PLANT NUTRIENT RECOMMENDATIONS BASED ON SOIL TESTS FOR TURF MAINTENANCE

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INTRODUCTION

Nutrient management laws passed by the Maryland Legislature in 1998 require that University of Maryland nutrient management guidelines be followed on state property and certain commercially managed turfgrass sites. These laws impacting turfgrass were part of an overall effort to regulate the agricultural industry. Major differences exist between the goals and practices of general agriculture and turfgrass management. The following information is intended to serve as a nutrient management guideline for turfgrass sites in an efficient, effective, and environmentally sound manner.

WATER QUALITY

Properly managed turfgrass has been shown to be an environmental asset. Turfgrass has significant cooling effects during the summer and traps much of the dust and dirt that is released each year into the atmosphere. Turfgrass absorbs carbon dioxide, ozone, sulfur dioxide, and other gases, while releasing oxygen.

Water runoff is greatly reduced and water infiltration is increased compared to most other agriculture and plant systems. Once turfgrass is established, soil loss from erosion is negligible. Runoff from established turf has compared favorably to forested land. Also, turfgrass is an efficient organic matter producing system. Thus, little nitrogen (N) or phosphorus (P) is lost from turfgrass sites if sound nutrient management practices are followed.

Onsite monitoring and numerous research studies have shown that nutrient loss from turfgrass sites is very small. However, research has also shown that certain types of improper N applications on specific types of sites can result in excessive nitrate (NO_3) leaching. This problem is very specific and has occurred as follows:

1. Very high rates of N were applied using soluble NO_3-N containing fertilizers (such as ammonium nitrate [NH_4-NO_3]);
2. The fertilizer was applied to dormant turf (such as bermudagrass during the winter);
3. Soils were predominantly sand; and
4. The sites had high water tables.

A sound turfgrass nutrient management plan shall take into consideration this set of conditions, which can cause a potential problem.

NITROGEN

Proper nitrogen fertilization is essential in maintaining quality turf that is resistant to pest problems, tolerant of stresses, and able to recover from damage. Current N recommendations are based on extensive research and are dependent on a variety of factors, such as: turfgrass species and cultivars, age of turf, soil type, management practices being used (irrigation, clipping removal, pest control programs), weather conditions, use of area, length of growing season, and the need for recovery from pest damage, adverse environmental conditions, and traffic. The nutrient management specialist shall take into account all of these factors in devising an appropriate N fertilization program. The program may vary from year to year as these conditions change.

Three major factors shall be considered in developing a N fertilization plan for turfgrass sites:

1. What types of N should be applied,
2. How much N needs to be applied annually, and
3. When should N be applied.

Inadequate attention to each of these factors increases the potential for thin turf, which is more prone to pest and stress problems and erosion. It also increases the potential for exposed soil, which is more prone to erosion. Also, the potential for leaching and runoff of N increases if guidelines are not followed.

Sources of N

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; and 2) fertilizers that contain some N in a slowly available form, which is not immediately available for plant use.

Quickly available N fertilizers contain NO_3-N or NH_4-N, or both. These are 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 form.

Leaching and runoff potential are 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 NH_4NO_3, potassium nitrate, and calcium nitrate. Fertilizers that contain predominantly NO_3-N shall only be used on sites not prone to runoff or leaching, sites where very rapid response is essential, and on sites where turf is actively growing.

Soluble N fertilizers that contain NH_4-N include: urea (NH_2-CO-NH_2), ammonium sulfate (NH_4SO_4), and ammonium chloride (NH_4Cl). These fertilizers can produce excellent quality turf, without leaching or runoff problems, if used properly. Most important is limiting these fertilizers to 1.0 lb. N/1000 ft^2 per application. Higher rates per application can result in

excessive growth of turf and can increase the potential for N loss on some sites.

Slow release fertilizers contain significant amounts of N that are 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. The N in all slow release fertilizers used for turfgrass maintenance is NH_4-N based. Slow release fertilizers, while varying considerably in individual characteristics and release patterns, 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 considered on the aforementioned sites that are prone to leaching or runoff, and when a N application needs to be made to turfgrass that is not in optimum growing conditions.

Rates of Nitrogen

When recommending rates of N fertilization, there are two primary issues: 1) how much N can be applied in any one application, and 2) how much total N can be applied annually. The maximum amount of N that should be applied in one application is primarily dependent on the amount of **soluble** N in the fertilizer. No more than 1.0 lb. **soluble** N/1000 ft^2 should be made in any single application. For a fertilizer that contains 50% of its N in a soluble form, and 50% in a slow release (water insoluble) form, no more than 2.0 lbs. total N/1000ft^2 should thus be applied in any single application (which would result in 1.0 lb. **soluble** N/1000ft^2 being applied).

Some fertilizers contain most of their N in a slow release form. For these fertilizers, applying 1.0 lb. soluble N/1000 ft^2 would result in very high total N rates. For example, a natural organic fertilizer contains 10% of its N in a soluble form and 90% in slow release form. Applying 1.0 lb. **soluble** N using this fertilizer would result in a total N rate of 10 lbs. N/1000 ft^2, which is well in excess of recommended annual rates of N for typical turfgrasses. Thus, for slow release fertilizers with little soluble N, the maximum amount applied in one application shall not exceed the total annual N requirement of the turf.

As previously discussed, the annual turfgrass requirements for N vary considerably, depending on a variety of conditions. Most critical, however, is turfgrass species. The annual N requirements for maintaining established stands of the most common turfgrass species grown in Maryland generally fall within the ranges listed in Table 1.

Table 1. Nitrogen Recommendations for Commercially Maintained Turfgrass Sites

	Total Nitrogen Annually (lbs. N/1000 ft^2)	
	Years 1-2	**Subsequent Years**
Cool Season Grasses		
Kentucky bluegrass	3.0 – 4.5	3.0 – 4.0
Turf-type tall fescue	3.0 – 4.0	2.0 – 3.0
Fine fescue	1.0 – 3.0	0 – 2.0
Perennial Ryegrass	3.0 – 4.0	3.0 – 4.0
Warm Season Grasses		
Bermudagrass	3.0 – 4.0	3.0 – 4.0
Zoysiagrass	1.0 – 3.0	0 – 2.0

Numerous factors influence whether moderate adjustments to these rates may be warranted. For example, if clippings are returned to the site when it is mowed, reductions in the annual N rates (as well as P and K) may be possible. Also, if the site receives little use, and thus, does not need higher growth rates to recover from traffic, lower rates shall be used. Other means of possible reductions in total N requirements include: the use of iron, increasing the height of mowing, and careful selection of cultivars when seeding, overseeding, or sodding.

Conversely, several factors may warrant moderate increases in annual rates. These include: heavily used sites that need high recuperative rates, sites that are mowed lower than typically recommended due to use requirements, and sites that have been damaged from adverse environmental conditions or pests. Also, on sites where pesticide use is not economically feasible or not permitted, somewhat higher N rates can be important in minimizing many pest problems, particularly weeds and diseases. Rates much higher than those recommended, however, can have the opposite effect.

Timing of N Applications

The primary potential for N loss from turfgrass sites occurs when excessive rates of N, particularly NO_3-N, are applied to turf that is not actively growing. Thus, most of the annual fertilizer requirements should be applied during periods of active shoot (leaf blades, rhizomes, stolons) or root growth (Table 2).

Table 2. Recommended Periods for N Fertilization of Turf Areas

	Recommended Periods	Periods to Avoid
Warm Season Grasses		
	1 month before dormancy breaks (mid April in central MD; later in western MD, and earlier on the eastern shore) through September 1st	September 1st through 1 month before dormancy breaks During severe or prolonged drought
Cool Season Grasses	1 month before top growth starts (late March in central MD) through early June Late August through 6 weeks after first killing frost	Mid-June through mid-August When turf is dormant due to heat, drought, or cold

The primary period for growth of warm season grass species (zoysiagrass, bermudagrass, and buffalograss) is from mid-spring, after dormancy has broken, through mid-fall, when the first killing frost is experienced. Thus, N applications to warm season grasses should generally be restricted to these periods. However, fertilizer that primarily contains 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 at this time. Applications after September 1 are generally not 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 1.0 lb. N/1000 ft^2 may be applied after September 1, to enhance its performance.

Cool season grasses have a longer growth period. They can exhibit growth at virtually any time 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 ⅔ to ¾ of the total annual N should be applied during the latter period, to maximize cool season 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. Nitrogen fertilizer should not be applied at this time. If irrigation is available, or if rainfall is adequate throughout the summer, little dormancy will occur and N uptake of cool season grasses will continue. Although not generally needed, applications of ¼ to ½ lb/1000 ft^2 can be made to these sites if growth is not adequate to meet the demands of the use of the site.

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. Also, some sites tend to be excessively wet each spring, making fertilization with large equipment difficult. Fertilization earlier, when the ground is firmer, may be the best alternative.

There is minimal risk of runoff or leaching problems from winter application of N if the following guidelines are followed: no more than ½-1.0 lbs. N/1000 ft^2 is applied; fertilizers containing significant amounts of NO_3-N are not used; and applications are not made to frozen ground if significant rainfall is in the immediate forecast. In most situations, however, mid-winter applications are not necessary, and the guidelines listed in Table 2 should be followed.

PHOSPHORUS AND POTASSIUM

Phosphorus (P) is critical in the establishment of turfgrass. Inadequate soil P will result in very poor seedling vigor, slow establishment of grass, and a stand with very poor density and root growth. The soil will thus be much more susceptible to erosion. Weed encroachment will also be much more severe due to the lack of competition from the thin turfgrass stand. Thus, it is essential that sufficient P be added to the soil at the time of seeding, if soil levels are inadequate. Although not as critical as during establishment of turfgrass, deficiencies in P in mature turf can result in poor spring greenup, reduced vigor, reduced density, and reduced drought tolerance. Light applications of P are generally sufficient to overcome deficiencies in mature turf.

Potassium (K) is not as critical as N or P during the initial establishment phase of turf. However, K plays an important role in mature turf regarding rhizome production and tolerances to heat, drought, and cold. Thus, sufficient K needs to be available for turfgrass, to ensure that quality turf will be obtained during and after summer or winter stresses. Severe deficiencies in K will result in thin, chlorotic, and unvigorous turf.

Whereas N application recommendations cannot currently be obtained from soil tests, recommendations for application of P and K can be obtained from such tests. A commercial turf maintenance company shall test sites within a year of the initiation of management of the site. Until such time as the first soil test is taken, not more than 1.0 lb. P_2O_5 and 2.0 lbs. K_2O per 1000 ft^2 shall be applied for maintenance of turf. After the initial soil test, subsequent sampling every 3 years is generally sufficient to monitor soil P and K levels.

Sites having different soil types, sites with different use or management histories, and sites having substantially different fertility levels, as determined by previous soil tests, should be sampled separately. Conversely, sites having similar soil types, having similar use and management histories, and having similar fertility levels, as determined by past soil tests, may be lumped together into one sample. For example, a single sample may be sufficient for an athletic field complex (or townhouse development, etc.) which has had similar management over a period of time and has a relatively uniform soil type.

Current P and K recommendations, based on soil test results for the maintenance of turf sites, are listed in Table 3.

Table 3. Phosphorus and Potassium Recommendations for Maintenance of Turf Sites Based on Soil Test Results From the University of Maryland.

	Soil Test Category		
	low	**medium**	**optimum----excessive**
	FIV 0-25	**FIV 26-50**	**FIV 51+**
	lbs. P_2O_5 or K_2O/1000 ft^2		
Phosphorus	2.0	1.0	0
Potassium	2.0 – 4.0	1.0 - 2.0	0 – 1.0

SOIL REACTION

Maintaining soil pH within an optimum range is important for maximizing the efficiency of nutrient use, and can be important in reducing weed and disease problems. Turfgrass can withstand a rather broad range of soil pH, but 5.8 to 6.2 is generally considered ideal. Wide deviations from this range can result in reduced P and micronutrient availability, and can interfere with soil N metabolism and availability. Depending on turfgrass species, problems in turf may start to occur at soil pH above 7.8 and below 5.4. Thus, to maximize efficiency of nutrient availability and use, soil tests should be taken as recommended previously for soil P and K to determine soil pH.

Recommended limestone applications, to achieve a soil pH of approximately 6.4 are shown in Table 4. If diseases such as take-all patch of bentgrass, summer patch of Kentucky bluegrass, or spring dead spot of bermudagrass are of concern, maintaining lower soil pH (5.4 – 5.7) may be desirable, and reduced or no limestone should be applied to achieve this level. Also, it is recommended, when practical, that limestone be applied approximately 1 month or more before seeding to minimize potential P availability problems and the potential for volatilization loss of applied N.

Table 4. Limestone Recommendations for Maintenance of Turfgrass (Pounds per Acre)

			Coastal plain		Piedmont & Mountain	
soil pH	loamy sands	sandy loams	loams	silt loams and silty clay loams	loams	silt loams and silty clay loams
6.4	0	0	0	0	0	0
6.3	0	0	0	0	545	650
6.2	0	0	545	545	760	1090
6.1	0	545	650	760	980	1415
6.0	435	760	870	980	1195	1850
5.9	545	870	1090	1195	1415	2180
5.8	650	1090	1195	1415	1740	2505
5.7	760	1195	1415	1630	1960	2940
5.6	870	1305	1630	1850	2180	3265
5.5	980	1525	1850	2070	2395	3590
5.4	1090	1630	2070	2180	2720	3920
5.3	1195	1850	2180	2395	2940	4355
5.2	1305	1960	2285	2610	3155	4355
5.1	1415	2070	2505	2830	3375	4355
5.0	1525	2285	2720	3050	3590	4355
4.9	1630	2395	2940	3155	3810	4355
4.8	1740	2505	3050	3375	4135	4355
4.7	1850	2720	3265	3590	4355	4355
4.6	1960	2830	3375	3810	4355	4355
4.5	2070	3050	3590	4030	4355	4355

1) Divide the above rates by 43.5 to obtain the equivalent rates in pounds per 1000 square feet.
2) Do not apply more than 2,000 pounds per acre for any one maintenance application to turfgrass.