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GYP SUM USE IN HOME GARDENS AND LANDSCAPES

Linda Chalker-Scott, Associate Professor and Extension Horticulturist, WSU Puyallup Research and Extension Center, Washington State University, and **Rich Guggenheim**, Horticulture Extension Educator, Canyon County Extension, University of Idaho

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Abstract

Gypsum has long been promoted as a soil amendment for home gardeners who wish to improve their soil structure. Popular books and websites claim that gypsum will loosen compacted soils and improve drainage. Gypsum is also claimed to reduce soil acidity and cure blossom end rot. Many of these claims are not supported with scientific evidence. This publication will review the scientific research behind the use of gypsum in home gardens and provide readers with a set of guidelines designed to improve problem soils and promote plant health.

What is Gypsum?

Gypsum, or calcium sulfate, is a naturally occurring mineral consisting of calcium and sulfur (CaSO_4 , Figure 1). It is moderately soluble in water, releasing positively charged calcium ions (Ca^{+2} cations) and negatively charged sulfate ions (SO_4^{-2} anions).

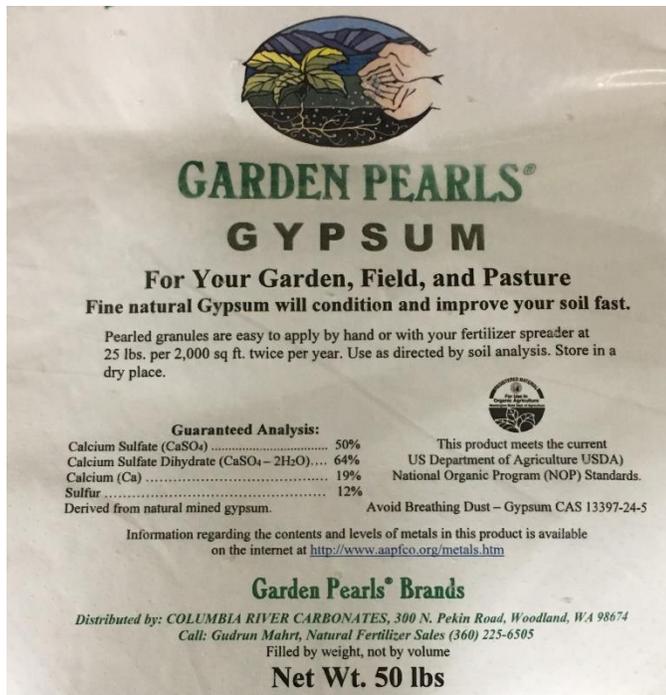


Figure 1. Commercially available gypsum intended for garden use. Photo by Rich Guggenheim.

What role does calcium play?

Calcium is an essential plant nutrient, required for cell membrane function as well as for cell wall structure. Calcium's availability to plants is influenced by the cation exchange capacity (CEC) of soil, in which both clay and organic matter can bind and release calcium. In this way, calcium also plays a role in building soil structure by binding clay particles together into aggregates. Soil aggregates improve water movement by increasing soil porosity.

What role does sulfate play?

Like calcium, sulfur plays an important role in plant nutrition as an essential component of proteins. Elemental sulfur (S) can acidify soils when it reacts with soil water to form sulfuric acid (H_2SO_4). The sulfate ion found in gypsum, however, does not form sulfuric acid in the soil and has no effect on soil pH.

Benefits of Gypsum Amendment

Documented Benefits

There is a robust collection of research articles on the agricultural use of gypsum. This literature has been recently reviewed elsewhere (Casby-Horton et al. 2015; Zoca and Penn 2017). In general, the use of gypsum on sodic (sodium containing) soils and some heavy clay soils is beneficial to soil structure and to plant health.

Gypsum can improve sodic soils, where excessive levels of sodium ions (Na^+) cause clay particles to disperse rather than aggregate. This phenomenon reduces soil porosity, creating poorly-drained soils with heavy crusts (Figure 2). Because calcium can readily bind to clay particles, the process of cation exchange replaces sodium with calcium. The sodium is leached through the soil and away from plant roots, reducing soil crusts and improving drainage. Plants benefit from the improved soil structure as well as from the elimination of excess sodium ions, which are toxic to most plants.



Figure 2. Salt buildup from salt-laden water percolating to the surface and evaporating. Photo by Tim McCabe, USDA Natural Resources Conservation Service.

Calcium’s affinity for binding sites on clay particles sometimes improves the structure of heavy clay soils by forming larger aggregates (peds). Peds enhance soil drainage and aeration and reduce compaction. In soils with a demonstrated calcium deficiency, adding gypsum can improve plant nutrition.

There are recent reports of possible environmental benefits as well. When added to a clay soil, the calcium in gypsum can bind phosphate, reducing runoff of this aquatic pollutant (Kauppila and Pietola 2013). Likewise, calcium can reduce aluminum toxicity in plants growing in acidic soils (Espejo-Serrano et al. 1999; Merino-Gergichevich et al. 2010; Vizcayno et al. 2001; Zoca and Penn 2017).

Unsubstantiated Benefits

Most of the purported benefits of gypsum, especially for home gardens, are not based on scientific evidence.

“Acidifies soil”: Gypsum does not change the natural pH of soil; acidity and alkalinity are significantly influenced by climatic factors, such as rainfall and temperature, by local geology, and by natural levels of organic matter.

“Improves water holding capacity of soil”: Water holding capacity of soils is closely tied to organic matter and soil texture. Gypsum cannot change either of these criteria, but it can increase water movement through heavy clay soils by reducing compaction and increasing ped formation.

“Improves fertility of soil”: Other than being a source of calcium and sulfur, gypsum has no effect on inherent soil fertility. Plant nutrient availability increases with increasing CEC, which is controlled by clay content, organic matter, and pH—not calcium.

“Cures blossom end rot of tomatoes and peppers”: This claim is based on the false impression that blossom end rot (Figure 3) is caused by a deficiency in soil calcium. The development of blossom end rot is directly influenced by water stress—not by calcium levels. There is no research indicating any relationship between gypsum addition and blossom end rot suppression.



Figure 3. Blossom end rot of tomatoes is not caused by calcium deficiency. Photo by Denny Schrock, Iowa State University.

Drawbacks of Gypsum Amendment

Without a professional soil test, it is impossible to know the concentration of calcium in the soil, the CEC, or pH. These are important variables in determining what effects a gypsum addition will have on plants or the environment. Excessive addition or misuse of gypsum can create an imbalance of soil minerals with unwanted results:

- Gypsum can increase leaching of aluminum and lead (McBride et al. 2013), which detoxifies soils but contaminates nearby watersheds (Lopez and Espejo 2002).
- Gypsum can increase leaching of potassium (Zoca and Penn 2017), iron and manganese (Vidal et al. 2003), and magnesium (Ritchey and Snuffer 2002; Warren and Shelton 1993; Zoca and Penn 2017) leading to deficiencies of these nutrients in plants on site and contaminating nearby watersheds.
- Gypsum applied to sandy soils can depress phosphorus, copper, and zinc transport (Zhu and Alva 1994).
- Gypsum can have negative effects on mycorrhizal inoculation of roots (Habte and Soedarjo 1995), which may account for reported negative effects of gypsum on tree seedling establishment and survival (Bakker et al. 1999; Singh et al. 1997).

Recommendations for Gypsum Use in Home Gardens and Landscapes

There are few articles relevant to gypsum use in urban areas, and none specific to home gardens and landscapes. We do know, however, that urban soils—including those in home gardens and landscapes—are vastly different from those in natural areas or agricultural situations. They often consist of abrupt layers, which are not amendable with gypsum improvement.

At this time our understanding of how gypsum affects soils and plants is inconsistent and incomplete. Plant species, soil type, and rainfall regime all interact with the physical and chemical changes that gypsum can effect on soils (Zoca and Penn 2017). Even in agriculture there is not yet “a suitable recommendation that considers different

soil (type, chemical, and physical characteristics), rainfall rates, temperature, crops, and cropping systems” (Zoca and Penn 2017). For home gardeners, this means there are no broad, science-based guidelines for applying gypsum. Your county Extension personnel should be consulted for local recommendations based on field data, if available.

Action Items for Gardeners

- Collect soil samples (as described in Fery and Murphy, 2013) for professional testing (Figure 4) before applying gypsum or any fertilizer. Be sure to ask for pH, levels of basic plant nutrients, and sodium.

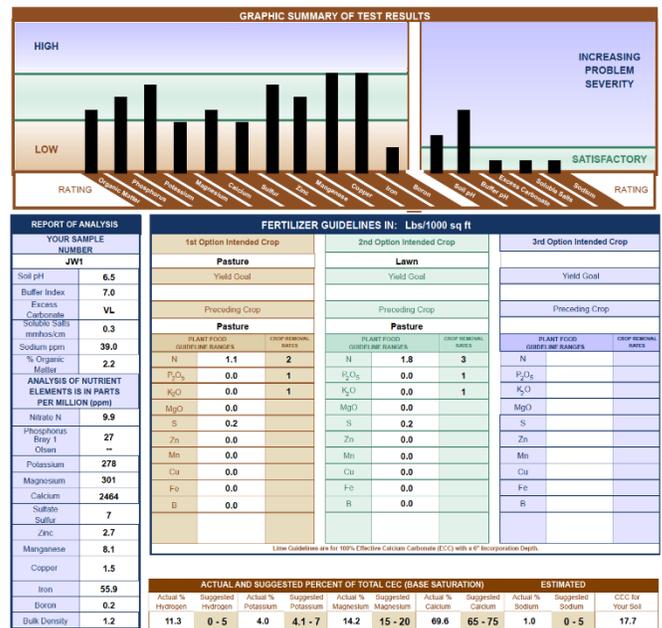


Figure 4. A soil test with nutrients, pH, and sodium levels reported. Photo by Rich Guggenheim.

- Do not use the calcium-to-magnesium ratio from your soil test to determine gypsum use. There is no indication that this ratio is relevant to gypsum application rates (Zoca and Penn 2017).
- Estimate your soil texture type with the ribbon test (Cogger 2010). This will help you determine if your clay content is high enough (>40%) that gypsum might be useful.
- Unless calcium is deficient and pH is in the optimal range, do not add gypsum. If sulfur is needed, use ammonium sulfate or potassium sulfate instead.

- Use a coarse woody mulch on landscape soils to reduce compaction, improve aeration, and conserve soil water naturally (Chalker-Scott 2015).
- Keep vegetable gardens well hydrated during the growing season to avoid water stress and blossom end rot.

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