Nitrogen, Phosphorus, and Potassium Recommendations for Golf Courses in Maryland

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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 air pollution, point sources including waste treatment facilities, agricultural production, forested areas, runoff from impervious surfaces, septic systems, and other urban inputs including fertilization of landscapes.

There are approximately 16,400 acres of maintained turfgrass on golf courses in Maryland. Of this maintained acreage, approximately 6,360 acres are 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. The 16,400 acres of maintained turfgrass are also often 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. However, it is imperative that a sound nutrient management plan be implemented on each course.

NITROGEN APPLICATIONS

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

RATES OF APPLICATION

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
8. Prevalent weed and disease problems.

Thus, 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), traffic is intense, and annual grass pressure is high. In some situations, N rates somewhat higher than those listed in Table 1 are needed 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 non-irrigated turf that receives minimal traffic. 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.**

TIMING OF APPLICATION

The primary potential for N loss from turfgrass sites is when excessive rates 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 winter-kill, particularly with bermudagrass. However, if bermudagrass has been overseeded with a cool season species such as perennial ryegrass, up to 1.0 pound N per 1000 square feet 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 are typically from late winter through early summer, and from late summer through early winter. Research would indicate that 2/3 to 3/4 of the total annual N should be applied during the latter period to maximize turfgrass performance and quality.

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, light applications of N during the summer (when traffic can be intense due to play on the golf course) can be especially beneficial to greens and tees in their recuperative capacity to traffic.

During the winter months, although top growth may have virtually ceased, root growth and N uptake may still occur during the periods when the ground is not actually frozen, particularly with Kentucky bluegrass. Research has shown that applications of N during this period can enhance root growth and spring performance of turf. If applications are deemed agronomically beneficial during this period, no more than 1.0 pound N per 1000 square feet should be applied, fertilizers containing NO_3-N should not be used, and applications should not be made to frozen ground if significant rainfall is in the immediate forecast.

Table 1. Recommended annual nitrogen rates for grow-in and maintenance of golf course turf in Maryland.

	Pounds actual nitrogen per 1000 square feet annually#	
	Grow-In*	Maintenance of Established Turf
GREENS		
Bentgrass	5 - 12	2 ½ - 5**
TEES		
Creeping bentgrass	3-6	2-5
Kentucky bluegrass	4-6	3-5
Perennial ryegrass	3-6	2-5
Bermudagrass	4-8	2-5
Zoysiagrass	3-6	1-3
FAIRWAYS		
Creeping bentgrass	3-6	2-5
Kentucky bluegrass	4-6	3-5
Perennial ryegrass	3-6	2-5
Bermudagrass	4-8	2-5
Zoysiagrass	3-6	0-3
IRRIGATED ROUGHS***		
Creeping bentgrass	3-5	2-4
Kentucky bluegrass	3-5	3-4
Perennial ryegrass	3-5	2-4
Turf-type tall fescue	3-4	2-4
Bermudagrass	3-5	2-5
Zoysiagrass	3-5	0-2
NON-IRRIGATED ROUGHS		
Fine fescue	2-4	0-2
Kentucky bluegrass	3-5	2-3
Perennial ryegrass	3-5	2-3
Turf-type tall fescue	2-4	2-3
Bermudagrass	2-4	1-3

No more than 1.0 pound soluble N should be applied in any one application.

*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.

**Higher total N rates may occasionally be warranted to meet the specific conditions or needs of a golf course or individual greens.

***Irrigated roughs include areas adjacent to fairways that receive irrigation but are maintained at a higher mowing height.

NITROGEN SOURCES

A wide range of N-containing fertilizers are available. These fertilizers generally fall into one of two broad categories, 1) fertilizers that contain only soluble, quickly available N, and 2) fertilizers that contain N in a slowly available form which is not immediately available for plant use.

Quickly available N-fertilizers contain NO_3-N and /or NH_4-N which is soluble and readily available for uptake by turfgrass plants. Turfgrass uptake may occur within a few days with NO_3-N fertilizer. Nitrogen uptake may begin within 7 – 10 days with NH_4-N fertilizers, as NH_4-N is converted to NO_3-N in the soil. Nitrogen uptake by turfgrass roots is predominately in the NO_3-N 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 on sites that are highly sloped. Fertilizers high in NO_3-N include NH_4NO_3, potassium nitrate, and calcium nitrate. Also, unless very rapid green-up is required for a specific event, fertilizers containing NO_3-N are not recommended for general maintenance.

Slow release fertilizers contain significant amounts of N that is not immediately available for plant uptake. Examples of fertilizer sources that contain various amounts of slow release N include sulfur coated ureas, polymer coated ureas, methylene ureas, ureaformaldehydes, IBDU, natural organics, and various types of sludge. Slow release fertilizers, while varying considerably in individual characteristics, typically provide more even turfgrass response, provide N over a longer period of time, and are less prone to N leaching and runoff as compared to soluble N fertilizers. Their use should be strongly considered on the aforementioned sites that are prone to leaching or runoff, and when N applications need to be made to turfgrass when growing conditions are not optimal.

The amount of N that can be applied in any one fertilizer application is dependent of the amount of soluble N in a particular fertilizer. No more that 1.0 pound soluble N per 1000 square feet should be applied in any one application.

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 is important for drought, heat, cold, and wear tolerances.

Application rates of P and K should be determined from soil tests. 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, however. 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 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 needed 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 - 5	1 - 2	0 - 2	0
Maintenance	2 - 3	1 - 2	0 - 1	0

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

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

MINIMIZING LEACHING AND RUNOFF POTENTIAL

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.

1. Identify those areas on the golf course most prone to potential losses or potential impacts on water systems. These include a) highly sloped areas, b) areas immediately adjacent to water, and c) areas with sandy soils with high water tables.
2. On highly sloped areas, use slow release N sources, apply a maximum of 1.0 pound N per 1000 square feet per application, and avoid application prior to any expected high rainfall event. If suitable for the site, plant turfgrass, such as fine fescue, or other species having lower N requirements.
3. In areas immediately adjacent to water, create a non-fertilized buffer strip of 3 to 6 feet. This strip is established primarily to prevent the direct application of fertilizer into water using rotary spreaders. If these areas need to be fertilized, use slow release N sources applied using a drop-type spreader.
4. On sandy soils having high water tables, use slow release N sources and apply at a maximum rate of 1.0 pound nitrogen per 1000 square feet.
5. Avoid fertilizing non-target areas such as impervious surfaces (sidewalks, roadways, parking lots). Fertilizer inadvertently applied to these areas should be removed immediately by sweeping or blowing.
6. 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.
7. When feasible, recycle clippings (compost, 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.
8. Drainage systems from greens, tees, and fairways should be directed to areas of lower maintenance, such as non-irrigated rough.
9. 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 has been shown to decrease movement of N through the putting green profile.
10. Develop plans to rapidly stabilize any disturbed soils so that soil movement is minimized.
11. Do not use fertilizers as deicing agents on sidewalks and roadways during the winter.

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 satisfactory 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. Higher rates of fertilization may occasionally be warranted for specific sites and/or conditions.

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