UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Soil Fertility and Fertilization Guidelines for Lawn Turf in Vermont

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Introduction

Maintaining adequate soil fertility of lawns is an important factor for turf growth and quality. Turf quality is often measured by grass density, uniformity and color and maintaining dense lawn turf is important for assuring adequate turf function such as supporting foot traffic and minimizing runoff and soil erosion.

Although this publication is focused on soil fertility and fertilization, it is recognized that the establishment and maintenance of viable and functional turf requires many cultural practices including proper site preparation, selection of adapted species and varieties, proper mowing, liming and fertilization, irrigation, integrated weed and pest management, aeration, thatch control, and other practices. All of these practices are important and any one of them can become the limiting factor in the development of poor turf if not attended to properly.

Soil Testing and Sampling

A soil test is the best way to assess the fertility needs for lawn turf. The soil testing program at the University of Vermont includes analysis, interpretation and recommendations based on research within the New England and New York region.

The results obtained from a soil test are only as good as the sample submitted; therefore, proper collection is critical for obtaining useful, accurate recommendations. If a landscape varies in soil type, previous fertilizer or lime treatments or other past management practices, it is recommended to take separate samples and test for each site since fertility histories may be quite different. Often front yards and back yards are sampled separately for this reason.

For each site to be tested, collect 12 to 15 subsamples per location in a regular grid pattern. Avoid any obvious spots where there may have been previous spills or over application of lime or fertilizer. For turf, it is recommended to sample to a 3 inch depth and discard thatch and leaf material. Each subsample collected should be approximately a 1" by 1" column 3 inches deep from the soil surface. This can be achieved using a trowel or shovel, but a soil probe is the best and easiest method.

Subsamples can be pooled into a clean, plastic bucket (avoid metal buckets) and mixed together to make one sample. From this composite sample, collect one cup and be place in a clean plastic bag for submission to the lab. Fill out the *Soil Test Submission Form* as completely as possible to be submitted with your sample. You can download a form at http://pss.uvm.edu/ag_testing/

How often one samples a turf area largely depends on needs. For established turf, sampling every three to four years can be useful in order to monitor any changes on soil test levels and adjust annual lime and fertilization programs; however, more frequent sampling may be required under some circumstances. When establishing turf, it is highly recommended to soil test early enough (one month prior) in order to apply the proper amounts of lime and critical nutrients that will be incorporated into the soil during site preparation. *According to Vermont law (H-37), no*

phosphorus fertilizer can be applied to established turf without a soil test recommendation taken within 18 months of application.

Soil pH and Lime Recommendations

Maintaining an optimum soil pH level is important for maximizing availability of plant nutrients, for encouraging activity of beneficial soil microorganisms, and for maintaining soil conditions that will support good root growth and turf quality. Most turf can grow well within a range of soil pH from 6.0 to 7.0 and the UVM Soil Test for lime recommendations for lawn turf uses 6.5 as the target soil pH on their soil test report.

Most soils in Vermont have a natural tendency to be acidic (low pH) and need periodic applications of lime to maintain pH in a range optimum for turf growth and quality. The primary function of lime is to raise the pH of the soil. However, over application of lime can result in raising the pH above optimum levels, and excessively high pH levels (over 7.5) can cause poor nutrient availability and create other turf problems. It is also more challenging and expensive to lower soil pH than to raise it. *Therefore, lime application rates should be based on achieving the target pH goal and lime should not be applied without a soil test.*

The most common liming material is calcium carbonate (sometimes referred to as Aglime) usually pulverized into a powder for quick reaction with soil acidity. A pelletized form of Ag Lime is often used on turf for ease of application and reduction in dustiness. Recommendations are given in tons of aglime per 1000 square feet (TSF), assuming a calcium carbonate equivalent (CCE) of 90% or higher. Most aglime sold in Vermont is within this range, but if your liming material has a CCE less than 90%, application rate should be increased accordingly.

Lime at seeding time - The best time to apply lime for correcting soil pH is during establishment when the lime can be tilled in during site preparation. Good distribution of lime throughout the root zone is best. If the recommendation is over 100 lbs., it would be best to till in half the amount and then apply the rest and till again during the final site preparation. Do not apply more than 200 lbs. of lime per TSF at establishment.

Lime on established turf - Since lime moves slowly into the soil, it is best to limit topdress applications on established turf to 50 lbs. per TSF. If soil test calls for more than this, apply in 50 lb. increments once in spring and once in the fall. Repeat this until the total recommendation is reached.

Why a thousand square feet? When it comes to application rates for lawns and other urban landscapes, the thousand square feet unit is most commonly used since most sites are less than an acre in area. *It is often abbreviated **TSF***. To put it in perspective, a 25' by 40' area would equal one TSF unit. There are 43,560 square feet in an acre; therefore, there are 43.56 TSF units in one acre. Most home sites range from ¼ to ½ acre in size. After subtracting for the house and driveway footprint plus other non-turf areas of the site, the actual lawn area often ranges from 10 to 15 TSF on many home sites. But it is important to get specific site measurements.

Nitrogen Recommendations

Nitrogen (N) is the mineral element needed in the largest quantities in turfgrasses. Nitrogen is an imporatant constituent of protein and DNA. It is the nutrient that most directly affects growth and green color. In most cases, N fertilizer must be applied regularly to maintain high quality turf. On the otherhand, too much N is a waste of money and can create unnecessary turf growth,

predispose the plants to certain diseases, increase the likihood of excess thatch layers and increase the risks of nitrate leaching into the ground water.

Applicaton Rate - The nitrogen needs for turf vary widely depending on many factors including turf function, turf vigor, grass species and soil N availability. *For lawn establishment*, the general recommendation is to apply 1 lb. of N per TSF at time of seeding and an additional 1 to 2 lbs. per TSF post seeding once the turf is up and growing, if needed. *No more than 1 pound of N per TSF should be applied at any one time.*

For maintenance of established turf, the amount of N recommened varies depending on the desired quality, function of the lawn, soil organic matter, and other cultural practices. Most lawns will perform well at applications of 1 to 3 lbs. per TSF per year. *Again, no more than 1 lb. per TSF should be applied at any one time.* Refer to **Table 1** for recommended timing and rates through the season.

To reduce the risks of N leaching, the least amount of N should be used to meet desired turf goals. Many turf managers have found that even 1/2 rates can provide acceptable results under some circumstances such as when clippings are returned during mowing. For a lawn that is over ten years old and is thick and has good color, there may be little need for additional N fertilizer every year.

Time of application - For many homowners that only fertilize their lawn once per year, the best time would be in early autumn around Labor Day. By this time, the cool season grasses are starting to recover from the hot, often dryer summer months and the N fertilizer will help stimulate tillering which improves turf density and promotes extended growth into the fall.

Avoid applying fertilizers or compost late in the fall. This increases the risk of nitrate leaching. *According to Vermont laws, fertilizer can only be applied to lawns between April 1 and October 15. The law also states that fertilizer cannot be applied within 25 feet of surface water.*

Table 1. Timing and rates of N fertilization for maintenance of established lawns

Desired	Turf	Applications	*Pounds of N per 1000 sq. ft. per application* [1]		
Quality	Traffic	Per Year	Spring Greenup[2]	Late Spring[3]	Late Summer/Early Fall[4]
Good	Minimum	1	0	0	1
Moderate	Moderate	2	0	1	1
High	High	3	1	1	1

[1] If soil organic matter is over 4% and if clippings are returned at mowing, try applying at 0.5 lb. N rate

[2] Too much N in early spring will promote excessive spring growth

[3] Avoid applying N fertlizer in mid summer during hot, dry periods

[4] Early to mid September is best. Avoid applying fertilizer after late September

The application rate of the fertilizer you apply is normally based on meeting N fertility needs. Refer to the section "Choosing a Fertilizer…" on page 4 for methods of calculating the proper rate. For topdressing established turf, use a N source that includes a *slow release* formula. This helps sustain a steady supply of N to the grass over a longer period of time. Most maintenance lawn fertilizers will indicate on the bag the amount of "slow release" N in the formula.

Organic fertilizers are usually made from animal waste or plant material and their N is primarialy slow release. The N from these sources are not immediately available to the turf when first applied since they require soil microbes to convert the organic-N to soluble forms that can be

taken up by the turf roots. This usually requires moderate to warm soils and adequate moisture therefore, early spring applications may not result in an immediate, noticable response. Compost is another source of slow release N. It is best to apply in a thin layer (no more than ¼ inch per year) usually in the early to mid fall. It is often applied in combination with core aeration.

Phosphorus and Potassium Fertilization Recommendations

Phosphorus (P) and potassium (K) are considered the second and third primary plant nutrients. Phosphorus is extremely important for many plant functions including respiration, cell division, root and seedling development, and plant maturation. Potassium is important for maintenance of turgor pressure (which has a strong influence on drought tolerance, cold hardiness and disease resistance) and enzyme activation in the turf plants.

The recommendations for P and K are determined by the levels found in the soil test and are based on meeting turf needs as well as building up or maintaining soil P and/or K levels . Thus, a soil test with a very low P or K level will have a high recommended rate, and a soil test with an optimum or high level will give a zero or minimum recommendation since there is already an adequate supply in the soil to meet the lawn's needs. *According to Vermont laws, without a soil test or if a soil test shows no need for P, then only a "zero P" fertilizer should be used for that turf.*

Application rates for P and K are based on the fertilizer chemical formulas P_2O_5 and K_2O, respectively. For maintenance applications of established lawns, no more than one pound of P_2O_5 or K_2O should ever be applied per TSF at any one time regardless of source including organic materials such as compost. More than 1 lb. P_2O_5 could be applied if incorporated into the soil such as during soil preparation for turf establishment. Fertilizers should never be applied just before a heavy rain or irrigation which could result in leaching or runoff. To reduce the risks of P runoff, the least amount of P should be used as possible to meet desired turf goals.

If soil test is very low for P and K, the best time to correct for these nutrients is during establishment so the nutrients can be tilled into the soil during final site preparation. This is particularly true for P since it moves so slowly through the soil. If correcting a low P or K soil on an established lawn, it may take a couple years using several applications (see below).

Choosing a Fertilizer for N, P and K – Understanding Fertilizer Grades and Ratios

Matching the right fertilizer to meet your N, P or K needs is important. Many fertilizers come as two-way or three-way mixed fertilizers. The ***fertilizer grade*** indicates the percentage of N, P and K in the fertilizer and can be determined from the three numbers found on the fertilizer bag. For example, a 30-3-6 fertilizer would have 30% N, 3% P_2O_5, and 6% K_2O. The ***fertilizer ratio*** is simply the proportion of each of these nutrients (usually rounded to the nearest whole number). The ratio of the above example would be 10-1-2.

To calculate a fertilizer ratio, simply divide each number in the fertilizer grade by the lowest number (not including zero). For example, the ratio of a 29-3-10 fertilizer grade will calculate as 9.6-1-3.3 by dividing each number by 3. On a practical basis, it would be best to round each number so the final ratio would be 10-1-3. If using a zero P fertilizer and the fertilizer grade is 29-0-10, then the ratio would be 3-0-1.

To select the most appropriate fertilizer, it is best to match the ratios of N, P and K that are recommended by the soil test to the same ratios of the fertilizer *grade* (or as close as possible). Use the same procedure to determine the soil test recommendation ratio that is used to calculate a

fertilizer ratio, by dividing the N, P and K recommendations by the lowest number. If a fertilizer cannot exactly match this ratio, then it is better to use one with a higher proportion of N relative to P and K (ie, a 3-1-1). This assures that if you are applying at the 1 lb. N per TSF rate, you will not over apply P.

For example, if your needs for maintaining an established lawn are 2 lbs. of N, 1 lb. of P_2O_5, and 1 lb. of K_2O per TSF for the year. You find a lawn maintenance fertilizer with the closest ratio that has a grade of 20-3-10. The ratio for this fertilizer is 7-1-3. You calculate that the fertilizer should be applied at 5 lbs. per TSF per application (see box below). Since 2 lbs. of N is the determined need, the fertilizer would be applied at a 1 lb. N rate twice in the season, once in late spring and once in early fall (refer to Table 1). To calculate the exact amounts of P_2O_5 or K_2O applied for the year using this regime, multiply the total amount of fertilizer applied by the percentage found in the grade for each nutrient. For example, the total fertilizer applied is 10 lbs. per TSF for the season. At that rate, a total of 0.3 lbs. of P_2O_5 and 1 lb. of K_2O were applied.

Calculating Fertlizer Rates Based on N Needs - Once a fertilizer is identified, it should be applied at the appropriate rate *to meet the N needs at a 1 lb. of N per TSF* rate per application. To calculate a fertilizer rate based on this rate, use the following equation:

Lbs. of fertilizer per TSF = 100 / N in the fertilizer grade

For example, the application rate of the bag of fertilizer with a grade of 20-3-10 would be:

100 / 20 = 5.0 lbs of fertilizer per TSF

and a 50 lb. bag would cover 10,000 square feet of turf (50 lbs / 5.0 = 10 TSF units). As another example, if the fertilizer formula only had 5% N, you would need to apply 20 lbs of fertilizer to achieve a nitrogen rate of 1 lb per 1000 square feet.

If the soil test for P or K is extremely low, it may be necessary to use a single nutrient fertilizer to meet these needs. Some common P fertilizers include *superphosphate* (16% to 21% P_2O_5) or *triple superphosphate* (40% to 47% P_2O_5). The most common K fertilizer is muriate of potash (60% to 63% K_2O). To calculate rate, divide the nutrient rate by the percentage labeled on the fertilizer bag times 100. For example, to apply 4 lbs. of K_2O using 60% muriate of potash:

(4 lbs. K_2O / 60 percent) x 100 = 6.5 lbs. of muriate of potash

Secondary Nutrients and Micronutrients

Calcium (Ca), magnesium (Mg), and sulfur (S) are secondary nutrients taken up in smaller amounts than N, P and K. In most cases, lawn turf needs little to no additional Ca or Mg as long as soil pH is adequate. Lime can come in two forms – calcium limestone which has only Ca or dolomitic limestone (which has Ca and Mg). If the soil test calls for lime but Mg is adequate, then using only calcium carbonate will usually satisfy Ca. It the soil is low in Mg, using dolomitic limestone will usually satisfy Mg needs. In the rare event that Ca or Mg is recommended for a lawn with an adequate pH, you can use gypsum as a source of Ca or Epson salt as a source of Mg. Neither of these have any liming effect on soil pH.

Sulfur (S) has not been found to be a problem for lawn turf. There are usually adequate supplies in the soil in the northeast U.S. The major time S is applied to turf is when soil pH is too high and elemental S is used to lower soil pH.

The micronutrients include iron, manganese, zinc, boron, copper, molybdenum, and chlorine and are required only in minute amounts in the plant. Most soils in the northeastern U.S. have adequate amounts of micronutrients and fertilization of these nutrients are not needed. Deficiencies can occur under rare circumstances such as when the soil pH is extremely high (above 8.0) on sandy soils which leads to some micronutrients becoming unavailable. Over application of some micronutrients can actually be toxic to turf. For instance, turfgrasses are particularly sensitive to boron if applied at too high a rate. Some micronutrients can become antagonistic to the uptake of other micronutrients. Over application of copper can lead to deficiencies of iron. So, care must be taken when applying these nutrients.

N and P Best Management Practices for Water Quality Considerations

Many parks, golf courses, and residential landscapes are located near ponds, lakes, rivers and coastal waters. These surface waters can be degraded by nutrient loss resulting from over-application or improper application of fertilizers and/or compost to home lawns and other turfgrass areas. Groundwater can also be contaminated from nutrient lost from lawns. The following is adapted from a list of recommended practices developed by a New England consortium of turf and water quality professionals (Guillard, 2008).

Recommendations for Managing Nitrogen (primarily for lawns)

- If an unfertilized lawn is considered acceptable, then do not fertilize.
- If the lawn is considered unacceptable, assess the possible reasons (pests, compaction, shade, low fertility, etc.). If fertilization is deemed necessary:
    - Do not apply before spring green-up and apply no later than September 30th. Avoid mid-summer fertilizing.
    - Apply one- half to one- third (or less) of that recommended on the fertilizer bag label and then monitor lawn response. Reapply at the reduced rate only when lawn response starts to fall below acceptability.
    - Slow- release formulations are preferable to soluble, fast- release formulations.
    - Apply a maximum of 2 lbs. N/ 1000 sq ft/ year on an established lawn 10 years old or older. Newly seeded turf, especially on new home sites where the topsoil has been removed, may require more.
    - If a soil test indicates phosphorus (P) and/ or potassium (K) are adequate, then fertilize with only nitrogen (N). If only blended fertilizers are available, choose the one with the lowest P content.
    - If near surface water (streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands, or drainage areas), leave a buffer strip of at least 25 feet of unfertilized grasses or other vegetation around water bodies.
    - Avoid using combination products that include both fertilizer and weed killers. Fertilizers with herbicides should not be applied within 25 feet of surface water.
- Other management considerations:
    - Return clippings and mow as high as possible (leave at least 3 inches). Clippings can supply slow- release nitrogen to the lawn and allow for reduced fertilizer applications.
    - Choose grasses, such as fescues, that require less water and nutrient inputs.
    - Maintain soil pH levels between 6.0 and 7.0.
    - Consider seeding white clover or other legumes into the lawn to naturally provide nitrogen.
    - If supplemental watering is applied, avoid overwatering. Do not exceed a total of 1- 1 ½ inches of water per week, including rainfall amounts.

- When establishing a new lawn, if organic matter is below 3%, incorporate compost or another organic material into the soil to raise the % of organic matter content to at least 3%, preferably 5%.

Recommendations for Managing Phosphorus (primarily for Lawns)

- If an unfertilized lawn is considered acceptable, then do not fertilize.
- Always test the soil to determine phosphorus levels before applying.
- If phosphorus fertilizer is required:
  - Avoid using P fertilizers on bare ground or on low- density lawns, unless it is a new seeding.
  - Use P- free fertilizer on established lawns, unless soil tests indicate P is too low.
  - Avoid applying phosphorus fertilizers when moderate to heavy rain is in the forecast.
  - Leave a buffer strip of unfertilized grasses or other vegetation around bodies of water.
  - Never apply phosphorus fertilizers to saturated or frozen ground.
  - Avoid using products that include both fertilizers and weed killers as the application rates of such products are based on the weed killer rather than the fertilizer.
- Other management considerations:
  - Return clippings where practical. On a well- established lawn, this can often supply adequate P for the lawn.
  - Maintain a soil pH of 6.0 to 7.0. This will ensure that most of the nutrients necessary for good turfgrass growth will be available to the grass plants. Monitor pH levels to determine if liming is necessary or not.
  - Soil test annually for P when applying organic fertilizers derived from composts to ensure that P levels do not become excessive.

References

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Dec/2015