



Best Management Practices for New York State Golf Courses

Nitrogen Fertilizer Use

Readily available N sources, such as water-soluble N (WSN), provide rapid turfgrass growth and color responses, but are more prone to leaching, particularly in sand-based soils. Slow release N sources are more variable in N content and release characteristics. Most N sources can be applied in granular or liquid form.

Water Soluble Sources

WSN, including inorganic N and synthetic organic urea, are released quickly into the soil, which can increase the risk of leaching at high rates. Inorganic sources include ammonium nitrate, ammonium sulfate, potassium nitrate, calcium nitrate, and mono-di-ammonium phosphate. Nitrate ($\text{NO}_3\text{-N}$) and ammonium ($\text{NH}_4\text{-N}$) are the principle sources of inorganic nitrogen that plants absorb. Plants generally grow best with a combination of $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$. NH_4 is best absorbed at a pH around 7.0 and less absorbed at more acidic pH. Conversely, $\text{NO}_3\text{-N}$ is best absorbed at an acidic pH.

Urea is a common and inexpensive water-soluble form of nitrogen. Urea can burn turf at high rates, but it has a lower burn potential than other inorganics. Losses due to volatilization may also be high when applied as a dry material on days that are hot ($>80^\circ\text{F}$) and humid. Lightly watering in urea solutions (when possible) reduces the amount of volatilization.

Slow Release Sources

Urea is also available coated in sulfur or a polymer for slow release with less volatilization and leaching. In other variations, urea and urea-ammonium nitrate (UAN) are also available with urease inhibitors, n-butythiophosphoric triamide (NBPT), and nitrification inhibitors, dicyandiamide (DCD). Inhibitors reduce volatility losses and slow the rate of nitrogen release. These coated and stabilized nitrogen fertilizers are effective at reducing the risks of contaminating groundwater and increase the utilization of nitrogen applied.

Other forms of urea include methyleneureas (MU), ureaformaldehyde (UF), triazone, and isobutylidene diurea (IBDU). The MU and UF fertilizers are available in short or long chain C-H or methyl links. Shorter chains have higher salt indexes, increase the burn potential, and release N quicker. The long chain formulations releases over a longer period with lower burn potentials. The products are grouped according to their "fraction". These distinctive fractions have characteristic water solubility and release rates.

The Association of American Plant Food Control Officials (AAPFCO) requires that ureaformaldehyde products be defined to contain at least 35% N-nitrogen, largely as insoluble but slowly available products with a water insoluble nitrogen (WIN) content of at least 60%. A ureaform produced with a 1.3:1 ratio of urea to formaldehyde contains 38% N of which 65-71% is WIN. A methylene urea product with a 1.9:1 ratio contains 39% N of which 36% is WIN. Products are often produced with a mixture of other water-soluble nitrogen sources and a percentage of WIN ureaformaldehyde. Course managers

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must understand the product being used, the percentage of water solubility, and the release rates in order to use these products effectively.

The UF and MU fertilizers require microbial activity to release their N. A urease enzyme hydrolyzes the urea to NH_4 and bacteria nitrify the NH_4 to NO_3 . Like the organic fertilizers, little N is released unless the soil temperature is over 50° F. As the soil warms, and microbial activity increases, more N is released.

IBDU, typically 31% N, does not require microbes because it is slowly hydrolyzed by water. IBDU is available in two grades: a coarse grade that is 90% WIN and a fine grade (greens grade) that is 85% WIN. The finer grade releases quicker and is less likely to be collected during mowing. Acid soils also increase the N release rate.

Liquid “Foliar” Sources

Almost any source of nitrogen can be applied in a liquid form and, depending on how much water is used when applying, the nutrient can be absorbed foliarly. Foliar products are available using combinations of urea and other inorganic nitrogen compounds. The product is typically sprayed to coat the leaf surface. Plant uptake is generally 10-70% of the fertilizer applied, which can be higher than the amount absorbed by the roots.

Release Rates

Research often evaluates different forms of fertilizers, rating each product according to turf quality, color, and clippings as a measure of growth. While these comparisons are important, knowing the portion of the fertilizer’s nitrogen content that is “immediately available” and its release rate can help in selecting products and balancing rates with plant requirements. Controlling the amount of available nitrogen also reduces the risk of excess nitrates being leached from the soil.

Biologically active soils may react quickly to release the water insoluble portion of the fertilizer adding more nitrogen that is available to the plant or movement into ground water. A series of studies confirmed that, under active growing conditions, perennial ryegrass, Kentucky bluegrass, tall fescue, and creeping bentgrass assimilate nitrogen, as either nitrate or ammonium, within 48 hours of applications. The results suggest that using prudent rates of application, the plant can quickly absorb and use the immediately available nitrogen that has been applied.

Organics Versus Synthetics

Several types of fertilizers have been measured for the losses associated with runoff and leaching of phosphorus, nitrate, and ammonium. Research has determined that once turf was established, natural organics lost 3-6% of the nitrogen applied as $\text{NO}_3\text{-N}$ leachate compared to 8.6-11.1% lost for synthetic organics. Little difference was found between sulfur-coated urea and the immediately available urea or ammonium phosphate fertilizer. Natural organics, notably dairy and swine composts, increased the percentage losses of phosphorus partially due to more P being applied at the same N amount of the synthetic fertilizer.

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Water Solubility

Water solubility can potentially increase the risk of leaching. While ammonium cations (NH_4^+) can be held within the soils cation exchange sites, some soils, especially sandy soils, have too little cation exchange capacity to hold ammonium or other cations like potassium or calcium. Nitrates are freely solubilized and mobile in the soil solution. Slow release fertilizers can be used on sites with higher leaching risks to decrease the risks to groundwater. Slow release fertilizers can be applied at a rate of 2-3 lbs N per 1000 sq. ft. per year in split applications. Applications should not be made in late fall (November or later). Since much of the water recharging groundwater occurs during the late fall, winter and early spring. Late fall N applications can result in leaching for two reasons: (1) increased precipitation and groundwater recharge during the period from late fall to early spring and (2) reduced plant uptake of N during winter dormancy.

Timing

Leaching studies conclude that applying fertilizers during clear weather can prevent episodic losses of nitrates to groundwater. The use of quick release, water soluble, immediately available nitrogen sources is an acceptable practice when properly applied. Conversely, over-application or applications that are stacked due to short interval application schedules using some slow-release products can increase the risk of leaching. Precipitation events and excessive irrigation can also drive the nitrates deeper into the soil profile. Testing has shown that applications should be limited so that the water-soluble, immediately available, and released fraction of fertilizer additions does not exceed 0.5 lbs N per 1000 sq. ft., 0.4 on sand, and no more than 0.7 on other soils (assuming no heavy rains in the next several days).