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"Analysis You Can Grow With"®

Lime Requirements

Why lime?

Acidic, or low pH, soils contain high concentrations of hydrogen ions (H^+) that are toxic to plants in large quantities. Correcting acidic soils, through the use of liming agents, can significantly increase yield and profitability of many cropping systems. When lime, also known as calcium carbonate ($CaCO^3$), is applied to low pH soils, the carbonate reacts with free hydrogen ions to produce water (H^2O) and carbon dioxide (CO^2). The occurrence of this reaction is referred to as neutralization.

When is lime needed?

Determining when to lime is accomplished by measuring the pH of the soil. pH is a measurement of the amount of free hydrogen ions present in soil solution. We refer to this portion of hydrogen ions as "active acidity." The lower the pH value, the higher the concentration of hydrogen ions in solution. Crop tolerance to low pH is different for certain crop species. For example, most leguminous crops (soybeans, alfalfa, etc.) are very intolerant to low pH and will suffer yield loss when soil pH drops below 6.0. On the other hand, most grass crops (corn, grain sorghum, wheat, etc.) are more tolerant to low pH and will yield fairly well until pH approaches 5.2. For this reason, we recommend applying lime to leguminous and other certain intolerant crops at a pH of 5.9 and below. For more tolerant crops, such as grasses, we recommend lime at pH of 5.2 and below.

How much lime?

The rate of lime required to raise soil pH to a desired level is determined by measuring the buffer pH. While active acidity refers to the hydrogen ions in the soil solution, "reserve acidity" is used to describe hydrogen ions bound to cation exchange sites on clay particles in soil. When all the hydrogen ions in the soil solution are neutralized, replacement ions are released from these exchange sites, buffering the change in soil pH. In order to effectively increase the soil pH, the active acidity and a significant portion of the reserve acidity must be neutralized. Buffer pH is the process used to measure the amount of hydrogen ions bound to these exchange sites. We add soil to a buffer solution, with a known pH and amount of acidity required to reduce the pH, and measure the pH decrease of the solution. This value is then used to determine the amount of reserve acidity, which directly relates to the quantity of lime needed for neutralization. Amount of lime needed to reach a soil pH of 6.5 can be viewed in table 1 at the bottom of this sheet.

Liming Materials

There are many liming products available that effectively increase soil pH. Ag lime ($CaCO^3$) is the most common material because it is affordable, effective, and relatively easy to apply. The effectiveness of ag lime is dependent upon the purity and the fineness of the product. Impurities in the ag lime, such as clay and sand, significantly reduce the effectiveness of the product. Likewise, coarse granules of $CaCO^3$ react much slower than fine granules, again reducing the effectiveness. Analysis of liming materials can provide an index of the effectiveness of the product, known as the "effective calcium carbonate equivalent (ECCE or ECC)." ECC is calculated by determining the percentage of $CaCO^3$ in a product and multiplying it based on a factor of fineness. The fineness factor is determined by sifting the material through three sieve sizes (4, 8, 60), which correspond to estimated rates of reaction based on size. ECC values are reported as percentages and allow us

to compare different liming materials. Pure, finely ground calcium carbonate has an ECC of 100%. One material with an ECC of 40% will need to be applied at twice the rate of a material with an ECC of 80%, in order to achieve the same soil pH. Liming materials vary widely in their ECC values, which makes it very wise to test materials before purchase to ensure quality.

Other liming materials are available and may have ECC values greater than 100%. This is possible because the chemistry of the product is different than $CaCO^3$ and neutralizes more hydrogen ions per unit of material. These products include burnt lime (calcium oxide, CaO), hydrated lime (calcium hydroxide, $Ca(OH)^2$), dolomitic lime (calcium and magnesium carbonate, $CaCO^3$-$MgCO^3$) and pelletized lime (finely ground calcium carbonate). All of these products are great liming options, however they are most often less economical when compared to ag lime. Above all, the best way to compare liming products is by analysis and comparison of ECC values.

Applying Lime

Neutralization reactions occur slowly in soil and should not be thought to instantaneously solve a soil acidity problem. Finely ground, high quality lime can take months to neutralize soil acidity. Lime applications should be made well in advance of planting. Incorporating lime to a depth of 6-7 inches will provide the most rapid pH response, and will provide the greatest benefit to the following crop. Soil samples should be collected regularly to monitor changes in pH and predict when another lime application is needed. In no-till situations, where incorporation is not possible, neutralization will take much longer. Application should be done as early as possible and at 30% of the recommended incorporated rate. More frequent applications may be needed as lime moves down the profile over a period of years.

Summary

- Lime is used to increase soil pH to optimal levels (6.0-6.8) for plant growth.
- Lime recommendations are given when soil pH values drop below critical thresholds that cause expected yield reduction. Critical thresholds vary by crop tolerance such that lime is recommended for legumes at pH<6.0 and grasses at pH<5.3.
- Liming rate is determined by buffer pH, which is a measure of the reserve acidity, and gives the amount of lime needed to raise pH to a target range.
- Many liming materials are available with ag lime being the most common. The effectiveness of a lime source is measured by the effective calcium carbonate equivalent (ECC or ECCE). This is given as a percentage and is dependent on the purity and fineness of the lime source. Pure, finely ground calcium carbonate has an ECC of 100%.
- Apply lime as far in advance of planting as possible, incorporating to a depth of 6-7 inches. Non-incorporated applications, such as no-till situations, should be 30% of the full incorporated lime rate.

If there is ever any confusion or further explanation needed regarding any of the topics discussed or other areas of crop production feel free to give us a call at: 308-345-3670

Table 1. Amount of lime needed to reach a target pH of 6.5. These values assume an ECC of 60% and may need adjusted for materials with different values.

Buffer pH	Lime Req. (tons/acre)
6.9	0.5
6.8	1.0
6.7	1.5
6.6	2.0
6.5	2.5
6.4	3.0
6.3	3.5
6.2	4.0
6.1	4.5
6.0	5.0