Gypsum for Field Crops in New York

Introduction

Gypsum is hydrated calcium sulfate ($CaSO_4 \times 2H_2O$). It is a good source of readily available calcium (Ca) and sulfur (S) and can bind with phosphorus (P). Misconceptions exist about gypsum's ability to adjust soil pH or improve soil structure. This fact sheet describes the benefits of using gypsum, and explains why gypsum does not change soil pH or alleviate compaction problems in agricultural fields in New York.

What Gypsum Does

Fertilizer Benefits

The cation exchange sites on clay and organic matter particles in the soil are able to hold base cations such as Ca, magnesium (Mg), and potassium (K) that are essential for plant growth. Over time, these nutrients are released into the soil solution for uptake by plants. If a soil is Ca deficient for a specific crop, gypsum can be a good source of Ca to consider, especially when the pH of the soil is already high and the addition of Ca-containing liming materials is not desirable.

Where the soil is deficient in S, gypsum is also a good supplement. Over the past few decades, reductions in atmospheric S deposition have led to reduced S availability in soils. Gypsum is highly soluble, quickly releasing S into the soil solution once applied and incorporated, and is thus a good source of sulfate, the form of sulfur that plants take up.

Physical Compaction Benefits

In dry regions, gypsum is often used to improve soil structure and reduce surface crusting in soils with high sodium (Na) content, known as sodic soils. High Na concentrations in soil disperse soil aggregates causing clay particles to bind together and form a hard, crusty soil surface or a compacted layer. For these soils, replacing Na with Ca can improve soil aggregation (Figures 1 and 2). Gypsum will not alleviate the type of physical compaction problems we see in New York soils, nor will it help with sodium related problems here because we do not have high Na soils.

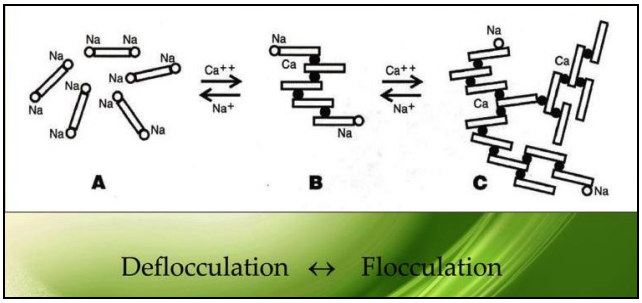

Figure 1. In sodic soils, clay particles are dispersed by high concentrations of Na (A). Soils with high Ca concentrations tend to be flocculated (C); soil aggregates stick together giving structure to the soil. Source: dl.sciencesocieties.org.

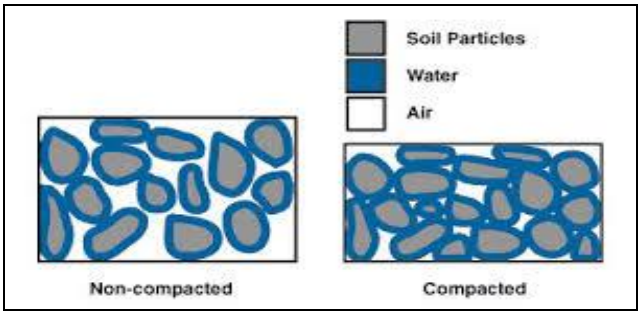

Figure 2. Soils with high Ca levels are not compacted (left). High Na concentrations cause dispersion of clay particles (right) causing chemical compaction. Source: http://www.extension.umn.edu/agriculture/tillage/soil-compaction/index.html.

Phosphorus Runoff Reduction Benefits

Recent studies show that gypsum application may reduce P runoff from agricultural fields into surface water. The Ca in gypsum binds to the P in the soil to form calcium phosphate, a less soluble form of P, thus reducing the risk of P runoff. However, reducing erosion and over-application of P fertilizer remain the most effective ways to reduce P losses. More information is needed before recommendations can be made for use of gypsum in this way.

What Gypsum Won't Do

Gypsum is not a liming material and will not raise or lower the soil pH. Remember that gypsum is calcium sulfate. Liming is a two step-process. First step: Ca exchanges with acidic hydrogen (H) and aluminum (Al) ions on soil particles. Second step: neutralization of H and Al. While the Ca in gypsum can satisfy

step 1, the sulfate part of gypsum does not neutralize the acidic H and Al ions in step 2 (Figure 3). Therefore, gypsum is not a liming material.

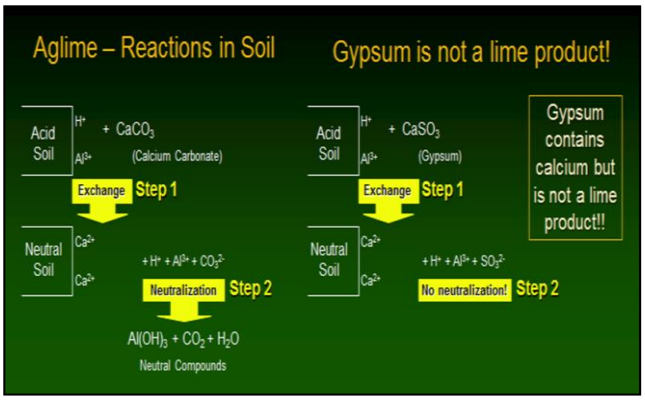

Figure 3. Gypsum does not neutralize acidity. With agricultural lime, the carbonate neutralizes acidity, not calcium or magnesium. The sulfate in gypsum cannot react with acidic H or Al ions to form neutral compounds.

Sources of Gypsum

Common sources of gypsum (Figure 4) include:

- Flue-gas desulfurization.
- Gypsum based dry-wall.
- Mined natural gypsum.
- Other manufacturing by-product.

The Ca and S content varies by source, but is usually between 19 and 23% Ca and 15 to 20% S. Gypsum derived from flue-gas desulfurization (FGD) gypsum is more soluble which means it dissolves faster in water. FGD gypsum typically has higher Ca and S contents than naturally derived gypsum. The difference in composition can affect the cost and effectiveness of various gypsum products.

Figure 4. FGD gypsum (left) is white to light tan and has fine particles. Gypsum from other manufacturing processes (right) is greyish and, unless finely ground, tends to have larger particles (Source: www.gypsoil.com)

When sold as a fertilizer the minimum guaranteed nutrient content has to be listed on the bag. If the quality of a gypsum product is uncertain, consider submitting a sample for chemical analysis.

Application

Gypsum can be applied in either a granular/powder or pelleted form. When applied as a granular/powder, the smaller particle size allows Ca and S to react with soil more quickly, but they can also coat/cake spreading equipment and create dust clouds. The pelleted form makes spreading easier, but the material is typically more expensive. Gypsum can be applied on the soil surface or incorporated into the soil. Incorporation will reduce the impact of wind on the application and will make Ca and S available more quickly.

Recommended application rates vary among crops and field characteristics. For field crops in New York, Ca is not typically a limiting nutrient, so application rates primarily depend on the S needs of the crop combined with the soil's ability to supply S. See Agronomy Fact Sheet #34 (Sulfur for Field Crops) for typical S removal estimates for various field crops.

Summary

Gypsum is a relatively inexpensive and readily available source of both Ca and S. It will not change the pH of the soil as it cannot neutralize acidity. It is not expected to improve soil aggregation in New York as there are no Na saturated or sodic soils in the state. Gypsum application may also reduce P runoff.

Additional Resources

- Cornell Nutrient Management Spear Program Agronomy Fact Sheet 34 (Sulfur for Field Crops): http://nmsp.cals.cornell.edu/guidelines/factsheets.html .

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

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

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