Potassium, Calcium, Magnesium— How They Relate to Plant Growth

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Potassium, calcium and magnesium play an important role in soil-plant relationships. These elements are not only essential to the complex biochemistry of plant growth, but their presence in the soil in adequate amounts and in suitable proportions to one another and to the other exchangeable cations, such as aluminum, hydrogen and NH_4+, is necessary if the soil is to be a suitable medium for plant-root development. Should one element be in excess, it may "tie-up" or make it unavailable to the plant.

POTASSIUM

Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and possibly calcium. This element plays an important part in many of the vital physiological processes in the plant; the exact mechanism by which potassium functions is not known. It is needed for the plant cell's metabolic processes and apparently has a role in influencing the uptake of certain other mineral elements, in regulating the rate of respiration, affecting the rate of transpiration and in influencing the action of enzymes, as well as in aiding the synthesis and translocation of carbohydrates. Potassium also has a counterbalancing effect on the results of a nitrogen excess. It enhances the synthesis and translocation of carbohydrates, thereby encouraging the cell walls to thicken and help the plant to remain upright.

Potassium plays a vital role in the winter survival of turfgrass, disease resistance, and in increasing the overall hardiness of the grass plant. Deficiency symptoms of potassium on turfgrass are yellow-streaked leaves, followed by browning and dying at tips and margins.

SOURCES OF POTASSIUM

Hardwood ashes supplied much of the potassium in the United States through the first part of the 19th Century. A decline in the potash industry resulted after the hardwood forests along the Atlantic Coast were depleted. The first factory that processed KCL (murate of potash) was in Germany, and the Germans monopolized the potassium market until World War I. The embargo placed on potassium exports forced development of the resources of the United States and of other countries as well. Most potassium today comes from New Mexico, California, and Utah.

CALCIUM

Calcium, as potassium, is absorbed by the turfgrass plant in the ionic form. The calcium in the soil other than what was added as lime or in fertilizer material originated in the rocks and minerals from which the soil was formed. Calcium is a part of many minerals, such as

Injury to turf from the misapplication of plant nutrients.

dolomite, calcite and calcium feldspars. Upon their disintegration and decomposition, calcium is released.

Calcium is an extremely important mineral in plant nutrition. Many soils, particularly in humid regions, contain this element in amounts so small that plant growth is limited. Turfgrasses as a group are able to tolerate low levels of calcium; however, abnormal growth has been observed with extremely low levels. One of the primary roles assigned to calcium in the plant is the key role it plays in the cell walls. Calcium is also important in root development, since short roots are observed on calcium deficient plants.

The first sign of calcium deficiency in older plants is the appearance of a reddish-brown discoloration in the tissue between the veins, along the margin of the blade. The most obvious method of correcting this deficiency is by the application of calcitic or dolomitic lime. Should calcium be required without changing the pH that would result from the use of lime, gypsum may be used.

Liming is the addition to the soil of any calcium-containing compound that is capable of reducing acidity. The correct use of lime refers only to calcium oxide (CaO), but the term almost universally includes such materials as calcium hydroxide, calcium carbonate, calcium-magnesium carbonate and calcium silicate slags.

A description of various liming materials describing their availability and manufacture follows:

Calcium Oxide — Calcium oxide (CaO), also known as unslaked lime, burned lime, or quicklime, is a white powder that is quite disagreeable to handle. It is manufactured by heating calcite limestone in an oven or furnace. The carbon dioxide is driven off, with calcium oxide remaining. This product is most frequently handled in paper bags because of its powdery and caustic nature. This material reacts quickly when added to the soil. When unusually rapid results are desired, either calcium oxide or calcium hydroxide should be used.

Calcium Hydroxide — Calcium hydroxide ($Ca(OH)_2$) is commonly referred to as slaked lime, hydrated lime or builder's lime. It is similar to calcium oxide in that it is a white powdery substance, difficult and unpleasant to handle. Slaked lime is prepared by the hydration of calcium oxide. A large amount of heat is generated; upon completion of the reaction, the material is dried and packaged.

Calcium and Mixed Calcium-Magnesium Carbonates — The carbonates of calcium and magnesium occur widely in nature and in many different forms. Crystalline calcium carbonates are referred to as calcite or calcitic limestone. Crystalline calcium-magnesium is known commonly as dolomite.

MAGNESIUM

Magnesium is also absorbed by plants in the ionic forms. This absorption takes place from the soil solution or possibly by contact exchange.

Magnesium plays a vital role in photosynthesis, as it is the central atom in the chlorophyll molecule. It is involved in many enzyme reactions. It reacts with phosphorus in uptake and transport. Magnesium is also quite mobile in the plant, and yellow deficiency symptoms first appear on the older leaves, as it moves to the younger plants.

SOURCE OF MAGNESIUM

Magnesium in the soil originates in the decomposition of rocks containing minerals such as brotite, dolomite and olivine. Upon decomposition, these minerals set magnesium into the surrounding soil solution. Once in the soil solution, magnesium may be 1) leached, 2) absorbed by living organisms, and 3) adsorbed by surrounding particles.

MAGNESIUM IN THE SOIL

The coarse-textured soils of the humid region are those in which a magnesium deficiency is generally manifested. These soil types usually contain small amounts of exchangeable magnesium. This condition is aggravated by the addition of large quantities of fertilizer salts which contain little or no magnesium. The magnesium in the soil is released by ion exchange when these fertilizers are added; the larger quantities of chlorides and sulphates speeds its removal by leaching. Magnesium can be supplied in dolomitic limestone, or as magnesium sulphate, if soil pH is to remain the same. A deficiency of magnesium is less of a problem on finer-textured soils and on soils found in the arid regions. In some semi-arid locations, magnesium compounds may actually be precipitated in the soil profile.

When the appearance of a plant and environmental factors indicate a nutritional disorder, steps should be taken to verify the problem before attempting to correct it haphazardly with nutrients that are not needed. Since nutrient deficiencies on turfgrasses are difficult to visually diagnose, a suspected deficiency should be verified with soil or tissue tests before trying to correct the problem. A most important criterion for a soil test is that it should measure the nutrient in the soil that is available to the plant. Many times nutrients in the soil are held tightly and are unavailable.