

The Importance of pH... More Than Likely Your Soil Needs Lime

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Your prospects of receiving a grade of 'A+' from your clientele in your 2005 job performance can be enhanced by taking part in a very important test this fall/winter season. And no, I am not talking about a good score on the ACTs, SAT's, or other college preparatory exams. This is an easy one—a soil test!

When is the last time your soil was tested? In Virginia, it is recommended to soil test every 3 years, with the more frequent testing required for the sandier soils in Eastern VA and the less frequent tests on the higher clay content soils of the Piedmont and west. Sand-based golf greens and athletic fields should be tested once per season because of their low nutrient holding capacity.

Any time is the right time to soil test, but the fall and winter months are ideal because maintenance activities are not as hectic as they were just a few months ago. In addition, due to the parent material of the soil, the climate in this region, and the fertility programs employed on turf, soil pH is typically lower than desired. Since it takes weeks to months to gain the desired pH adjustment from lime applications, the fall and winter months provide an opportunity to take advantage of slow but sure soil chemical reactions that will benefit the turf next spring.

The proper steps in sampling.

- 1) How many samples should be taken? The value of the test is only as good as the sample submitted, so common sense goes a long way towards soil testing success. In the past I have been asked to review a single soil test report taken across 19 greens at a golf course. Further confounding the situation, this course had 10 sand-based greens and 9 native soil greens. What was the value of the soil test? Zero. I had to tactfully indicate to the clientele that instead of the \$6 spent on a single sample from all their greens, it really was important that they opened up their pocketbooks and paid a total of \$114 to do them each individually! Golf greens and tees (at minimum, tee complexes) must be sampled individually in order to have meaning. Since the cost of a soil test is so inexpensive for its value, don't pinch pennies when it comes to sampling. More extensive sampling is always preferable to less.

For a typical homelawn or industrial turf setting, divide the landscape into logical sections (e.g. front, back, or side lawns, etc.). Larger acreages should also be split into known areas to improve the value of test results.

Dividing athletic fields (north and south halves of a football field, infield/outfield for baseball, etc.) is logical. Similarly, split large acreage golf fairways into logical areas, paying attention to changes in terrain (elevation, drainage, vegetation, etc.) as a basis for the divisions.

- 2) How is a sample taken? A soil probe designed for soil sampling is certainly an ideal instrument, but a spade, shovel, or garden trowel can work just fine. The first thing to consider is the appropriate depth of the sample. Soil test analyses are typically conducted on the basis of a 6" deep slice of soil (typically called an acre furrow slice). Therefore, the common recommendation for turf soil samples is a 4-6" depth, an area that is occupied by the majority of that plant's root system. Ensure the digging instrument is clean (e.g. not rusty) and collect 12-20 samples from the area in a plastic bucket (preferred over a galvanized metal bucket that might lead to higher than expected metal levels in the sample). Remove any thatch or mat layer from the top of the sample. Mix the sub-samples together into a single composite sample and place this in a soil test box obtained from the local extension office or from a private lab. There will also be forms requesting contact information, sample identification criteria, and the turf being grown at this location (if using the Virginia Tech laboratory, these forms, pricing information, and important links further describing soil testing procedures can be found at www.cses.vt.edu/html/soiltest.html).
- 3) Sample problem areas separately. This is logical as well, especially if one is playing detective and trying to figure out why the turf in a particular location is not performing up to expectations. What are some potential problem areas to avoid in sampling? Samples collected near areas where pets do their "business" (I am going to assume you know what I mean) will provide very strange nutrient and soluble salt values. Soil taken from areas that had a recent fertilizer spill will similarly skew the results. During this time of year it is particularly important to avoid sampling from areas around the ash pile where debris from wood-burning stoves and fireplaces are being tossed. There are many other situations that can similarly lead to wasting hard-earned money on what will be prove to be worthless results.

What kind of information will be received on a soil test report? This varies somewhat between labs, but generally levels and recommendations for pH, phosphorus, potassium, calcium, magnesium, zinc, and manganese will be reported. For Virginia Tech's lab, there is a small additional fee for testing of soluble salts and organic matter. Soil nitrogen (N) levels (if provided) will not have much meaning over time. Nitrogen is a very dynamic nutrient in the soil and is constantly changing in form. For this reason, most labs do not provide

soil N test results, but will offer N fertilization recommendations based on the grass and management situation indicated on the sample form.

Putting the test results to work. By soil testing in the fall and winter you will be submitting samples when the activity in soil testing labs is lower than it typically will be in the spring when a large number of samples from crop fields will be submitted. During the off-season expect to have test results returned within 2-10 days depending on the lab. Some services offer faxed results as an option, while others will post them on the web or use e-mail notification. Another advantage to fall/winter testing is that you have the most important information required in order to plan for next year's fertility program.

All the data received is important, but soil pH is probably the most critical information on the report. Why? Having an adequate pH is the single most important soil chemical property governing nutrient availability (Figure 1). Highly alkaline or acidic soils can result in either excessive or insufficient quantities of nutrients, and some nutrients (such as a macronutrient like phosphorus) have declining plant availability at both acid and alkaline pHs. The chart helps reinforce why slightly acidic pH's are deemed desirable for turfgrass management since nutrient availability is maximized.

I can cite the following example to emphasize how important pH is in nutrient availability. A golf course battling algae on their putting greens had witnessed a steady decline in their bentgrass turf over the summer months that could not be attributed to disease or nematode pressure. Cutting heights were raised, cultivation programs to improve drainage and reduce compaction were employed, but the quality of turf continued to decline. When I asked for a soil test report I was informed that they had not tested their soil for a few years, so I immediately got them to do a soil test. When the data came back, the pH was near 5.0 and the levels of manganese and zinc were astronomical, to the point that phytotoxicity from these micronutrients was a likely culprit in their poor turf quality. It did not take long to figure out that the source of the elements was not from their fertility program, but instead from very frequent applications of selected fungicides containing manganese and zinc that were being sprayed to combat the algae. Now, knowing what the problem was, how were the manganese and zinc going to be removed from the soil? My short answer (to their immediate dismay) was it essentially could not be removed. However, I told them they need not despair because we could apply the science of chemistry to manage their problem. I suppose they were expecting some exotic compound or technique to be used because they were clearly unimpressed when I said the solution was lime. However, this cheap, seemingly innocuous treatment to raise pH was exactly what solved the problem. It effectively converted the excessive amounts of soluble, plant-available forms of manganese and zinc to more plant-

unavailable forms instead. By getting soil pH's up to 6.5 the turf quality showed steady improvement over the next few weeks.

More on liming sources. If pH is significantly low the soil test will recommend a lime application, likely either calcium and/or magnesium carbonate. The plant and soil could care less about the source of the lime. Agricultural grade lime works fine for liming turfgrasses, but the large particles are often unacceptable either for playing quality of sports turfs or for overall aesthetics. Agricultural grade lime is very affordable and it is sensible to consider its use in areas where particle size is not an issue. However, for most fine turf situations, either pulverized (i.e. powdered) or pelletized forms of lime are preferred because the material can be quickly washed off the leaf surface and into the soil. The pulverized form is very much like a finely ground powder or dust, while the pelletized form is comprised of aggregates of the same powder that have been bound together with lignosulfates (essentially a water soluble glue). The glue is either solubilized or broken down microbially over time. The pelletized form provides definite advantages in handling and application, but will be significantly more expensive than ag lime sources.

There are two liming sources that can affect a change in soil pH very quickly: calcium oxide (true lime) and calcium hydroxide. Neither is likely to be used on existing turfs as are the carbonate forms because they are caustic, difficult to handle, and have high foliar burn potential on the grass. However, the high reactivity of these materials makes them effective liming sources for rapidly raising soil pH's if they can be incorporated into the soil prior to turf establishment.

Other considerations in choosing a liming source. Pay attention to the Calcium Carbonate Equivalent (CCE), a percentage value found on the bag label that describes purity and/or acid neutralizing values of liming sources (Table 1). Pure calcium carbonate (CaCO_3) has a CCE of 100%. Don't be alarmed when you find that most sources of CaCO_3 will have CCEs of 90-98% (the values are lower because of small amounts of impurities in the liming source). Another point to realize is that depending on the liming source, it is very possible that CCE's will exceed 100%. Note that the neutralizing values for magnesium carbonate (MgCO_3), dolomitic limestone [$\text{CaMg}(\text{CO}_3)_2$], calcium hydroxide (CaOH_2), and calcium oxide (CaO) are all greater than 100% (Table 1). How can a neutralizing value be greater than 100%? Consider MgCO_3 for the explanation. Based on their chemical properties as liming agents, CaCO_3 and MgCO_3 have the same acid neutralizing capacity. However, the molecular weight of MgCO_3 is 84, whereas that of CaCO_3 is 100. This means that 84 parts of MgCO_3 will neutralize the same amount of acidity as 100 parts of CaCO_3 . In mathematical terms, $100/84 = 1.19$ times more neutralizing value for equal amounts of MgCO_3 than CaCO_3 (or 119% CCE). You can apply this information in the selection and

application of the lime source. For instance, if the soil test recommendation indicates that 50 lbs of CaCO_3 is recommended per 1000 sq ft (the recommendation is on the basis of pure CaCO_3), and the lime source available has a CCE of 90%, 55.5 lbs of the source ($50 \text{ lbs}/0.9 = 55.5 \text{ lbs}$) per 1000 sq ft will be necessary for the recommended liming rate. Conversely, if dolomitic limestone (with a CCE on the label of 109%) is selected, only 46 pounds/1000 sq ft ($50 \text{ lbs}/1.09 = 46 \text{ lbs}$) are required.

Does pelletized lime react faster than other lime sources? This is something that I always thought was true—until I started to research the topic more extensively. Particle size of the liming material certainly plays an important role in how fast the change in pH will occur. Smaller particles have much greater surface area than larger particles, and are going to react faster. This makes perfect sense in terms of the rate of reaction of pulverized (i.e. powdered) limestone, but how about the pelletized forms that have the limestone dust particles glued together? Research at several universities has shown that ag-grade lime with all of its different sized particles reacts as quickly (and in some cases quicker) than pelletized lime sources. Dr. Lloyd Murdock, Extension Soils Specialist at the University of Kentucky explains it as the result of two factors: 1) some time is involved in the solubilization and microbial breakdown of the glue in the pellet, and 2) the pelletized lime is concentrated in zones across the turf, rather than the more uniform distribution over the entire area from the composite of dust and larger particles in the ag-grade lime source. This shows again that while every situation in turf management is not appropriate for ag-grade lime applications, there are lower maintenance turf situations for which it is likely not necessary to pay extra for more expensive lime sources.

What are typical lime application rates? Most lime recommendations will not exceed 50 lbs/1000 sq ft per application. If more is required, it is usually recommended that the application be split over 8-12 week periods. Since foliar burn potential is greatly reduced in the cooler periods of fall and winter, the higher application rates are of much less concern for turf at this time of year. Taking this one step further, if warm-season turfgrasses require lime, there is essentially no foliar burn potential because the turf is dormant. The only possible concerns would be if very high rates of more soluble lime sources are made right before dormancy break in the spring.

Summary. There is some very powerful chemistry at work in soil testing. It is not necessary for turf managers to know exactly what extractions and procedures occur in the lab, but you should be aware that all testing laboratories do not use the same chemicals to analyze the soil. Thus, slightly different numbers may be reported back for nutrient levels for the same soil. There are lots of claims made regarding soil test analyses procedures and how one technique is superior to others. Each procedure has its own merit depending on

the situation. However, I have always found that while the numbers received in a report regarding pounds per acre and parts per million are obviously important, it is ultimately the explanation and interpretation of the results, and the reliability of the recommendation that matters most.

The phrase at the bottom of the Virginia Tech Soil Testing Laboratory's web site sums up the strategy for the best way to make a passing grade with your turf next year:

Don't guess, soil test!

Lime material	Neutralizing value (%)
CaO (calcium oxide)	179
Ca(OH) ₂ (calcium hydroxide)	136
MgCO ₃ (magnesium carbonate)	119
CaMg(CO ₃) ₂ (dolomitic limestone)	109
CaCO ₃ (calcium carbonate)	100

From "Soil Fertility and Fertilizers", 3rd Edition, Tisdale and Nelson

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