Turf Nitrogen and Phosphorus Management Practice, To Help Protect Surface Water Quality

By Robert J. Mugaas, Michael L. Agnew and Nick E. Christians

Few soils have enough natural nitrogen (N) fertility to maintain desired turfgrass quality and recuperative ability throughout the growing season. Nitrogen shortages can lead to slow growth, yellowing of the plants, thinning out of the turf and increased incidence of some diseases. However, excessively high levels of N can lead to excessive shoot and leaf growth, reduced root growth, low plant carbohydrate (food) reserves, increased susceptability to environmental stress and some diseases. One of the first important considerations in using N fertilizers responsibly is to match the site conditions and the desired maintenance program with proper N fertilizer sources.

Nitrogen Fertilizer Sources

Nitrogen fertilizer sources are often categorized as inorganic types or organic types. A brief description of several N sources is given in Table 1.

Inorganic fertilizers such as ammonium nitrate and ammonium sulfate are all water soluble or *quick-release* N sources. That is, N becomes available as soon as water is applied to the turf. Their response is quite predictable and results are fairly immediate. However, their burn potential is quite high and the effects are rather short-lived. On sandy soils, high application rates of these products combined with high irrigation or rainfall amounts may result in higher N losses due to leaching. Leaching is the movement of water and possibly nutrients down into and potentially beyond the turfgrass rootzone. Once beyond the rootzone, nitrates can continue moving through the soil and may find their way into water sources.

Organic fertilizer products, natural or synthetic, are those containing carbon (C) in their chemical structure. Nitrogen from natural organic sources becomes available only after the product begins to breakdown due to soil microbial action. These are considered *slow-release* N sources as N is gradually released to the soil solution and becomes available for plant use. Soil temperature and moisture are key factors governing the microbial activity and thereby the N release. Compared to quick-release sources, these have a lower leaf-burn potential and can be applied at slightly higher rates without damaging the turf.

The primary synthetic organic fertilizer product is urea. It is considered a quick-release N product with a relatively high foliar burn potential. Urea has been further processed and/or combined with other materials giving these products more or less of a slow-release characteristic. Their N release is dependent on soil chemical and/or microbial action, have a fairly low leaf burn potential and can be applied at slightly higher rates than quick-release N sources.

Nitrogen Fertilizer Use

The amount of N required by a lawn or turfgrass area depends on the type of grass plants present and the management practices used. High maintenance lawns often contain the more vigorous improved Kentucky bluegrass and turf-type perennial ryegrass varieties. These lawns will perform better when adequate water and fertilizer are regularly provided. Low maintenance lawns usually consist of common types of bluegrass in combination with a mixture of other grasses. These lawns grow and spread more slowly and usually receive little extra water or N fertilizer. Table 2 describes the annual application of N requirements for these lawn types and how leaving the clippings on the lawn impact the yearly N requirements.

On highly leachable soils, sands and sandy loams, the above recommended N application rates may result in excessive loss of nitrate-N due to leaching. Where soluble N sources are used on these soil types, reducing the N rates to 0.25 to 0.5 lb. N / 1000 ft^2 per application may minimize potential nitrate-N leaching. If, frequent, lower N rate applications are not practical, slow-release N sources may be a better choice for these soils. This practice is adaptable to late season N fertilization and may be especially true where sandy soils are in close proximity to surface or groundwater resources.

Watering practices that result in water movement beyond the rootzone may increase potential nitrate-N leaching. Frequent, daily irrigation during cool moist periods can also increase the leaching potential. Irrigation practices that take into consideration the grass plant's needs during any particular climate condition will be more effective. Adding enough water to compensate for that removed by plant uptake and evaporation will minimize potential N pollution problems from leaching. Sloped areas may require more frequent but smaller amounts of water per application as they will be

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Editor's Note

Last winter Bob Mugaas, Hennepin County extension horticulturist, had the opportunity to spend a study leave at Iowa State University researching scientific literature to find out what is known about present lawn practices and their impact on water quality.

The "Turf Nitrogen and Phosphorus Management Practices" article, which begins on this page, and another on "Responsible Turf Pesticide Use" to be carried in the November issue, are a result of that work by Mugaas, Michael L. Agnew, extension horticulturist/turf, and Nick E. Christians, professor of horticulture, at Iowa State University.

Says Mugaas: "A larger, more comprehensive publication will be forthcoming this fall. It is hoped that this information about turf fertilizer and pesticide practices and their impact on water quality will help you communicate with greater knowledge about these issues.)

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more vulnerable to runoff before ample water has infiltrated into the soil.

Irrigation of 0.25 to 0.5 inches immediately after an application of a quick-release N source will help move the N into the surface soil where it can potentially be used by the grass plant. Also, it will be somewhat protected from runoff and possible volatilization back to the atmosphere.

Grass clippings should be returned to the lawn area to decompose and recycle nutrients back to the turf area. They should not be blown or raked into street gutters or onto sidewalks and driveways where they may be carried in runoff to surface water areas. Nutrients released to the water environment through decomposition may be responsible for causing undesirable algae and vegetative growth.

NEVER apply N fertilizers to water resources directly or apply them to frozen ground.

Nitrogen fertilizer product knowledge and being familiar with the site may help minimize or even eliminate potential adverse impacts on water quality. In addition, always follow manufacturers' guidelines or consult with local extension turf specialists for appropriate application rates.

TABLE 1 **Characteristics of Common Turfgrass N Sources**

Fertilizer Source	N content %	Leaching Potential	Burn Potential	Low Temp. Response	Residual Effect
Inorganic					
Ammonium nitrate	33-34	High	High	Rapid	Short
Calcium nitrate	16	High	High	Rapid	Short
Ammonium sulfate	21	High	High	Rapid	Short
Organic - Natural					
Activated sewage sludge	6	Very Low	Very Low	Very Low	Long
Manures	3-10	Very Low	Very Low	Very Low	Long
Other natural products	3-10	Very Low	Very Low	Very Low	Long
Organic - Synthetic					
Urea	45-46	Moderate	High	Rapid	Short
Urea solutions	12-14	Moderate	High	Rapid	Short
Sulfur coated urea	14-38	Low	Low	Moderate	Moderate
Resin coated urea	24-35	Low	Low	Moderate	Long
Isobutylidene diurea (IBDU)	30-31	Mod. Low	Low	Moderate	Moderate
Methylene ureas and Ureaformaldehyde*	38	Low	Low	Low	Mod. Long to Long

** Some products may contain urea in addition to the ureaformaldehyde component.*

TABLE 2. **Annual Nitrogen Requirements and Application Timing for Lawns in the Upper Midwest**

	Nitrogen (N) to apply lbs. N/1000 ft²	Timing of Applications*
High maintenance lawn		
(Irrigation, clippings removed)	4	May - June, Aug., Sept., Oct. - Nov.
(Irrigation, clippings not removed)	3	May - June, Aug., Oct. - Nov.
Low maintenance lawn		
(No irrigation, clippings removed)	2	Aug., Oct. - Nov.
(No irrigation, clippings not removed)	1	September

* *Assume 1 lb. N/1000 ft² of a soluble, quick-release N source applied at each application.*

Note: Lower more frequent rates of a quick-release N fertilizer can be used on sandy to sandy loam soil. Slow-release N fertilizers could also be substituted for the quick-release types. Follow manufacturers and/or Extension suggestions for proper application rates.

Phosphorus

Phosphorus (P) is an essential nutrient contained in every living grass plant cell. The amount of P needed by the grass plant is significantly less than nitrogen or potassium. It is considered to have positive effects on turfgrass establishment, rooting and increased root branching, maturation and seed head production. Phosphorus is particularly important during early grass seedling growth and development stages.

While P is an important nutrient for grasses and other green plants, it is also an important nutrient for algae and weeds in our lake systems. Phosphorus is often the least abundant and therefore growth-limiting plant nutrient in fresh-

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water lakes. Lake enrichment with P can cause undesireable algae "blooms" and vigorous growth of other lake weeds, a process termed eutrophication. For this reason, much concern has been raised about the contribution of lawn and garden fertilizers to lake pollution.

Offsite Movement of Phosphorus

Phosphates, (P combined with oxygen), are removed from the soil solution and immobilized in the soil. Consequently, P is not prone to leaching and poses little or no threat to groundwater resources.

Offsite transport of P to surface waters tends to be associated with sediment erosion. Phosphorus is carried along with the soil (silt and clay fractions primarily) and organic matter sediments to which it is adsorbed. Phosphorus may also be carried by wind erosion and later deposited into lakes. Living plants such as trees, shrubs and turfed areas around lakes can help stablize the soil against wind and water erosion. Also, they can act as filters to help remove these fine soil particles from the air, thus trapping both the soil particles and any associated nutrients adsorbed onto them.

Phosphorus Management Practices

Phosphorus fertilizer additions to turf areas should be based on a reliable soil test. These can usually be obtained from soil testing labs at the land grant universities or through private soil testing laboratories.

Since P is quickly immobilized in the soil, it does not pose a threat to water resources from leaching. Where sediment is eroded from the site, it is likely that some amount of P will be carried with it. In established turfgrass areas, runoff potential is quite low due to the dense turfgrass canopy and extensive fibrous root systems. Therefore, where P is applied to turfgrass areas, it should be watered into the soil where it is immobilized and generally protected from loss by runoff.

During the winter months, leaves, dead grass plant parts and other organic debris may, upon breakdown due to freezing and thawing actions, release soluble forms of phosphate (and nitrates). These potentially can run-off from frozen ground, especially slopes, during spring snowmelt and early spring rains and possibly be carried into surface water areas. Thus, raking the lawn in the fall to remove excess organic debris may also be beneficial from a water quality standpoint. Grass clippings, leaf litter and other forms of organic debris should be removed and kept off of hard surface areas they can be carried in runoff to surface water areas. Obviously, these same materials should not be dumped on or near shoreline areas where nutrients released during decomposition can move directly into the water.

Since P is very immobile in the soil, it is often advisable to add some P at the time of establishment even though soil P levels may be adequate for an established turf. This will ensure some available P near the soil surface for the very young developing grass roots. Protecting newly seeded areas, especially slopes, with some type of mulch cover during establishment will help prevent runoff and erosion of soil and possible nutrients. Applying P to an established turf following core cultivation will help get P down into the soil, thereby protecting it from loss by runoff.

General Fertilization Practices

In addition to the specific nitrogen and phosphorus management practices already mentioned, following are some general lawn fertilization practices which can help reduce potential water pollution.

1. Be careful to never directly deposit or inadvertently apply fertilizer materials into lake areas.
2. Fill granular fertilizer spreaders on a hard surface where any spills can be easily cleaned up. NEVER wash off fertilizer spills into the street or other hard surface area where they can easily get into storm sewers and ultimately into surface water areas. Wash off granular fertilizer spreaders over turfed areas to prevent runoff of fertilizer material from hard surfaces. Fill and clean liquid fertilizer applicators over turfed areas for similar reasons.
3. Close the gate on the fertilizer spreader when crossing hard surface areas or go back and sweep up the material and re-use it another time or put it back into the spreader.
4. Drop spreaders are more precise but slower than rotary type spreaders. Near shoreline areas, apply fertilizer around the perimeter of the property with a drop spreader to create a "buffer" zone. The rest of the area further away from the shoreline can be fertilized with a rotary spreader. Since the perimeter has already been done with the drop spreader, it is not necessary to try to get close to the shore potentially, getting the fertilizer into the water. The same kinds of precautions should be taken when using liquid applications.
5. Avoid getting fertilizer into natural drainage areas or pathways on a property. These may not necessarily be hard-surfaced areas and can carry fertilizer directly into the surface water area before having the chance to infiltrate into the surrounding turf/soil area.
6. For shoreline areas, a "buffer zone" of unmanaged grasses or possibly natural vegetation could be left growing around the shoreline. This can help prevent soil erosion and may also retain some of the nutrients that might otherwise enter the lake.

Improper management or use of turf fertilizers may contribute to potential pollution of surface and ground water resources. However, combining appropriate landscape management practices with a modest lawn fertilizer program may further reduce surface water pollution.

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