Determining Lime Requirement by On-Site Soil Testing with pH Indicator Strips

Introduction

The current VDOT Nutrient Management Plan allows Roadside Managers to forgo soil testing if the size of the area to be vegetated is less than 2 acres and subsoil materials are exposed. The amount of lime allowed is set at 2 tons/A. However, in some areas this amount of lime may be not needed if the soil pH is between 6.0-6.5. Applying additional lime to soils with adequate pH will force the pH above the recommended level which can also be harmful to plant uptake of certain nutrients, and is costly.

It is easy to test soil pH on-site and to calculate how much lime to apply. This protocol will explain how this is done.

Background Information

The soil pH is the amount of “active” acidity in the water that surrounds soil particles. It is a direct measure of the hydrogen ion concentration in a soil:water slurry. This is referred to as “Water pH,” and it is determined by suspending soil into distilled water on a 1:1, volume to volume ratio. This is what you will be measuring when you perform an on-site pH test.

However, you should be aware that when you send soil to an approved soil testing laboratory, they will perform both the “Water pH” test as well as “Buffer pH” tests*. The latter test measures the total acidity that is in the soil solution, which includes “active” and “residual” acidity, but the pH value itself is meaningless with respect to actual soil pH. The Buffer pH test is a more exact predictor of how much lime is required to neutralize the hydrogen ions. This test also “self-adjusts” for different types of soil texture. When doing an on-site pH test using indicator strips with distilled water, you are performing the “water” pH test. The next step is to calculate the amount of lime required by the use of two tables which account for soil texture and different liming agents.

For more information, check out these sites:

http://www.uky.edu/Ag/ukturf/pubs.htg/Lawn%20Care/id72.htm
http://extension.agron.iastate.edu/soilfertility/presentations/soilphliming04.pdf

* *As a side note, some labs use a Mehlich buffer solution to perform this test.*

Supplies Needed for On-Site Soil Water pH Test

1) **Small Paper Cup**

2) **1/8th Cup Dry Measure & 1 Cup Wet Measure**

Dry Measure

Wet Measure

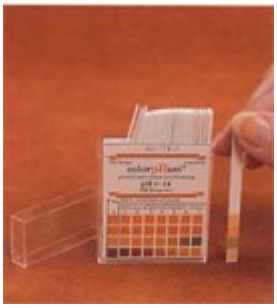
3) **Jug of Distilled Water from Grocery Store or Pharmacy**

4) **Disposable Straw or Coffee Stir Straw**

5) **pH Indicator Strips - Wide Range**
Whatman 53280 (4.5-10) Color-Bonded pH Strips 100 for $19 (do not need to use this if you use the ColorpHast brand)

6) **pH Indicator Strips - Narrow Range**
ColorpHast by Merck comes in various ranges, but buy the narrow range 4-7. They cost around $18/100 strips. With this brand you do not need the broad range (1-14).
http://www.sanitationtools.com/Products.asp?Product=1438&Category=65

Whatman 53283 Integral Comparison Strips 3.8-5.5 range, 0.2 pH units
53284 Integral Comparison Strips 5.2-6.8 range, 0.2 pH units
200 strips for $30
http://www.labsafety.com/search/pH+indicator+strips/34548/
These are more accurate, but need to use the wide range strips to determine the range to decide which narrow range strip to use.



Protocol for On-Site Soil Water pH Test

1. Sample the area to be seeded in the prescribed zig-zag pattern as described in the Nutrient Management Plan. Take all 20 sub-samples and mix them in a bucket (paint bucket works well). Remove rocks, vegetation, bark, debris. From the well-mixed soil, remove a scoop with the 1/8th cup dry measuring cup. Pack down the soil with light pressure and take a knife to level off the top.
2. Add the soil to the disposable cup. Pour 1/8th of a cup of ***Distilled*** water into the wet measuring cup. Add this to the cup and use the stir straw to mix for about 30 seconds or until all soil is wet.
3. The solid should sink to the bottom. The liquid may be brown, but that is fine. Take a wide range strip (unless you are using the colorpHast brand) and dip the color end into the solution. You may need to tilt the cup gently to have enough liquid to submerge the strip. Count to 10 and pull out. If the tape is covered in dirt, use a tissue to gently wipe off the dirt. Then compare the colors on the tape to that on the box. If you do not feel confident with the result, dip a new strip.
4. Now you should have a ball-park estimate of the water pH of the soil. Test the solution with the narrow-range strip to get a more accurate reading.
5. The next step is to calculate how much lime is required to raise the pH between 6.0-6.5.

Calculating The Lime Rate

1. You need two pieces of information to do this part. You need the WATER pH that you determined prior to this part, and you need to know the soil's texture which is then used to estimate soil charge or CEC.
2. Soil texture can be determined in a soil testing laboratory, but also can be done by the feel of the soil in your hand. If you have never done this before, find someone who has and ask them for a lesson. Once you do this a couple of times, you will readily be able to estimate the general soil texture class for this purpose. Generally, soils with sand, loamy sand, coarse sandy loam have CEC between 2-5 meq/100g soil. The CEC of soils with fine sandy loam, loam, silt loam is between 5-15. And the CEC of soils with clay, clay loam will be greater than 15. In other words, the finer the soil particles, the higher the CEC, and more lime will be required to satisfy the total acidity present.
3. Use Tables 1 & 2 on the next two pages to determine how much lime must be applied to raise the pH between 6.0-6.5.
4. Lime will remain active in the soil for 2 to 3 years. If lime was previously applied to the soil with in this period and the pH is close to 6.0 (+/- 0.2) there is no need to apply more at this time.

Table 1. Amount of Lime (assume CCE at 100%)* to Raise Soil pH to 6.5 by Soil Texture and Water pH			
Sandy Texture			
Water pH**	**lb/1000 sq ft**	**lb/A**	**T/A**
4.8***	135	5,880	2.94
5.0	120	5,230	2.61
5.5	80	3,480	1.74
6.0	45	1,960	0.98
Loamy Texture			
Water pH	**lb/1000 sq ft**	**lb/A**	**T/A**
4.8	180	7,8401	3.92
5.0	145	6,316	3.16
5.5	85	3,703	1.85
6.0	60	2,614	1.31
Clayey Texture			
Water pH	**lb/1000 sq ft**	**lb/A**	**T/A**
4.8	200	8,712	4.36
5.0	170	7,405	3.70
5.5	110	4,792	2.40
6.0	70	3,049	1.52

*Not all liming materials are the same. Pure calcium carbonate (calcite, CaCo3) is the standard agricultural limestone product and its calcium carbonate equivalent (CCE) and its “Neutralizing Value” (NV) are both 100%. Most liming products NV is between 85-90%.

Some products such as dolomitic limestone contains both calcium carbonate and magnesium carbonate. Its NV is between 108-195%, and less dolomite is needed compared to pure calcite . Therefore, it is necessary to know the “Neutralizing Value” of the product because you may need to apply more or less than indicated in Table 1.

**There are gaps between water pH values in this chart. If the water pH value is between numbers, round the pH down. For example, if the water pH value you measured with the pH indicator strip is 5.2 in Clayey soil, then apply 3.70 tons/A of limestone with NV of 100%.

*** If the pH value is **less than 4.0**, then this may be **sulfidic materials** you are dealing with. Liming recommendations must be based of reactive potential acidity on acid-base accounting. Consult Lee Daniels at Virginia Tech for more information (http://www.cses.vt.edu/revegetation/remediation.html)

Calculating Amount of Lime to Apply When the CCE/NV is Not 100%

Table 2 is from DCR's Nutrient Management Standards and Criteria (2005) and provides an easy way to calculate how much lime based on NV/CCE to apply. The left hand column provides the amount of lime (T/A) needed as directed in Table 1. In the top row, find the NV or CCE of your lime. Now you can determine in T/A how much of your specific lime product to apply.

Table 2.Lime Applications Rate Adjustment Based on % CCE (NV) of Material

	% CCE of Liming Material										
T/A lime from Table 1	50	60	70	80	90	100	110	120	130	140	150
0.5	1.00	0.75	0.75	0.75	0.50	0.50	0.50	0.50	0.50	0.25	0.25
1.0	2.00	1.75	1.50	1.25	1.00	1.00	1.00	0.75	0.75	0.75	0.75
1.5	3.00	2.50	2.25	2.00	1.75	1.50	1.25	1.25	1.25	1.00	1.00
2.0	4.00	3.25	2.75	2.50	2.25	2.00	1.75	1.75	1.50	1.50	1.25
2.5	5.00	4.25	3.50	3.25	2.75	2.50	2.25	2.00	2.00	1.75	1.75
3.0	6.00	5.00	4.25	3.75	3.25	3.00	2.75	2.50	2.25	2.25	2.00
3.5	7.00	5.75	5.00	4.50	4.00	3.50	3.25	3.00	2.75	2.50	2.25
4.0	8.00	6.75	5.75	5.00	4.50	4.00	3.75	3.25	3.00	2.75	2.75

Conclusion

At this point you should know how much lime should be added to adjust the pH of the soil to the desired level. You should know how much of the specific liming agent to use based on CCE/NV.

If you have questions, please contact W. Lee Daniels at Virginia Tech, Dept CSES - 540-231-7175 or wdaniels@vt.edu