Turf Questions
. . . and answers

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How Nitrogen Works

(Second of Two Articles)

There are great differences in the way and in the speed by which nitrogen is released to the plant, both of which mean a great deal to the grass and the manner in which it can use the nitrogen.

Each nitrogen material is mineralized (converted to nitrate nitrogen) at a rate which is dependent on the composition of the material and its ease of conversion by bacteria.

Ammonium Sulfate, $(NH_4)_2SO_4$, nitrifies rapidly in the soil. The ammonia quickly is seized upon by the nitrifiers and is converted to nitrates which are made immediately available to the grass. It is very easy to have too much nitrate, more than the grass can use. The excess may be lost in the air as ammonia, or it may be leached downward by rain or irrigation water. The excess taken into the plant causes greatly accelerated growth. The excess also may scorch (ammonia burn) the grass. Because of the rapidity of conversion this source of N must be used frequently at light rates to avoid sudden excesses with attendant flushes of soft succulent growth.

Must Be Converted

Urea cannot be used as such by plants. Even though it is soluble it must be converted to mineral forms before plants can use it. Under ideal conditions this occurs after about a three-day delay following application.

Natural organic materials (seed meals, sludges, tankage) hold most of their N as proteins which must be "decayed" by microorganisms which, by steps, form ammonia, nitrites and finally, nitrates. Part of this protein nitrogen is so resistant to decay that it can be considered unavailable to grass up to 70 per cent in some forms of leather tankage and up to 50 per cent in some sludges. Proteins which microbes easily can digest and convert will be nitrified at about the same rate as ammonium sulfate or urea.

The synthetic organic, ureaform, is a nitrogen product that is manufactured to a rigid set of specifications that assures a controlled rate of release. A small portion nitrifies easily, similar to ammonium sulfate or urea. Another portion, the larger, more complex molecules, mineralizes over a much longer period because it is less attractive to the soil microflora. Still another portion releases its nitrogen months after application, resembling somewhat the more resistant portions of natural organics but differing in that the microbes finally do break it down. Each portion grades insensibly into the next by gradual changes in molecule sizes. There are no abrupt changes from one to the other.

Nitrification Studies

Nitrification studies are conducted in laboratories without plants to measure relative rates of mineralization to nitrate nitrogen. The temperature usually is held at 80 to 85 degs. F., a point at which optimum bacterial activity may be expected. A typical set of results is presented to show the way in which quickly available and slowly-available materials are converted. (*See table on page* 44)

Per Cent of Total Nitrogen Converted to Nitrates in:

	3 Weeks	9 Weeks	15 Weeks
Cottonseed Meal	49	54	54
Leather Tankage	28	34	35
Process Tankage	30	35	36
Sewage Sludge	42	49	50
Ammonium Sulfate	89	93	91
Ureaform (C.A.M.)	17	42	50
6-6-6 Fertilizer, 50% of N from UF (C.A.M.)	47	68	74

Interpretation: The best natural organic materials released only half of their total N. Most of it was converted to nitrate in the first 3 weeks the same as sulfate of ammonia. Thus the first five materials are classed as quickly available.

The ureaform released only 17 per cent of its total N in the first 3 weeks. At the end of 9 weeks, only 42 per cent had been converted to nitrates. Half of it was converted in 15 weeks with nitrates still being formed. This performance places this material in the slowly-available class.

The 6-6-6 fertilizer exhibits an excellent steady curve of nitrate formation over the 15 week period, giving this formulation a "controlled release" classification.

Varied Reactions

Reactions in the soil are varied and complex but, in order to understand them we are forced to oversimplify them, for purposes of illustration.

beneficial organisms, fungi flourish in acid soils. Disease-producing fungi often are destroyed by bacteria.

Aeration: Abundant oxygen favors beneficial organisms. Excess of water reduces oxygen supply and encourages anaerobic conditions with formation of nitrites and other toxic substances. Nitrates are torn apart when oxygen is low because bacteria need oxygen.

Salts: Low concentration. Continued use of salt forming nitrogen carriers discourages bacteria.

Light: Kills most microorganisms. Surface of soils tends to be nearly sterile. May explain poor response of granular materials that lie on top of turf.

Organic Matter: Organic matter is a source of food and energy. Both natural and synthetic sources of carbon and nitrogen favor microbial activity.

Food Supply: Microbial population densest where food supply is plentiful and continuous.

Summary: Nitrogen of the air must be fixed, then converted to nitrates for use by the plant. Bacteria do work, therefore, require a source of energy to accomplish conversion, carbon in organic materials furnish energy. Bacteria use nitrogen as food. Bacteria require oxygen, therefore, a well-aerated soil is essential. A neutral reaction (pH 7.0) favors optimum microbial activity.

$$\text{Fertilizer} + \text{Bacteria} = \underset{\text{Ammonia}}{NH_3} \quad \underset{\text{Ammonia}}{NH_3} + \underset{\text{Oxygen}}{O_2} \underset{\text{Nitrosomonas}}{=} \underset{\text{Nitrous Acid}}{HNO_2} \pm \underset{\text{Water}}{H_2O}$$

$$\underset{\text{Nitrous Acid}}{HNO_2} + \underset{\text{Oxygen}}{O_2} \underset{\text{Nitrobacter}}{=} \underset{\text{Nitric Acid}}{HNO_3} \quad \underset{\text{Nitric Acid}}{HNO_3} + \underset{\text{Magnesium Oxide}}{MgO} = \underset{\text{Magnesium Nitrate}}{MgNO_3} + \underset{\text{Water}}{H_2O}$$

Magnesium nitrate is soluble and can be absorbed by the plant through the root hairs. In addition to magnesium there will be nitrate salts of all other available bases (Ca, K, Na, etc.)

Optimum Conditions

Nitrification proceeds most effectively under these conditions:

Temperature: 85 degs. F. optimum, but organisms can adapt readily to gradual changes.

Moisture: 50-70 per cent of water-holding capacity, the same as for higher plants — but can tolerate wide extremes.

Acidity: Neutral (7.0) reaction best for

Midsummer Disease

Q. We built our own greens with no experience whatsoever. The grass looks good but lately I am beginning to think that our soil mixture was not in the correct proportions.

The greens are very firm with shallow root systems. I've read your column in GOLFDOM for years. For hard greens you say to aerate and incorporate sand. Should the sand be applied as is or should it be mixed with topdressing?

Also, our greens are very susceptible to disease in midsummer. We don't fertilize at all during this time. I was wondering if fertilizer, applied in midsummer, would aid the grass in

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California Pros
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of was when Bob Rosburg had to pull up stakes in Palo Alto and go to Portland," remarks Markovich.

"Here's a man who won the PGA Championship a couple of years ago! What does a fellow like that have to do to be appreciated in his own back yard?" asks the venerable Richmond pro-owner.

Rosburg was one of those commonly mentioned for the job at the Olympic Club which eventually went to the highly popular Harrison.

But however well founded are the fears of LoPresti, Duino, Ward and Markovich, they can be temporarily allayed. There is no imminent outland invasion. The last check of the section's 143 country clubs showed that all of the vacancies had been filled.

Feeding the Hungry
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frozen for use tomorrow — or next month.

A good example of this built-in flexibility was seen on Wednesday, the last day of the practice rounds. A constant, heavy rain closed the course early in the day. This discouraged many of the spectators, and the 1,000 luncheon guests estimated for the day turned out to be 400.

It was only necessary to leave the frozen food part of the menu right where it had been: in the freezer. It came in handy on Sunday in feeding the spectators who showed up for the Palmer-Nicklaus playoff.

Success of the combination frozen and kitchen-prepared food service operation points the way to more of the same for future special events at golf courses of all sizes.

Grau's Answers
(*Continued from page 44*)

warding off disease. (Indiana)

A. Where greens have too much clay we advocate thorough aerating followed by incorporating coarse sand without additional soil added. The straight sand fails to create a layer because the aerating procedure destroys any layer that might be made. You will find vertical columns of sand and many new white roots in the holes.

All greens are susceptible to disease in midsummer. Fertilizer might help if the grass is very hungry and needs plant food. First, I would want to know what you are using and how you are using it. Also, what kind of grass do you have? Reduced irrigation, keeping the greens on the dry side, can help reduce disease. Hydrated lime dusted on weekly at 1 to 2 lbs. to 1,000 sq. ft. can be of considerable help in checking disease and helping grass to recover.

Future Compaction?

Q: Under separate cover, I am sending to you for analysis a soil sample taken from our No. 1 green. This is a bentgrass green and consists of a mixture of Arlington and Cohansey.

During the 1961 playing season, we built five new greens with the same mixture as contained in the sample. As far as we can tell so far, results have been excellent. The base for these greens is tiled and contains five ins. of gravel and we have approximately eight to ten ins. of topsoil. Although results so far have been very gratifying, I am wondering if there is any danger in the future of compaction with this mixture. Also, I would like a recommendation as to the type of topdressing to use. . . . Indiana.

A: This office is not equipped to make soil analysis — only inspection and observation. You will do well to have your own state experiment station run tests on representative samples drawn according to their suggestions. A test run on the soil in a single cup-cutter core would be quite meaningless.

The roots in the core you sent are amazing. The sandy loam texture is ideal. You need fear little or no compaction. The topdressing to use must be of the same character as the soil in the greens. Any change in texture or composition will create layers and trouble.

Leaching A Factor

In a soil as sandy as yours, leaching will be a factor. This is good. It means you have excellent drainage. To compensate for loss of nutrients by leaching, the simple solution is to use more slow-release nitrogen which doesn't leach.

The Arlington-Cohansey blend is not in common use because of the wide difference in color of the two grasses. My guess is that the Cohansey will win out in the long run. If you are having good results with this blend, there is no reason you should not continue.