GYPSOIL™ BRAND GYPSUM

FACT SHEET

When to Use Gypsum, When to Use Lime

Gypsum and Lime Both Improve Soil Conditions But They Have Vast Differences

Ag lime and gypsum are excellent soil amendments that can be used separately, together, or in a rotation to improve soil conditions. However, understanding the differences between lime and gypsum, and how they impact soil chemistry, is important when choosing the right amendment(s) to achieve a more balanced soil.

What is Agricultural Lime?

Ag lime is an **acid-soluble material that is applied to cropland to raise the pH of acidic soils**. It comes in many forms including calcium carbonate ($CaCO_3$), magnesium carbonate ($MgCO_3$) and others. It can be applied in a single pass with a lime spreader. Acidic soils trigger a chemical reaction allowing carbonate molecules to strip H^+ molecules from the soil, releasing water and CO_2. The vacated H^+ is replaced with calcium and/or magnesium on the cation exchange sites, depending on the type of lime used.

It is important to consider the Ca and Mg levels on the soil exchange sites before choosing a lime source. Magnesium carbonate, called dolomitic lime, is often the cheapest form of lime. It can exacerbate problems in high Mg soils and lead to poor drainage, compaction, waterlogging, etc.[1] Conversely, in high Ca soils where Mg is deficient, dolomitic lime is preferred over hi-calcium lime.

What is Gypsum?

Gypsum is calcium sulfate dihydrate ($CaSO_4$ $2H_20$). Flue gas desulfurization (FGD) gypsum, such as GYPSOIL™ brand gypsum, is a co-product material derived from the scrubbing of flue gas emissions in coal-burning power plants. Gypsum can be spread with lime and litter spreaders. **Gypsum is not acid soluble and will not change the soil pH. It helps to shift the Ca and Mg levels in soil and offers a readily available form of sulfate sulfur, a valuable secondary nutrient that benefits the soil and crop. The sulfate in gypsum binds with excess Mg in the soil to form soluble Epsom salt, which moves lower into the soil profile. This Mg is replaced by Ca, improving water holding capacity, root development and soil quality.**[2]

Key Terms

Soil pH
A measure of acidity or alkalinity of soil, relative to the amount of hydrogen atoms presents. On a scale of 0-14, a pH around 7 is neutral, lower numbers indicate acidic conditions, greater numbers are more alkaline. The soil pH can limit yield potential and nutrient availability. Many plants thrive when soil pH is around 6.2-6.8.

Cation Exchange Capacity (CEC)
The number of “holding sites” in soil clay and organic matter that can attract positively charged molecules. Not all soils have the same CEC, for example, soils with more clay and organic matter have a greater holding capacity than sandy soils with less organic matter. Amendment rates vary by soil CEC.

Base Saturation
The base saturation is the percentage of exchange sites occupied by positively charged atoms and molecules such as Ca^{++}, Mg^{++}, H^+, K^+, NH_4^+, etc. Gypsum rates are calculated to achieve desired base saturation numbers.

Balanced Soil Properties

Soil pH: 6.2-6.8

Base saturation Ca: 70-80%

Base saturation Mg: 10-13%

HEALTHIER CROPS. BETTER SOILS.

Why pH Matters

Soil pH is a measure of the active hydrogen (H^+) ions in the soil, a key component of many of the chemical processes related to soil health. Acidic soils, or soils with excess H^+, can limit the crops' ability to reach its genetic potential by limiting nutrient availability and soil biological activity throughout the growing season. Scientists recommend a soil pH of 6.2 to 6.8 for most crops. **If soil pH is too high or too low, plant vigor and yield will suffer.**

Proper Levels of Calcium and Magnesium

The Cation Exchange Capacity (CEC) in soil measures the nutrient holding capacity, or the number of exchange sites in a given volume of soil that attract positively charged cations or nutrients. Important cations include calcium (Ca^{++}), hydrogen (H^+), magnesium (Mg^{++}), potassium (K^+), sodium (Na^+) and ammonium (NH_4^+). Different soil types have different nutrient holding capacities. As an example, clay soils generally have more exchange sites than sandy soils. In general, properly balanced soils have a desired range for each of these nutrients. In a balanced soil, **Ca^{++} and Mg^{++} should take up about 85 percent of the exchange sites collectively. The remaining 15 percent are open for other cations.**[3]

Look for soil test results showing a base saturation, or percentage of nutrient holding sites occupied by cations, of 70-80 percent for Ca and 10-13 percent for Mg. If Ca or Mg base saturations are outside of the ideal range, soil productivity is hindered and problems may exist with compaction, sodic conditions, crusting, poor draining and more.

Negatively-charged clay particles form strong bonds with Ca^{++}. The resulting aggregated particles form pore spaces so air, water, soil bacterium and roots move more freely through the soil profile. Alternately, Mg^{++} forms weak bonds with clay particles. Even rain droplets can break the bonds, displacing the soil and blocking the pathways for water, nutrients, roots and air in the soil. Compaction, crusting problems and waterlogging are common when the Mg levels are too high and/or Ca is too low. This is why the desired base saturations of Ca and Mg must be attained.

Choosing Lime, Gypsum or Both

When choosing to use lime, gypsum, or both products, start with accurate soil test results, including the soil pH, CEC, organic matter and the base saturation numbers for Ca and Mg in each field. These results will help you select the proper treatment. Here are a few scenarios to consider:

Low pH, Balanced Mg and Ca

- Result of too much H^+ on the cation exchange sites, **can be corrected with ag lime**
- The carbonate in lime helps to raise pH by driving excess H^+ ions off of the exchange sites, replacing the H^+ with Ca and/or Mg (depending on lime form)

Balanced pH, High Mg and Low Ca

- **Can be corrected with gypsum** when Mg levels are too high, the sulfate in gypsum bonds with excess Mg to form leachable Epsom salt, making room on the exchange sites for other cations
- The exchange sites gain the Ca molecules
- pH is not changed

Low pH, High Mg and Low Ca

- May use **ag lime to raise pH and gypsum to drive excess Mg off of the exchange sites**
- High calcium ag lime is preferred
- Do not use high Mg ag lime (dolomitic)
- Apply gypsum and ag lime products together or in a rotation, depending on budget constraints, land ownership agreements, etc.

[1]Dontsova, Katerina, and L. Darrell Norton. "Effects of Exchangeable Ca:Mg Ratio on Soil Clay Flocculation, Infiltration and Erosion," Sustaining the Global Farm – Selected papers from the 10th International Soil Conservation Organization Meeting, May 24-29, 1999, West Lafayette, IN. International Soil Conservation Organization in cooperation with the USDA and Purdue University, West Lafayette, IN. (1999). pp 580-585.

[2]Chen, Liming, David Kost, and Warren A. Dick. "Gypsum as an Agricultural Amendment." The Ohio State University Extension Bulletin 945 (2011). pp. 1464-1470.

[3]Kinsey, Neal, and Charles Walters, Hands on Agronomy, (Acres USA, 1999). pp. 52-53.

HEALTHIER CROPS. BETTER SOILS.

