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Calculating the Value of Lime

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Introduction

Correcting low soil pH is an important part of growing agronomic crops. In South Carolina, most soils are naturally acidic and agricultural fields may become more acidic over time due to nitrogen fertilizer application. Liming the soil is necessary if the soil pH needs to be raised for ideal crop growth. It is important for agricultural growers to make informed decisions on the best liming material to purchase and understand what value they are getting. This publication aims to answer the following question for growers:

How can I compare different lime analyses to determine what material is best for my crops and what is the best value economically?

Guaranteed Analysis

There are many liming materials available with different analyses. Agricultural lime should not be purchased without a "Guaranteed Analysis." Figure 1 shows an example of a Lime Guaranteed Analysis. South Carolina Law Section 46, Chapter 26 determines the labeling requirements of the lime guaranteed analysis to include: 1) the net weight, 2) the brand or trade name, 3) the type of the agricultural liming material, 4) Calcium Carbonate Equivalence, 5) the minimum percentage of calcium and magnesium expressed as elemental calcium and elemental magnesium, 6) the minimum percent by weight passing through United States Standard sieves, and 7) the name and principal office address of the manufacturer or distributor.[1] The guaranteed analysis is determined by a certified lab and inspected by Clemson University's Department of Plant Industry in the state of South Carolina.

GUARANTEED ANALYSIS
NEWFOUNDLAND DOLOMITIC LIMESTONE

CALCIUM CARBONATE EQUIVALENCE	not less than 100%
ELEMENTAL MAGNESIUM	not less than 12%
ELEMENTAL CALCIUM	not less than 22%
GRADATIONS	
PASSING #10 MESH SCREEN	not less than 90%
PASSING #50 MESH SCREEN	not less than 50%
PASSING #100 MESH SCREEN	not less than 25%

Figure 1. Example of Lime Guaranteed Analysis.

The guaranteed analysis will state analytical measurements as "not less than X %." These are the minimum percentages that the material is guaranteed to meet. It is important to note that the percentages in the guaranteed analysis do not add to 100%.

Calcium Carbonate Equivalence

Calcium Carbonate Equivalence or CCE, is the standard by which a liming material is measured. The definition of CCE used by the state of South Carolina is "the acid neutralizing capacity of an agricultural liming material expressed as weight percentage of calcium carbonate.[1]" All liming materials are compared on a percentage basis to pure calcium carbonate which has a CCE of 100%. In breaking down the definition of CCE, "Acid neutralizing capacity" or "liming capacity" is the ability of the lime to increase the soil pH. Calcium Carbonate Equivalence is measured based on the weight (for example, lbs or tons) of the material versus an equal weight of pure calcium carbonate. Pure calcium carbonate has the chemical formula $CaCO_3$.

Many liming materials often have sand added to them to increase spreading ease and uniformity, and so are not in pure form. A liming material with a CCE greater than 100% indicates it has more liming capacity than pure calcium carbonate. Consulting the guaranteed analysis for agricultural lime will indicate the CCE of the material. Figure 2 shows standards for CCE of different liming materials in the state of South Carolina.

Material	Calcium Carbonate Equivalent
Burnt Lime	**Not less than 140%**
Hydrated Lime	**Not less than 110%**
Shells	**Not less than 85%**
Limestone	**Not less than 85%**
Limestone (75% Neutralizing Value)	**Not less than 75%**
Industrial Slag	**Not less than 50%**

Figure 2. Standards for Classification in terms of CCE of Agricultural Liming Materials.[1]

Elemental Nutrients

In addition to adjusting the soil pH, liming materials contain nutrients that have a fertilizer value for growing crops. Different types of lime contain different nutrients. For example, dolomitic lime is a mixture of calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) and contains the macronutrients calcium and magnesium. If a future crop is in need of magnesium, choosing dolomitic limestone would have liming capacity as well as adding magnesium fertilizer to the soil. Nutrients in a liming material are an added value of some types of lime, and the fertilizer value should be taken into account when determining the economic value of a liming material. The amount of fertilizer added to the soil can be calculated by multiplying the percentage of elemental nutrients by the amount of liming material spread per acre. The fertilizer value of lime can then be compared to the commercial price of the nutrient purchased separately.

Particle Size Gradations

Another important aspect of determining the value of lime is the particle size. In the guaranteed analysis of the lime, this is listed as gradation. Mesh screens are used to determine particle size for liming materials. The larger the number of the mesh screen, the finer the particle must be to pass through the screen. Looking back at Figure 1, the lime material has been evaluated based on #10, #50, and #100 mesh screen sizes. The #100 mesh screen has the smallest holes and only fine particles will pass through, while the #10 mesh screen has larger holes and more of the material (coarser particles) can pass through this screen. A lime with a smaller particle size will dissolve more quickly and change the pH faster than lime with a larger particle size. Large pieces of lime will take a long time to break down and change the soil pH. In general, lime takes between 6-12 months to dissolve and react in the soil to increase the pH. If the pH is to be raised in a short amount of time, it may be economically beneficial to pay more for lime with finer particles. Liming material must be dissolved by water to increase soil pH so particle size alone is not the only factor in changing soil pH quickly. Adequate water must also be available to change the soil pH.

Relative Neutralizing Value

In order to compare lime quality, a calculation can be made called Relative Neutralizing Value or RNV. RNV takes into account both the CCE and fineness of the lime to determine its effectiveness. RNV is useful for adjusting lime recommendations and comparing price between two lime sources.

The equation for RNV is:

RNV= % CCE x ½ x (% passing #10 mesh screen + % passing #50 mesh screen)

The standard lime in South Carolina is agricultural "Limestone" as defined in Figure 2 with a CCE of at least 85%, 90% of particles passing through a #10 mesh screen, 50% of particles passing through a #50 mesh screen, and 25% of particles passing through a #100 mesh screen. Lime recommendations given by Clemson University's Agricultural Service Laboratory assume standard limestone is applied.

Calculating RNV

The RNV for standard limestone is calculated as:

RNV= % CCE x ½ x (% passing #10 mesh screen + % passing #50 mesh screen)

RNV= 0.85 x ½ x (90+50)

RNV= 59.5%

The RNV of the Newfoundland Dolomitic Limestone (Figure 1) is calculated as:

RNV= .100 x ½ x (90+50)

RNV= 70%

Adjusting Lime Recommendations

If the lime recommendation from the Agricultural Service Lab is to apply 2 tons of standard limestone/ acre to adjust soil pH, the lime recommendation can be adjusted for the use of the Newfoundland Dolomitic Limestone by the following equation:

RNV of Newfoundland Dolomitic Lime= 70%, Assumed RNV of standard limestone= 59.5%

$\frac{59.5}{70}$ = 0.85 adjustment

2 tons (standard limestone recommendation assuming 59.5% RNV) x 0.85 adjustment= 1.7 tons of Newfoundland Dolomitic Limestone with RNV 70%

Comparing Lime Prices

Example Lime #1

Lime price ($/ton)= $35, RNV = 67%

Price per ton of effective lime = $\frac{\$35}{0.67}$ = $52.24

Example Lime #2

Lime price ($/ton)= $40, RNV = 85%

Price per ton of effective lime = $\frac{\$40}{0.85}$ = $47.06

In the example, Lime #2 is a better value than Lime #1, even though Lime #1 is less expensive per ton. Using RNV to compare lime price and effectiveness is a useful tool for growers.

Conclusions

Although supply may be limited for certain types of lime, it is important for growers to understand lime analysis and make decisions that best fit their farm both economically and to benefit soil fertility. Deciding which lime to purchase should not be made on price alone. In determining lime value, first calculate the Relative Neutralizing Value of the material using the calcium carbonate equivalence and particle sizes. Second, use the RNV calculation to compare the price of multiple liming materials to decide which is a better value. Lastly, consider the fertilizer value of the lime. Savings in commercial fertilizer should be taken into account when analyzing the economic value of a liming material. If soil is lacking in a nutrient that a liming material contains or if a future crop will benefit from added nutrients from the liming material, this should be taken into account. If soil pH needs to be raised quickly, a finer particle size may make sense even if the cost is more. Use RNV calculations to adjust the Clemson Agricultural Service Lab's standard limestone recommendations to your desired lime source.

References:

[1] Definitions and standards from South Carolina Agricultural Liming Materials and Landplaster Act, Code of Laws of South Carolina, Title 46, Chapter 26.