The phosphorus treatments were split into 2 applications during the growing season. Soil tests on samples taken in November 1991 are given in Table 6. It is clear that the phosphorus from surface applications is found mostly in the thatch and the 0-3 inch depth. Injecting the phosphorus clearly places the phosphorus deeper in the soil. The higher rate of phosphorus injected is much higher than would be recommended based on soil tests and obviously raises P levels deeper in the soil as would be expected. When P is applied only on the surface, roots deeper in the soil tend to extract P from that zone thereby leaving much lower P levels deeper in the root zone. The benefit from the deeper placement of P with the Hydroject is not yet apparent based on observations of the turf to date.

A similar study with potash was established in 1990 on an annual bluegrass turf mowed at fairway height and growing on loam soil. Treatments are similar to those for the P study, but the rates of application of K_20 (Table 7) are 3 and 6 lbs. per 1000 sq. ft. In this loam soil, there is limited downward movement of K from surface applications. This occurred for both 3 and 6 lb. treatments. When injected with the Hydroject, it is clear the K is being placed deeper in the soil after 2 years of treatments. Based on these studies, the conclusion is that the Hydroject can be used effectively to inject P and K in to turf soils. These studies will be continued to evaluate the benefits of nutrient injection to turf.

NITROGEN CARRIER EVALUATIONS

Several nitrogen carriers were evaluated for responses at the Hancock Turfgrass Research Center in 1991. One study was conducted on perennial ryegrass. Nitrogen was applied at the rate of 1 lb. N per application on 3 dates: May 15, July 8 and August 14. Plot size was 4 ft. by 6 ft. with 3 replications. Carriers evaluated in this study are shown in Table 8: Rejuvenate and 21-0-0 are from the Anderson's Co.; Lawn Restore is from the Ringer Co.; Milorganite from the Milwaukee Sewerage Commission; Sustane from the Sustane Co.; and Sun-Shine from the Sun-Shine Co. There is a clear response to the applied N based on turf quality rating starting 2 weeks after application. Although a few products gave a somewhat slower response initially, later in the season most gave consistent quality ratings. Clippings were collected on 5 dates during the growing season (Table 9) as another means of measuring response to the applied nitrogen. On 3 of the 5 dates there were significant differences from the untreated check. Generally, the clipping weight responses were consistent with turf quality ratings.

A similar study with the same treatments was established on Britsol Kentucky bluegrass. Turfgrass quality ratings (Table 10) and clipping weight measurements (Table 11) showed responses which were consistent with observations from the study on perennial ryegrass.

A study designed to evaluate the efficacy of a coated fertilizer developed by the Vicksburg Chemical Co. was established in May. Carriers included Multicote, the coated fertilizer; miniprilled potassium nitrate and urea. The N was applied at the rate of 4 lbs. N per 1000 sq. ft. for the season: the Multicote was applied at 2 lbs. N each on May 8 and July 5; the miniprill and urea were applied on 6 dates, May 8, May 29, June 19, July 5, August 5 and August 27. The Multicote fertilizer provided the highest quality ratings consistently through the season (Table 12), better than the other N carriers in spite of more frequent applications. Clipping weight data (Table 13) indicated that the Multicote treatment gave uniformly high growth rates in spite having been applied only 2 times during the growing season. These data point out this carrier has the potential to be applied 2 times per year and give uniform release nitrogen for turf needs.

Table 8

Perennial Ryegrass Organic Fertilizer Study 1991
Quality Ratings, 1=poor, 9=excellent
Treatments applied May 15, July 8 and August 14.
Each treatment 1 pound of nitrogen per 1000 sq. ft.

Treatment	6/1	7/3	7/18	8/14	8/26	9/9	10/6
Rejuvenate	5.5 BC	5.5 B	7.6A	7.0ABC	8.0 B	6.8AB	6.8 BC
Anderson 21-0-0	5.2 C	5.5 B	6.5 B	6.8 BC	6.8 C	6.8AB	6.5 CD
Ringer Lawn Restore	6.5A	6.5A	7.4A	7.4AB	9.0A	7.8A	7.0 BC
Milorganite	6.0AB	6.2AB	6.5 B	7.5A	7.8 B	7.8A	7.2AB
Sustane	6.0AB	5.8AB	7.1AB	7.2AB	8.0 B	7.5A	6.8 BC
Sun-Shine	6.2A	6.2AB	6.6 B	7.6A	7.8 B	7.8A	7.6A
Check	4.0 D	4.5 C	5.4 C	6.4 C	5.5 D	5.8 B	6.1 D

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

Table 9

Perennial Ryegrass Organic Fertilizer Study 1991
Clipping Weights in KG M^{-2}
Treatments applied May 15, July 8 and August 14.
Each treatment 1 pound of nitrogen per 1000 sq. ft.

Treatment	6/6	7/5	7/31	8/30	9/19
Rejuvenate	.405	.342A	.098ABC	.273A	.160
Anderson 21-0-0	.403	.363AB	.063 C	.218ABC	.134
Ringer Lawn Restore	.444	.378A	.122A	.184 BC	.139
Milorganite	.442	.342A	.086 BC	.207 BC	.174
Sustane	.443	.338A	.104AB	.204 BC	.165
Sun-Shine	.456	.388A	.084 BC	.236AB	.162
Check	.484	.199 B	.023 D	.164 C	.134

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

Table 10.Kentucky bluegrass Organic Fertilizer Study 1991
Quality Ratings, 1=poor, 9=excellent
Treatments applied May 15, July 8 and August 14.
Each treatment 1 pound of nitrogen per 1000 sq. ft.

Treatment	6/7	7/3	7/18	7/31	8/14	8/26	8/31	9/3	10/6
Rejuvenate	6.9 B	7.1AB	7.2A	7.4ABC	6.8 B	8.1A	7.1AB	7.1 B	6.9 BC
Anderson 21-0-0	7.0 B	6.2 B	6.0 BC	5.9 D	5.8 C	6.5 B	6.2 B	6.2 C	6.5 C
Ringer Lawn Restore	7.8A	7.1AB	6.6ABC	8.0A	7.8A	8.2A	7.4A	7.8A	7.9A
Milorganite	6.8 B	6.9AB	5.8 CD	6.6 CD	6.9AB	7.5A	6.9AB	7.2AB	7.4AB
Sustane	7.3AB	7.2A	6.8AB	7.5AB	6.8 B	7.9A	7.2A	7.1 B	7.2AB
Sun-Shine	7.4AB	6.6AB	6.9AB	6.8 BC	7.2AB	8.2A	6.6AB	7.5AB	7.4AB
Check	6.1 C	5.2 C	4.9 D	5.0 E	5.0 C	5.1 C	5.2 C	5.2 D	6.2 C

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

Table 11

Kentucky bluegrass Organic Fertilizer Study 1991
Clipping Weights in KG M^{-2}
Treatments applied May 15, July 8 and August 14.
Each treatment 1 pound of nitrogen per 1000 sq. ft.

Treatment	6/6	7/5	7/31	8/30	9/19
Rejuvenate	.408	.415A	.180A	.267A	.214A
Anderson 21-0-0	.433	.340AB	.088 CD	.199AB	.192A
Ringer Lawn Restore	.473	.412A	.165AB	.253A	.233A
Milorganite	.460	.395A	.122ABCD	.211AB	.205
Sustane	.445	.429A	.145ABC	.218AB	.221A
Sun-Shine	.472	.393A	.114 BCD	.235A	.208A
Check	.387	.250 B	.068 D	.145 B	.122 B

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

Table 12

Vicksburg Chemical Coated Potassium Nitrate Study
Initiated May 8, 1991
Quality Ratings, 1 = poor 9 =excellent

Mulitcote treatment applied May 8 and July 5 at 2 pounds of nitrogen per 1000 sq. feet. for a total of 4 pounds of nitrogen per 1000 sq. ft. KNO_3 miniprills and Urea treatments applied May 8, May 29, June 19, July 5, August 5 and August 27 to total of 4 pounds of nitrogen per 1000 sq. ft.

Treatment	6/7	7/3	7/24	8/5	8/13	9/12	10/6	11/6
Multicote	5.75A*	7.00A	6.75A	7.50A	8.0A	8.00A	8.00A	7.50A
Mini-Prills	4.50 B	7.25A	6.00 B	6.50 B	7.0 C	6.75 B	6.62 B	6.25 B
Urea	4.75 B	6.50A	6.25AB	6.75AB	7.5 B	6.75 B	6.62 B	6.25 B
Check	4.00 B	4.00 B	5.00 C	5.00 C	6.0 D	5.75 C	5.38 C	5.25 C

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.

Table 13

Vicksburg Chemical Coated Potassium Nitrate Study
Initiated May 8, 1991
Clipping Weights in kilograms per square meter.
Mulitcote treatment applied May 8 and July 5 at 2 pounds of nitrogen per 1000 sq. feet. for a total of 4 pounds of nitrogen per 1000 sq. ft. KNO_3 miniprills and Urea treatments applied May 8, May 29, June 19, July 5, August 5 and August 27 to total of 4 pounds of nitrogen per 1000 sq. ft.

Treatment	6/10	7/23	8/27	9/20	11/13**
Multicote	.33A*	.45A	.30A	.06A	38.71 B
Mini-Prills	.27AB	.33 B	.24A	.05A	40.79 B
Urea	.29AB	.35 B	.26A	.06A	41.42 B
Check	.21 B	.09 C	.10 B	.02 B	46.88A

* Means followed by the same letter are not significantly different at the 5% level using the LSD range test.
** Clegg readings in g-max values.

Table 14
Manganese Sulfate Study, 1991
Creeping bentgrass green, HTRC
Quality ratings 1 = poor 9 = excellent
Treatments applied 5/24, 6/26, 7/10, and 7/30

Treatment	Rate OZ/M	5/25	5/29	6/26	7/11	7/15	7/31
MNSO4	2	7.8A*	6.5A	1.0**	5.2 B	6.2	6.8 BC
MNSO4	4	6.5 B	5.5 B	1.0	5.8 B	6.5	6.2 C
FeSO4	2	6.8 B	5.6 B	4.0	6.8A	8.0	7.9A
Check	---	6.2 B	6.0AB	1.0	6.0A	6.2	7.0 B

* Means followed by the same letter are not signficantly different at the 5% level suing the LSD range test.
** Burn rating 1 = no burn, 9 = dead

Table 15 Manganese Sulfate Study, 1991
Creeping bentgrass green, HTRC
Quality ratings 1 = poor 9 = excellent
Treatment applied 9/3

Treatment	Rate OZ/M	9/4	9/5	9/6	9/11
MNSO4	6	6.5 B*	6.2 B	6.6 B	6.5 B
MNSO4	8	7.1AB	6.8 B	7.0 B	6.6 B
FeSO4	2	7.8A	8.0A	8.0A	7.9A
Check	---	6.5 B	6.6 B	7.2 B	6.8 B

* Means followed by the same letter are not signficantly different at the 5% level suing the LSD range test.