DEPARTMENT OF AGRICULTURE

Best Management Practices for Nitrogen and Phosphorus Fertilizer Use on Turfgrass in Minnesota

Introduction:

Of the fertilizer nutrients typically supplied to turfgrass, nitrogen and phosphorus present the greatest risk to water quality. When allowed to runoff into lakes and streams, nitrogen and phosphorus can result in excess algae growth. Nitrogen in the nitrate form can also leach through soil and contaminate groundwater, making it unsafe for human consumption.

The following best management practices for nitrogen and phosphorus fertilizer use on turfgrass are designed to protect water quality while at the same time being economical and practical to implement. They refer to practices relating to the timing, rate, placement and source of fertilizer application and other practices that increase fertilizer use efficiency and decrease potential loss to the environment. The best management practices are based on University of Minnesota Extension recommendations found in the University of Minnesota publication *Fertilizing Lawns,* the Golf Course Superintendent's Association of America's *2017 BMP Template,* and the Minnesota Phosphorus Lawn Fertilizer Law, found in chapter 18C of the Minnesota State Statutes.

As used in this document, the term "turfgrass" includes a number of grasses that form dense turf and tolerate mowing. Turfgrass is used for groundcover on lawns, sports fields and golf courses. The terms turfgrass and lawn are often used interchangeably. Fertilizer used on turfgrass is often called lawn fertilizer.

BEST MANAGEMENT PRACTICES FOR BOTH NITROGEN AND PHOSPHORUS FERTILIZER

Best management practices (BMPs) in this section apply to the use of both nitrogen and phosphorus lawn fertilizers. BMPs specific to the use of nitrogen or phosphorus lawn fertilizer are provided in their own sections that follow.

1. **Maintain adequate soil nutrient levels for healthy turf**

   Although lawn fertilization should be done with care, it should not be neglected or avoided. Some level of fertilization is required to maintain healthy turfgrass and to prevent areas of exposed soil that have the potential of contributing to sediment and nutrient runoff. These BMPs are designed to protect water quality from both improper fertilizer use and from sediment and nutrient runoff that can occur when turfgrass is not properly maintained.

2. **Avoid off-target fertilizer applications**

   The Minnesota Phosphorus Lawn Fertilizer Law requires fertilizer spilled or spread on paved surfaces such as sidewalks, driveways, and streets to be cleaned up immediately. This applies to all fertilizers, whether they contain phosphorus or not. Off-target applications of lawn fertilizer can be reduced by using drop spreaders, broadcast (spin) spreaders with side deflectors, and sprayers, all of which provide a greater degree of placement control.

3. **Apply fertilizer only when turfgrass is actively growing**

   In general, do not apply readily available fertilizer to turfgrass before late-May in the spring, after mid-October in the fall, and during dry summer periods if turfgrass is not irrigated. Applying fertilizer to turfgrass that is not actively growing can result in loss of phosphorus and nitrogen in runoff and loss of nitrogen by leaching.

4. **Follow University of Minnesota guidelines on fertilizer application rates and timing**

   Table 3 gives University of Minnesota guidelines for nitrogen application on established turfgrass. Tables 4 and 5 give University of Minnesota guidelines for phosphorus application on new and established turfgrass. Applying over these amounts will not benefit turfgrass and increases the risk of fertilizer runoff and leaching. Applying under these amount will lead to a decline in turfgrass health that can lead to soil erosion.

5. **Calibrate fertilizer application equipment**

   The amount of fertilizer an applicator (spreader) applies at a given setting varies based on the product being applied, the speed the applicator travels at, and the applicator's condition (wear). The recommended settings found in a fertilizer applicator owner's manual or on the fertilizer product container is a good starting point but is not a substitute for calibrating an applicator for every fertilizer product it is used for. Fertilizer applicators which receive heavy use, such as used by commercial services, should be recalibrated annually. (Owner's manuals and product labels can often be found on the Internet.)

   The University of Minnesota Extension publication *Fertilizing Lawns* provides methods for fertilizer applicator calibration. Since the speed which an applicator is pushed or pulled at will affect its application rate, care should be taken to maintain a consistent speed during calibration and actual fertilizer application.

   Fertilizer recommendations for turfgrass are given in pounds per 1,000 square feet (lb/1,000 sq ft). Whatever the calibration method used, math needs to be done so the results are expressed in lb/1,000 sq ft.

6. **Mow at the highest recommended or allowable height of cut**

   As mowing heights decrease so does turfgrass rooting depth. Mowing at the highest recommended or allowable height of cut will encourage greater root development and will increase the ability of turfgrass to access nutrients and water in the soil. For most turfgrass a mowing height of 3.0 to 3.5 inches is recommended by the University of Minnesota.

7. **Water (irrigate) when needed; avoid over watering**

   Fertilizer should be watered in after application, either by at least 0.1 inches of rainfall or watering. Avoid applying fertilizer when heavy rain is predicted, as this can result in nutrient runoff. During times of drought, turfgrass should receive at least 0.25 inches of water weekly to keep plant crowns alive and to prevent long-term damage (crowns are the part of turfgrass plants where new growth is initiated).

   Over-watering turfgrass may leach nitrogen past the roots of plants and into groundwater. Follow watering guides provided in University of Minnesota Extension publication *Watering Lawns and Other Turf*. Typically no more than 1.0 to 1.5 inches of water should be applied per week (minus any rainfall) during the summer months.

   Some cities have watering restrictions during summer months. Be aware of these restrictions and schedule needed watering accordingly.

8. **Control movement of non-fertilizer sources of nutrients from turf**

   In addition to applying nitrogen and phosphorus fertilizers carefully, care should be taken to prevent other sources of nitrogen and phosphorus from leaving turfgrass and entering rivers and lakes. Soil erosion should be controlled by properly mulching newly seeded turf and preventing established turfgrass from thinning and exposing soil. When there is potential for soil erosion, a silt fence, straw bale, or sediment log barrier should be installed on the downslope edge to keep eroded soil from leaving the site. Grass clippings and leaves should be kept off paved surfaces and out of the street and drainage ways where they can be washed away during storms.

9. **Select lawn care services based on best management practice use**

   Make discussing BMPs part of the service selection process when using a lawn care service. Discuss with the service provider the desired turfgrass maintenance level, the number and rate of nitrogen fertilizer applications, and whether phosphorus lawn fertilizer is to be used. Choose lawn care services who base their program on the guidelines provided in this document.

BEST MANAGEMENT PRACTICES FOR NITROGEN FERTILIZER

1. **Determine proper turfgrass maintenance level**

Nitrogen fertilizer rate guidelines for established turfgrass are based on maintenance levels, so it is important to determine the desired maintenance level as a first step. Turfgrass maintenance levels can be divided into high, medium, and low-maintenance categories based on the species of grass and the planned level of use, function, and appearance as shown in Table 1.

High-maintenance turfgrass requires more nitrogen fertilization and therefore has a greater risk of nitrogen loss through runoff or leaching. Turfgrass that can be adequately managed as low-maintenance has a lower risk to water quality and turfgrass managers should always strive to minimize the use of nitrogen fertilizer and other inputs (Frank and Guertal, 2013).

It should be noted that low-maintenance does not mean no maintenance. Some level of nitrogen fertilization is required to maintain healthy turfgrass and to prevent areas of exposed soil that have the potential of contributing to sediment and nutrient runoff. Table 3 recommends that low-maintenance lawns receive an annual nitrogen application of 0.5 to 1.0 lb/1,000 sq ft.

Table 1: Turfgrass maintenance levels

Maintenance level	Typical use	Turfgrass plants	Watering
Low-maintenance	Residential lawns Institutional grounds Low-use parks Golf course roughs Roadsides	Common bluegrass varieties Fine fescues Tall fescue Buffalograss or other native grasses	Not watered or watered during dry periods only.
Medium-maintenance	Residential lawns Commercial lawns General grounds Sports fields Golf course fairways and tees	Kentucky bluegrass Fine fescues Tall fescue Perennial ryegrass	Watered so that function is not compromised.
High-maintenance	Showcase lawns High-use parks Playgrounds Golf course greens	Improved bluegrass varieties Improved perennial ryegrass Bentgrass	Watered on a regular basis.

2. **Place priority on late summer and early fall fertilizer applications**

Late summer and fall are the optimum times to apply nitrogen fertilizer to turfgrass. This is contrary to the traditional springtime application. Spring applications of nitrogen fertilizer before late-May cause a surge of top growth in the plants, which makes turfgrass look lush in the spring but depletes plant energy reserves prior to summer. Consequently, when summer stress periods occur, plants are weaker and less able to survive.

A complication that prevents many homeowners from delaying spring fertilizer applications until late May is that pre-emergence crabgrass herbicides are most commonly available in “weed and feed” products which combine the herbicide with fertilizer. The proper timing for the herbicide application is earlier in May than the proper timing for the nitrogen fertilizer application but both need to be

applied at the same time when applied in a combined product. Herbicide label instructions are legal requirements, so in the case of a "weed and feed" products the application timing required by the herbicide should be followed. When possible "weed and feed" products should be avoided for crabgrass control and crabgrass control should be done through cultural control or a combination of cultural control and herbicide treatments that are applied independent of a fertilizer application.

When nitrogen fertilization is applied once a year on low-maintenance turfgrass, that application should be made in late summer or early fall, as shown in Table 3. Nitrogen fertilizer, including "winterizer" turfgrass fertilizer products, should not be applied in the fall after mid-October. In the past, late-October and November nitrogen applications were recommended, but recent research shows late fall applied nitrogen fertilizer can result in significant loss of nitrogen to the environment due to cold temperatures reducing the ability of turfgrass to uptake nitrogen.

3. **Use enhanced efficiency nitrogen fertilizer, such as slow-release and stabilized products**

Readily available forms of nitrogen fertilizer become completely available to plants soon after their application. When compared with readily available forms of nitrogen fertilizer, slow-release and stabilized nitrogen fertilizer products last longer in the soil, provide turfgrass more time to make use of the applied nitrogen, and reduce potential of nitrogen runoff, volatilization, and leaching. Slow-release and stabilized fertilizers are recommended for use on all soils but are particularly beneficial on sandy soils where the potential for nitrogen loss through leaching is high.

Table 2 lists typical forms of readily available, slow-release, and stabilized nitrogen fertilizers. Turfgrass fertilizers marketed as "slow-release" often contain a blend of slow-release and readily available forms of nitrogen. To be marketed as "slow-release," turfgrass fertilizer need to have 15% or more of their nitrogen content in the slow-release form.

The greater the slow-release nitrogen fertilizer content a lawn fertilizer has, the better able it is to meet the nitrogen needs of turfgrass over a period of time. Although sometimes difficult to find, the University of Minnesota recommends using lawn fertilizers which have 50% or more of their nitrogen content in the slow-release form.

Table 2: Typical readily available, slow-release, and stabilized forms of nitrogen fertilizer for turfgrass

Readily available	Slow-release	Stabilized
Ammonium sulfate Calcium nitrate Potassium nitrate Urea	IBDU (isobutylidene diurea) Methylene urea Natural organics (e.g. Sustane) Polymer coated urea Sulfur-coated urea	NBPT and DCD treated urea (e.g. UMaxx) NBPT and NPPT treated urea (e.g. Litmus) NBPT treated urea (e.g. Agrotain Ultra)

4. **Credit nitrogen value of grass clippings left after mowing**

   Grass clippings left after mowing gradually decompose and act like a slow-release fertilizer, reducing the need for nitrogen and phosphorus fertilizer. By leaving grass clippings, the need for nitrogen fertilizer can be reduced by 1.0 lb N/1,000 sq ft per year, as shown in Table 3.

   A mulching style mower reduces the size of clippings making them less visible and more readily decomposed.

5. **Follow University of Minnesota guidelines for nitrogen fertilizer rates and timing to new turf**

   Exercise caution when applying fertilizer during turfgrass establishment as these applications are particularly susceptible to loss via leaching and runoff. Follow guidelines in University of Minnesota Extension publication *Fertilizing Lawns* when applying nitrogen fertilizer to new turfgrass areas. Current recommendations are to apply an initial nitrogen (N) fertilizer application that supplies 0.5 lb N/1,000 sq ft at time of establishment of a new turfgrass area. A second fertilizer application is recommended two weeks after seedling emergence or sodding that supplies an additional 0.5 lb N/1,000 sq ft. Both applications should be watered in with no more than 0.25 inches of irrigation.

   Fertilizer recommendations for turfgrass are given in pounds per 1,000 square feet (lb/1,000 sq ft). An acre is 43,560 sq ft, so 1,000 sq ft represents approximately 0.023 acres. A typical urban lawn may range from 5,000 to 10,000 sq ft. The amount of actual fertilizer product required is based on the nitrogen (N) application rate guideline and the percent nitrogen content of the specific fertilizer used. University of Minnesota Extension publication *Fertilizing Lawns* provides guidance on calculating turfgrass fertilizer application rates.

   (Example calculation: If an application of 0.5 lb N/1,000 sq ft is desired and you purchase a fertilizer with a 20-0-10 analysis (% nitrogen, % phosphate, % potash), 2.5 lb of fertilizer product per 1,000 sq ft should be applied. This is because the fertilizer product contains 20% nitrogen (0.5 N/1,000 sq ft target nitrogen rate ÷ 0.20 nitrogen content of fertilizer = 2.5 lb fertilizer/1,000 sq ft applied).)

6. **Follow University of Minnesota guidelines for nitrogen fertilizer rates and timing to established turfgrass**

   Follow University of Minnesota Extension guidelines when applying nitrogen fertilizer to established turfgrass. Guidelines are based on the lawn's planned maintenance level and soil organic matter level, if known. If soil organic matter level is not known, guidelines for medium soil organic matter can be used. Current guidelines are given in Table 3.

7. **Use organic matter soil test for more accurate nitrogen fertilizer application rates**

Nitrogen is mobile in the soil and does not typically remain in the turfgrass rooting zone from one season to the next. Therefore, soil testing turf for nitrogen level is not recommended. However, soil testing for organic matter level allows for more accurate nitrogen fertilizer application rates and is a recommended practice. Soils high in organic matter require lower nitrogen fertilizer application rates and nitrogen fertilizer guidelines provided by the University of Minnesota Soil Testing Laboratory (http://soiltest.cfans.umn.edu/) are adjusted based on soil organic matter content as shown in Table 3. Other soil testing laboratories also provide nitrogen fertilizer rate guidance based on organic matter levels. A listing of laboratories certified for soil testing by the Minnesota Department of Agriculture can be found at www.mda.state.mn.us/soiltesting.

If soil organic matter level is not known, guidelines for medium soil organic matter can be used.

The method for taking a proper soil test to determine organic matter level is the same method for determining phosphorus level and is described in the BEST MANAGEMENT PRACTICES FOR PHOSPHORUS FERTILIZER section of this document.

Table 3: Annual nitrogen application guidelines for established turfgrass

Maintenance level and practices	**Total annual nitrogen (N) to apply lb N/1,000 sq ft/year** [3]				**Number and timing of applications** [3]
	Soil organic matter level [1, 2]				
	Low	**Med.**	**High**	**Organic**	
High-maintenance turfgrass					
Watered, clippings removed	4.0	3.5	3.0	2.5	Four annual applications: Aug, Sept, early-Oct, late-May to June
Watered, clippings returned	3.0	2.5	2.0	1.5	Three annual applications: Aug, Sept, late-May to June
Medium-maintenance turfgrass					
Some watering, clippings removed	3.0	2.5	2.0	1.5	Three annual applications: Aug, Sept, late-May to June
Some watering, clippings returned	2.0	1.5	1.0	0.5	Two annual applications: Sept, late-May to June
Low-maintenance turfgrass					
No watering, clippings removed	2.0	1.5	1.0	0.5	Two annual applications: Sept, late-May to June
No watering, clippings returned	1.0	1.0	0.5	0.5	One annual application: Sept

1. Soil organic matter levels: Low = < 3.1%, Medium = 3.1 – 4.5%, High = 4.6 – 19%, Organic Soils = >19%.
2. If soil organic matter level is not known, guidelines for medium soil organic matter can be used.
3. Assuming each individual application does not exceed 1 lb N/1,000 sq ft (for annual applications greater than 1.0 lb N/1,000 sq ft). Divide total annual nitrogen (N) by the number of applications to determine the amount of nitrogen (N) to apply per individual application.

(Adapted from University of Minnesota Extension publication *Fertilizing Lawns,* 2017)

BEST MANAGEMENT PRACTICES FOR PHOSPHORUS FERTILIZER

1. **Soil test and correct phosphorus-deficient soils before seeding or sodding new turfgrass areas**

   Phosphorus-deficient soils should be corrected prior to seeding or sodding whenever possible. There are three reasons for this: First, since phosphorus moves very little in the soil, it is recommended to mix phosphorus fertilizer four to six inches deep in the soil. This is relatively easy prior to seeding or sodding a new lawn but more difficult after establishment. Second, newly emerged grass seedling roots require phosphorus as one of the major nutrients for proper growth and development. Third, mixing phosphorus into the soil (rather than applying it to the surface) reduces the chance of phosphorus runoff into lakes and streams.

   A soil testing laboratory can determine the current level of phosphorus in a particular soil. See section 3 on how to properly take a soil sample for phosphorus. This procedure is the best way to accurately determine the phosphorus requirements of a lawn. When soils are found to be phosphorus-deficient, apply phosphorus fertilizer according guidelines on your soil test report or according to University of Minnesota Extension guidelines found in publication *Fertilizing Lawns.*

   Because of its benefit to establishing new turf and relative immobility in the soil, some level of phosphorus fertilization is recommended for establishing new turf regardless of soil test level as shown in Table 4. If soil test results are not available at the time of seeding or sodding a new turfgrass area, the University of Minnesota recommends applying a standard rate of 1.0 lb P_2O_5/1,000 sq ft. The Minnesota Phosphorus Lawn Fertilizer Law allows application of phosphorus fertilizer to turfgrass during the establishment year by seed or sod. This includes the establishing entirely new areas of turfgrass and repairing damaged sections of existing turfgrass but does not include overseeding of existing turfgrass.

   Fertilizer recommendations for turfgrass are given in pounds per 1,000 square feet (lb/1,000 sq ft). An acre is 43,560 sq ft, so 1,000 sq ft represents approximately 0.023 acres. A typical urban lawn may range from 5,000 to 10,000 sq ft. The amount of fertilizer product required is based on the phosphate (P_2O_5) application rate guideline and the percent phosphate of the specific fertilizer product used. University of Minnesota Extension publication *Fertilizing Lawns* provides guidance on calculating turfgrass fertilizer application rates.

   (Example calculation: If an application of 1.0 lb P_2O_5/1,000 sq ft is desired and you purchase a fertilizer with an 18-24-12 analysis (% nitrogen, % phosphate, % potash), 4.2 lb of fertilizer product per 1,000 sq ft should be applied for the target phosphate application. This is because the fertilizer product contains 24% phosphate (1.0 lb P_2O_5 target application / 0.24 phosphate content = 4.2 lb of fertilizer product).)

Table 4. Phosphorus guidelines for new turfgrass areas before seeding or sodding

Phosphorus (P) soil test level		**Amount of phosphate (P_2O_5) to apply**
--------- ppm ---------		lb P_2O_5/1,000 sq ft *
Bray-P1 method	Olsen-P method	
0-10	0-7	5.0
11-25	8-18	2.0
Over 25	Over 18	1.0
* Multiply by 44 to convert the rates in lb/1,000 sq ft to lb/acre		

(From University of Minnesota Extension publication *Fertilizing Lawns*, 2017)

Fertilizers used to establish new turfgrass areas are typically labeled as starter fertilizers and contain a higher phosphorus content than maintenance lawn fertilizers. Starter lawn fertilizer should be used when establishing new turfgrass and correcting phosphorus-deficient soils for established turfgrass due to its higher phosphorus content. Due to the limited types of pre-packaged starter fertilizer available to consumers, it may be necessary to over-apply nitrogen to a turfgrass area in order to apply enough phosphorus to correct the soil's phosphorus deficiency.

2. **Apply phosphorus to established turfgrass areas only when needed as shown by soil or tissue testing**

The Minnesota Phosphorus Lawn Fertilizer Law restricts the use of phosphorus fertilizer on turfgrass unless a soil is shown to be phosphorus-deficient by soil or tissue test. When soils are found to be phosphorus-deficient, apply phosphorus fertilizer according to University of Minnesota Extension guidelines found in publication *Fertilizing Lawns.*

Soil testing is the most common way of determining if a soil is phosphorus-deficient and guidelines for proper soil testing are given in section 3. University of Minnesota phosphorus fertilizer rate guidelines based on soil test level are given in Table 5. Phosphorus-free lawn fertilizer is widely available and must be used by law unless a soil is shown to be phosphorus-deficient. When soils are phosphorus deficient, soil testing should be conducted at least every three years until adequate phosphorus levels are established.

Tissue tests for phosphorus can be conducted at many accredited soil testing laboratories, including the University of Minnesota's Soil Testing Laboratory on the Saint Paul Campus. Tissue tests allow for quick determination of phosphorus deficiencies in turfgrass, however tissue tests should not be used as a guide for correcting soil deficiencies.

Table 5. Phosphorus guidelines for established turfgrass

Phosphorus (P) soil test level		**Amount of phosphate (P_2O_5) to apply**
--------- ppm ---------		lb P_2O_5/1,000 sq ft *
Bray-P1 method	Olsen-P method	
0-10	0-7	1.0
11-25	8-18	0.5
Over 25	Over 18	0.0
* Multiply by 44 to convert the rates in lb/1,000 sq ft to lb/acre		

(From University of Minnesota Extension publication *Fertilizing Lawns*, 2017)

3. **Take a proper soil test**

Soil testing is the primary method of determining if a soil is phosphorus deficient and therefore it is important soil testing is done correctly following University of Minnesota Extension publication *Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens and Landscape Plants.* Soil should be sampled to a six-inch depth for new turfgrass areas and a three-inch depth for established turfgrass. Each soil sample should be a composite of subsamples collected from randomly selected spots within the chosen area. Take 5 – 10 subsamples for areas less than 1,000 square feet. Take 10 - 15 subsamples for larger areas like industrial grounds and athletic fields. Collect the subsamples in a clean plastic pail, mix the soil thoroughly, remove grass tops, roots and other organic matter, and place about one pint of this mixture in a sample bag or box. Label sample according to the directions of the soil testing laboratory being used.

A listing of laboratories certified for soil testing by the Minnesota Department of Agriculture can be found at http://www2.mda.state.mn.us/webapp/lis/soillabs.jsp

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