UREAFORM: FIRST SYNTHETIC SLOW RELEASE FERTILIZER

By John T. Hays, Research and Product Development Specialist, Boots Hercules Agrochemicals Co., Wilmington, Delaware

Fertilizers based on the reaction of urea with formaldehyde have been known for a long time. Solutions containing urea and formaldehyde were marketed by the du Pont Company in 1939. The pioneering work on the solid condensate was done by Dr. K.G. Clark of the U.S. Department of Agriculture (USDA), as reported in publications beginning in 1946. He coined "ureaform" for this product, and this name seems to us to be far preferable to "urea-formaldehyde" to distinguish the odorless, stable fertilizer from the noxious urea-formaldehyde resins made with a large excess of formaldehyde. There is no free formaldehyde in ureaform (as exemplified by Nitroform slow release fertilizer), and it cannot liberate formaldehyde under use conditions.

Manufacture of solid ureaform was begun by the du Pont Co. and the Nitroform Corporation in the mid-1950's. Hercules purchased the Nitroform Corp. in 1960 and marketed Nitroform slow release fertilizer until early this year, when Boots Hercules Agrochemicals Company (formed jointly by Hercules Incorporated and the English firm Boots) took over marketing this product. Du Pont has discontinued manufacture, so Nitroform slow release fertilizer is the only solid ureaform manufactured in this country at present. O.M. Scott utilizes urea-formaldehyde solutions in the manufacture of mixed fertilizer, but these products are technically not ureaforms.

In addition to designating ureaform as the "oldest" synthetic source of slowly available nitrogen, we might add that it is also the longest lasting (in the agronomic sense).

Ureaforms and natural organics undergo decomposition by soil microorganisms to form ammonia (ammonification), which may be converted to nitrate (nitrification). Variables, such as temperature, soil pH, and aeration have a great effect on these reactions. The microbiological reactions are less sensitive to particle size and soil moisture. Generally, conditions that favor plant growth also favor microbiological reactions.

Quality factors

According to the "Specialty Fertilizer Labeling Format" proposed by the American Association of Fertilizer Control officals and widely adopted: "When a fertilizer infers or connotes that the nitrogen is slowly available through use of *organic, organic nitrogen, ureaform, longlasting*, or similar terms, the guaranteed analysis must indicate the percentage of water-insoluble nitrogen in the material."

Unfortunately, specification of minimum WIN and its source, which is all that is required by the labeling format, gives no indication of agronomic availability; a fertilizer can appear to be of high quality on the basis of its WIN but be of little value because of low availability. In the case of ureaforms, solubility determinations can be used to calculate the Activity Index (AI), which gives an indication of agronomic availability.

Ureaform Specifications

The specifications for commercial Nitroform ureaform fertilzer are:

Total nitrogen—38.0 percent (minimum)

WIN—27.0 percent (71 percent of 38 percent total nitrogen)

AI—40 (minimum) (percent WIN soluble in hot water)

The AI thus supplements the WIN determination by indicating the percentage of the WIN that is readily available (soluble in hot water). The AI does not give the complete picture: it gives no measure of the cold water-soluble fraction, and it does not indicate the availability of the fraction insoluble in hot water. Nevertheless, an AI of 40 in the normal WIN range will assure availability of a major portion of the ureaform.

The solubility approach is not directly useful for other types of slowly available fertilizers. For sulfur-coated urea, dissolution rate or coating thickness is needed to indicate availability. For IBDU, particle size and soil moisture content are needed. For natural organics, the permanganate value is of some use.

Rate of Release—Nitrification Studies

When a fertilizer containing organic nitrogen is incubated with soil, micro-organisms in the soil convert the nitrogen to ammonia. Under favorable conditions (near neutral pH, adequate aeration), the ammonia formed is quickly oxidized by soil bacteria to nitrate (nitrification). Measurement of the nitrate produced under carefully controlled conditions is thus a good laboratory indication of the rate of release of nitrogen from ureaforms and other organic nitrogen fertilizers.

We have found the nitrification method to offer a good qualitative basis for comparison of slowly available nitrogen fertilizers. Generalizing from a large number of laboratory experiments at 86° F (30° C), we arrive at the following projection of rate of nitrogen release from commercial Nitroform ureaform.

This pattern allows application of a relatively large amount of nitrogen in a single application, provides gradual release for up to 24 weeks, and leaves a portion for carry-over and utilization in the next growing season. To get an early response comparable to that from a soluble source, it is necessary to apply more ureaform nitrogen initially, or as is frequently done, to add a soluble source along with the ureaform.

Product Grades Available

Nitroform ureaform is available in both granular and powder forms. The granular form, Blue Chip nitrogen fertilizer, is designed for direct application in mechanical spreaders. It is also used in balanced fertilizer (N,P,K).

Powder Blue nitrogen fertilizer is the powder form. It is well suited for use in liquid-application equipment. One gallon of water will carry 1 pound of Powder Blue in a power sprayer. Screens should be removed from the spray system to avoid clogging, and a nozzle with a large orifice (9/64 inch or larger) should be used. Other fertilizer materials (P,K) normally applied in liquid form can be used along with Powder Blue as desired.

Another advantage of applying the powder form, in addition to its ready application in water suspension, is that it is somewhat more readily available than the granular form. Our nitrification data have indicated that the powder releases 1.3 to 1.65 times as fast as the granular.

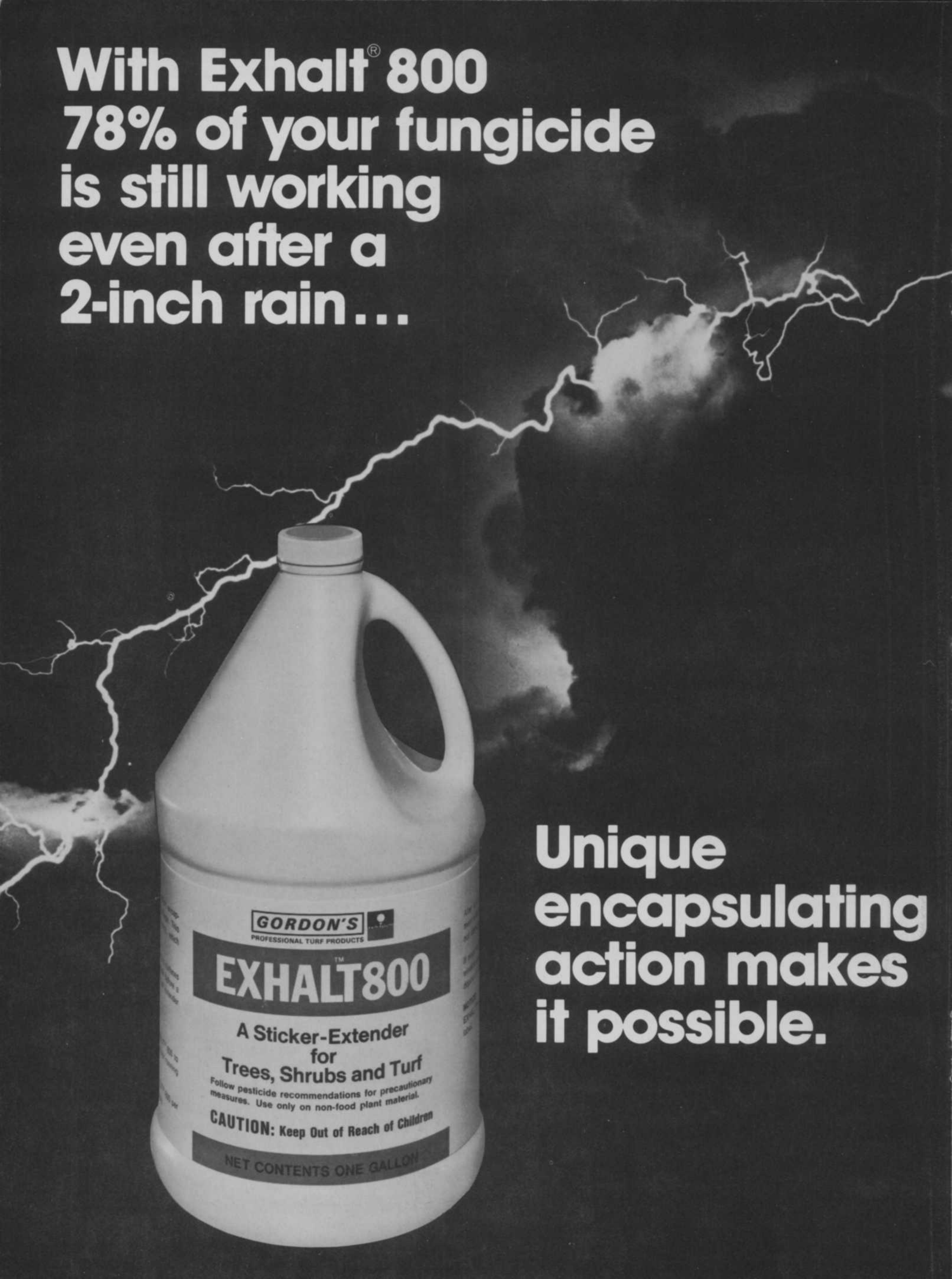
Recommended amounts

On fairways, lawns and other similar turf areas, application of 10 to 15 pounds of Nitroform fertilizer per 1,000 square feet or 400 to 600 pounds per acre is recommended. Split applications are preferred with the heaviest application at the most important phase of the growth cycle. For cool-season grasses (bluegrass, fescue and bent) apply ⅔ in the fall and ⅓ in the spring. For warm-season grasses (bermuda, zoysia, centipede, and St. Augustine) apply ⅔ in the spring and ⅓ in the fall. For seedbed application, the year's supply is worked into the top 2 to 4 inches of soil.

On bentgrass greens, three applications of 7 to 10 pounds of Nitroform fertilizer per 1,000 square feet are recommended: the first in early spring, the second in early summer, and the third in early fall. A fourth application at half this rate may be needed in mid-summer until the residual nitrogen has built up. For seedbed application on average-size greens, use 25 pounds of Nitroform fertilizer worked into the top 3 inches of soil.

A striking feature of these recommendations is the relatively large amounts of nitrogen used in a single application. Thus 10 to 15 pounds of Nitroform fertilizer (3.8 to 5.7 pounds of actual nitrogen) is routinely put on turfgrass and other plants in a single application. Contrast these amounts with those of soluble fertilizer, where the rule of thumb is to use no more than 1 pound of nitrogen per 1,000 square feet in a single application and then to take the precaution of watering it in.

WTT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Unique encapsulating action makes it possible.

Percentage of fungicide retained after rains, Exhalt 800 versus Brand X:

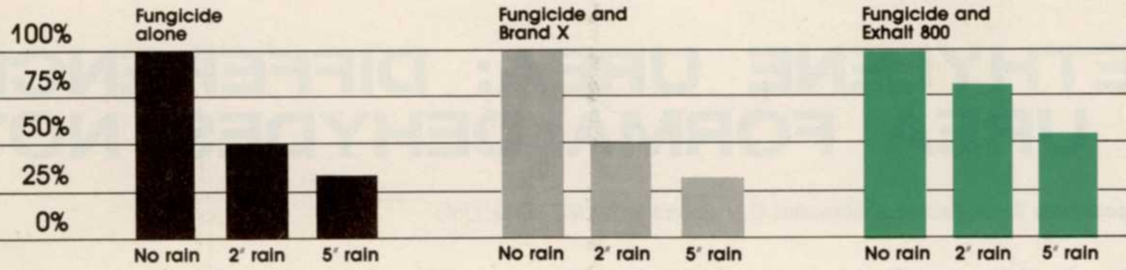


Chart shows how Exhalt 800 resisted wash-off in a laboratory test. Spray coatings were applied to glass panels and dried 10 minutes at approximately 70° F. Retention after erosion by rain was measured by solvent stripping the panels and determining the residual fungicide by quantitative ultraviolet spectroscopy.

See how Exhalt 800's encapsulating action guards against costly fungicide wash-off:

This test with Exhalt 800 shows 78% of fungicide was still intact after a 2-inch rain. Even after 5 inches of moisture, 60% was still in place.

We're painfully aware that you may be disenchanted with spreader-stickers, so we want to emphasize that Exhalt 800 is *not* a spreader-sticker. Rather it is a *Sticker-Extender*, and there's a world of difference!

The *spreader* part of a spreader-sticker is a detergent that actually assists in wash-off. Exhalt 800, on the other hand, has a unique encapsulating action that causes fungicide to *resist* wash-off.

Simply stated: Spreader-Stickers *assist* wash-off; Exhalt 800, a unique Sticker-Extender, *resists* wash-off.

Defies Rain

To illustrate its clinging power, let's suppose you have added Exhalt 800 to your fungicide and treated 18 greens. An hour later a dark, menacing cloud rolls in; in the next 45 minutes it dumps two inches of rain on your treated greens. What now?

Obviously, some of your treatment is washed away. But the silver lining is . . . *some 78% of it is still in place and working*. Thanks to Exhalt 800's unique encapsulating power, you won't have to repeat the whole costly process again tomorrow.

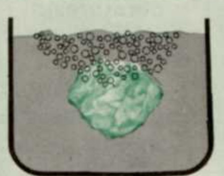
Even in arid regions plagued with occasional fungus flare-up, Exhalt 800 pays. It lets you spray and, after an hour, irrigate. With no more worry about losing your greens to either fungus or drought.

The Exhalt 800 difference

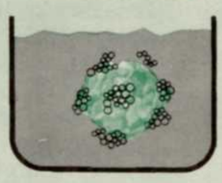
Unlike spreader-stickers that wash off with the first rain, Exhalt 800 (a sticker-extender) clings with encapsulating power. It's an extremely sticky, flexible, fabric-like protector that encases every fungicide particle, keeping it in place and working despite rainfall.

A closer look at Exhalt 800's unique encapsulating action:

One miniscule fungicide particle, greatly magnified. Countless millions of such particles in water become the spray solution.



Exhalt 800 enters spray tank. Hydrophobic (repelled by water), it breaks into myriad of tiny droplets and attaches to fungicide.



Tiny Exhalt 800 droplets form a porous "fabric" that encapsulates every fungicide particle, causing it to cling to turf or foliage.

To get a clear picture of Exhalt 800's superiority, study the chart above. This test, important though it is, is just one of many. Our files hold much other massive evidence of Exhalt 800's unique encapsulating power: the field-test data from many leading universities (test results available on request).

While Exhalt 800 is used extensively on turf, it also is registered for use with insecticides for trees and ornamental shrubs. In every use, it lets plants "breathe," grow and develop normally. It's economical and easy to use.

Exhalt 800 is effective with most brands of wettable-powder and flowable fungicides, including Gordon's Dymec 50™, Formec 80™, and Topmec 70W™.

Try Exhalt 800 now

The evidence is clear and overwhelming — Exhalt 800 doesn't cost, it pays. Don't you owe it to yourself and your greens committees to give it a trial? One gallon will prove it to you. If your distributor doesn't have Exhalt 800, or if he's out of reach, order a trial gallon direct from us. Send a check for $28, we'll rush a gallon postpaid. *Send to PBI/GORDON Corporation, P.O. Box 2276, Kansas City, Kansas 66110.*

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NITROGEN SOURCES FOR TURF FERTILIZATION

METHYLENE UREA: DIFFERENCES IN UREA FORMALDEHYDES NOTED

By George McVey Senior Technical Associate, O.M. Scott & Sons, Marysville, Ohio

The development of nitrogen products derived from condensing urea with formaldehyde represented a significant advance in nitrogen fertilizer technology. It provided the basis for developing nitrogen-containing fertilizer products with some properties similar to natural organic nitrogen sources. These similarities include: (1) a controlled release of nitrogen and (2) a low burn potential. Additional beneficial properties provided by urea-formaldehyde (also known as methylene urea, MU) condensation products that are more beneficial than those provided by natural organics nitrogen sources include: (1) high nitrogen analysis (38 percent versus less than 10 percent nitrogen), (2) excellent consistency, (3) improved flexibility in adjusting nitrogen release characteristics, (4) lack of odor, and (5) economy.

Chemical properties

The nitrogen release characteristics of MU can be controlled by the method of manufacturing that is selected. Analytically the release characteristics are classified by the solubility of this product in water varying in temperature. Two temperatures are selected: (1) room temperature (22°C.) and (2) boiling water (100°C.). Based on the solubility at these two temperatures, the biological activity can be predicted. As the percent of the cold water insoluble nitrogen (CWIN) that is soluble in hot water decreases (NAI), the nitrification rate (conversion of MU to nitrates) decreases. The nitrification rate is dramatically reduced as compared with ammonium sulfate and urea. This rate can be reduced to a point that is relatively inactive biologically.

One of the primary benefits of MU is attributed to its low salt index. The low salt index at equal rates of material is dramatically reduced as compared with conventional fast release nitrogen sources. These differences are even more dramatic when compared on an equal nitrogen basis. Since the salt index is a measure of burn potential, it is obvious that on an equal weight or equal nitrogen basis, MU would have a much lower burn potential as compared with soluble nitrogen sources.

MU's slow release characteristics are also reflected in the rate of conversion to ammoniacal and nitrate nitrogen in the soil. The ammoniacal nitrogen level in the soil solution is up to four times higher when treated with urea as compared with the MU treatment. After 6 weeks, the ammoniacal nitrogen level is essentially zero regardless of the nitrogen source. In contrast, the nitrate nitrogen level dramatically increases as the ammoniacal nitrogen level decreases. This increase was only evident if the nitrogen source was MU. The nitrate nitrogen level continued at a high level for 120 days (50 to 100 ppm) if the soil was treated with MU. In contrast, soil treated with urea never had a nitrate level greater than 30 ppm. Urea readily leached from the media before conversion of urea to nitrates was realized, resulting greater pollution potential than with MU.

Biological properties

Controlled release nitrogen sources are often characterized by improved safety, increased residual, a more uniform growth pattern, and less total clipping removal as compared with turf treated with soluble nitrogen sources.

As the percent of cold water insoluble nitrogen increases, the degree of injury decreases. These differences are more dramatic when the fertilizer is applied to wet turf; however, they are still apparent on dry turf. At a CWIN of 42 percent, injury was not objectionable at all rates (1 to 4 pounds of nitrogen per 1,000 square feet) or methods of application (wet versus dry foliage). In contrast, complete formulations containing only 2 percent CWIN caused extreme foliar injury when applied to wet foliage using only 1 pound of nitrogen per 1,000 square feet under the conditions of this study (applied in late August under high temperatures).

When we compared two MUs relative to turf response, a substantial difference in turf color was noted. The spring greening response from a late fall fertilization was very slow when turf was treated with ureaform (Category 1) but was dramatically increased when treated with MU (Category 2). In this same experiment, the nitrogen source IBDU was also included. The initial response was comparable to that with ureaform whereas the residual of MU and ureaform was longer than for IBDU.

Spring applications of IBDU and MU (Category 2) were compared. In this study, initial greening was very slow when the turf was treated with IBDU even though rates of 2 pounds of nitrogen per 1,000 square feet were applied. In contrast, turf treated with MU exhibited a rapid spring greening response. The residual characteristics of these products were similar.

The residual of the MU (Category 2) was compared with that for urea. The initial surge of growth was reduced from 1.9 grams for turf treated with urea down to 1.1 grams when the turf was treated with MU (a 42 percent reduction in fresh weight).

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The reduction in initial surge growth is reflected in the residual. The differences from only one application, however, are not dramatic. When repeat applications of MU from Category 2 were used, the residual characteristics became more apparent. In this study, the fertilizer program was discontinued in the fall of the second year. Clipping fresh weights in the spring of the third year dramatically reflected the residual characteristics when MU containing 42 percent CWIN was compared with a product containing 2 percent CWIN. The color of the turf treated with the controlled release nitrogen source (23-7-7 42 percent CWIN) was comparable to that of turf treated with the fast release nitrogen source (10-6-4 2 percent CWIN) in 27 out of 32 observations over a 2.5-year period.

Turf growth is another measure of the controlled release properties of MU. The total fresh weight of clippings can be substantially reduced when turf is treated with MU as compared with urea. The weight of clippings removed over a 6-week period was reduced by one-third when Kentucky bluegrass was treated with MU as compared with treatment with urea. The lower weight of clippings removed is reflected in the fact that there is less tendency for scalping because of delayed mowing, a reduction in mowing frequency, and less labor for collecting and removing clippings. **WTT**

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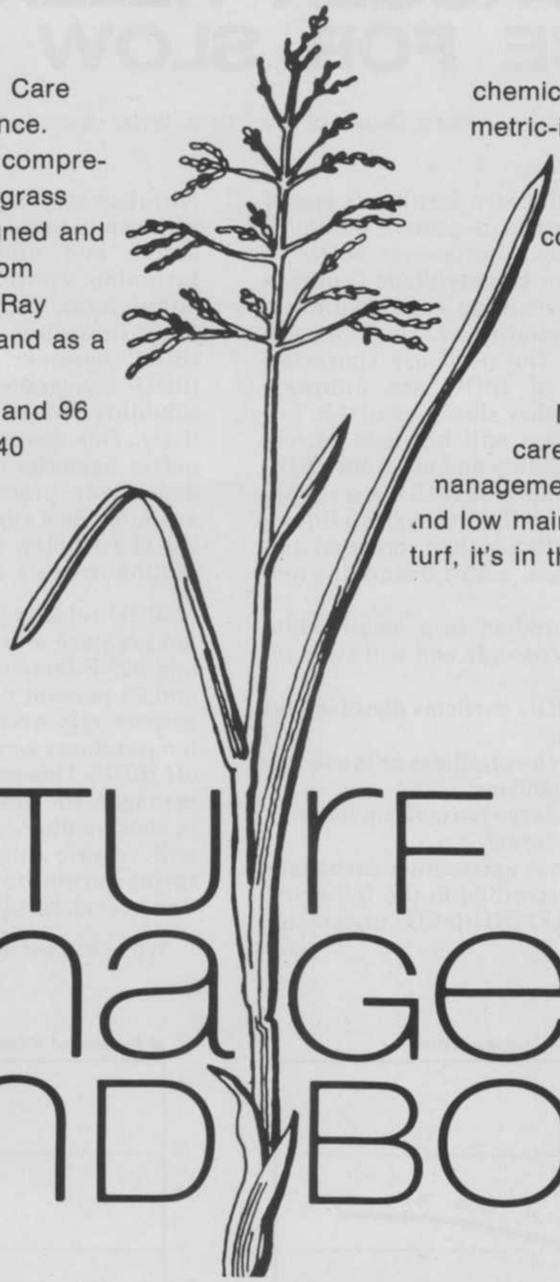

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NITROGEN SOURCES FOR TURF FERTILIZATION

IBDU: NITROGEN RELEASE IS UNIQUE FOR SLOW RELEASE

By Robert Rehberg, National Sales Manager, Estech General Chemical Corp., Winter Haven, FL

Proper management of nitrogen fertility is one of the keys to successful turf management due to its many effects on physiological processes. IBDU® is the trademarked name for Isobutylidene Diurea, a slow release fertilizer containing 31 percent nitrogen, marketed in North America by Estech General Chemicals Corporation. The n-release characteristics and properties of IBDU are uniquely different from those of other slowly available fertilizers and this discussion will highlight factors governing nitrogen availability and use from IBDU.

Preparation-The manufacture of IBDU is a simple mixing of isobutyraldehyde(IBA), which is a liquid, with solid urea. The product is then screened and bagged into two size ranges, a 0.5-1.0 mm. fine and a 0.7-2.5 mm. coarse.

The finished IBDU product is a small white granule which is not hydroscopic and will store indefinitely.

N Release Mechanism-IBDU particles dissolve and the molecule splits to give:

(a) isobutyraldehyde which volatilizes or is used as a food source by microorganisms.

(b) urea, which would undergo normal conversions to ammonium and nitrate forms.

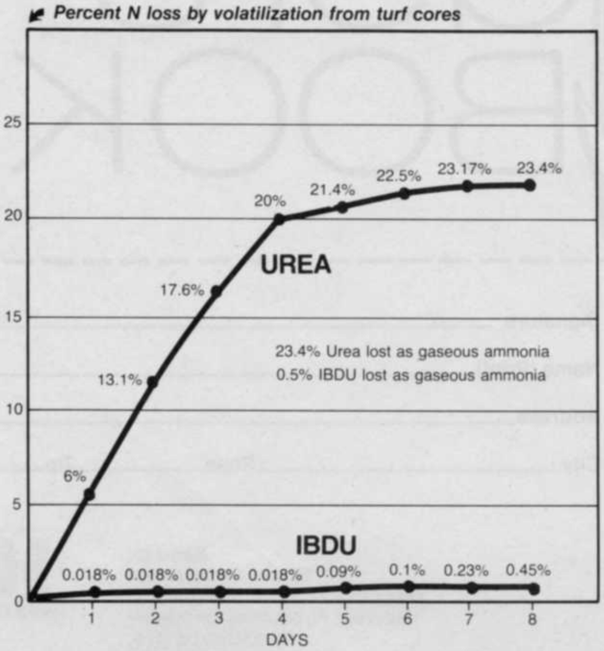
The hydrolysis of urea to ammonium carbonate occurs quickly in soils according to the following equation: $CO(NH_2)_2 + 2H_2O\ (NH_4)_2CO_3$ urea water ammonium carbonate.

Nitrobacteria could then convert the ammonium nitrogen to nitrate if temperatures are about 40° or above and other environmental factors are favorable. However, turf can utilize nitrogen in either form. The urea conversion would be the same regardless of parent material, UF, SCU or IBDU; however, the rate determining step for IBDU conversion to plant available forms is solubility, which is independent of bacterial activity. This distinguishes IBDU from UF which requires bacterial conversion, a highly temperature dependent process, and SCU which becomes available as a result of holes in the coating, cracking of particles, microbial oxidation of the sulfur coating, osmosis, or other factors.

IBDU release is temperature dependent only as temperature effects solubility, so at constant 40° F and 80° F temperatures approximately 50 percent and 75 percent of the nitrogen would be released respectively over a three month period. Freezing temperatures would stop water movement and shut off IBDU. This relationship works well for the turf manager; the grass plant does not grow as rapidly in cool weather so not as much N is required. IBDU will release longer into fall and sooner in the spring during the important carbohydrate assimilation period, resulting in greener, healthier turf.

We are often asked the question, "What happens

Percent N loss by volatilization from turf cores



Percent of N loss by leaching from turf cores