# Nutrient Management Guidelines for Golf Courses in Maryland

University of Maryland
Turfgrass Technical Update
TT118 - December 2013

**Dr. Thomas Turner, Turfgrass Specialist;**
**University of Maryland Department of Plant Sciences & Landscape Architecture**

---

Elevated levels of nitrogen (N) and phosphorus (P) have been identified as major contributors to the decline of the health of the Chesapeake Bay. As such, potential sources for the movement of these nutrients into waters impacting the Bay have been identified and goals have been established for the reduction of N and P loads entering the Bay. Potential sources include agricultural production, air pollution, point sources including waste treatment facilities, leakage from sewer infrastructure, septic systems, runoff from impervious surfaces, pet and animal waste, and other urban inputs including fertilization of landscapes.

Nutrient management laws passed by the Maryland Legislature in 1998 required that University of Maryland nutrient management guidelines be followed on state property and commercially managed turfgrass sites, including golf courses. In 2011, additional regulations were enacted that further specify how N and P may be applied to turfgrass in Maryland, including golf courses, and that require state training and certification of nutrient applicators. These new laws regarding turfgrass fertilizer applications became effective in 2013. The following information serves as a nutrient management guideline for the maintenance of golf courses in Maryland.

A 2006 survey by the United States Department of Agriculture stated there are 16,400 acres of maintained turfgrass on golf courses in Maryland. Of this maintained acreage, it is estimated that there are 6,360 acres considered receiving moderate to intensive management. This includes 460 acres of putting greens, 650 acres of tees, and 5,250 acres of fairways. The remaining acres receive less intensive management, including no to moderate rates of fertilization. Also, the maintained turfgrass areas are commonly surrounded by large areas receiving no or minimal management inputs, including non-mowed and forested areas. Research has shown that properly fertilized and maintained turfgrass on golf courses will have minimal impact on elevating N and P levels of ground or surface water.

# NITROGEN APPLICATIONS

Nitrogen applications to golf course turf are essential to provide sufficient growth to recover from the intense traffic received from use, to minimize the potential for disease incidence, and to maintain sufficient turfgrass density to minimize weed encroachment and surface water runoff and potential soil erosion. Three areas of N applications that are interrelated need to be addressed in developing a sound N management program: the source of nitrogen in a fertilizer, the rates of application (per application and total annual N applied), and the timing of applications during the year.

## Sources of Nitrogen

A wide range of N-containing fertilizers are available to the turfgrass manager. These fertilizers generally fall into one of two broad categories: 1) fertilizers that contain only soluble, quickly available N, or 2) fertilizers that contain some N in a slowly available form, which is not immediately available for plant use. The amount of N fertilizer that can be applied in any single application is dependent on the type of N fertilizer. Following are the main categories of N fertilizers as defined by the Maryland regulations:

**Water Soluble Nitrogen -** Fertilizers that contain N that can immediately go into solution, and thus have N that is rapidly available for turf uptake, are categorized as water soluble N fertilizers. These fertilizers, while quickly available for turf use, have the most potential for leaching if used improperly.

The most common water soluble forms used for golf course fertilization contain N in the ammonium form ($NH^{+4}$). Soluble N fertilizers that contain ammonium N include urea, ammonium sulfate and ammonium chloride. These fertilizers can produce excellent quality turf without leaching or runoff problems if used properly. The ammonium N can be adsorbed by the soil, reducing the potential for N movement. Ammonium sulfate can be particularly useful in suppressing diseases such as take-all patch in young bentgrass, and some of the other common patch diseases of turfgrass, such as spring dead spot of bermudagrass.

Some water soluble N fertilizers contain N in the nitrate ($NO^{-3}$) form. Leaching and runoff potential is much higher for $NO_3$-N. Thus, where conditions exist that are conducive to leaching or runoff, fertilizers that contain significant amounts of $NO_3$-N should not be used. These conditions include sandy sites (sands and loamy sands) with high water tables, when turf is not actively growing, and sites that are highly sloped. Fertilizers high in $NO_3$-N include ammonium nitrate, potassium nitrate, and calcium nitrate. Fertilizers that contain predominantly $NO_3$-N should only be used on sites not prone to runoff or leaching, where very rapid response is essential, and on turf that is actively growing. Turfgrass uptake may occur within a few days with $NO_3$-N containing fertilizers compared to 7-10 days with $NH_4$-N fertilizers. Generally, fertilizers containing significant amounts of $NO_3$-N are not recommended for turfgrass fertilization.

Excessive rates of soluble N per application can result in excessive growth of turf (which can eventually affect tolerance to environmental stress and pest resistance) and can increase the potential for N loss through leaching, particularly on sandy soils.

**The 2011 Maryland turfgrass fertilization regulations limit the application of water soluble N fertilizers to 0.7 pounds actual N per 1000 $ft^2$ per application.**

**Slow Release Nitrogen –** Slow release N fertilizers contain N in a form that delays its availability for plant uptake after application. It extends N availability significantly longer than a reference rapidly available nutrient source such as urea. Slow release N fertilizers include sources such as sulfur coated urea (SCU), polymer coated ureas, ureaformaldehyde (UF), methylene ureas, isobutlyidene diurea (IBDU), and natural organics. To be considered a slow release N fertilizer, the fertilizer must contain at least 20% water insoluble or controlled release N. The N in all slow release fertilizers used for turfgrass maintenance, including natural organics, is ultimately converted in the soil to $NH_4$-N.

Slow release fertilizers are less prone to N leaching and runoff as compared to applications of soluble N fertilizers that are applied in excess of recommended rates. While varying considerably in individual characteristics and release patterns, slow release N fertilizers typically provide more even turfgrass response and provide N for turfgrass uptake over a longer period of time. The use of slow release fertilizers should particularly be considered on sites that are prone to leaching or runoff, and when an N application needs to be made to turfgrass during non-optimum growing conditions.

**The 2011 Maryland turfgrass fertilization regulations limit the application of slow release N fertilizers to 0.9 pounds actual N per 1000 $ft^2$ per application.**

**Natural Organic Nitrogen –** Natural organic fertilizers are a type of slow release N fertilizer that is derived from either a plant or animal product and do not contain synthetic materials. They have not been altered from their original state except by physical manipulation (drying, cooking, chopping, grinding, shredding, or pelleting). Most natural organic fertilizers contain P, and thus have additional regulations imposed on their application. Natural organic fertilizers for turfgrass fertilization cannot contain more than 5% P. Also, natural organic fertilizers that contain P cannot be applied to turfgrass areas that have soil test P levels measuring optimum or excessive. On turfgrass that has low or medium soil P levels, natural organic fertilizers cannot be applied in excess of the amount of P recommended by the soil test, cannot be applied at a rate more than 0.25 lbs. of $P_20_5$ per 1000 $ft^2$ per application, and cannot exceed 0.50 lbs. of $P_20_5$ per 1000 $ft^2$ annually.

**Enhanced Efficiency Nitrogen** – Enhanced efficiency N fertilizers are a type of slow release N fertilizer that further decrease the potential of nutrient loss to the environment and release less than 0.7 lb. N/1000 $ft^2$ per month**. If a turfgrass fertilizer is classified as an enhanced efficiency N fertilizer, Maryland regulations allow up to 2.5 pounds of actual N per 1000 $ft^2$ be applied in one application, as long as 80% of the annual rate for a given turfgrass species is not exceeded.**

## RATES OF APPLICATION

The rates of nitrogen fertilizer application to golf course turf include restrictions on both 1) the rate of fertilizer applied per individual application and 2) the total rate of fertilizer applied on an annual basis. The rate per individual application is regulated on the basis of the nitrogen source (the percentage of soluble and slow release N contained in the fertilizer) as described in the previous section “Sources of Nitrogen”.

The amount of N that needs to be provided annually for satisfactory golf course turf depends on a number of factors, some of which can change from year to year. These include:

1. Turfgrass species
2. Age of turf
3. Length of growing season
4. Soil type and soil organic matter levels
5. Clipping removal
6. Irrigation intensity
7. Intensity of traffic and use of area
8. Prevalent weed and disease problems.

Thus, total annual N application rates should be continually evaluated, both during a given season and on an annual basis. The ranges of annual N rates that are typically needed for adequate growth and quality on Maryland golf courses are listed in Table 1. These recommended ranges for N rates take into account the variability in the factors listed above. For example, rates at the higher end of recommended ranges may be appropriate on sites where clippings are removed, irrigation intensity is high (which increases growth rates and nutrient uptake), traffic is intense (such as heavily played public golf courses), and annual grass pressure is high. In some situations, N rates somewhat higher than those listed in Table 1 are needed in an unusual year to meet the specific conditions and needs of a given golf course or site on a golf course. Rates at the lower end of the recommended ranges are often adequate on lightly or non-irrigated turf that receives less intensive traffic and on more mature turf. Some turfgrass species, such as fine fescue and zoysiagrass, inherently require less N to perform satisfactorily in Maryland, and may deteriorate when more N is applied than is recommended. . **It is imperative that golf course superintendents evaluate annually the conditions and expectations at their own course to determine appropriate rates.**

# Table 1. Recommended Annual Nitrogen Rates for Maintenance of Golf Course Turf in Maryland

| | **Annual Rate*** |
|---|---|
| | Pounds N/1000 $ft^2$ |
| | |
| GREENS | |
| Bentgrass | 2.5 - 5.0 |
| | |
| TEES | |
| Creeping bentgrass | 2.0 - 4.0 |
| Kentucky bluegrass | 3.0 – 5.0 |
| Perennial ryegrass | 2.0 - 4.0 |
| Bermudagrass | 2.0 – 4.0 |
| Zoysiagrass | 1.0 – 3.0 |
| | |
| FAIRWAYS | |
| Creeping bentgrass | 2.0 – 4.0 |
| Kentucky bluegrass | 2.5 – 4.0 |
| Perennial ryegrass | 2.0 – 4.0 |
| Bermudagrass | 2.0 – 4.0 |
| Zoysiagrass | 0 – 2.0 |
| | |
| IRRIGATED ROUGHS** | |
| Creeping bentgrass | 2.0 – 3.5 |
| Kentucky bluegrass | 2.5 – 3.5 |
| Perennial ryegrass | 2.0 – 3.5 |
| Turf-type tall fescue | 2.0 – 3.0 |
| Bermudagrass | 2.0 – 3.0 |
| Zoysiagrass | 0 - 2.0 |
| | |
| NON-IRRIGATED ROUGHS | |
| Fine fescue | 0 – 1.5 |
| Kentucky bluegrass | 2.5 – 3.0 |
| Perennial ryegrass | 2.0 – 3.0 |
| Turf-type tall fescue | 2.0 – 2.5 |
| Bermudagrass | 1.0 – 3.0 |

* Lower rates for maintenance may be adequate on soils with good organic matter levels, on turf older than 5 years, for selected cultivars of a given species, and/or on courses with lower than typical traffic. Rates up to 25% higher may be appropriate to maximize the establishment rate during the grow-in period of turf established from seed. Grow-in includes the period from the first mowing of turf (established from seed, sprigs, or plugs) to the date when turf is opened for play. Fertilization of turf established from sod should follow maintenance recommendations.

No more than 0.7 pound soluble N per 1000 $ft^2$ should be applied in any one application.
No more than 0.9 pound slow release N per 1000 $ft^2$ should be applied in any one application (higher rates in one application may be made if using an enhanced efficiency nitrogen source).

For tall fescue – Kentucky bluegrass mixtures, rates recommended for tall fescue should be used.

**Irrigated roughs include areas adjacent to fairways that receive irrigation and may have clippings removed, but are maintained at a higher mowing height than fairways. Golf cart traffic may be intense on these areas.

## TIMING OF APPLICATION

The potential for N loss from turfgrass sites primarily occurs when an excessive rate of $NO_3$-N is applied to turf that is not actively growing. Thus, most of the annual fertilizer requirement should be applied during periods of active shoot (leaf blades, rhizomes, stolons) and/or root growth using $NH_4$-N based fertilizers.

The primary period for growth of warm season grass species (zoysiagrass, bermudagrass,) is from mid-spring, after dormancy has broken, through mid-fall, when the first killing frost is experienced. Thus, N applications should generally be restricted to these periods; however, fertilizer that contains primarily $NH_4$-N can be applied up to a month before dormancy is typically broken in the spring so that N is available for plant uptake when growth begins. This can be helpful in the recovery from winter damage and spring dead spot of bermudagrass. Applications after September 1 are not generally recommended due to the possible enhancement of winterkill, particularly with bermudagrass. However, if bermudagrass has been overseeded with a cool season species such as perennial ryegrass, up to 0.9 pound N per 1000 $ft^2$ may be applied after September 1 to enhance its performance.

Cool season grasses generally have a longer growth period than warm season grasses in Maryland. They can exhibit growth at virtually anytime during the year if moisture and temperature conditions are conducive. The prime periods for growth on non-irrigated sites are typically from late winter through early summer, and from late summer through late fall.

Under extended hot and dry periods during mid-summer, cool season grasses may experience a period of dormancy until rainfall occurs. If irrigation is available or if rainfall is adequate throughout the summer, however, little dormancy will occur and N uptake will continue. Thus, periodic light applications of N (1/10 to ¼ lb N/1000 $ft^2$) during the summer (when traffic can be intense due to high use of the golf course) can be especially beneficial to greens, tees, and fairways to maximize their recuperative capacity.

**The 2011 Maryland turfgrass fertilization regulations further restrict the timing of application of N fertilizers on golf courses. Between December 1 and March 1, N fertilizers cannot be applied to golf course turf. Between November 15 and December 1, only 0.5 lb. N/1000 $ft^2$ can be applied, and a soluble N source must be used.**

## PHOSPHORUS AND POTASSIUM APPLICATIONS

Adequate soil phosphorus (P) and potassium (K) are essential for satisfactory turfgrass growth and performance. Phosphorus is particularly critical for new sites being established from seed, or for overseeding turf during renovation projects. Established turf, however, can generally tolerate relatively low levels of soil P. Potassium is generally more critical on established turf, and may play a role in drought, heat, cold, and wear tolerances. Whereas K applications are not regulated, **P applications must be based on soil test recommendations.** However, there is one exception to the requirement for a soil test prior to the application of P. A soil test is not required if the application is made for the purpose of establishing turf on bare ground, the fertilizer is incorporated, and the application is made in accordance with the seeding recommendations of the University of Maryland (publication TT-116). This exception does not pertain to overseeding existing turf.

Areas on the golf course that potentially will be fertilized should be sampled every 3 years. Putting greens and some tees present a unique situation. Due to the very high sand content of most greens and tees, the cation exchange capacity of these soils tends to be exceptionally low and, consequently, the storage capacity for most nutrients is very low. In addition, frequent irrigation (which increases growth rates) and clipping removal result in a fairly rapid depletion of existing nutrients. Thus, soil tests of high sand content greens and tees should preferably be done on an annual or biannual basis to monitor changes in soil P, K, and pH. While soil tests should be taken routinely to monitor soil K levels, experience has shown that K fertilizer rates that are approximately ½ that of the annual N fertilizer rate are generally sufficient to maintain adequate soil K levels. Recommended rates for P and K applications based on soil tests are shown in Tables 2 and 3, respectively.

## Table 2. Phosphorus Application Recommendations for Golf Course Turf[+]

| | Soil Test Phosphorus Category | | | |
|---|---|---|---|---|
| | low | medium | high | excessive |
| | Pounds $P_2O_5$ per 1000 square feet | | | |
| | | | | |
| Establishment | | | | |
| Broadcast* | 2 - 3 | 1 - 2 | 0 - 1 | 0 |
| Incorporated** | 3 - 4 | 1 - 2 | 0 - 1 | 0 |
| | | | | |
| Maintenance | 2 – 3[++] | 1 - 2 | 0 | 0 |

[+]Any subsequent applications should be based on additional soil tests

[*] Or incorporated into soil up to 2 inches
[**] Incorporated into soil over a 2 inch depth

[++] 3 lb. $P_2O_5$/1000 $ft^2$ should only be used on soil testing "very low" for phosphorus

## Table 3. Potassium Application Recommendations for Golf Course Turf

| | Soil Test Potassium Category | | | |
|---|---|---|---|---|
| | low | medium | high | excessive |
| | Pounds $K_2O$ per 1000 square feet | | | |
| | | | | |
| Establishment | | | | |
| Broadcast* | 2 - 3 | 1 - 2 | 0 - 2 | 0 |
| Incorporated** | 3 - 5 | 1 - 2 | 0 - 2 | 0 |
| | | | | |
| Maintenance | 2 - 4 | 1 - 3 | 0 - 2 | 0 |

* Or incorporated into soil up to 2 inches
** Incorporated into soil over a 2 inch depth

## Additional Fertilizer Application Requirements

- Fertilizer cannot be applied to impervious surfaces such as walkways, driveways, and roadways. If fertilizer does land on impervious surfaces, it must be removed or returned to the turf (such as by sweeping or blowing).
- Fertilizer containing N or P cannot be applied to frozen ground, even if the date is before December 1 or after March 1.
- Delay scheduled fertilizer applications if heavy rain is forecast.
- Do not use fertilizers as a deicer.
- No fertilizer can be applied with 15 feet of waterways of the state. If a drop spreader, a rotary spreader with a deflector, or a targeted liquid spray is used for applications, then fertilizer can be applied no closer than 10 feet of waterways. Waterways include:
  1. Surface water subject to the jurisdiction of the State,
  2. The Chesapeake Bay and its tributaries,
  3. A pond, lake, river, stream, public ditch, or tax ditch within the State
  4. A public drainage system within the State other than those designed and used to collect, convey, or dispose of sanitary sewage.

## Additional Recommendations to Minimize Potential Leaching and Runoff Losses

Following the fertilization guidelines previously outlined will greatly minimize the potential for leaching and/or runoff losses of nutrients applied to golf courses. In addition, the following procedures will aid in further minimizing any potential nutrient movement or negative impact on water quality.

1. Identify those areas on the golf course most prone to potential losses or potential impacts on water systems. These include highly sloped areas, areas immediately adjacent to water, and areas with sandy soils with high water tables.

   a) On highly sloped areas, use slow release N sources, apply a maximum of 0.9 pound N per 1000 $ft^2$ feet per application, and avoid application prior to any expected high rainfall event. If suitable for the site, plant species, such as hard or chewings fescue, or other species having lower N requirements.
   b) On areas immediately adjacent to water, plant species having low N requirements.
   c) On sandy soils having high water tables, use slow release N sources and apply at a maximum rate of 0.9 pound nitrogen per 1000 $ft^2$.

2. Irrigate turf after it has been fertilized to bring fertilizer into contact with soil and move soluble N into the soil. Irrigation intensity must be low enough that water can infiltrate into soil and not run off.

3. When feasible, recycle clippings (by composting, etc.) that are removed from greens, tees, and fairways. Where clippings are not removed and left on site, annual fertilizer N requirements may be reduced over time. During mowing operations, avoid the direct discharge of clippings into water systems.

4. Drainage systems from greens, tees, and fairways should be directed to areas of lower maintenance, such as non-irrigated rough.

5. Addition of appropriate organic matter (meeting United States Golf Association putting green root zone mixture specifications) should be part of the putting green construction root zone mixture. The addition of organic matter will increase nutrient retention.

6. Develop plans to rapidly stabilize any disturbed soils so that soil movement and erosion is minimized.

7. Adjust soil pH to recommended levels for a given turfgrass species and site (the ideal soil pH may be lower on putting greens than for other sites on the golf course). Excessive soil acidity can detrimentally impact soil microorganisms that are important in soil nitrogen transformations and availability.

**It should be emphasized that the information presented within this publication for N, P, and K applications is meant only as a guideline.** While these recommendations should be satisfactory to meet the N, P, and K requirements of golf course turf in most situations, there are many factors that could impact whether modifications of these recommendations are warranted for a specific site.