Liming Materials

Introduction

A liming material can bring the pH of a soil to optimum levels for crop production if used properly. Liming materials also provide calcium (Ca) and/or magnesium (Mg) to the soil for plant uptake. In Agronomy Fact Sheets 5 and 6, soil pH and lime recommendations were discussed. In this Fact Sheet, considerations of quality, cost, availability, and material handling will be discussed to enable selection of the liming material that best fits the lime requirements of the farm.

Liming Material Quality Parameters

Materials that can cause an increase in pH include carbonates, oxides or hydroxides of calcium and magnesium. When looking at liming materials it is often hard to distinguish one material from another. Quality standards used to differentiate liming materials include Total Neutralizing Value (TNV), Calcium Carbonate Equivalence (CCE), Fineness, and Effective Neutralizing Value (ENV). Water is sometimes added to dry limestone to improve the handling characteristics of the ground limestone. The moisture content of agricultural limestone does not influence its effectiveness but a moisture content between 4 and 5% will improve the spreading uniformity and reduces the off site movement of very fine particles (<100 mesh).

Total Neutralizing Value (TNV)

This is the percentage of the material that can neutralize acid expressed as the calcium carbonate equivalence (CCE) of the product.

Calcium Carbonate Equivalence (CCE)

This standard compares the liming material to pure calcium carbonate ($CaCO_3$). Some materials such as hydrated lime and burned lime will have a CCE higher than 100%. Pure magnesium carbonate ($MgCO_3$) will neutralize about 1.2 times more acidity than $CaCO_3$ so dolomitic limestone will have a higher CCE than calcitic limestone (Table 7). All liming materials include some inert material that will not be able to increase the pH of the soil. The inclusion of such inert material will reduce the CCE of the material as compared to pure materials.

Table 1: Calcium carbonate equivalent (CCE) of a few common liming materials.

Common name	Chemical formula	CCE
Calcitic limestone	$CaCO_3$	100
Dolomitic limestone	$CaMg(CO_3)_2$	109
Burned lime, quick lime	CaO	179
Hydrated or slaked lime	$Ca(OH)_2$	136

Assuming 100% pure material.

Fineness

The rate of reaction of a liming material is determined by the particle sizes of the material; 100% of lime particles passing a 100-mesh screen will react within the 1st year while only 60% of the liming materials passing a 20-mesh sieve (but held on 100 mesh sieve) will react within a year of application. Material that does not pass the 20 mesh sieve is not expected to react within a 1 year following application. So, to be of practical use, limestone CCE equivalents need to be adjusted for the fineness of the material. To determine the fineness of a limestone the following calculations need to be done:

- Subtract the % passing a 100 mesh sieve from the % passing a 20 mesh sieve and multiply this difference with 0.60.
- Add the % passing the 100 mesh sieve and divide the sum by 100.

Thus, the fineness of a material of which 70% passes a 100 mesh sieve and 97% passes a 20 mesh sieve is {(97-70)*0.60 +70}/100=0.86.

Effective Neutralizing Value (ENV)

The ENV is the fraction of the material's CCE that will react with soil acidity in the first year of application. The ENV is calculated by multiplying a liming material's CCE and its fineness. As an example: a liming material with CCE of 90% and a fineness of 0.86 has an ENV of 90*0.86= 77.4.

Liming Material Identification

In New York, the Department of Agriculture and Markets (NYSDAM) regulates agricultural liming materials. Liming materials are defined as "all materials and all calcium and magnesium products in the oxide, hydrate, carbonate, silicate form or combinations thereof and intended for use in the correction of soil acidity…". Liming materials must be registered with the NYSDAM. This process ensures that the product will meet minimum quality standards set by NYSDAM: a liming material must have ≥60% CCE, ≥80% must pass a 20 mesh sieve, and ≥30% should pass a 100 mesh sieve (this implies the ENV should be ≥36%). Liming materials sold in bags must have a label that includes:

- Name and address of the company registering the product.
- Brand name.
- Type of material (limestone, marl, oxide, hydrate, shells, industrial by-products).
- TNV as expressed by the CCE.
- Minimum fineness at delivery.
- Amount and types of foreign material in the package if any.
- If the product has been damaged or otherwise changed after original packaging, a label must be provided explaining the kind and degree of alteration.
- Net weight being sold.
- A guarantee of the weight % of Ca and Mg.
- Particle size distribution (100, 20 mesh).

Materials sold in bulk must have:

- A guarantee of the %ENV.
- The weight of the bulk material necessary to equal one ton of lime with 100% ENV.

Various Liming Materials

Ground limestone is usually mined and then pulverized or ground into finer particle sizes to increase the ENV of the material. Ground limestone usually contains $CaCO_3$ and some impurities. However, some limestones will also include $MgCO_3$. Ground limestones make up the majority of lime that is sold in NY. Ground limestone with less than 1-6% Mg is called "calcitic limestone". If the limestone has 6% Mg or more it is called "Dolomitic Limestone".

Burned lime (also called quicklime) is ground limestone that has been exposed to high temperatures to remove carbon dioxide. Calcium oxide (CaO) is what remains after the process. Pure calcium oxide has a CCE of 178% and reacts quickly (powdery lime material). Magnesium oxide (MgO) will also be present if it was present in the ground limestone prior to being cooked. Burned lime must be handled carefully as it quickly reacts with water creating hydrated lime and releasing large amounts of heat.

Hydrated lime is calcium hydroxide ($Ca(OH)_2$). This is a very fast acting and powdery lime material. This material is caustic and can easily burn plants that are already established. Finely ground hydrated lime can have an ENV of 120-135% and if too much is applied the soil pH could quickly rise beyond the targeted pH.

Marls are composed of sea shell fragments, and $CaCO_3$. They are often found and used around coastal areas. Marls tend to react similarly to ground limestones.

Cost Effectiveness

The best way to economically compare two lime products is to look at the cost per ton of ENV obtained by dividing the cost per ton of limestone by the ENV. If the ENV is not listed (as is the case with some packaged lime products) the ENV needs to be calculated from the CCE and particle size distribution.

In Summary

Liming materials vary greatly in quality. To select the most economic liming material, compare products based on cost per ton ENV.

Additional Resources:

- Agronomy Fact Sheet #1 (Soil sampling), #5 (Soil pH); #7 (Lime recommendations for field crops): http://nmsp.css.cornell.edu/publications/factsheets.asp
- Lime guidelines for field crops in New York: http://nmsp.css.cornell.edu/nutrient_guidelines/.

For more information

Cornell University
Cooperative Extension

Nutrient Management Spear Program
http://nmsp.css.cornell.edu

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