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Liming Acid Soils

The degree of the soil acidity has a direct influence on the quantity and quality of a crop. An acid soil can restrict the root and top growth of plants, reduce the availability of plant nutrients, decrease desirable biological activity, and increase the availability of toxic elements in the soil. If soil acidity is not managed properly, full benefit of other expensive and time-consuming soil management practices cannot be realized.

What is an acid soil? Soil and organic matter particles that hold high concentrations of hydrogen or aluminum, or both, cause a soil to become acidic. The soil and organic matter particles carry a negative charge that holds or absorbs such positive elements as hydrogen, calcium, magnesium, potassium, sodium, and aluminum. Soils vary in their ability to hold these positive elements. The total amount of elements that can be held by the soil and organic matter particles is known as the soil's cation exchange capacity.

The term "pH" refers to the degree of acidity of a soil. The pH of soil indicates the concentration of hydrogen ions held on the clay and organic matter particles. A pH of 7.0 is neutral; below 7.0 is acid, and above 7.0, alkaline. The lower the pH (below 7.0), the more acid the soil. The higher the pH (above 7.0), the more alkaline the soil. A soil with a pH of 5.0 is 10 times more acid than one with a pH of 6.0, and 100 times more acid than one with a pH of 7.0.

What causes acid soil conditions? Soil acidity develops gradually in humid regions as abundant precipitation percolates through the soil, carrying dissolved nutrients below the root zone. (This is called leaching.) Growing plants also remove calcium and magnesium from the soil. The lost calcium and magnesium is replaced by hydrogen and aluminum, resulting in increased soil acidity. The use of acid-forming fertilizers also contributes to soil acidity.

How is soil acidity corrected? Soil acidity can be corrected when hydrogen or aluminum held by soil and organic matter particles are replaced with calcium or magnesium. Finely ground limestone is one of the most commonly used materials. If calcium is the only element needed, calcitic limestone is used. If magnesium is also needed, dolomitic limestone is used.

Maintaining the proper soil pH is as important for maximum crop yields as fertilizing, watering, and pest control***. The decision to lime and the amount to apply must be based on a soil pH test and the crop species to be grown.*** Do not guess. Some plants, like rhododendrons, azaleas, and blueberries as well as other members of the Ericaceae family grow best in acid soil (pH 5.0). Most vegetable garden plants grow best in soil with a pH in the 6.2 range. The recommended range for a lawn is between 6.0 to 7.0.

What does limestone do? Limestone corrects soil acidity, supplies calcium or magnesium, or both, improves the availability of some plant nutrients, promotes desirable biological activity, and improves the structure of some soils. Proper liming combined with other desirable soil management practices usually brings increased yields and better quality crops.

As shown in **Figure 1**, the availability of plant nutrients changes as the soil pH is increased or decreased. Over-liming, especially of sandy soils low in organic matter, can reduce yields of some crops by markedly reducing the availability of some nutrient elements. It is difficult to lower the pH of a soil that has been over-limed. If a soil test indicates the soil pH is too high recommendations will be made on how to try and lower the pH level.

What can be used as a liming material? The type of liming material one chooses is generally determined by the need for magnesium, availability, cost, rate of reaction with soil, and ease of handling and storage.

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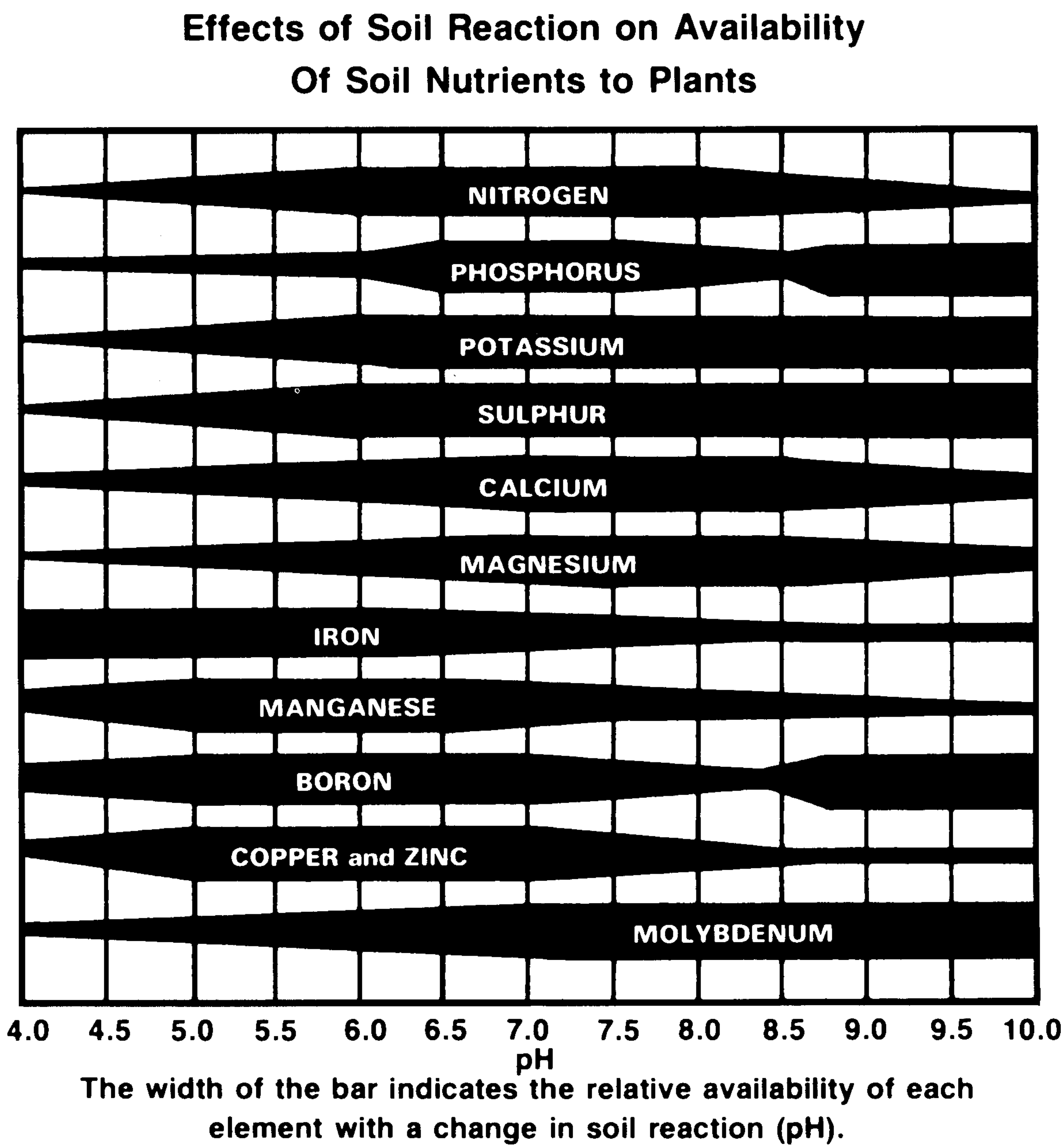

Figure 1. Shows how nutrient availability in soil changes at various soil pH ranges

Some common forms of liming materials and their characteristics, which are used in home lawns and gardens are calcic limestone (almost entirely calcium carbonate), dolomitic limestone (contains up to 50% magnesium carbonate) and dolomite limestone (almost entirely magnesium carbonate).

Effective neutralizing value of limestone. The effectiveness of a liming material in correcting soil acidity is determined by its neutralizing value or power (ENV). Pure calcium carbonate has a neutralizing power of 100;

other liming materials are compared on a percentage basis with pure calcium carbonate. Limestone recommendations are based on a product with 100% ENV.

Because of impurities and other forms of carbonates in liming materials, the neutralizing power of commercial products can range from 50 to 200 percent. Most high-calcium limestones have a neutralizing power between 75 and 95 percent. When a material contains appreciable amounts of magnesium carbonate, calcium hydrozide, calcium oxide, or magnesium oxide, the neutralizing power will be greater than 100 percent.

The information required for determining ENV is found on the limestone bag (**Figure 2**). This information is required by law to be on the label for bagged material. The actual ENV may or may not be on the label. If it is not listed you can calculate the ENV of the product you have by inserting the information listed on the bag into the "ENV score card" which is illustrated in **Figure 3** on page 4. Once you figure out the Weight Equivalent to 100% ENV you can multiply this figure by the number of pounds of limestone that was recommended in your soil test report.

Lawn and Garden Limestone

MINIMUM GUARANTEED ANALYSIS

Calcium Carbonate ($CaCO_3$)--------- 54.0%
Calcium Oxide (CaO) ---------------- 30.0%
Elemental Calcium -------------------- 21.4%
Magnesium Carbonate ($MgCO_3$)---- 44.0%
Magnesium Oxide (MgO)------------ 20.0%
Elemental Magnesium (Mg)--------- 12.0%

NEUTRALIZING VALUE

Total Calcium Carbonate
($CaCO_3$) Equivalent---------------------- 104.0%
Calcium Carbonate ($CaCO_3$)
Equivalent from Magnesium
Sources--------------------------- 50.0%
Calcium Oxide (CaO) Equivalent------ 57.0%

FINENESS

% Through No. 20 U.S. Standard Sieve ---------- 98.0%
% Through No. 60 U.S. Standard Sieve ---------- 60.0%
% Through No. 100 U.S. Standard Sieve --------- 40.0%

Figure 2. An example of the information found on the label attached to a limestone product.

Soil test recommendations. Let's say you have your soil tested and the pH is 5.5. The soil is from a vegetable garden and the recommendation calls for 75 lbs. of limestone per 1000 sq. ft. to raise the soil pH to 6.2. The limestone product used is illustrated in Figure 2. Based on the "Limestone ScoreCard" calculation in Figure 3 it has been determined that the *weight equivalent to 100% ENV* of this product is **1.35**. Therefore multiply 75 lbs. (the rate of limestone recommended in the soil test report) by 1.35 (the weight equivalent to 100% ENV) which equals 101.25 lbs. This is the actual rate of limestone that is needed to raise the present soil pH of 5.5 to 6.2, a 26.25-lb. increase.

When and how should limestone be applied? Generally, limestone can be applied anytime the soil is not too wet to drive or walk on. However, since limestone should be thoroughly mixed with the surface soil for maximum effectiveness, the best procedure is surface application followed by rototilling, spading under, or double- digging. For land that is not tilled, limestone should be applied in early spring when freezing and thawing are taking place or in the fall after a long, dry period. If the soil test shows that pH should be increased substantially, the limestone should be applied at least three or four months before it is needed by the crop to allow sufficient time for reaction with the soil.

Instructions for filling out the "Limestone Score Card":

Line 1. Enter the % limestone passing 100-mesh sieve.

Line 2. A. Enter % passing 20-mesh sieve.
B. Enter % passing 60-mesh sieve.
C. Subtract values on 2B. from 2A. and enter here.
D. Multiply value on Line 2C. by 0.40 (40% of the particles are assumed to have reacted) and enter the result.

Line 3. A. Enter % passing 60-mesh sieve (same as line 2B.).
B. Enter % passing 100-mesh sieve (same as Line 1).
C. Subtract 3B. from 3A. and enter here.
D. Multiply value on Line 3C. by 0.80 (80% of the particles are assumed to have reacted) and enter the result.

Line 4. Add Lines 1, 2D., and 3D. and enter the sum on Line 4.

Line 5. Enter the total calcium carbonate equivalence (CCE) in decimal form (i.e. CCE divided by 100).

Line 6. Multiply Line 4 by Line 5 and enter the answer on Line 6. This is the ENV.

Line 7. Divide 100 by the ENV (Line 6) and enter this on Line 7. This is the quantity of this limestone required to equal 1 unit (i.e. one pound) of 100% ENV.

Score Card (example)

1.	Passing 100- mesh		40.0
2. A.	Passing 20-mesh	98.0	
2. B.	Passing 60-mess	60.0	
2. C.	Line 2A. minus Line 2B.	38.0	
2. D.	Line 2C X 0.40		15.2
3. A.	Passing 60-mesh	60.0	
3. B.	Passing 100-mesh	40.0	
3. C.	Line 3A. minus Line3B	20	
3. D.	Line 3C X 0.80		16.0
4.	Line 1 + Line 2D + Line 3D		71.2
5.	%CCE divided by 100		1.04
6.	Line 4 X Line 5		74.048 = ENV
7.	100 divided by Line 7		1.35 = Weight equivalent to 100% ENV

Figure 3. – An example of a "Limestone Score Card" filled in to calculate the ENV of the limestone product (Lawn and Garden Limestone) illustrated in Figure 2.

Resource: *Liming Acid Soils*, Agriculture Fact Sheet 4-5-4, by J.W. Schwartz and R.F. Follet, Soil Scientist, USDA, Science and Education Administration, 2/79; and *Cornell Field Crops and Soils Handbook*, A Cornell Cooperative Extension Publication, 2nd Edition, rev. 10/87.

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