Formula

The Benefits of Calcium Sulphate Use in Soil & Agriculture

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A good soil environment is vital for the growth and health of plants

Tight and compacted soils may limit plant growth and cause disease problems. Nevertheless, these soils can be greatly improved by the application of calcium sulphate (gypsum) which helps improving the soil structure, drainage and aeration.
A natural mineral, calcium sulphate benefits from several decades of safe use. It is also suitable for organic growers.

Characteristics of the soil

Formed over a long period of time, soil is the biologically active material that covers much of the world's land surface to depths ranging from a few mm to over 1m. It is home to the roots of the plants as well as to various micro-organisms and small animals.
Nevertheless, the physical and chemical properties of soils may differ significantly, depending on their composition and location:

Soils can have high proportions of sand. These soils are generally coarse-textured and absorb and drain water easily but hold relatively low amounts of water and also leach nutrients very easily.
Other soils have higher proportions of silt particles. These medium-textured soils are generally more desirable for plant growth.
A third type of soils has higher proportions of clay particles. These soils are fine-textured. They are usually poor draining and difficult to manage when wet. When dry they become dense by shrinkage and therefore hard. On the other hand, the small particle sizes of clay give it a very large surface area allowing good retention of nutrients.

The consistence of soils can range from friable to firm. Moderately friable soil that crumbles when squeezed is most desirable for agricultural and horticultural use.

A well-structured soil has aggregates that pack to create many pores, which is important for free drainage, aeration and root growth. By contrast, weakly structured soils are prone to erosion through wind and water, tend to compact, and may crust after heavy rainfall. As a consequence, water will take longer to enter the soil bulk and will tend to run off if the surface is sloping. These factors all tend to reduce plant growth and crop output.

Calcium sulphate improves physical soil properties

Calcium sulphate helps improving the structure and physical condition of soils, by loosening tight, compacted soil, generally improving soil structure, aeration and permeability. Its calcium component encourages the clay particles in the soil to flocculate (group together) thereby improving soil structure. The calcium component also favours the growth of soil organisms that help create and maintain a convenient soil structure.

Improvements in soil structure bring a lot of benefits

Flocculation of small particles into larger aggregates facilitates the penetration of water and nutrients into and through the soil. Surface crusting is often a problem with fine-textured soils where the structure of the surface layers is destroyed by rainfall and irrigation. This results in run off, limited water infiltration and soil-air gas exchange, and reduced seed emergence. Calcium sulphate prevents crusting by restoring structure and maintaining more stable aggregates.
Another benefit involved by the application of calcium sulphate is the creation of pores of different sizes. These ensure the balance between free drainage on the one hand and water holding capacity on the other. The larger pores allow water infiltration and drainage, while the small pores hold the water so as to provide water storage for the plants. A good range of pore sizes is also important for aeration to provide the roots with oxygen. Lastly, a porous soil allows easier root penetration facilitating the supply of minerals and water. This leads to better growth and prevents drought.

A common consequence of intensive cultivation is soil compaction. Alone or in conjunction with mechanical methods, calcium sulphate helps creating soil aggregates that are less likely to compact. A less compact soil not only allows easier root penetration but is also easier to manage.
Clay textured soils tend to expand when they get wet, and to shrink when they dry. As a consequence, large cracks appear at the surface. By moderating change in water status, calcium sulphate reduces these volume variations and therefore the amount of cracking.
The calcium of calcium sulphate also increases the activity of soil organisms which break down dead plant material and other organic matter. This process produces organic elements that bind soil particles together and stabilise soil structure.

Calcium sulphate improves chemical soil properties

Calcium sulphate acts as a pH buffer, which can contribute to neutralising both soil alkalinity and acidity. Soil pH directly affects the life and growth of plants because it affects the availability of all plant nutrients. Around 6.5, most plant nutrients are in their most available state. A nutrient must be and remain soluble long enough to successfully travel through the soil solution into the roots.

Alkaline soils: Thanks to the supply of sulphur, calcium sulphate corrects soil alkalinity and lowers high pH conditions (above 6.5). Alkaline soils contain large quantities of sodium which has severe detrimental effects on soil structure, such as loss of aggregation and reduced pore spaces. The addition of calcium sulphate helps restoring aggregation and pore space by leaching out harmful sodium through ionic exchange:
$CaSO_4 + NaCO_3 \rightarrow CaCO_3 + NA_2SO_4$
Sodium sulphate is then leached out of the soil by rainfall or heavy irrigations. Calcium sulphate may also be used in areas where high rates of sodium are contained in the irrigation water.

Acid soils: For acid soils with a pH below 6, the usual recommendation is for the application of ground limestone which is alkaline. It is highly effective in raising pH and is a source of calcium nutrition on surface soil. But also calcium sulphate (slightly alkaline) may counteract acid soils and raise low pH conditions, more gently than lime, and especially at lower soil depths which interfere with root development, nutrient transportation and absorption. Calcium from lime does not migrate to the subsoil and requires a chemical reaction to become available to the growing media. The calcium of calcium sulphate, on the other hand is readily available because it is water soluble (2g/l) and leaches down through the soil profile into the subsoil depths. Acid soils need lime, but to gain optimum benefits and improved yield calcium sulphate and lime blends are recommended.

Calcium sulphate is a fertiliser

Fertilizers are physical compounds given to plants to improve the health, productivity, and appearance, as they provide different essential nutrients intended to encourage plant growth. They are usually applied either through the soil, for uptake by plant roots, or by foliar feeding, for uptake through leaves. Fertilizers typically provide, in varying proportions, the 3 major plant nutrients: nitrogen, phosphorus, potassium (known shorthand as N-P-K); the secondary plant nutrients (calcium, sulphur, magnesium) and sometimes trace elements with a specific role in plant nutrition (boron, chlorine, manganese, iron, zinc, copper, molybdenum, selenium). Fertilisers may be needed in soil for a number of reasons, including humus deficiency, incorrect crop rotation and specific requirements of a particular crop. They may be required due to the geological origin of the soil in certain areas.
Calcium sulphate is used in agricultural and horticultural fertilisers, dressings and pesticides. It provides a natural source of calcium and sulphur, which can be directly assimilated by plants and are vital to fertilisation and healthy plant growth.

Calcium supply: Calcium is an important element for plant growth. It stimulates the formation of micro organisms necessary to fix nitrogen in the roots. Unlike some other nutrients, it does not move easily within the plant from older leaves to the growing tips where it is needed. As calcium sulphate is relatively soluble, it is a good source of medium-term release calcium which has reasonable mobility through the soil profile. Calcium is especially important for the horticultural crops (apples, citrus fruits, nectarines, grapes, tomatoes etc.) as it is important in fruit development. Fruit with a higher-than-average calcium status are less likely to suffer physiological and post-harvest storage problems. The advantage of calcium sulphate as a calcium fertiliser is that it has little or no effect on soil pH. Application of minerals (e.g. lime) that raise pH, make trace elements less available and tend to reduce plant growth.

Sulphur supply: Calcium sulphate is also a good natural source of sulphur which activates the function of the chlorophyll, which is required for protein synthesis and plays an important role in the actions carried out by plant cells. The application of calcium sulphate provides sulphur in a form that is readily available to plants. Sulphur depletion can occur from intensive farming which exhausts the natural reserves in the soil and also from the use of complex fertilisers that are weak in sulphur. Cultivations that may require the addition of sulphur are e.g. peas, beans, cabbage, beets, onions, garlic etc. Calcium sulphate allows the application of sulphur without further input of phosphorous, whereas fertilizers like superphosphate raise the concentration of phosphorous in the soil.

Indirect fertilisation: In addition to its direct fertilisation properties, the SO_3 component of calcium sulphate amends nutritional tie-up and makes essential nutrients more available. It helps valorising the 3 major plant nutrients (nitrogen, phosphorus, and potassium), the 3 secondary nutrients (calcium, sulphur, magnesium) as well as different trace elements, such as iron and zinc.

SO_3 -- + MgO → $MgSO_4$ Magnesium sulphate
SO_3 -- + K2O → $K2SO_4$ Potassium sulphate

Water savings – an additional benefit of the application of calcium sulphate

Calcium sulphate promotes water infiltration, retention and conservation. By allowing water to penetrate the soil without forming puddles or water logging, calcium sulphate conserves water by stretching intervals between irrigations. Farmland treated with calcium sulphate requires up to 33% less water than soils without recent calcium sulphate application.

Application of calcium sulphate

Calcium sulphate mixes well with other dry fertilisers. Calcium sulphate is also useful as a carrier to assist in the uniform application of small quantities of zinc, manganese, boron and the other trace elements. Calcium sulphate is easy and safe to apply using conventional dry-spreading equipment. Recent interest has been shown in waterborne applications via an irrigation/fertigation system.

If used as a fertilizer, calcium sulphate should be applied once or two times per year, in order to replace minerals continuously lost from the site.
If used for soil improvement, calcium sulphate is applied every few years to develop and maintain good soil structure.
Calcium sulphate relies upon rainfall to solubilise it and so move it into the soil profile where it has its effect; it is therefore best applied in early spring or after harvest when rainfall can do its work. It can, however, be applied at any time because calcium sulphate does not damage plant tissues - even at high application rates.
Ground gypsum is quite fine and even the pulverised product contains a proportion of fine material. It should, therefore, be applied only in calm or at the most "light breeze" conditions.

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