Gypsum as a soil amendment

What is gypsum?

Gypsum is a naturally occurring mineral containing approximately 23% calcium and 19% sulphur. It is also referred to as calcium sulphate and often occurs in hydrated form as $CaSO_4 \cdot 2H_2O$. Commercial agricultural gypsum may vary in nutrient concentrations and effectiveness depending on its purity, moisture content, particle size and source.

Sources of gypsum for agricultural fields

Sources of gypsum include:

- Natural gypsum: This is gypsum mined from natural geologic deposits. Purity varies depending on the deposit and mining location.
- Synthetic gypsum: This is a by-product of manufacturing processes (e.g., phosphogypsum, a by-product created when making phosphoric acid).
- Recycled drywall gypsum: This is usually obtained by grinding old drywall, particularly from new construction. It should be used cautiously because of possible contaminants. Laboratory analysis is advised before land application.

How gypsum reacts in soil

When gypsum contacts soil water, it dissolves into plant available nutrients as:

$$CaSO_4 \cdot 2H_2O \rightarrow Ca^{2+} + SO_4^{2-} + 2H_2O$$

The calcium ions interact with cation exchange sites to displace sodium ions, particularly in sodic soils. Once calcium occupies more of the exchange sites, it causes clay particles

Key points

- Gypsum is a source of calcium and sulphur for plants.
- Gypsum is a soil amendment but not an agricultural lime. It should not be applied for the sole purpose of liming acidic soil.
- Gypsum can improve soil structure and moisture conservation, especially in sodic soils.

to flocculate (i.e., come together to form larger particles) thereby forming a more stable soil structure/aggregate. The displaced sodium must be leached below the root zone with sufficient water to realize the gains of gypsum application.

Gypsum is not a liming material

Although gypsum contains calcium, it is not a liming material. The calcium component of gypsum and some other liming materials is not responsible for neutralizing soil acidity. Agricultural lime contain carbonate, oxide or hydroxide compounds that neutralize soil acidity (H^+). Gypsum contains sulphate-sulphur and has no acid-neutralizing ability. Therefore, gypsum should not replace lime when a soil test recommends liming, as it does not raise soil pH enough to correct soil acidity.

Uses of gypsum in agricultural fields

Gypsum is used as:

Image credit: Thomas Eder (Vecteezy)

- A source of calcium and sulphur for plants. Unlike elemental sulphur that acidifies the soil and lime that increases soil pH, gypsum does not affect soil pH.
- A soil and water management practice to:
  - Improve soil water holding capacity as a result of flocculated clay particles and more stable soil aggregates.
  - Reduce surface crusting and sealing thereby allowing rainfall and irrigation water to enter the soil more easily.
  - Reduce runoff and erosion risk by increasing the amount of water that moves into the soil instead of flowing across the surface.
  - Supports deeper root access to water by improving soil structure and, in some soils, allowing calcium to move into the subsoil and improve rooting conditions.
  - Reduce dissolved phosphorus losses under some conditions.

In some acidic subsoils, gypsum may reduce the harmful effects of aluminum on plant roots. This can help roots grow deeper, but it does not mean that gypsum neutralizes soil acidity.

Consideration before gypsum application to agricultural fields

Gypsum may be applied to the soil after crop harvest, before planting, or after hay is cut and bailed. Before applying gypsum, consider whether:

- The soil is deficient in calcium or sulphur to optimize crop yield and the soil pH is optimal.
- The gypsum quality such as purity, particle size, and heavy/trace metal content. A gypsum source may contain heavy metal concentrations above acceptable levels. Always request a product analysis from the supplier.
- Your soil has a hard crust formed following irrigation. Gypsum can help alleviate soil crusting.
- Soil test report shows a sodium adsorption ratio or exchangeable sodium percentage (ESP) of $\geq$ 15%. The ESP is the percentage of cation exchange capacity that is occupied by sodium cations. An ESP level of $\geq$ 15% is common in sodic soil and gypsum can be used to displace the sodium. Gypsum application must be followed by leaching of the displaced sodium.
- Gypsum requirement to correct soil sodicity can be calculated[1] as:

$$GR = BD \times D_s \times (ESP_A - ESP_D) \times CEC \times 0.086$$

  - GR is the pure gypsum application rate in Mg/ha (metric tonnes/ha).
  - BD is the soil bulk density in Mg/m^3.
  - D_s is the depth of soil to be amended in m.
  - ESP_A is the actual ESP as reported on soil test report in %. It is usually reported under the percent base saturation on soil test report.
  - ESP_D is the desired ESP in %. It should be based on crop tolerant level.
  - CEC is the cation exchange capacity in meq/100g.
  - 0.086 is a conversion factor for atomic mass of pure gypsum.

Other related resources:

- BC Liming Economic Calculator
- Evaluation of Agricultural Limestone
- Soil Acidity and Liming Facts
- Soil pH
- Acidifying Soils
- Liming Acid Soils in Central B.C.
- [1]Management of Sodic Soils in Alberta

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