First report from Otto Schmeisser Research Green

By Monica L. Elliott, Marcus Prevatte
University of Florida - IFAS
Fort Lauderdale Research and Education Center

During the summer of 1990, the FGCSA in cooperation with the University of Florida built a 20,000-square-foot putting green at the Fort Lauderdale Research and Education Center. The purpose was to build a field laboratory to be used by the turf researchers at the center for their research projects and to conduct independent field testing of products that superintendents wished to evaluate on bermudagrass maintained as a putting green. The following is a summary of the construction of the green and the results of the first six months of the nitrogen source study, the first project initiated for the superintendents.

GREEN CONSTRUCTION

After the field site was scraped, trenches were cut and drainage tile was installed in a herringbone pattern according to USGA guidelines. Four inches of pea gravel (3/8 inch) was spread across the entire site. At this point, the green was divided into four different construction zones based on choke layer and hybrid bermudagrass cultivar: 1) USGA specifications exactly with 2 inches of coarse sand (choke layer) plus 12 inches of topsoil mix planted with Tifdwarf ; 2) Terrabond geotextile material was installed in place of the choke layer with 14 inches of topsoil mix placed on the Terrabond and planted with Tifdwarf. 3) no choke layer or geotextile material was added so the 14 inches of topsoil mix was placed directly on the gravel layer and planted with Tifdwarf. 4) no choke layer or geotextile material was added and the 14 inches of topsoil mix was planted with Tifgreen 328.

The topsoil mix was mixed offsite and was composed of 80% Ortona sand and 20% Canadian peat moss. The green was fumigated one week before planting with metam-sodium using a "ro-to-vate and roll" method which tilled the topsoil mix to a 5½-inch depth followed by a soil-packing step. Pre-plant fertilizers were applied the day before fumigation and were rototilled into the topsoil mix at the time of fumigation. The bermudagrass was planted Aug. 1, 1990. The slopes were planted with the appropriate cultivar for that section of the green. The slopes were composed of native soil from the site.

During the establishment period, the green was hand-weeded when necessary. Insecticide treatments were necessary on a regular basis for control of sod webworms. No diseases occurred, so no fungicides were applied.

NITROGEN SOURCE STUDY.

It was determined that the average amount of nitrogen applied to bermudagrass greens that are not overseeded during the winter months was 18 pounds per 1,000 square feet per year, with 1 pound per 1,000 square feet per month applied from May through October and 2 pounds per 1,000 square feet per month applied from November through April.

The FGCSA Research Committee decided that the first project to be established was an evaluation of slow-release nitrogen fertilizers. The fertilizers evaluated are listed in Table 1. There were four sources of slow-release nitrogen with all products using urea as the nitrogen base. First, let us examine what a slow-release nitrogen product is relative to ammonium sulfate, a quick-release nitrogen product.

Two primary reasons for using a slow-release nitrogen product are 1) to provide uniform nitrogen release for plant uptake for a specific period of time; and 2) prevent nitrogen leaching as it is the nitrate form of nitrogen that is readily leachable. In warm, moist soils, ammonium sulfate is rather quickly converted to nitrate through the bacterial process of nitrification. The urea in the slow-release nitrogen products will be hydrolyzed to ammonium and then converted to nitrate via nitrification also. However, this process will not take place until the urea, which is completely water-soluble, comes into contact with water. In other words, the urea must be "released" into the soil before the other steps can take place.

Sulfur-coated urea is made by spray-

Table 1. Nitrogen analysis of products in nitrogen source study on the FGCSA Research Green

		Percentage						
Company	Formulation	Total Nitrogen	Nitrate Nitrogen	Ammoniacal Nitrogen	Water Soluble Org. Nitrogen	Urea Nitrogen	Water insoluble Nitrogen	Source of Slow-Release Nitrogen
O.M Scott	40-0-0	40.2	0	0	10.9	12.1	17.2	Methylene Ureas[1]
Vigoro	25-0-12[4]	25.0	3.5	1.8	0	2.0	17.7	IBDU[2], SCU[3]
Vigoro	25-0-14[4]	25.0	4.3	0	0	10.2	10.5	IBDU, SCU
Vigoro	30-0-0	30.0	0	0	0	15.5	14.5	IBDU, SCU
LESCO	29-0-0	29.0	0	0	21.75	7.25	0	SCU
Nor-Am	40-0-0	40.0	0	0	20.5	5.0	14.5	Methylene Ureas
Nor-Am	38-0-0	38.0	0	0	7.0	4.0	27.0	Methylene Ureas
Howard	40-0-0	40.0	0	0	28.0	0	12.0	Methylene Ureas
Cleary	18-0-0(L)	18.0	0	0	7.2	6.3	4.5	Methylene Ureas
Traylor/ Arcadian	18-0-0(L)	18.0	0	0	9.0	9.0	0	Triazone
Grensmiths[5]	28-0-0(L)	28.0	0	0	0	28.0	0	None

Footnotes:
1 Urea-formaldehyde reaction products
2 Isobutylidene diurea, IBDU™
3 Sulfur-coated Urea
4 Also contains potassium nitrate as nitrogen source.
5 Dicarbamide dihydrogensulfate (Combination product of urea and sulfuric acid)

ing granular urea with molten sulfur followed by a clayfilm coating. The urea is released as microorganisms decompose the sulfur coating, water penetrates cracks in the coating or the particles break apart. Again, once the urea is released, it will be converted to ammonium and then to nitrate.

The methylene ureas are products resulting from polymerization of urea with formaldehyde. The formaldehyde derivative is basically a chain of urea molecules linked together. The number of urea molecules linked together (a maximum of five) determines the polymer product with each fertilizer having a different composition of these polymer products. The urea is released by microbial decomposition of the polymers. Common names are ureaform, methylene diurea and methylene urea. Four products in the study are dry formulations. One product is a liquid suspension of methylene urea.

Isobutylidene diurea (IBDU™) results from polymerization of urea with isobutylaldehyde. The urea is released by hydrolysis of the particles in water. Therefore, the process of putting the urea into solution is dependent on particle size (small means faster release) and amount of soil water (dry soil means slower release).

The fourth material, triazone, is produced by reacting liquid urea, formaldehyde and ammonia. The solution resulting is water soluble and is a source of slowly available nitrogen. Please note that this product is a solution and not a suspension. In other words, it is a clear liquid whereas a suspension (Cleary's 18-0-0) is more like milk of magnesia and the particles are simply suspended in the carrier.

One product evaluated is *not* a slow-release source of nitrogen: Greensmith's N-pHURIC™ liquid 28-0-0. It was included in the study because it is a new and unique product to lower the pH of irrigation water. It was used in this study simply as a nitrogen source. It combines urea and sulfuric acid in a carefully controlled process. In other words, don't try this yourself. Why? it is extremely dangerous to mix these products together and, more importantly, the correct procedure for mixing these products is patented. The

Table 2. Soil pH values associated with nitrogen fertilizer treatments evaluated on FGCSA Research Green

Company	Formulation	July 2	July 17	July 30	Aug. 14	Aug. 27	Sept. 10	Sept. 24
O.M. Scott	40-0-0	7.0[1]	7.0	7.0	7.0	7.1	7.0	6.7
Vigoro	25-0-12	6.9	7.1	6.8	7.0	7.1	7.1	7.0
Vigoro	25-0-14	7.0	6.9	7.1	6.9	7.1	7.0	6.9
Vigoro	30-0-0	7.0	6.9	7.1	7.0	7.1	7.1	7.0
LESCO	29-0-0	6.9	7.0	6.8	6.7	7.0	7.0	6.4
Nor-Am	40-0-0	7.1	7.1	6.9	7.0	7.1	7.0	6.5
Nor-Am	38-0-0	7.2	7.1	7.0	7.0	7.0	7.1	6.7
Howard	40-0-0	7.1	7.2	7.1	7.0	7.0	7.1	7.0
Cleary	18-0-0(L)	7.0	7.0	6.8	6.8	7.1	7.1	6.7
Traylor/ Arcadian	18-0-0(L)	7.1	6.9	6.8	6.9	7.2	7.2	6.8
Greensmiths	28-0-0(L)	7.0	7.0	7.0	6.9	7.3	7.0	6.8

1 Values represent results of pooled samples from all four replicate plots of each treatment. Therefore no statistucal analysis was performed.

product evaluated, N-pHURIC™ 28/27 contains 28% urea nitrogen and 27% equivalent sulfuric acid. There is 9% sulfur from the sulfuric acid equivalent.

Pre-experiment Management. The section of the green containing the Terrabond layer and planted with Tifdwarf was used for this study. From Jan. 1, 1991, to March 1, 1991, the experimental area was fertilized every two weeks with 1 pound of nitrogen per 1,000 square feet using Vigoro's Par Ex 8-0-8 fertilizer with micronutrients. The nitrogen sources in this material are sludge and IBDU™. The area was not fertilized from March 1 through March 25 to remove as much nitrogen as possible from the system. All other maintenance practices remained the same, including a mowing height of 3/16 inch.

Experimental Design. Each plot was 8 feet by 10 feet with four replicate plots per treatment. The 11 treatments are listed in Table 1. The design was a randomized complete block. This means there were four rows with 11 plots per row. Each treatment was represented once in each row to reduce any variability naturally associated with the green.

Application Rate and Methods. Each treatment material in the Nitrogen Source Study was applied at the rate of 1 pound of nitrogen per 1,000 square feet on March 26, April 9 and April 23. Potassium was applied at 1 pound per 1,000 square feet as potassium sulfate (0-0-50) on April 23. No quality scores or dry clipping weights were obtained during this period.

The experiment officially began on

Table 3. Quality scores for nitrogen fertilizers evaluated on FGCSA Research Green.

Company	Formulation	May 14	June 27	July 11	July 23	Aug. 6	Aug. 20	Sept. 5	Sept. 17	Oct. 2
O.M. Scott	40-0-0	8.0 bc1	6.8bc	6.9 ab	7.6 ab	7.2 a	7.0 a	7.5 ab	6.5 a	5.9 a
Vigoro	25-0-12	8.5 ab	7.2 ab	7.1 a	7.6 ab	7.4 a	7.0 a	7.5 ab	6.6 a	6.4 a
Vigoro	25-0-14	8.6 a	7.2 ab	7.1 a	7.7 ab	7.4 a	7.0 a	7.5 ab	6.7 a	6.3 a
Vigoro	30-0-0	8.4 abc	7.0 abc	7.1 a	7.8 ab	7.4 a	7.1 a	7.4 ab	6.7 a	6.3 a
LESCO	29-0-0	8.6 a	7.1 ab	7.1 a	7.7 ab	7.4 a	7.0 a	7.1 ab	6.8 a	6.1 a
Nor-Am	40-0-0	8.4 abc	7.1 ab	7.1 a	7.6 ab	7.5 a	7.0 a	7.8 a	6.6 a	6.2 a
Nor-Am	38-0-0	6.2 d	6.1 d	6.5 c	6.9 c	6.8 a	6.3 b	7.5 ab	6.4 a	6.0 a
Howard	40-0-0	8.3 abc	7.0 abc	7.1 a	7.7 ab	7.5 a	7.0 a	7.6 ab	6.7 a	6.1 a
Cleary	18-0-0(L)	7.9 c	6.7 c	6.8 b	7.3 bc	7.1 a	7.0 a	7.8 a	6.7 a	6.3 a
Traylor/ Arcadian	18-0-0(L)	8.0 bc	6.8 bc	6.8 b	7.4 bc	7.1 a	7.0 a	7.6 ab	6.7 a	6.3 a
Greensmiths	28-0-0(L)	8.2 abc	6.7 c	7.0 ab	7.9 a	7.4 a	7.1 a	7.0 b	6.4 a	5.9 a
LSD		**0.5**	**0.3**	**0.2**	**0.5**	**0.7**	**0.3**	**0.7**	**0.5**	**0.7**

May 7, 1991. Beginning on this date, 0.5 pounds of nitrogen per 1,000 square feet was applied every two weeks until Oct. 15. This coincides with the average summer application rate of 1 pound per 1,000 square feet per month. The dry materials were spread by hand in two directions over the plots and the area immediately irrigated with 0.12 to 0.14 inches of water. Liquid formulations were applied next.

These materials were mixed with water and applied with a fine-nozzle watering can so that the equivalent of 10 gallons of water per 1,000 square feet was applied.

Potassium was applied as potassium sulfate (0-0-50) at the same rate as the nitrogen, 0.5 pounds per 1,000 square feet, every time the nitrogen was applied. Since two of the Vigoro materials (25-0-12 and 25-0-14) had potassium nitrate as one of their nitrogen sources, the potassium sulfate applied to these plots was reduced accordingly to achieve the 0.5 pound potassium rate.

General Maintenance. Phosphorous was applied as triple superphosphate (0-46-0) at 1.5 pounds phosphorous per 1,0000 square feet when the green was aerified on June 5 with ⅝-inch hollow tines. The cores were removed and the area topdressed with an 80/20 topsoil mix. The area was lightly verticut in May, June, July and August and topdressed accordingly. Micronutrients were applied in May (Vigoro's F-169G with boron, copper, manganese and zinc) and July (manganese sulfate only) at the rate of 0.5

pound manganese per 1,000 square feet. Height was maintained at 3/16 inch using a Jacobsen green mower with groomer attachments. Plots were cut six days each week.

Pests and Pesticides. No herbicides were used during the six-month period. Crusade (fonofos) insecticide was sprayed once on June 15 for control of sod webworms. No other insect problems occurred. Symptoms of bermudagrass declines, a root rot disease, first appeared in early to mid-August. The disease progressed very slowly in the Tifdwarf area, as compared with the Tifgreen area, and did not thin out completely. Banner (propiconazole) was applied at the rate of 4 fluid ounces per 1,000 square feet on Sept. 20. A slight adverse color response did occur as a result of this application. All treatments were equally affected by the disease and the fungicide application as demonstrated by the decline in the quality scores.

Soil pH. Beginning in July, soil pH was obtained before each nitrogen application. Soil samples (four 1-inch cores of 6 inches depth) were obtained from all four plots (replications) of the same treatment, pooled together and the soil pH determined for each treatment. This was done to determine if any general changes in soil pH were observed. For all sampling dates, the soil pH did not vary by more than 0.5 units between any two nitrogen treatments. Since no replicate samples were obtained, no statistical analysis was performed.This was simply a general survey of pH values. The soil pH averages for all sampling dates are listed in Table 2.

Evaluation. Quality scores were determined using color and density of the grass in each plot. Scores were based on a scale of 1 to 10 with 10 being a *perfect* score. Two people rated the plots each time and those scores were averaged. Plots were rated one week after each nitrogen application with two exceptions. On May 28, we simply forgot. This was our first day of clipping weights, and we forgot the quality scores. No quality scores were obtained June 13 due to the aerification on June 5 as density could not be evaluated fairly. The summary of quality scores is shown in Table 3.

Dry weight of collected clippings from each plot were determined once each month. Again, clipping weights were obtained approximately one week after a nitrogen application. A strip of turfgrass that was 22 inches wide (width of mower) and 9 feet long was cut from each plot. The clippings were collected and dried at 60°C for 96 hours at which time the weight was determined. Values are listed in Table 4.

When comparing quality and quantity scores for each date, please note that values in the column for that date that are followed by the same letter are *not* statistically different from each other. You will note that tat the end of each column in Tables 3 and 4, there is a value called LSD which means "Least Significant Difference." The LSD value is a value that the treatment means must equal or exceed to be considered significantly different. In the footnote for these tables, it is indicated that "P-0.05." This indicates we are 95% confident that means exceeding the LSD value for each column are in fact different and that the observed variation is not due to random chance. The best explanation of statistical analysis and reasons for replications, test design, etc. can be found in the December 1990 issue of *Golf Course Management.* The article is titled "Developing a Test Program on the Golf Course" and was written by Nick Christians. This should be read by every superintendent. It will help you understand research reports from the university and help you to design your own experiments.

In summary, although there were significant differences early in the summer, there were few differences in quality by the end of the six-month period. To make you own decisions, compare quality scores to quantity scores. Each golf course situation is unique and you must decide what is most appropriate for your situation. The reduction in clipping weights beginning in August is probably a reflection of stress due to the bermudagrass decline root rot disease and the summer weather patterns. When disease symptoms were most severe in late September and early October, there were no significant differences in quality scores between any of the treatments which implies that none of the nitrogen sources prevented disease development. No quality scores were obtained after Oct. 2 so that an intensive cultural program could be initiated to reduce the disease symptoms.

This study will continue to be conducted until next May using the winter rates of nitrogen: 2 pounds per 1,000 square feet per month. The research green will not be overseeded so evaluation will be for bermudagrass only.

Would like to thank the following companies who contributed directly to the construction of the green: American

Peat and Soil; Vigoro Industries; Lantana Peat and Soil; Bilberry and Associates; Florida Rock and Sand; Pifer, Inc.; Boynton Pump; Golf Ventures; South Florida Grassing; Central Florida Turf; Hector Turf; Swiftline Trucking; D&K Sprinkler; W.W. Googe Trucking; DeBra Turf; ISS Landscape Management; and Williams Pump Service.

The following companies have donated material and services for maintenance of the research green: Golf Agronomics; Vigoro Industries; Golf Course Services, Inc.; DeBra Turf; Liqua-Tech; and Woodbury Chemicals.

Table 4. Clipping weights (grams) for nitrogen fertilizers evaluated on FGCSA Research Green

Company	Formulation	May 28	July 5	Aug. 6	Sept. 6	Oct. 1
O.M. Scott	40-0-0	8.6 ab[1]	11.1 cde	5.2 bc	3.8 a	4.5 bc
Vigoro	25-0-12	11.7 a	13.2 ab	6.2 ab	4.1 a	4.4 bc
Vigoro	25-0-14	8.2 ab	13.0 b	6.5 a	4.3 a	5.2 ab
Vigoro	30-0-0	9.4 ab	12.0 bcd	6.0 ab	4.2 a	5.2 ab
LESCO	29-0-0	9.5 ab	15.0 a	6.1 ab	4.4 a	5.7 a
Nor-Am	40-0-0	10.1 ab	12.2 bc	6.8 a	4.4 a	4.3 bcd
Nor-Am	38-0-0	8.4 ab	8.1 g	3.6 d	3.0 a	3.4 e
Howard	40-0-0	10.3 ab	10.5 def	5.7 ab	3.8 a	4.1 cde
Cleary	18-0-0(L)	7.5 b	9.6 efg	4.3 cd	3.9 a	4.0 cde
Traylor/ Arcadian	18-0-0(L)	9.0 ab	9.2 fg	4.3 cd	3.6 a	3.8 cde
Greensmiths	28-0-0(L)	9.5 ab	11.3 cd	5.0 bc	2.8 a	3.5 de
LSD		**4.1**	**1.6**	**1.2**	**1.7**	**0.9**

1 Values are the mean dry weights of clippings collected from four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t-test.