The Physical, Chemical, and Biological Dynamics of Applying Gypsum vs Lime In The Soil: A Comparison

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Gypsum (CaSO₄, * 2H₂O) and agricultural lime (CaCO₃) are good soil amendments that can have a myriad of beneficial impacts. In particular, they can correct nutrient imbalances, improve soil textures and structures, increase soil pH in acidic soil, and improve saline alkaline soils. In addition, they are good sources of calcium and sulfur for plant growth and microbial activities. They possess different activity coefficients, ion complexations, and metabolic activities.

In order to properly place the important elements of gypsum and lime in perspective, we need to define and briefly identify their roles in soil and plant metabolisms.

**Calcium:**

Plays a multitude of pronounced roles in soil and plant health, as well as in nutrition. Calcium, in the form of calcium pectate, is critical in forming plant cell walls. Root tips, shoot tips, and young leaves demonstrate distorted growth because of a lack of Ca translocation and cell wall formation.

As a soil amendment, Ca performs vital functions in order to maintain physical and chemical balances in the soil. Mulder’s synergism and antagonism chart attests to the importance of ample calcium in the soil and consequently in the plants.

**SO₄-S and S: A Nutritional Perspective**

Plants use sulfur as an SO₄= form for metabolic purposes. Sulfur is a must for nitrogen fixing nodules and is vital for formation of chlorophyll. Plants utilize sulfur in protein synthesis, amino acids, enzymes, and vitamins.

Sulfur is a natural anti-fungal element, which helps the plants to resist diseases and aids in seed formation and vigorous growth. Recent studies highlight the key importance of sulfur in microorganisms’ lives, along with human and animals’ overall health and well-being.
**Gypsum** (CaSO4 *2H2O) as a Soil Amendment

Gypsum or calcium sulfate is a naturally occurring mineral. It provides both calcium and sulfur and typically possesses calcium variations ranging from 20 to 22.5 percent. Sulfur variations generally range from 16 to 18 percent.

Gypsum is a natural compound, with a Ph of approximately 6.7. It does not impact the overall soil Ph which in many agronomic situations is inherently advantageous. It improves water penetration by flocculating soil particles. This can be a key factor in reducing soil compaction, lowering sodium levels, and improving soil aggregate stabilities. In my three-plus decades tenure as a soil agronomist, I have reviewed over 30,000 soil and petiole analyses reports. In many cases, there have been a plethora of discrepancies on (N/S) nitrogen and sulfur ratios.

In general, there has not been ample residual sulfate sulfur to make N/S =10. This ratio has very pronounced impact on plant protein synthesis. However, calcium from gypsum is quite beneficial for the N/S, Ca/K, and Ca/Mg ratios. Adding gypsum has been very effective in helping these important ratios by improving nutrients use efficiencies.

De Ann Presley, from Kansas State University highlighted key differences between gypsum and lime in a 2014 issue of KSU’s Agronomy eUpdate. Presley notes that “gypsum is about 200 times more soluble than lime and it is naturally found in the soil profiles of the more arid parts of state.” In addition, gypsum reduces aluminum toxicity in acidic soils. In all soils regardless of pH, Gypsum is a good Ca2+ additive when Ca2+ is needed (James Walworth University of Arizona).

**CaCO3 (lime) as a Soil Amendment:**

Lime is a naturally occurring mineral which has been used to increase and improve soil Phs of < 7. In contrast to gypsum and calcium sulfate anhydrides, lime solubility is contingent upon soil Ph. Lime solubility increases in acidic soils and decreases as soil Ph increases. Lime is a good source of calcium overall. However, it is also important to know the soil pH to make lime work to the fullest.

When the soil Ph is > or around 8.2, lime becomes extremely insoluble. In acidic soils, supplemental CaCO3 will dissolve. However, this does not occur in alkaline soils. In calcareous soils, applying lime with the intent of increasing soluble calcium is inherently illogical.

Lime is beneficial as a source of Ca for low Ca soils. It may be slightly helpful for water penetration in acidic soils (pH of 6 or <6). However, there are no marked improvements at pH levels of 7 or higher.