FORM, FUNCTION, FIT: which nitrogen source is right for you?

IT'S TIME TO PICK A NITROGEN FERTILIZER SOURCE for your sports field. How do you make that decision? Advertisements frequently tout nitrogen (N) fertilizer as the "slowest release," "the quickest green-up," or "the most available." Add technical terms such as methylene urea, ureaformaldehyde and controlled-release polymer, and the topic of nitrogen fertilizers starts to get complicated indeed. But, it's really not. The basic chemistries and manufacturing processes behind most of our commonly available N sources fall into five to six major groups, and you can sort out the ones you should use (and when to use them) from there.

Let's discuss the groups:

Soluble sources of N that are manufactured from inorganic (no carbon in the source) N sources.

Sources of water-soluble N include potassium nitrate (13-0-44, this and all other analyses are always expressed as percent N-P_2O_5-K_2O), ammonium sulfate (21-0-0), and, if you can still find it, ammonium nitrate (34-0-0). [Note: Since people are used to buying the analysis '34-0-0', some fertilizer dealers now sell a product with a '34-0-0' analysis that is actually created from urea, or it may be a blend of ammonium sulfate and urea. This is not an issue, it is simply a way to provide an analysis (34-0-0) that people are familiar with without having to deal with the legal complexities now associated with the sale of ammonium nitrate.] Any time you need a rapid turfgrass response, be it greening or growth, a soluble material should be in your spreader or spray tank. Soluble fertilizers provide quick turf green-up, which may be important when you need turf to grow and fill bare spots. Always apply water-soluble sources at lower rates (0.5 to 1 pound of N per 1,000 square feet per month of active growth) and water them in. This helps avoid the turf burn that can occur with heavier rates of soluble products. Care must be taken to not over-apply, especially if you are managing turf on sandy soils, and to not over-irrigate once the materials are out. Also, check your local and/or state regulations to make sure that you are applying your soluble N during months in which it is permitted.

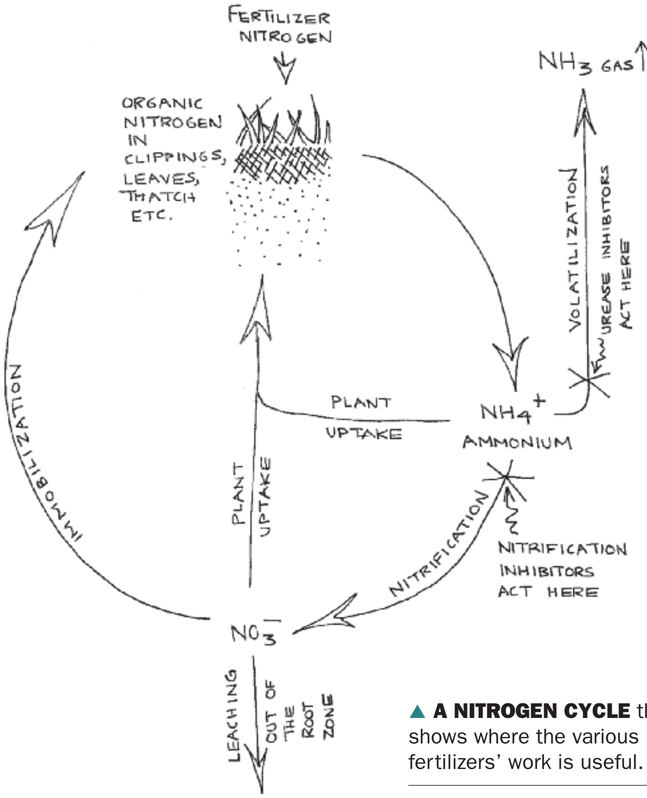
Soluble sources of N that are manufactured from a synthetic organic N source. We have one such source: urea.

Urea gets a separate mention because it is, by the broadest definition, organic (there is carbon in its formula – NH_2-CO-NH_2). But in reality urea can be lumped in with the inorganic soluble N sources, because it behaves like those sources—rapid turfgrass response, immediately available to the plant; watch overapplication as it can cause turfgrass burn and possible negative environmental effects. Urea is often the choice for use in foliar N programs, and it works well for that, with ample research showing that foliarly applied N is readily taken up by the turf, much of it within 12 hours of application. Urea is often the background fertilizer used for many slow-release N sources (discussed below).

Slow-release N sources that are slow-release because there is a physical barrier around a prill of soluble N fertilizer. Often, these are called "coated" fertilizers.

The oldest coated N fertilizer is sulfur-coated urea, or SCU (~32-0-0). Introduced decades ago, it still is a common product, and there are also newer generation materials that are both sulfur and polymer-coated. Sulfur-coated urea is made by spraying molten sulfur onto urea granules. Release of N from the sulfur-coated urea granule depends on the time it takes water and microorganisms to break down the sulfur coating. The thicker the coating, the slower the release rate. Release will be faster in warm, wet soil conditions that favor microbial activity. One problem with some forms of SCU is that the coating process creates larger granules, which are easily crushed or picked up by mowers. Newer micro-prill technologies have helped solve this problem, and SCU products remain a viable slow-release N source for turf.

Polymer-coated-urea (PCU) products have fast become a major part of the slow-release N market. These products work by allowing urea to gradually diffuse through the polymer membrane at a rate that, depending on the exact technology, may vary according to temperature, moisture or coating thickness. These products provide a precise N-release rate, and some can even deliver N for an entire growing season. The release rates are widely variable, and products can have release times ranging from 45 to 270 days. Materials with longer release patterns (180 days or more) can be excellent for producing a long-term greening response without the fluctuations in turf growth that may occur with more frequent applications of soluble N. The science of polymer coating has gotten quite specialized,



▲ **A NITROGEN CYCLE** that shows where the various fertilizers' work is useful.

and while urea used to be the product that was almost always coated, other fertilizer sources may now be coated (such as potassium sulfate).

Slow-release N sources that are slow-release because urea has been converted via chemical processes into a slow-release N source.

Slow-release fertilizers created by chemical reactions all start as urea. The most common product currently on the market in the turfgrass industry is ureaformaldehyde (UF), formed by reacting urea and formaldehyde to produce chain molecules of varying lengths. The length of the chains controls N release, with shorter chains having quicker N release for turfgrass use. Ureaformaldehyde reaction products are also often called Methylene ureas (MU) (as if it was a synonym with UF) but it is really not. Specifically, methylene-ureas tend to be the group of ureaformaldehyde reaction products that are intermediate in chain length, and have an N content of 39 to 41%. In comparison, a ureaformaldehyde that has long been on the market, Ureaform, has the longest chains, and is thus very slow in the release of N for plant use.

Regardless of the chain length, N release occurs as microorganisms break the chains, releasing N which is available for plant use. The release patterns of ureaformaldehyde products are controlled by the length of the chains; the shorter the chain, the quicker the release. Additionally, some short-chain UFs are frequently marketed as liquid slow-release materials, such as triazone. Ureaformaldehyde fertilizers are quite popular in the turfgrass market, and there is a wide variety of products available for your use. Before choosing a specific fertilizer you should consult the fertilizer label to determine the relative N percentages that are rapidly or slowly available for plant use.

The other slow-release N fertilizer that is chemically slow release is isobutylidene diurea (IBDU). A combination of urea and isobutyraldehyde, IBDU does not depend on soil microorganisms for release but is broken down by water (hydrolysis) into urea. The rate of urea release from IBDU varies with particle size, temperature and moisture. The smaller the particle, the faster the release. The higher the temperature, the faster the release. Recent discussions with turfgrass managers reveal that few use IBDU, often because it is difficult to obtain. If available, it is an excellent material for cool-season use for long-term N supply because it does not require microbial activity for N release.

Slow-release N sources that are slow-release because they are a 'true' natural organic material in which the N must be released via the biological process of mineralization.

These natural organic slow-release N sources are generally manufactured from some type of waste material. Sometimes the material is composted to help reduce odors, or the material may be dried and granulated to improve handling and spreading characteristics. Common organic fertilizer waste materials include sewage sludge, poultry litter, meat-processing waste and other animal by-products such as fish or feather meal. Much of the N in such fertilizers is organic N in the form of relatively complex chemical compounds, and is not available for plant uptake until microbes have converted it into nitrate and ammonium.

Soil temperature greatly influences microbial activity and the rate at which N is mineralized from these organic fertilizers. In cold soils, little activity will occur; an organic N fertilizer applied during winter in the northern US will just sit there with little N available for plant use until the soil warms. By contrast, fresh poultry litter applied to turf during hot weather is relatively quickly available, as most of the organic N is rapidly converted to nitrate and ammonium.

Some relatively new N fertilizers on the market are blends of organic wastes, such as fish meal, feather meal or poultry litter, and a water-soluble inorganic N such as ammonium sulfate. Such a product would produce a rapid greening response from the inorganic N and an extended response from the organic N. These "hybrid" materials can still burn turf if you apply them at high rates, and the labels usually have a warning to that effect. Read the guaranteed

▲ **RESEARCH TRIALS** are often conducted to evaluate N release of various fertilizers over time. In this study, different N sources are applied to hybrid bermudagrass, and each week color, quality and clipping yield data is collected from each plot.

analysis on the back of the bag to determine the source of the N, and how much of it is soluble and/or slow-release.

Urea to which nitrification inhibitors and/or ammonia volatilization inhibitors have been added.

The majority of nitrogen must be taken up by the plant as nitrate-N or ammonium-N. Soluble N sources already have the N in that form, and slow-release sources either have that N "trickle" out via a physical barrier that degrades over time, or by being released from a chemical formula via hydrolysis or microbial breakdown. Sometimes, however, the plant available forms (nitrate or ammonium) can be converted into other N forms that are less desirable for the plant or surrounding environment. In one case, ammonium-N gets converted to nitrate-N by the microbial process called nitrification. The nitrate-N is still plant available, but because it is an anion it can be prone to leaching from the plant's rootzone. In the second case, another loss path is when N is lost as ammonia gas, out of the plant canopy to the atmosphere (this is volatilization, which is caused by the urease enzyme).

To slow down these processes of nitrification and volatilization inhibitors are added to the urea fertilizer. There is a separate nitrification inhibitor and urease inhibitor, but some fertilizers may contain both. Additionally, there are several different nitrification inhibitors on the market and thus you should carefully read the label to see what your fertilizer may contain. The most common nitrification inhibitor in turfgrass fertilizers is dicyandiamide (DCD), while the most common urease inhibitor is N-(n-butyl) thiophosphoric triamide, (NBPT). Use of a fertilizer with a nitrification inhibitor may help to limit N leaching, and use of a fertilizer with a urease inhibitor may help reduce N loss to the atmosphere.

So, those are six basic groups of N fertilizers. Things get more complicated when other nutrients are added and blends are created. With variations in nutrient ratios, coating types, type and proportion of slow-release N and other characteristics, you can see how the number of possible (and actual) products can become so large.

So how do you pull all this information into a coherent plan for selecting a fertilizer? First, think about what you want your N to do. Do you need to heal worn spots and grow turf? In that case, use a soluble and readily available source to promote growth. Or, do you simply need a background green color with minimal growth? A long-chain MU or polymer coat with a long release pattern might work well. Do you have an environmentally sensitive area, one with a high sand content, in an area with intense rainfall? Consider adding slow-release or materials with inhibitors to protect the environment. Last, calculate your cost per pound of nutrient. Comparing N sources on a price per pound basis removes the percent N content from the equation, helping you make a cost effective decision. ■

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