
Urea	2	Nov 1	6.3eg	6.2gi	7.2cf	8.5ac
Urea	2	Nov 15	4.2km	7.3oq	6.5gi	8.2cd
Urea-Dwell*	1	Oct 15	6.3eg	5.7il	5.3lm	5.7km
Urea-Dwell	1	Nov 1	4.3kl	4.7mo	5.2mn	5.7km
Urea-Dwell	1	Nov 15	3.3np	3.7rt	5.2mn	5.7km
Urea-Dwell	2	Oct 15	7.5bc	7.0ef	7.0dg	8.3bd
Urea-Dwell	2	Nov 1	5.8gh	5.8hj	7.0dg	8.5ac
Urea-Dwell	2	Nov 15	4.0kn	4.0pr	6.2hj	8.7ab
14-0-0*	1	Oct 15	7.5bc	6.7fg	5.8jl	4.5p
14-0-0	1	Nov 1	7.0ce	7.7cd	6.8eg	4.5p
14-0-0	1	Nov 15	5.2hj	8.2bc	8.0b	5.3mo
14-0-0	2	Oct 15	9.0a	8.2bc	6.7fh	7.3fg
14-0-0	2	Nov 1	9.0a	8.5ab	7.3ce	7.3fg
14-0-0	2	Nov 15	7.0ce	9.0a	9.0a	8.0de
18-4-10*	1	Oct 15	5.0ig	4.3oq	3.5su	4.0qr
18-4-10	1	Nov 1	4.2km	3.3sv	2.8vx	4.0qr
18-4-10	1	Nov 15	3.0p	2.8vx	2.7wx	4.5p
18-4-10	2	Oct 15	7.0ce	6.2gi	5.5km	7.2g
18-4-10	2	Nov 1	5.5hi	5.0ln	4.7np	7.2g
18-4-10	2	Nov 15	3.2op	3.3sv	4.0qs	7.5fg

Table 1. Continued.

Carrier	N rate lbs/M	Date of application	11/20/80	12/17/80	4/8/81	5/13/81
Ammonium nitrate	1	Oct 15	6.3eg	5.8hj	4.7np	5.5lm
Ammonium nitrate	1	Nov 1	5.0ij	5.2km	5.2mn	6.0ij
Ammonium nitrate	1	Nov 15	3.3np	3.8qs	5.3lm	6.2ij
Ammonium nitrate	2	Oct 15	7.8b	7.0ef	7.7bc	8.3bd
Ammonium nitrate	2	Nov 1	6.7df	6.2gi	7.5bd	8.5ac
Ammonium nitrate	2	Nov 15	3.8lo	4.3pr	7.2cf	8.5ac
20-0-16*	1	Oct 15	4.7jk	3.8qs	4.0qs	4.5p
20-0-16	1	Nov 1	3.8lo	3.3sv	3.7rt	4.5p
20-0-16	1	Nov 15	3.2op	2.8vx	3.7rt	5.0o
20-0-16	2	Oct 15	6.2fg	4.7mo	5.2mn	7.7ef
20-0-16	2	Nov 1	5.5hi	4.5np	5.0mn	8.0de
20-0-16	2	Nov 15	3.2op	3.7rt	4.3pq	7.7ef
S. coated urea#	1	Oct 15	5.3hj	5.3jl	4.5oq	5.7km
S. coated urea	1	Nov 1	4.0kn	4.5np	4.2pr	5.8jl
S. coated urea	1	Nov 15	3.0p	3.3sv	4.0qs	6.2ij
S. coated urea	2	Oct 15	7.3bd	6.3gh	6.5gi	8.8a
S. coated urea	2	Nov 1	5.5hi	5.2km	6.2hj	8.8a
S. coated urea	2	Nov 15	3.7lp	3.7rt	6.0ij	8.8a
IBDU-fine	1	Oct 15	3.2op	3.0ux	2.8vx	5.0o
IBDU-fine	1	Nov 1	3.0p	2.5x	1.8yz	4.3pq
IBDU-fine	1	Nov 15	3.0p	2.5x	1.8z	3.5s
IBDU-fine	2	Oct 15	4.2km	3.5ru	4.5oq	7.7ef
IBDU-fine	2	Nov 1	3.5mp	2.8vx	4.2pr	7.2g
IBDU-fine	2	Nov 15	3.3np	2.5x	3.3tv	6.0ik

*Carriers are 10-1-8 from Milwaukee Sewage Commission; Dwell from Olin-Matheson Co.; 14-0-0 (Iron-S) from Scott's; 18-4-10 from Lebanon Co.; 20-0-16 from Lakeshore Equipment Co.; S-coated urea - special grade for greens from CIL.

#Quality ratings in columns followed by the same letter are not significantly different from each other using Duncan's Multiple Range Test at the 5% level.

injury resulted in some discoloration, but no permanent injury occurred as these plots had good color the next spring. Obviously, timing of the late season N application is dependent on the N carrier. Slow release materials must be applied earlier than completely soluble carriers to get the same response in November. These plots were not treated for snowmold control to see if snowmold susceptibility might change with N treatment. There was essentially no snowmold on the plot area in the spring, so no differences were recorded.

Another study was on late season nitrogen-potassium balance on the Penncross green. All combinations of 0 and 1 pound of N with 0, 1 and 2 pounds of K₂O were applied on November 10. No snowmold treatment was applied to this plot area, but since there was no snowmold of consequence on the plots no differences could be recorded due to N-K₂O balance. Only nitrogen responses occurred.

Late season N studies on carriers and timing of application were again conducted on Poa annua fairways. The treatments applied are shown in Tables 2 and 3. These studies were conducted with Dan Garson and Gary Thommes, students working on a special study basis. Appreciation is expressed to Kurt Thuemmel, superintendent at Walnut Hills Country Club, and Mark Magee, superintendent at the Country Club of Lansing for their cooperation in these studies. The nitrogen was applied at 1.5 pounds per 1000 square feet. Plot size was 5 feet by 7 feet. All fertilizers were weighed previously and applied by hand.

As observed in other studies, slow release carriers such as IBDU and Milorganite must be applied earlier in the fall to allow for release of available N before mid-November for late fall uptake and response. Note that December applications still did not give much response by mid-May, but did by June (Country Club of Lansing).

Sulfur-coated urea gave good responses with the CIL material responding faster than the LESCO source with the latter giving longer response in the late spring and early summer. There was a noticeable pattern of green spots from the LESCO source in June at the Country Club of Lansing. The CIL treated plots did have a few smaller green spots, but these were not as noticeable. The larger sulfur-coated urea particles from LESCO were apparently just releasing the N from scattered particles later in the season when the rest of the N had been utilized. This could be overcome by another N fertilization.

A study of several slow release nitrogen sources was initiated in July on a blend of Kentucky bluegrasses on the grounds at the Traverse City Country Club. Appreciation is expressed to Tom Mead and Steve White for their cooperation in this and other studies conducted there. The N carriers (Table 4) are: 1) oxamide with two different size ranges, a finer grade (passing a 20 mesh screen) which will give a faster response, and a coarser grade (6-16 mesh); 2) FLUF (flowable ureaformaldehyde) applied as a liquid with a CO₂ sprayer; 3) Powder Blue, fine grade ureaformaldehyde (applied dry mixed with sand); 4) 10-1-4, a flowable complete fertilizer; 5) several carriers containing sulfur-coated urea from LESCO; 6) sulfur-coated urea from CIL (32-0-0); 7) IBDU (coarse); 7) 24-4-12, containing IBDU as part of the N; 8) 18-5-9, containing ureaformaldehyde as part of the N; and 9) Dwell-treated urea with Dwell serving as a nitrification inhibitor.

Turf responses (Table 4) were generally as expected. For uniform responses, both short-term and long-term, the slower releasing materials mixed with soluble N gave the most uniform ratings. The slower responding materials gave the longest responses as would be expected. Note ratings for IBDU and coarse oxamide compared to other materials in November. FLUF clearly gives a faster response than Powder blue. The sulfur-coated urea materials gave responses intermediate between the slow releasing sources and soluble N (urea). Dwell-treated urea did give a longer response than urea alone, indicating some inhibition of nitrification did occur. Complete fertilizers (24-4-12 and 18-5-9) gave both short- and long term responses, although 18-5-9 contains more soluble N than 24-4-12, so the response

Table 2. 1980-81 Fall Nitrogen Responses on a *Poa annua* fairway at the Walnut Hills Country Club, East Lansing. Averages for 3 replications. Nitrogen applied at 1.5 pounds per 1000 square feet.

Treatment		Evaluation date (9-1;9-dark green)					
Carrier	Date of application	10/31/80	11/18/80	12/17/80	4/6/81	4/22/81	5/15/81
IBDU	Oct 15	5.8f [#]	5.7i	5.8hm	5.7ij	6.7g	7.2hk
IBDU	Nov 1	5.5fg	4.7kl	5.0lp	5.5jl	7.3ef	7.2hk
IBDU	Nov 15	5.3g	4.0m	3.7qt	4.5m	6.0h	6.5km
IBDU	Dec 1	5.3g	4.0m	3.2t	2.7n	5.5h	5.3n
S.C. Urea (CIL)*	Oct 15	8.2b	8.5bc	7.7bd	6.8df	8.3ac	8.0cg
S.C. Urea (CIL)	Nov 1	5.5fg	7.2f	7.3df	6.7dg	8.7a	7.8dh
S.C. Urea (CIL)	Nov 15	5.3g	4.0m	5.5in	6.8df	8.3ac	8.3ae
S.C. Urea (CIL)	Dec 1	5.3g	4.0m	3.5rt	5.7ij	7.7ce	8.5ad
18-5-9*	Oct 15	8.3b	8.3cd	6.5ei	4.8lm	7.2eg	6.3lm
18-5-9	Nov 1	5.3g	7.2f	8.3ac	7.2ce	8.2ac	7.0il
18-5-9	Nov 15	5.3g	4.8kl	5.2kp	7.7ac	8.7a	7.8dh
18-5-9	Dec 1	5.2g	4.0m	4.3os	6.5eh	7.7ce	7.3gj
Milorganite	Oct 15	6.3e	6.5gh	6.3gk	6.8df	7.2eg	7.0il
Milorganite	Nov 1	5.5fg	5.2j	4.8mp	6.7dg	7.3ef	7.7ei
Milorganite	Nov 15	5.5fg	4.0m	3.5rt	6.2fj	7.3ef	8.2bf
Milorganite	Dec 1	5.2g	4.0m	3.3st	4.8lm	6.7g	6.8jl
Urea*	Oct 15	9.0a	9.0a	6.8dh	4.8lm	7.2eg	6.0m
Urea	Nov 1	5.5fg	8.2cd	8.5ab	6.2fj	7.7ce	6.8jl
Urea	Nov 15	5.2g	4.7kl	5.8hm	7.8ac	8.2ac	7.3gj
Urea	Dec 1	5.2g	4.0m	4.2ps	6.8df	7.2eg	7.5fj
Dwell*-Urea	Oct 15	8.7a	8.5bc	7.2dg	5.8hj	7.5de	7.3gj
Dwell-Urea	Nov 1	5.3g	7.8e	8.3ac	6.7dg	8.3ac	7.5fj
Dwell-Urea	Nov 15	5.3g	4.7kl	6.2gk	7.7ac	8.3ac	7.7ei
Dwell-Urea	Dec 1	5.5fg	4.0m	4.5nr	6.2fj	7.5de	7.3gj

Table 2. Continued.

Carrier	Date of application	10/31/80	11/18/80	12/17/80	4/6/81	4/22/81	5/15/81
31-3-10*	Oct 15	7.8c	7.8e	6.3fj	6.3fi	7.3ef	6.3lm
31-3-10	Nov 1	5.5fg	6.7g	7.5ce	7.2ce	8.0bd	6.0m
31-3-10	Nov 15	5.5fg	4.0m	5.3jo	6.8df	8.5ab	7.8dh
31-3-10	Dec 1	5.3g	4.0m	3.7qt	5.0km	7.2eg	7.5fj
24-4-12*	Oct 15	7.3d	8.0de	6.0hl	6.0gj	7.8ce	7.0il
24-4-12	Nov 1	5.5fg	6.8g	7.2dg	6.2fj	8.3ac	7.8dh
24-4-12	Nov 15	5.2g	4.0m	5.0lp	6.7dg	7.8ce	7.3gj
24-4-12	Dec 1	5.3g	4.0m	3.5rt	5.5jl	7.7ce	6.8jl
Ammonium nitrate	Oct 15	9.0a	8.7ab	6.8dh	4.7m	6.8fg	6.3lm
Ammonium nitrate	Nov 1	5.3g	7.8e	9.0a	6.8df	8.2ac	6.5km
Ammonium nitrate	Nov 15	5.3g	5.0jk	5.8hm	8.0ab	8.7a	7.3gj
Ammonium nitrate	Dec 1	5.5fg	4.0m	4.3os	6.2fj	7.5de	7.5fj
S.C. Urea (LESCO)*	Nov 1	5.5fg	6.2h	6.3fj	7.3bd	8.7a	8.7ac
S.C. Urea (LESCO)	Nov 15	5.3g	4.0m	4.3os	6.7dg	8.0bd	9.0a
S.C. Urea (LESCO)	Dec 1	5.5fg	4.0m	3.3st	5.8hj	7.8ce	8.5ad
28-0-10*	Nov 1	5.7f	5.8i	5.2kp	6.8df	8.5ab	8.2bf
28-0-10	Nov 15	5.5fg	4.0m	4.2ps	6.8df	8.3ac	8.5ad
28-0-10	Dec 1	5.5fg	4.0m	3.3st	5.8hj	8.3ac	8.8ab
Check		5.3g	4.0m	3.2t	2.3n	3.8i	3.8o

*Carriers are S.C. Urea (sulfur coated urea), regular grade, from CIL; 18-5-9 from Lebanon Co.; Dwell from Olin-Matheson Co.; 31-3-10 from Scott's; 24-4-12 from Estech; S.C. Urea from LESCO; 28-0-10 from LESCO.

#Quality ratings in columns followed by the same numbers are not significantly different from each other using Duncan's Multiple Range Test at the 5% level.

Table 3. 1980-81 Fall Nitrogen REsponses on a *Poa annua* fairway at the Country Club of Lansing. Averages for 3 replications. Nitrogen applied at 1.5 pounds per 1000 square feet.

Treatment		Evaluation date (9-1;9=dark green)					
Carrier	Date of application	11/6/80	11/20/80	12/9/80	4/13/81	5/4/81	6/5/81
IBDU	Oct 15	5.3f	6.2ef	6.3fh	6.67ag	6.67be	6.00bg
IBDU	Nov 1	5.0fg	4.8ij	4.8kn	5.17df	6.17cg	7.17af
IBDU	Nov 15	5.0fg	4.7ij	3.7pr	5.17df	5.83dg	6.83ag
IBDU	Dec 1	5.0fg	4.7ij	3.3qr	3.83fg	5.00fg	6.83ag
S.C. Urea (CIL)*	Oct 15	7.0cd	8.3b	8.2bc	8.00ab	8.33a	7.00af
S.C. Urea (CIL)	Nov 1	5.0fg	5.8g	6.5fg	7.50ac	7.83ab	7.33ae
S.C. Urea (CIL)	Nov 15	5.0fg	4.7ij	4.7ln	4.67ef	4.67g	5.33dh
S.C. Urea (CIL)	Dec 1	5.0fg	4.5j	3.7pr	5.83af	6.67be	8.33ac
18-5-9*	Oct 15	7.8b	8.3b	8.5ab	6.67ae	7.17ae	5.83ch
18-5-9	Nov 1	5.0fg	6.7cd	7.2de	7.50ac	7.67ac	5.67ch
18-5-9	Nov 15	5.0fg	4.7ij	5.3jl	7.00ad	6.83ae	7.17af
18-5-9	Dec 1	4.8g	4.7ij	3.8pr	6.33ae	6.17cg	7.67ad
Milorganite	Oct 15	5.7e	6.0fg	6.0gi	7.83ac	7.00ae	7.00af
Milorganite	Nov 1	5.0fg	5.2h	4.8kn	7.17ad	6.83ae	6.67ag
Milorganite	Nov 15	5.0fg	4.5j	3.3qr	6.67ae	6.17cg	7.67ae
Milorganite	Dec 1	5.0fg	4.5j	3.3qr	5.83bf	5.67eg	7.50ae
Urea*	Oct 15	8.7a	8.8a	9.0a	6.50ae	6.83ae	4.50fh
Urea	Nov 1	5.0fg	7.0c	7.2de	7.67ac	6.50bf	5.83ch
Urea	Nov 15	5.0fg	4.7ij	5.8hj	7.17ad	6.67be	6.50ag
Urea	Dec 1	5.2f	4.7ij	4.2np	5.83bf	6.00dg	6.50ag
Dwell*-Urea	Oct 15	8.5a	8.7a	8.8ab	7.17ad	7.00ae	6.33ag
Dwell-Urea	Nov 1	5.0fg	6.5de	7.2de	7.00ad	7.17ae	7.50ae
Dwell-Urea	Nov 15	5.0fg	4.7ij	5.3jl	7.17ad	7.17ae	7.33af
Dwell-Urea	Dec 1	5.0fg	4.7ij	4.0oq	6.33ae	6.50bf	6.50ag

Table 3. Continued.

Carrier	Date of application	11/6/80	11/20/80	12/9/80	4/13/81	5/4/81	6/5/81
31-3-10*	Oct 15	6.8d	8.0b	7.8cd	6.67ae	6.83ae	6.50ag
31-3-10	Nov 1	5.0fg	5.7g	6.2fh	7.00ad	6.17cg	6.17ag
31-3-10	Nov 15	5.0fg	4.7ij	4.5mo	6.67ae	6.67be	7.50ae
31-3-10	Dec 1	5.0fg	4.5j	3.7pr	6.00af	6.50bf	7.00af
24-4-12*	Oct 15	7.3c	8.2b	7.8cd	7.17ad	7.67ac	6.67ag
24-4-12	Nov 1	4.8g	6.2ef	6.7ef	7.50ac	7.00ae	7.00af
24-4-12	Nov 15	4.8g	4.7ij	5.2jm	6.33ae	7.00ae	7.50ae
24-4-12	Dec 1	5.0fg	4.7ij	3.7pr	6.00af	6.83ae	7.50ae
Ammonium nitrate	Oct 15	8.7a	8.8a	8.8ab	5.83bf	6.67be	5.00eh
Ammonium nitrate	Nov 1	4.8g	6.5de	6.8ef	7.5ac	6.83ae	6.00bg
Ammonium nitrate	Dec 1	5.0fg	4.7ij	3.8pr	7.00ad	6.67be	6.67ag
S.C. Urea (LESCO)*	Nov 1	5.0fg	5.3h	4.8kn	6.33ae	7.33ad	8.83ab
S.C. Urea (LESCO)	Nov 15	5.0fg	4.5j	4.0oq	6.50ae	7.17ae	8.17ad
S.C. Urea (LESCO)	Dec 1	4.8g	4.7ij	3.5pr	5.67ad	7.00ae	8.17ad
28-0-10*	Nov 1	5.0fg	6.0fg	5.5ik	7.33ad	7.83ab	9.00a
28-0-10	Nov 15	4.8g	4.7ij	4.0oq	6.67ae	7.33ad	9.00a
28-0-10	Dec 1	5.0fg	4.5j	3.3qr	6.00af	7.17ae	8.83ab
Check		4.8g	4.5j	3.2r	2.00g	2.83h	4.50fh

*Carriers are S.C. Urea (sulfur coated urea), regular grade, from CIL; 18-5-9 from Lebanon Co.; Dwell from Olin-Matheson Co.; 31-3-10 from Scott's; 24-4-12 from Estech; S.C. Urea from LESCO; 28-0-10 from LESCO.

#Quality ratings in columns followed by the same numbers are not significantly different from each other using Duncan's Multiple Range Test at the 5% level.