Minerals and Management

Measuring the Nutritive Values of Gypsum

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"TURF" is a common word throughout Europe and U.S.A., and its origin lies in the Sanskrit word "darbhus" which means a tuft of grass. In general terms "turf" refers to a piece of the outermost layer of soil with the living matted vegetation. Historically, the concept of open yard, now generally known as lawn, originated in China as early as the 12th Century. Later, Victorian England imported this practice into the British Isles. Turf grass, like any other living organisms, is sensitive to the various environmental stresses, and responds to a good and sound management program including the provision of essential plant nutrients to enable it to carry out its vital metabolic processes.

Properties of Gypsum

Gypsum is a naturally occurring mineral in the earth's crust. From a chemical standpoint, gypsum ($CaSO_4 \cdot H_2O$) is calcium sulfate combined with two molecules of water.

In most of the naturally occurring deposits, it is found in combination with anhydrite ($CaSO_4$). Anhydrite is, primarily, calcium sulfate devoid of water molecules. Gypsum, in its pure form comprises 20.9% combined water, 46.6% sulfur trioxide and 32.5% lime as calcium oxide (CaO).

Although not very soluble in water, gypsum is 150 times more soluble than calcium carbonate. It is the most soluble mineral form of calcium. Solubility of gypsum, when applied to soil, depends on several factors, including the amount of available soil moisture and the extent of the contact between the gypsum and the soil particles.

Traditionally, gypsum has been used on plants in a fine powdered form. Gypsum, in this form, is highly soluble in soil solution. However, only gravity-type spreaders can be used to apply this material to large areas as its light and dusty nature is not suited to centrifugal or whirly-bird type spreaders. Coarse grind gypsum (20 percent passing 100 mesh) is somewhat superior to the powdered form in bulk handling and field spreading characteristics.

A new form of gypsum has recently been developed by United States Gypsum Company. It combines some of the major physical and chemical characteristics which are considered essential in relation to the use of gypsum in agriculture. It has a particle size range of 6x30 mesh, and is compatible for bulk-blending with other fertilizer materials. It can be bulk-blended and bulk-spread with conventional fertilizer spreaders. It has tailored solubility under normal field conditions as it becomes available to plants at a controlled rate. Controlled solubility makes it longer-lasting and prevents it from being prematurely leached out of the soils before plants are able to utilize it. It is non-segregating to a large extent and is non-caustic. Granular gypsum can also serve as carriers for micro-nutrients, pesticides and herbicides.

Gypsum, A Soil Conditioner

Soil is the medium for plant growth. Physical and chemical properties of soils profoundly affect plant growth and development as the plants depend upon soils for nutrients and water under a favorable soil physical environment. Soil structure and soil consistency are the main factors influencing the soil physical environment.

Soil structure refers to the arrangement of soil particles. A good soil structure is synonymous with the abundance of water stable aggregates or granules. A soil having a good soil structure is subject to minimum surface crusting, minimum soil erosion, and allows water and air to circulate through the soil system. A good soil structure can be promoted by the flocculation (forming large chunks) of the dispersed soil particles.

Various factors may cause soil structural degradation. Most important among these are the concentration of sodium ions, excessive cultivation, compaction, flooding, poor drainage, high clay content, low organic matter, etc.

Gypsum has long been used as a soil conditioner, and its primary role, in this regard, is related mainly to its flocculating action on the clay particles. From physico-chemical standpoint, clays are negatively charged particles. These particles, like any negatively charged particles attract positively charged ions, such as calcium, magnesium, potassium, sodium, ammonium and others. Sodium ions, when present in soils, in excess of 10-20 percent of the total cations, adversely affect the soil physical property. The detrimental effect of sodium ions is related to soil swelling, reduction in soil pore space and in increased hydration.

When gypsum is applied to such soils, the calcium ions from the dissolved gypsum replace the sodium ions on the soil particles and bring about the flocculation of the soil particles. Another mechanism by which the calcium ions influence the soil physical condition is to flocculate the clay particles in association with the oriented water molecules.

When the soils become dry, the particles are pulled together and, in the presence of calcium ions, this action causes flocculation of the dry particles.

Various synthetic soil conditioners, such as polyacrylamide bitumen emulsions, polyvinyl alcohols, polyvinyl acetates and others have also been tried as soil conditioning agents. The mode of action of these substances involves the formation of linkages between the soil

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particles which, in turn, is caused by the primary absorption. The synthetic soil conditioners are, however, expensive and thus economically prohibitive for large scale uses. Moreover, they lack nutritional values. Gypsum, on the other hand, is a much less costly product and is also an important source of two major plant nutrients, sulfur and calcium.

Gypsum, a Source of Calcium

Gypsum supplies calcium which is one of the major essential elements for plant growth and development. Calcium is required for maintaining the cellular protoplasmic organization, and is also responsible for the formation of calcium pectate which acts as a cementing agent for the cell walls. Calcium deficiency in plants is generally characterized by the failure of the terminal buds and the apical tips of the roots to develop. It influences the protein synthesis by its ability to regulate the uptake of nitrate nitrogen. Calcium affects the activity of certain enzyme systems. Calcium ions are involved in the movement of ions into the root cells by synthesizing and maintaining the root membranes.

A Source of Sulfur

Sulfur, like nitrogen, is a major essential element and acts as an agent of low energy bonding in the protein synthesis. Sulfur also influences the process involved in the hardening of protoplasm in cold or drought condition. Sulfur is similar to phosphorous in activities related to energy transfer within the plant system. Sulfur is needed for the synthesis of sulfur containing important amino acids; cystine, cysteine and methionine. It also acts as an activating agent for certain proteolytic enzymes, and is a constituent part of some vitamins, co-enzyme A and of glutathione. It is also found in oils of plants belonging to mustard and onion families.

Plants suffering from sulfur deficiencies are known to accumulate nitrates as well as amides. Plants take up sulfur in the form of SO_4 ions.

Time and Rate of Application

Rate of application depends upon a number of factors, such as the soil type, soil fertility status, organic matter content and the nature of the plant species.

Time of application would depend upon the objective and the management techniques employed in the establishment and maintenance of turf. When new turf is being established, the ideal thing to do would be to apply a generous amount of gypsum at the time of land preparation. For maintenance purposes, gypsum should be applied at any time of the year, but late fall and spring application would be more effective. Gypsum can also be applied in mixture with other lawn fertilizers.

From the foregoing, it is evident that the gypsum application can be a very productive tool in the establishment and maintenance of good turf. Its primary role is related to the improvement in soil physical property leading to improved soil structural condition, improved soil drainage, improved air and water circulation, increased water holding capacity and greater root penetration.

Plant roots need adequate quantities of oxygen to carry out their important metabolic processes. Greater root proliferation and greater root penetration also allows the plants to explore large volume of soil for plant nutrients and water. Enhanced root activity provides a greater amount of organic matter essential for a good soil structural condition.