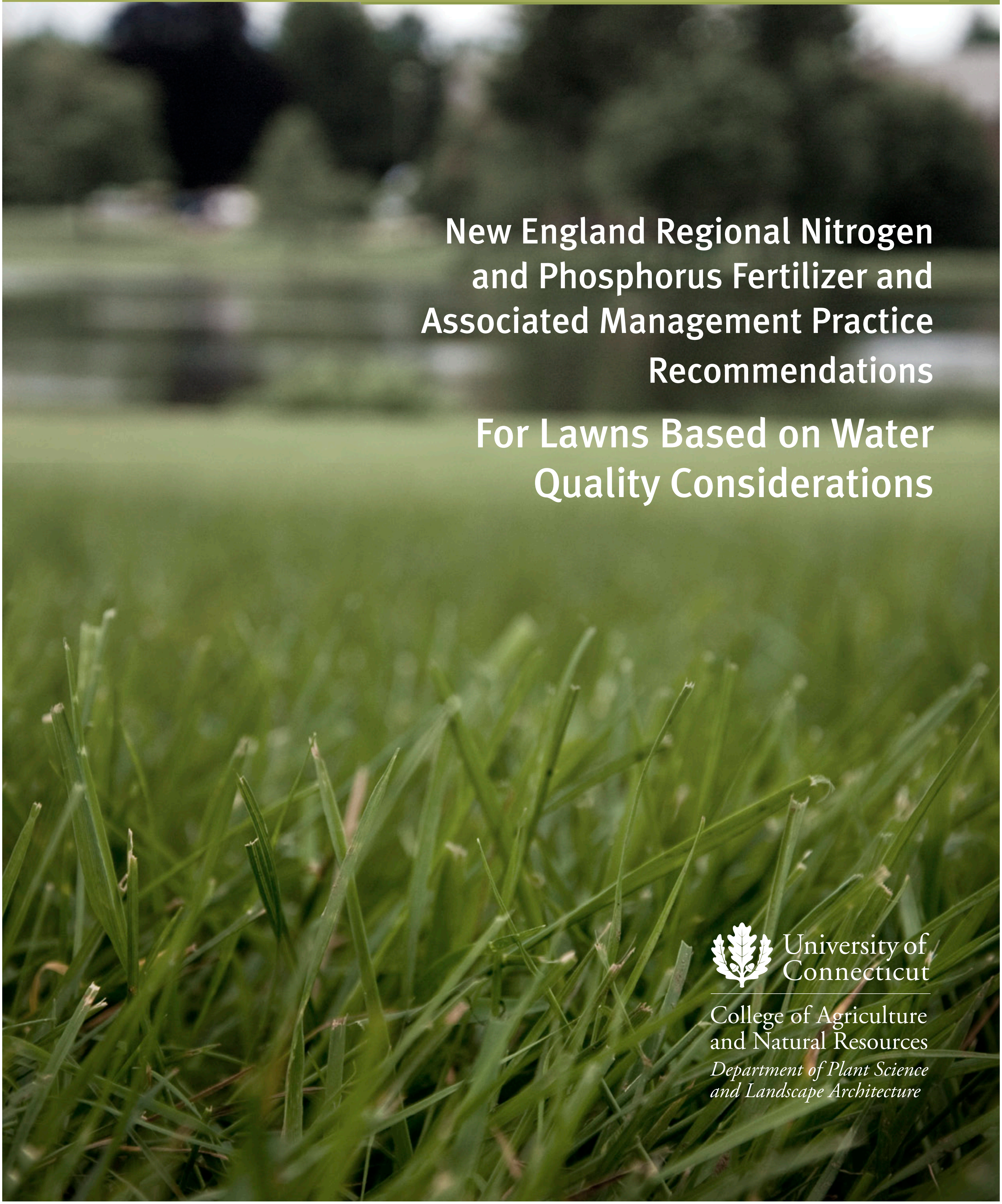
Turfgrass Nutrient Management Bulletin B-0100



New England Regional Nitrogen and Phosphorus Fertilizer and Associated Management Practice Recommendations

For Lawns Based on Water Quality Considerations

University of Connecticut
College of Agriculture and Natural Resources
Department of Plant Science and Landscape Architecture

New England Regional Nitrogen and Phosphorus Fertilizer and Associated Management Practice Recommendations for Lawns Based on Water Quality Considerations

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January, 2008

This material is based in part upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under agreement number 2006-51130-03956.

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INTRODUCTION

Significant land-use changes have occurred in New England during the last 30 to 50 years. Traditional agricultural crop production has declined rapidly and is being replaced with residential and commercial development. As urban and suburban development encroaches into rural landscapes, turfgrass is replacing cropland as one of the largest areas of managed land cover in the region. This situation is not unique to this region of the country; turf is replacing cropland along the entire Eastern Seaboard of the United States.

Because a large land area devoted to lawns in New England is located adjacent to pond, lake, river, and coastal shorelines, nutrient losses from lawns may contribute significantly to the degradation of receiving waters. Many coastal and inland aquatic ecosystems in New England have been documented as experiencing frequent algal blooms (eutrophication) that is attributable to nitrogen and/or phosphorus enrichment. These blooms can result in hypoxia (low water oxygen) causing death of desirable aquatic animals and plants. Algal blooms also may interfere with recreational activities on the water. Nitrogen (N) has been identified as the primary pollutant contributing to hypoxia in salt water and estuaries, and phosphorus (P) has been identified as the primary nutrient pollutant in fresh waters.

In addition to surface water impairment, nutrient enrichment of groundwater is also of concern for environmental and human health reasons. In much of New England, shallow groundwater discharges into ponds, lakes, streams, rivers, and coastal waters. Any dissolved nutrients in the discharging groundwater are then deposited into these surface waters creating potential problems with algal blooms as discussed above. Deeper groundwater that is contaminated with nitrate and used for drinking water is problematic. If contaminated, deep groundwater can remain with elevated concentrations for many years. Drinking water in New England is derived from either groundwater wells or surface reservoirs. When drinking water contains 10 mg nitrate-N/L or greater, it is considered nonpotable in all New England states. In Rhode Island, an advisory is issued for drinking water supplies that test between 5 and 10 mg nitrate-N/L. Losses of N from lawn fertilizers contribute to nitrate-N in drinking water sources. There are human health issues with elevated nitrate such as methemoglobinemia with infants and possible cancer risks for the general populace when nitrate is converted to nitrite forming nitrosamines.

Despite water quality concerns with N and P fertilizer losses from lawns, there has been relatively little change in fertilizer practices for many years. The majority of lawncare companies and homeowners still rely on decades-old fertilization recommendations and practices where fertilizer is applied on a schedule at a set rate (usually based on 1 lb N per 1000ft^2 at each application, three or four times a year – generally associated with specific holidays such as Memorial Day, Labor Day, or Thanksgiving) rather than being based on an objective testing method such as a soil or plant tissue test. This greatly increases the chance of over-application of fertilizer.

Since most lawn fertilizers contain a mixture of N, P, and K (potassium), P and K are applied at the time of fertilization with N at amounts depending on the percentage grade (i.e., the concentration or amount of P and K in the fertilizer bag) and amount of fertilizer applied based on the N rate. Therefore, P and K are usually applied regardless of turfgrass needs. In the case of P, this could lead to water quality impairment if the amount applied exceeds turfgrass needs.

Because of water quality concerns and the need of revisions in lawn fertilization recommendations, this document was created to give updated lawn N and P fertilizer recommendations and management practices with the best information available based on science. In cases where the research is not complete or lacking, recommendations are given based on the best understanding that is currently available. Recommendations will be applicable to both surface and ground water concerns, and will cover intensive to non-intensive lawn management.

The format for this document will be as follows:

- A separate section for N and P
- A Summary list of recommendations for N and P
- Justification and rationale for each of the recommendations

Although N and P recommendations will be separated out, it should be noted that many of the recommended lawncare practices are mutually inclusive for both nutrients under a good lawn fertility management approach.

RECOMMENDATIONS FOR NITROGEN

A standard soil test allows one to monitor soil pH, P, K, and other nutrients, and reliable recommendations for lime and fertilizers for lawns are developed from these tests. Soil N can be measured accurately, however, a routine standard soil test for N and resultant fertilizer recommendation for lawns is problematic since there are no calibration data that relate some measure of soil N to lawn responses. Consequently, N recommendations for lawns have been based on set rates and dates, regardless of actual needs. Until a reliable soil test for N becomes available to guide N fertilization of lawns, the following guidelines are suggested:

- If unfertilized lawn considered acceptable, then do not fertilize.
- If fertilization is decided upon for established lawn, do not apply before spring greenup and apply no later than October 15th in southern New England and September 15th in northern New England; with cool-season grasses avoid fertilizing in the mid-summer.
- If fertilization is decided upon, apply one-half to one-third (or less) of that recommended on the fertilizer bag label then monitor lawn response. Reapply at the reduced rate only when lawn response starts to fall below acceptability.

- If fertilization is decided upon, slow-release formulations are more preferable than soluble, fast-release formulations.
- If a soil test indicates that P and/or K are adequate, there is no need to apply these and only N may be necessary. In these cases, fertilizers that contain only N (e.g., urea, ammonium sulfate, corn gluten) are preferable than blended N-P-K fertilizers. If only blended grade fertilizers are available, choose the one with the lowest P.
- If fertilization is decided upon, set a target maximum loading rate of 2 lbs N/1000ft^2/year on established lawns of 10 years old or older. Newly seeded turf, especially on new home sites where the topsoil has been removed, may require more.
- For new turf, if soil organic matter is below 3%, incorporate compost or another organic matter source into the soil to raise the organic matter content to at least 3%; a minimum of 5% would be preferable.
- Return clippings and mow as high as can be tolerated (leave at least 3 inches). This can supply a slow-release course of nitrogen to the lawn and allow for reduced fertilizer applications.
- Choose grasses such as fescues that require less nutrient and water inputs.
- Maintain soil pH levels between 6.0 and 6.5.
- Consider introduction of white clover or other low-growing legumes into the lawn to naturally provide nitrogen.
- If supplemental watering is considered, avoid over-watering.
- Request a soil test for nitrate and base N rates for your lawn (experimental option).
- If fertilization is decided upon, leave a buffer strip of unfertilized grasses or other vegetation around water bodies, i.e., streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands or drainage areas, etc. Unless the buffer width is stipulated by local or state regulations, leave at least a 20-foot set back from the water.
- Avoid using combination products that include both fertilizers and pesticides (weed and feed, etc.).

JUSTIFICATION/RATIONALE

- **If unfertilized lawn considered acceptable, then do not fertilize**.
  For many lawns that are currently viewed as being acceptable, there may be sufficient mineralization of soil organic matter and grass clippings, and addition of nitrogen from other sources that meet the N needs of existing grass species in that lawn. Therefore, no fertilization is recommended in these cases. Fertilizing where none is needed may increase N losses in addition to increasing the amount of mowing needed. In certain limited cases, however, the unfertilized lawn may have very low density. When this occurs in combination with relatively high extractable P concentrations (>14 mg P/kg soil, based on Morgan or modified-Morgan extractant), there may be an increased risk of P losses in sediment-bound runoff (Easton and Petrovic, 2004; Ohno et al., 2007). In these special cases, some N could be applied to increase turf density to reduce the risk of P loss. An adequate turf density will slow surface runoff, allowing for more infiltration. However, this situation of low turf density under no or low N fertilization may possibly be a case of incorrect grass selection for that site. In these cases, lower-input grasses such as fescues or zoysiagrass (a warm-season grass adapted to southern New England) would be a better choice than Kentucky bluegrass or perennial ryegrass.

- **If fertilization is decided upon for established lawn, do not apply before spring greenup and apply no later than October 15th in southern New England and September 15th in northern New England; with cool-season grasses avoid fertilizing in the mid-summer.**
  Allow turfgrasses to come out of dormancy in the spring before applying fertilizers. Soils should be allowed to warm and dry out before fertilization. There may be sufficient N inherently available such that fertilizer application can be delayed until late spring or early summer if needed. Application of N fertilizers to dormant or semi-dormant turf in the spring, or to actively growing spring turf when evapotranspiration (ET) is low and soils saturated or slow to drain, increases the risk of N loss. If relatively high soil nitrate is present and ET low, then that nitrate is subject to losses during wet conditions either by leaching or runoff, because water movement into the plant is reduced. Under saturated soil conditions, nitrogen could also be lost via denitrification. This is a gaseous loss of nitrogen from the soil and constitutes a waste of fertilizer dollars since the nitrogen does not enter into the plant. Losses of nitrogen via denitrification also contributes to the greenhouses gas emissions of nitrous oxide, which has about 300 times the warming power of carbon dioxide. Turfgrass fertilized with N has been reported to contribute as much as 30% of the total nitrous oxide emissions from a given land area (Kaye et al., 2004). Turf fertilized with higher rates of N has higher nitrous oxide emissions than lower rates (Bremer, 2006).

  There is evidence to show that fall fertilization constitutes a high risk for nitrate leaching, and that this risk increases with later fall applications (Mangiafico and Guillard, 2006). For Northern New England, the last N application should be no later than September 15th. For Southern New England, the last N application should be no later than October 15th. Avoid rates above 0.5 lbs N/1000ft^2 if a fall application is made. Never apply on frozen ground; never practice a dormant application (December–March). If water quality is of utmost concern, avoid fall fertilization entirely – no application past August. Research indicates that there is no quality benefit to turf in the spring when previous fall fertilization occurred from the middle of October to the middle of December. However, nitrate leaching losses increased linearly as fertilizer application was delayed from September to December (Mangiafico and Guillard, 2006). The physiological basis behind these data is based on how a grass plant acquires N. It has to come in an ionic form (usually nitrate, NO_3^-) moving with the water stream into the plant. Movement of water through the plant is driven by ET. Generally, ET is low during the mid to late fall in New England. So, it is physiologically impossible for the turf to absorb all available nitrate in the soil water solution provided by fall fertilization, unless ET is very high over an extended period. The nitrate not taken up by the grass is then subjected to leaching or runoff losses. It is not logical to increase soil nitrate at a time when ET is low and risk of leaching and runoff is high.

With cool-season grasses (bluegrasses, ryegrasses, fescues), avoid N application in the mid-summer. Cool-season grasses can undergo heat and drought stress during the hottest and driest time in mid-summer. Application of N at this time only increases the stress imposed on the grass plant that results in a further deterioration of its roots. This can be attributed to the addition of salts from the fertilizer formulation, or to the energy imbalance within the plant when N application stimulates leaf growth at the expense of root growth. Also, application of N during the mid-summer increases the incidence and severity of diseases such as brown patch and leaf spots.

- **If fertilization is recommended, apply one-half to one-third (or less) of that recommended on the fertilizer bag label**. **Reapply only when lawn response starts to fall below acceptability.**
  The fundamental problem for N recommendations is that there is no objective test (i.e., soil test, tissue test, etc.) that is used to guide N fertilizer rates. Currently, N fertilizer rates are based on set dates (usually popular holidays or dates so that makes it easier to remember – e.g., Tax Day, Memorial Day, July 4th, Labor Day, Thanksgiving) at a set rate – usually 1 lb of actual N per 1000ft^2. The outcome is that N is usually applied 2 to 4 times a year, without any basis whether it is needed or not. The concern from a water quality standpoint is associated with the excess amounts and/or late season applications. There is a lack of accounting for the inherent availability of N at any one particular site (mineralization of soil organic matter, return of clippings, biological N fixation from clovers, atmospheric deposition, etc.). This is why objective testing methods are so needed. Surveys in Connecticut have indicated that the majority of homeowners follow fertilizer label information to guide how much to apply (Dietz et al., 2002). And of course, the bag information uses the set rate/set date approach described above. In the absence of an objective test, however, one can begin with this approach of reduced rates and refine the approach as more information becomes available from research. The concept of applying less fertilizer more frequently when fertility is truly required needs to replace the current set rate-date approach. This can be accomplished by taking the fertilizer bag directions then applying one-half to one-third what is recommended on the label. Then monitor response for two weeks. If response is not quite acceptable after this period, then apply a little bit more. However, this approach needs to be coordinated with available water. If dry weather conditions prevail, then it may be likely that no response to the fertilizer will be observed because little N was taken up due to a lack of water movement into the plant. In these cases, wait until after sufficient rains arrive or adequate supplemental watering is applied before deciding to make another N application. If the turfgrass is viewed as acceptable under sufficient soil moisture conditions, then no more fertilizer is required until response starts to become unacceptable. Then repeat the reduced-rate approach. From a water quality perspective, it is better to apply a little bit of N more frequently, then a relatively large amount of N. Single dose, high rate, water soluble N applications (1 lb/1000ft^2 or more) to mature turfgrass should be avoided to minimize the potential of nitrate leaching (Frank et al., 2006). One cannot "take back" excess fertilizer N, which is then subject to loss. This concept should be acceptable when framed in the water quality protection argument. Also, it provides opportunity for the frequent "activity" on the yard that current research has indicated as important to the homeowner – they are doing "something" on a regular basis. A drawback to this approach, however, is that most lawn fertilizers contain relatively high concentrations of N, and the homeowner spreader equipment is not sophisticated enough to allow accurate calibration nor even distribution of rates less than 1 lb N/1000ft^2. So, there may be frustration and disillusionment with this suggested approach when high N containing fertilizers are used. To better reach water quality goals with this approach, we recommend the homeowner or lawncare professional select as low an N grade fertilizer as possible – preferably a formulations with a maximum N grade of 15%.

- **If fertilization is recommended, slow-release formulations are more preferable than soluble, fast-release formulations**.
  Choose a fertilizer than contains at least 50% of the N in a water-insoluble formulation (higher is better). This will be stated on the fertilizer bag label as WIN (Water-Insoluble Nitrogen). If this percentage of WIN fertilizer is not available, then 30% would be the next target value. There are several synthetic slow-release N fertilizer formulations that are readily available (polymer-coated urea, methylene urea, sulfur-coated urea, IBDU). Another good choice in this respect is the composted, organic-derived fertilizers. From a water quality perspective, the synthetic controlled-release products are just as effective in lessening the threat to water quality as the naturally organic-derived products. For the typical homeowner, avoid formulations that are entirely soluble or fast-release (urea, ammonium sulfate, calcium nitrate, ammonium nitrate) if possible. With slow-release or organic fertilizers, do not apply more than 1 lb of actual N per 1000ft^2 at any application (for protein-based organic fertilizers, follow rate limits as for soluble fertilizer formulations that follows, since the N release can be relatively fast). With soluble, fast-release fertilizers, do not apply more than ½ lb of actual N per 1000ft^2 at any application. Generally, there is a greater chance of nitrate leaching with soluble formulations than with slow-release formulations (Guillard and Kopp, 2004). However, over the long-term, there may not be any advantage in using

slow-release N formulations if the application rates exceed plant needs; similar nitrate losses may be observed (Petrovic, 2004).

- **If a soil test indicates that P and/or K are adequate, there is no need to apply these and only N may be necessary. In these cases, fertilizers that contain only N (e.g., urea, ammonium sulfate, corn gluten) are preferable than blended N-P-K fertilizers. If only blended grade fertilizers available, choose the one with the lowest P**.
  For the most part, it is difficult for homeowners to obtain N-only fertilizers. Consequently, the most commonly available lawn fertilizers are blended as an N-P-K formulation. If a soil tests indicates that P and/or K are adequate, then applying a blended N-P-K fertilizer to meet N needs adds P and K that are not necessary. In terms of water quality issues, the extra P may be problematic; K is generally not a water quality issue. In these cases, N-only fertilizers are preferable (urea, ammonium sulfate, corn gluten). For the typical homeowner, these N-only products may not be readily available. Therefore, choose a blended fertilizer with the lowest P or P-free.

- **Set a target maximum loading rate of 2 lbs N/1000ft^2/year or less on established lawns of 10 years old or older. Newly seeded turf, especially on new home sites where the topsoil has been removed, may require more**.
  Regardless of formulation used, maintain a target maximum loading rate of 2 lbs N/1000ft^2/year on established lawns of 10 years old or older. The reasoning behind this is that organic matter accumulation and storage of N in the soil beneath turfgrass seems to become maximized at approximately 10 to 25 years (Porter et al., 1980). Because of this, older mature turf has less storage capacity for excess N than a younger turf site. Consequently, the risk of N losses from older turf site may be greater than a younger turf site. Newly seeded turf, especially on new home sites where the topsoil has been removed, however, may require more N than an older turf site. In these cases, target a maximum loading rate of 3 lbs N/1000ft^2/year following recommendations above (half the label rate and monitor response). Reduce the target amount to the 2 lb load or less as turf matures to 10 years old. Avoid application if weather forecast is for moderate to heavy rains. Until a reliable soil test for N recommendations is developed, a reasonable approach to lawns that require N would be to target applications in the late-spring/early summer (mid/late-May southern New England; late May/early June northern New England) and again during late summer/early fall (no later than September 15th for Northern New England; no later than October 15th for Southern New England). Sweep or blow any fertilizer that lands on hard surfaces (driveways, walkways, roads) back onto the lawn.

- **For new turf, if soil organic matter is below 3%, incorporate compost or another organic matter source into the soil to raise the organic matter content to at least 3%; a minimum of 5% would be preferable**.
  With many new turf seedings or soddings, especially on new home sites where the original topsoil has been removed and replaced, there is insufficient organic matter (OM) in the soil to support good grass growth and establishment. This increases the reliance on supplemental N fertilizers to ensure good lawn grow-in. Risk of nitrate leaching and runoff loses are greatest during turf establishment (Easton and Petrovic, 2004). During grow-in, the grass root system is not fully developed and does not have the uptake capacity as an established root system. Subsequently, there is a greater potential for nitrate leaching, especially with soluble N formulations. A lack of turf density during grow-in increases the potential for runoff losses of N if heavy rains or over watering occurs. Sufficient OM in the soil rootzone will lessen the need for fertilizers during grow-in, and also provides better water-holding capacity of the soil. As the OM decomposes, a slow and steady release of N can be obtained. A soil test will indicate how much OM is present. A minimum of 3% is recommended with at least 5% being preferable. If the soil tests low in OM before a new seeding is initiated, compost or another source of OM (e.g., peat moss) can be added to the soil and incorporated to a depth of no deeper than 6 inches before the grass seed is sown or sod laid. If using compost, be sure that it is mature and stable. Green compost can produce toxic compounds during breakdown that can kill the new seedlings or sod.

- **Return clippings and mow as high as can be tolerated**.
  Returning the clippings back to the turf is advocated. Use of a mulching mower is good for this purpose, but a side-discharge mower will work as long as the grass is mowed on a regular basis. If the practice of returning clippings has been used for several years, the amount of N applied based on current fertilizer bag recommendations can be cut by half or more (Kopp and Guillard, 2002). Follow the reduced rate approach described above. Contrary to popular belief, clippings do not contribute to thatch. Clippings are primarily leaf blades with very small amounts of lignin. Therefore, they are subject to rapid decomposition. Research has shown that most of the clippings decompose within 4 weeks after mowing (Kopp and Guillard, 2004), releasing N back to the turf plants. A higher cut of the lawn is desirable. A suggested height of cut would be 3 inches or higher. This reduces the need for supplemental irrigation, which in turns reduces the chance for over-watering that increases N losses by leaching or runoff. A higher height of cut encourages deeper and more extensive root system. A deeper and more extensive root system will extract more available nutrients from the soil, thus reducing the need for supplemental fertilizers. Keep clippings on the lawn. Do not direct clippings onto hard surfaces (driveways, walkways, roads) or into water bodies. Clippings are high in nutrients and should be treated as if they were a fertilizer. Returning clippings without a concomitant reduction in fertilizer rates may lead to increased nitrate leaching losses (Kopp and Guillard, 2005).

- **Choose grasses such as fescues that require less nutrient inputs**.
The traditional grass species mix for lawns in New England is Kentucky bluegrass-perennial ryegrass-red fescue, with bluegrass and ryegrass the predominate species. Often, red fescue is not included in the mix. Kentucky bluegrass and perennial ryegrass have relatively high requirements for nutrients and water to maintain quality. Change selection from these higher-input requiring species to the lower-input requiring fescues and other species. There are the fine-leaf fescues (creeping red, Chewings, hard, sheep), and the turf-type tall fescues (including the compact (dwarf) tall fescue types). There is plenty of confusion, however, with turf-type tall fescues and the older varieties of tall fescue. The older types (Kentucky 31, Alta, Fawn) are very coarse texture (very wide), clumpy, and have fast regrowth rates that makes them stand out in a mixture after mowing. These are the types used for pasture and utility purposes, such as roadside slope stabilization and medians. For turf purposes, do not select the utility/forage types; these will result in poor-quality lawns. Read the seed label and avoid anything that contains Kentucky 31, Alta, or Fawn. Or, look for the phrase "Turf-type" or "Compact-type" tall fescue. But, this is not always readily available or listed on the label. We suggest lawn seed with a blend of at least three different turf-type or compact tall fescues, or a mixture of turf/compact-type tall fescue and fine fescues (70:30 to 80:20 tall fescue: fine would be okay), or a mixture of turf/compact-type tall fescue and a lower input or heat tolerant Kentucky bluegrass (90:10 or 80:20, tall fescue: bluegrass).

  Where possible, choose an endophyte-enhanced fescue. Often times, this information is included on the seed label. The endophyte is a fungus that infects the fescue plant and produces compounds that help to reduce aboveground chewing insects and some diseases, and increases the drought tolerance of the grass. However, the endophyte-enhanced fescues should NOT be used around grazing livestock including horses. The compounds released by the fungus are not particularly good for them. This is not a problem with dogs or cats that eat some grass once in a while.

  There are other lower-input grass species that are adapted to our regional climate that could make acceptable lawns, but quality may not be as good as the fescues, or there is limited evaluation of these species to date. Try these on a small area first and evaluate for a few years before committing them to the entire lawn. These should not be necessarily promoted for those expecting a higher-quality lawn, but for the lower-maintenance enthusiasts, these would do just fine. A species that received more interest in the past than today is redtop (*Agrostis alba*), which is a bentgrass. This grass is tolerant of a wide-range of soil and climatic conditions (it is commonly used for roadside medians and slopes, so it can take a punch!). Zoysiagrass is a warm-season grass that is cold-tolerant for southern New England; it is not adapted for northern New England. This is a great grass for low-input, but only remains green for a few months during the growing season – it is early to dormancy in the late summer, and late to greenup in the spring. Also, once established, it aggressively spreads and may become a weed problem in flowerbeds and gardens, or as an unwanted species that invades neighboring properties. But, under our summer conditions along coastal areas or in southern New England, there is no better grass for little to no input (especially supplemental watering) than this grass. This would be an ideal grass for summer coastal properties. Several new introductions are being promoted for lower-maintenance lawns – junegrass (*Koeleria* spp.) and hairgrass (*Deschampsia* spp.). Limited evaluations trails at UConn have shown these species to be very resilient under low-input conditions (1 lb N/1000ft^2/year; no irrigation, no pest control). More evaluation is needed before routine recommendations about these species can be made for New England.

- **Maintain soil pH levels between 6.0 and 6.5.**
Maintain the soil pH to between 6.0 and 6.5, as this will encourage more mineralization of organic matter and increased inherent available soil N to the lawn by creating more favorable conditions for the soil microbes. This in turn will reduce the need for external N fertilizer. Sample the soil to a depth of 4-inches below the thatch layer. Do not include any aboveground grass parts or thatch in the sample. Apply the amount of liming material according to the soil test report recommendations. Generally, lime can be applied to an established lawn at a rate of no more than 50 lbs/1000ft^2 per application at any time except when the ground is frozen. For a new seeding, the entire lime recommendation can be applied then incorporated to a depth of 4 to 6 inches.

- **Consider introduction of white clover or other low-growing legumes into the lawn to naturally provide nitrogen.**
Low-growing legumes such as white clover or birdsfoot trefoil will naturally provide N fertilizer to the grass (Sincik and Acikgoz, 2007). The low-growing forms should not compete excessively with the grass species if properly managed. A higher mowing height will help check the growth of the legumes. With white clover, choose the small-leafed form, often called "Dutch" white clover. 'Kalo' birdsfoot trefoil is derived from an Oregon-selected dwarf English variety that would be suitable for lawns. If any household member is allergic to bee stings, however, intentionally seeding legumes into the lawn may not be a prudent choice as the flowers attract bees.

- **If supplemental watering is considered, avoid over-watering.**
The loss of N from lawns via water occurs primarily as nitrate. This form of N is highly soluble and mobile in water. Losses of nitrate are directly related to the amount of water running off or leaching from turf (Morton et al., 1988; Kopp and Guillard, 2005). Inexpensive rain cut-off sensors are available for previously-installed automatic watering systems; newer systems should come equipped with them. Soil water content can easily be monitored by

inspecting the soil, and visually appraising the depth of the moist soil. The preferred approach, however, would be to let the lawn go dormant under dry conditions. It is encouraged that supplemental watering be limited to only those times when grass loss is imminent due to prolonged drought.

- **Request a soil test for nitrate and base N rates on this (experimental option).**
  The current soil test recommendations for N are not reliable. They have never been calibrated to any measure of N in the soil and associated response of the lawn. Limited experimental work suggests that a soil test for nitrate (usually available in most soil testing laboratories) may help to guide N fertilizer recommendations. However, this is experimental and users should be made aware of the status of this test. The suggested protocol is to take a soil sample one week to 10 days before the anticipated fertilizer application date. If values are >15 ppm, then there is a low probability of turf response to added fertilizer (little to no N needed); between 10-15 ppm, there is a moderate probability of response (a little N needed); between 5-10 ppm, there is a higher probability of response (moderate amounts of N needed); below 5 ppm there is a high probability of response (most amount of N needed). This is only in the early testing stages, but may be better than the current approach of no objective testing. Therefore, use this approach with some caution since the recommendations based on the soil nitrate values are preliminary. Ongoing studies should provided better fertilizer guidelines for this approach in the next year or two.

- **If fertilization is recommended, leave a buffer strip of unfertilized grasses or other vegetation around water bodies, i.e., streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands or drainage areas, etc.**
  Fertilizing too close to water bodies increases the chance of N movement into the water. An unfertilized buffer strip of grasses or other vegetation will increase the uptake and attenuation of any N lost from the lawn in runoff or shallow, lateral-moving groundwater. Less mowing of the buffer strip is better; higher vegetation will also discourage geese. If a path to the water is required, mowing a narrow path in the buffer strip in a zig-zag pattern is better than a straight line if geese are a problem. Inclusion of vegetation types other than grasses will increase diversity and wildlife activity in the buffer. Unless the buffer width is stipulated by local or state regulations (some states have 50 to 100 foot setbacks), leave at least a 20-foot setback from the water. The effective width of the buffer, however, will be determined by the site conditions – wider widths will be required with steeper slopes, lower vegetation densities, soils with poor drainage, lower percentage of grass in the buffer, shorter vegetation heights, and less grass in the buffer.

- **Avoid using combination products that include both fertilizers and pesticides (weed and feed, etc.).**
  Application rates on the bag label for combination products are usually based on the pest control product and not the fertilizer. This can result in over application of N. For control of summer insects, an application of a combination product may actually increase the incidence of summer turf diseases due to the N. Additionally, broadcast application of combination products results in pesticides being applied where they are not needed. It is better to use spot applications of specific pesticides for pest problems in lawns.

RECOMMENDATIONS FOR PHOSPHORUS

A standard soil test allows one to monitor soil P accurately, and reliable recommendations for P fertilizers for lawns are developed from this test. Most university soil testing laboratories in New England use the Morgan or modified-Morgan extractant for P. This extractant is a relatively weak acid that is suitable to measure the plant-available P in the sandy soils of New England. Use of other extractants (Bray1 & 2, Mehlich 1 & 3) will result in higher soil test extractable P than the Morgan extractants because they are much stronger acids. Consequently, these strong-acid extractants may over-estimate the plant available P in New England soil due to the solubilization of P forms that may not normally be available to turf. These extractants are commonly used by most private or commercial soil testing laboratories. Therefore, you should inquire as to the extractant used in the soil test and use caution if the stronger-acid extractants are used; it will be likely that the available P is overstated.

- If unfertilized lawn considered acceptable, then do not fertilize.
- Soil test for P – don't guess!
- Avoid P fertilizers on bare ground or low-density lawns, unless it is a new seeding.
- If fertilization is decided upon, use a P-free fertilizer on lawns near or bordering water bodies, unless soil tests indicate that the soils are low in P.
- Avoid application of P fertilizers prior to moderate to heavy rain forecast.
- Return clippings where possible. Once a lawn is well established, this can often supply adequate P for the lawn.
- Maintain soil pH levels between 6.0 and 6.5. Soil test to monitor pH levels and to guide liming recommendations.
- If fertilization is decided upon, leave a buffer strip of unfertilized grasses or other vegetation around water bodies, i.e., streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands or drainage areas, etc.
- Never apply P fertilizer to saturated or frozen ground.
- Soil test annually for P when applying organic fertilizers derived from composts to ensure that P levels do not become excessive.
- Avoid using combination products that include both fertilizers and pesticides (weed and feed, etc.). Application rates on the bag label are usually based on the pest control product and not the fertilizer.

- **If unfertilized lawn considered acceptable, then do not fertilize.**
  For many lawns that are currently viewed as being acceptable, there may be sufficient mineralization of organic matter and/or clippings to meet the P needs of existing lawn grass species. Advocating P fertilization where none is needed will increase the risk of P losses.

- **Soil test for P – don't guess!**
  This is relatively straight forward, in that a soil test is the best guide to P fertilization. On established turf, if the soil test for extractable P reads in the medium-low or greater range, or optimum or above optimum range, or above 5 ppm (modified-Morgan P) apply no P. If reading is low and turf quality below acceptability with adequate N, then apply 0.5 lb P/1000ft^2 in the spring. If reading is low, but turf quality is acceptable, then do not apply P. On newly seeded turf, if the extractable P is in the high or greater range, or above optimum range, or above 10 ppm (modified Morgan P) apply no P. If reading is low, then apply 0.5 lb P/1000ft^2 preplant incorporated to a 4-inch depth, and another 0.5 lb P/1000ft^2 surface broadcast after grass has emerged.

- **Avoid P fertilizers on bare ground or low-density lawns, unless it is a new seeding.**
  In certain cases, the lawn may have very low density and/or bare spots. This may be due to low fertility, poor water holding capacity of the soil, soil compaction, or loss of turf due to pests (insects, weeds, diseases, small mammals). When this occurs with relatively high extractable P concentrations (>14 mg P/kg soil, based on Morgan or modified-Morgan soil test), there may be an increased risk of P losses due to runoff (Easton and Petrovic, 2004; Ohno et al., 2007). In these cases where fertility is the problem, some N could be applied (maximum 0.5 lbs N/1000ft^2) to increase turf density to reduce the risk of P loss. Soils that do not hold water adequately should be amended with organic matter. Compacted soils should be aerated and/or amended with organic matter. If pests are the problem, they need to be controlled. In all cases, the problem needs to be addressed and the bare spots reseeded or sodded as quickly as possible. An adequate turf density will slow surface runoff, allowing for more infiltration. Cover seeded areas with straw or another appropriate mulch to prevent erosion.

- **If fertilization decided upon, use a P-free fertilizer on lawns adjacent or bordering water bodies, unless soil tests indicate that the soils are low in P.**
  Near adjacent or bordering water bodies, choose fertilizers with no P, unless the soil tests indicate that the soils are low in P. Use a drop spreader instead of a rotary type spreader near sensitive areas. Be mindful of local or state regulations for no-fertilizer buffers adjacent to water.

- **Return clippings where possible.**
  Returning clippings will add P back into the lawn, thereby reducing the need for fertilizers. Always keep clippings on the lawn. Do not direct clippings onto hard surfaces (driveways, walkways, roads) or into water bodies. Clippings are high in nutrients and should be treated as if they were a fertilizer.

- **Avoid application of P fertilizers prior to moderate to heavy rain forecast.**
  Avoid surface application of P fertilizers if the weather forecast is for moderate to heavy rains. This increases the chance of soluble P losses in runoff or by leaching.

- **If fertilization is recommended, leave a buffer strip of unfertilized grasses or other vegetation around water bodies, i.e., streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands or drainage areas, etc.**
  Fertilizing too close to water bodies increases the chance of P movement into the water. An unfertilized buffer strip of grasses or other vegetation will increase the uptake and attenuation of any P lost from the lawn in runoff or shallow, lateral-moving groundwater. Less mowing of the buffer strip is better; higher vegetation will also discourage geese. If a path to the water is required, mowing a narrow path in the buffer strip in a zig-zag pattern is better than a straight line if geese are a problem. Inclusion of vegetation types other than grasses will increase diversity and wildlife activity in the buffer. Unless the buffer width is stipulated by local or state regulations (some states have a 50 to 100-foot setback), leave at least a 20-foot setback from the water. The effective width of the buffer, however, will be determined by the site conditions – wider widths will be required with steeper slopes, lower vegetation densities, soils with poor drainage, lower percentage of grass in the buffer, shorter vegetation heights, and less grass in the buffer.

- **Never apply P fertilizer to saturated or frozen ground.**
  When P is applied to saturated or frozen lawns, there is an increased risk of P losses in runoff. Allow the soils to drain before applying the P fertilizer. The application of fertilizer to frozen ground is never justified.

- **Soil test annually for P when applying organic fertilizers derived from composts.**
  For lawns receiving compost as a fertilizer source, it is especially important to monitor the soil P levels on an annual basis. Most composts are derived from materials relatively high in P and low in N. To meet the N needs for lawns, most composts are applied at high rates. Yearly applications at these rates can increase soil P levels far beyond grass needs and exceed those levels considered a threat to water quality (Soldat and Petrovic, 2007). Research at UMaine has indicated that soil P of 14 ppm (modified-Morgan P) is a threshold above which water-soluble P could be expected in increase more rapidly with additional P loading (Ohno et al., 2007).

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