USE OF UREAFORM FERTILIZERS

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Following the earlier talks on the program, I am in a position to summarize the information you have heard and to compare it with that we have on use of ureaform fertilizers, as exemplified by Nitroform® ureaform fertilizer produced by Hercules.

The types of slowly available nitrogen fertilizers discussed are:

Coated Fertilizers (Sulfur-coated urea, Osmacote)
Urea-Aldehyde Condensates (low molec. wt.) (IBDU)
Natural Organics (Milorganite)
Ureaform (Urea-formaldehyde condensate)

The standard nitrogen fertilizers such as urea, ammonium nitrate and sulfate, and diammonium phosphate are all extremely soluble in water. This solubility makes their nitrogen very quickly available but also makes it possible for them to damage growing plants or to be lost by leaching. Methods of making slowly available fertilizers are simply ways of decreasing this solubility. This is done in coated fertilizers such as sulfur-coated urea by actually creating a physical barrier through which the nitrogen must diffuse. In other types, the solubility is reduced because the nitrogen is chemically combined; in IBDU urea is reacted with isobutyraldehyde; in ureaforms, urea is reacted with formaldehyde to form a polymer; in natural organics, nature provides the nitrogen combined in proteins or other complex organic structures. These various types of fertilizers are released by different mechanisms which in turn cause different responses to changes in soil conditions such as moisture, temperature, and pH and also in fertilizer properties such as particle size and coating thickness.

The diffusion-dissolution process of release from coated fertilizers is most affected by temperature, but is little affected by pH or soil moisture.

IBDU is hydrolyzed chemically by moisture in the soil; it is released just as rapidly in sterilized soil as in soil containing active microorganisms. Its release is thus greatly dependent on soil moisture, particle size, and pH, but is not greatly affected by temperature. Therefore, it is an effective fertilizer at low temperatures.

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 which favor plant growth also favor microbiological reactions.

These points are summarized as follows:

Fertilizer	Release Type	Critical Variables
Coated	Diffusion	Temperature
IBDU	Chemical Hydrolysis	Moisture, Particle Size, pH
Ureaform, Natural Organics	Microbial	Temperature, pH, Aeration

Quality Factors

According to the "Specialty Fertilizer Labeling Format" proposed by the American Association of Fertilizer Control Officials and widely adopted: "When a fertilizer infers or connotes that the nitrogen is slowly available through use of organic, organic nitrogen, ureaform, long lasting or similar terms, the guaranteed analysis must indicate the percentage of water-insoluble nitrogen in the material." This requirement to specify minimum values for water-insoluble nitrogen (WIN) protects the customer from being sold a "slowly available" fertilizer which in fact does not contain sufficient WIN to affect its availability in a practical manner. 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 WIN but be of little value because of low availability. The WIN value obviously needs to be supplemented by a measurement indicating agronomic availability. Measurements of effects on plant growth are needed, or, alternatively, measurement of fertilizer changes in soil (such as nitrification). Such tests require weeks to give significant results, however. 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^{R} ureaform fertilizer are:

Total N - 38.0% (minimum)

WIN - 27.0% (71% of 38% total N)

Activity Index (AI) - 40 (minimum)
(Percent WIN soluble in hot water)

The AI thus supplements the WIN determination by indicating the percentage of the WIN which 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, microorganisms 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.

Figure 1 compares a generalized nitrification curve for Nitroform^{R} with that for ammonium sulfate. This illustrates in a striking fashion the difference between the rapid release from the soluble ammonium salt and the gradual release from the ureaform. Figure 2 shows a nitrification curve for Nitroform ureaform (this time at a somewhat more rapid rate than in the generalized curve

Figure 1

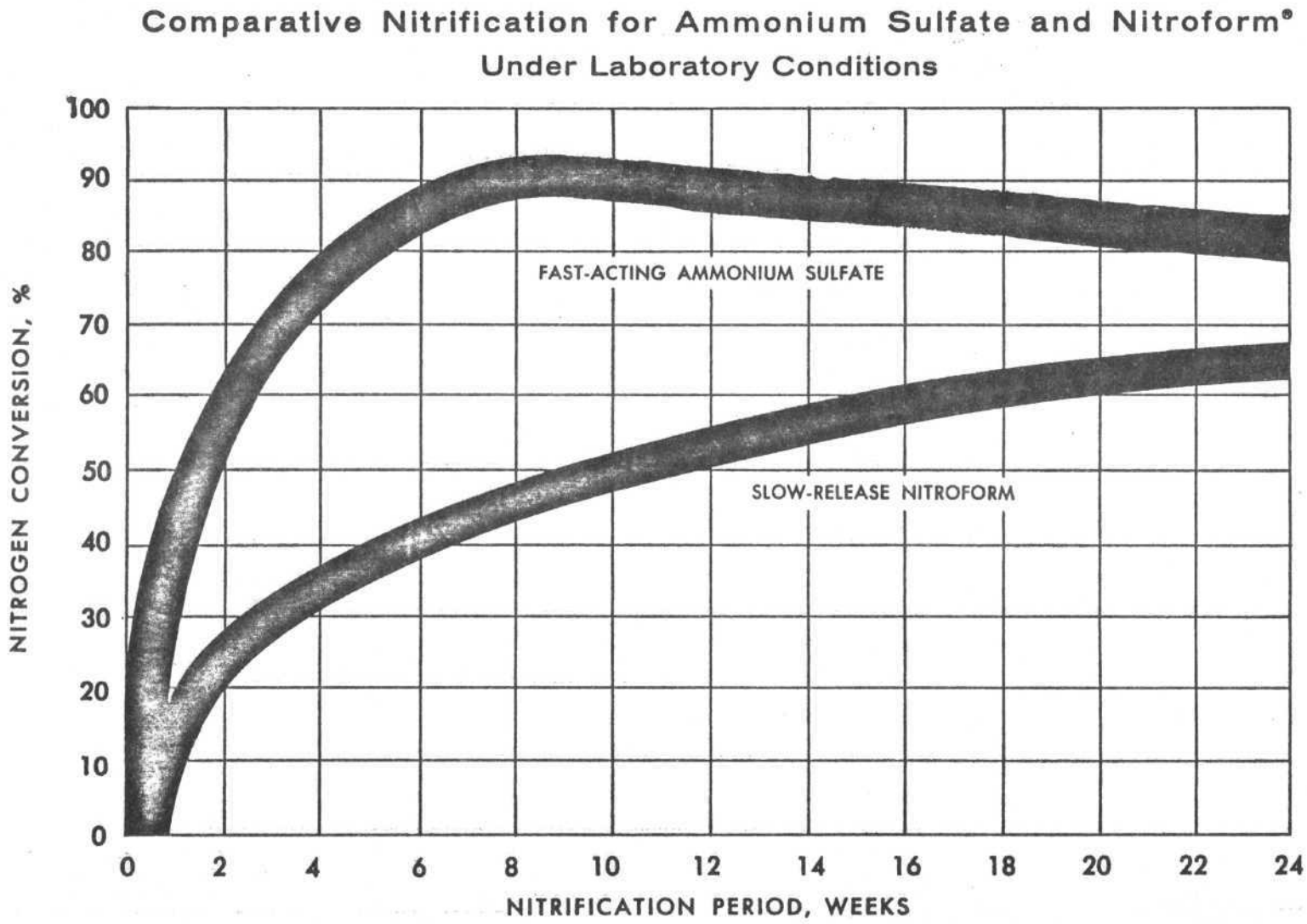
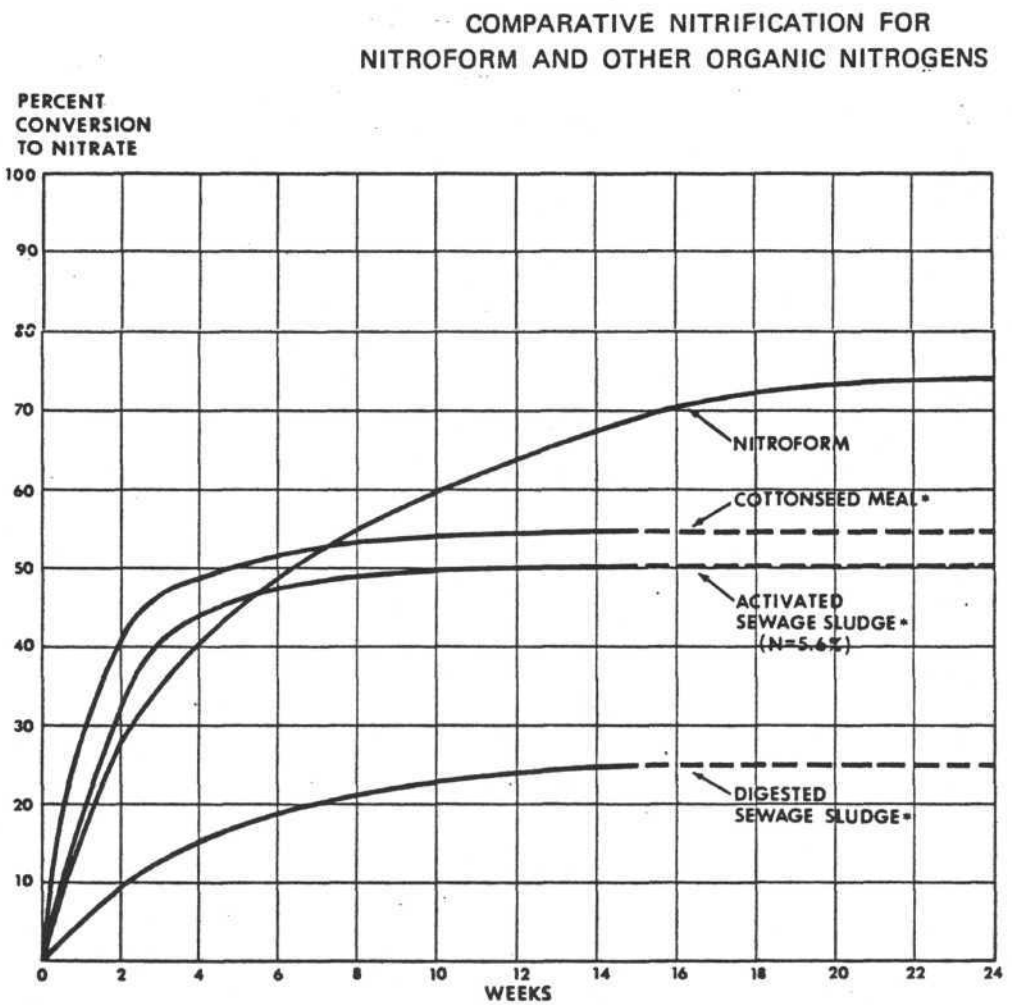

Comparative Nitrification for Ammonium Sulfate and Nitroform®
Under Laboratory Conditions
NITROGEN CONVERSION, %
100
90
80
70
60
50
40
30
20
10
0
FAST-ACTING AMMONIUM SULFATE
SLOW-RELEASE NITROFORM
0
2
4
6
8
10
12
14
16
18
20
22
24
NITRIFICATION PERIOD, WEEKS

Figure 2



*The nitrification rates used are based on published USDA data.

of Figure 1) compared with published USDA data on various natural organics. The natural organics appear to be a little more rapid initially but level off at a value indicating incomplete release.

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[R] ureaform.

Time	Converson to NO_3^- (cumulative)
4 weeks	30-40%
8 weeks	45-60
12 weeks	50-65
24 weeks	60-75

This pattern allows application of a relatively large amount of nitrogen in a single application, provides gradual release 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[R] ureaform is available in both granular and powder forms. The granular form, Blue Chip[R] nitrogen fertilizer, has the following screen analysis (U.S. Standard)

through 10-mesh	100%
through 20-mesh	8
through 40-mesh	> 2

It is designed for direct application in mechanical spreaders and is well known to golf course superintendents and other professionals concerned with quality turfgrass and to nurserymen who specialize in high quality stock. It is also used in balanced fertilizers (N, P, K). The Blue Chip[R] tag indicates that at at least 50% of the nitrogen in such a fertilizer is derived from Nitroform[R] ureaform.

Powder Blue[TM] nitrogen fertilizer is the powder form made so that 100% will pass a U.S. Standard 60-mesh screen. It is well suited for use in liquid-application equipment. One gallon of water will carry 1 lb. of Powder Blue[TM] in a power sprayer. Screens should be removed from the spray system to avoid clogging and a nozzle with a large orifice (9/64" or larger) should be used. Powder Blue[TM] is particularly suited for use on close-knit areas such as golf greens; the small particles move readily into deep turf and are not picked up by mowers or lawn sweepers. It is used by nurserymen as the plant food to protect stock through the retail sales period. Other fertilizer materials (P, K) normally applied in liquid form can be used along with Powder Blue[TM] 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. We do not have as complete quantitative data on this point as we would like. Release of nitrogen from ureaforms is not as sensitive to particle size as IBDU or as materials like oxamide and magnesium ammonium phosphate, but the powder form will show a few percent more nitrogen released than the granular form in a given period of time.

Recommended Amounts

On fairways, lawns, and other similar turf areas, application of 10-15 lb. of Nitroform[R] fertilizer per 1,000 sq. ft. or 400-600 lb./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 2/3 in the fall and 1/3 in the spring. For warm-season grasses - Bermuda, zoysia, centipede, and St. Augustine - apply 2/3 in the spring and 1/3 in the fall. For seedbed application, the year's supply is worked into the top 2-4 inches of soil.

On bentgrass greens, three applications of 7-10 lb. of Nitroform[R] fertilizer per 1,000 sq. ft. is recommended: one 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 summer until the residual nitrogen has built up. For seedbed application, on average-size greens, use 25 lb. of Nitroform[R] fertilizer worked into the top three inches of soil.

For greenhouse, foliage crops, and bedding plants - trees, shrubs, and evergreens, use:

Soil Surface - 1/4 lb./in. of plant diameter
S 1 tsp./6 in. pot

Soil Mix - 6-7 oz./bu. or 2-3 lb./cu. yd.

Bedding plants - 2-3 lb./100 sq. ft.

These recommendations should be useful guides, but the turfgrass manager or nurseryman will adopt them to his own condition.

A striking feature of these recommendations is the relatively large amounts of nitrogen applied in a single application. Thus 10-15 lb. of Nitroform[R] fertilizer (3.8-5.7 lb. actual N) is routine applied to turfgrass and other plants in a single application. Contrast this with soluble fertilizer when the rule of thumb is to apply no more than 1 lb. of N/1,000 sq. ft. in a single application and then take the precaution of watering it in.

Summary

Nitroform[R] ureaform fertilizer has the following characteristics:

(1) Consists essentially of chemically combined urea with greatly reduced solubility.

(2) Nitrogen is released through action of soil microorganisms. Biological reactions are dependent on temperature - require same conditions as growing plants.

(3) Quality is indicated by combination of WIN and AI. Other slowly available fertilizers require data such as coating thickness, particle size, soil, moisture, and permanganate values to indicate quality.

(4) Nitrification studies in soil indicate 30-40% release in 4 weeks, 60-75% in 24 weeks, with a portion being carried over for utilization in the following season.

(5) Is available in granular and powder form. The powder form can be sprayed in a water suspension and is somewhat more rapidly released than the granular form.

(6) Recommendations for turfgrass and nursery stock call for relatively large single applications (4-8 lb. N/1,000 sq. ft.). Soluble fertilizers generally cannot be applied in these quantities.