MAGNESIUM

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When discussing the macronutrients plants require for growth, most people will think of nitrogen, phosphorus and potassium immediately. After a bit more thought calcium comes to mind. In past issues of the MCFGA bulletin all of these nutrients have been discussed. Next in the series of macronutrients is magnesium, the fifth major plant nutrient.

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Magnesium is required by most plants in a lesser amount than the previously mentioned nutrients and, in fact, typically will be about 0.5% of the dry weight of a plant (Nelson, 1985; Marschner, 1986). Compare this to nitrogen or potassium which are usually about 4.0% of the dry weight of a typical plant (Nelson, 1985). This lower requirement by the plant does not make magnesium any less important in maintaining growth of the plant.

Magnesium is the central atom of the chlorophyll molecule (Marschner, 1986; Jacob, 1958). Jacob (1958) stated that this made magnesium occupy one of the most important key positions in the plant organism. As well as it's important roll in chlorophyll and therefore photosynthesis, magnesium is also important in improving phosphate uptake (Roschdejestwensky; 1939; Bartholomew, 1933; Troug and Goates, 1947; Obst, 1933), the activation of enzymes (Jacob, 1958; Marschner, 1986), the formation of carbohydrates (Bolelоucky, 1936; Kowalew, 1940), the formation of proteins (Pfeil, 1957; Cammarano et. al., 1972; Sperrazza and Speremulli, 1983), the formation of fats in the seeds of oil producing plants (Mosolow, 1938), the formation of vitamins (Scharrer and Bürke, 1953; Pfützer, Pfaff and Roth, 1952; Michael, 1941) and cell formation and plant growth (Albert and Armstrong, 1935; Albert, Armstrong and Bern, 1949; Bertrand, 1940).

Magnesium is the central atom of the chlorophyll molecule.

In association with chlorophyll synthesis, magnesium is critical in maintaining internal cell pH. High concentrations of Mg^{2+} and K^{+} are required in the cholorplasts and cytoplasm to maintain a pH of 6.5 to 7.5 (Marschner, 1986). The maintenance of this pH has a strong influence on the structure of proteins and therefore, enzyme activity in a plant (Smith and Raven, 1979).

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Magnesium is also required for RNA polymerases and therefore for the formation of RNA in the nucleus of cells (Marschner, 1986). This is thought to be related to the bridging of individual DNA strands as well as the neutralization of acid proteins in the nuclear matrix (Wunderlich, 1978). Galling (1963) showed that in response to magnesium deficiency RNA synthesis stopped immediately and would resume rapidly after the addition of magnesium. In addition, protein synthesis would remain unaffected for over 5 hours when magnesium was deficient, but after this time period the synthesis would rapidly decline.

The transfer of energy within a plant and within plant cells can be affected by the magnesium level in that plant. Magnesium is critical in the synthesis of ATP in plants and acts as a bridging component between ADP and the enzyme (Marschner, 1986). The addition of magnesium to this reaction can increase the rate of ATP formed by about three times (Lin and Nobel, 1971).

The importance of magnesium in plant propagation was observed by Bertrand (1940) in investigations he made on its content in pollen. Related information was found in plants low in magnesium producing impaired strawberry fruit formation (Davis, Hill and Johnson, 1934), decreased grain yields and reduced seed germinating power (Masajewa, 1954).

Adequate magnesium in a plant also appears to be important in drought resistance of the plant (Kiselew, 1939; Ehrenberg and Buchner 1949). Plant transpiration is also apparently influenced by magnesium content (Arland, 1953). Winter hardiness of fruit tree seedlings was found to be reduced due to a sensitivity to lack of water which was increased by magnesium deficiency (Jacob, 1958).

Along with apparent plant strength due to adequate magnesium in the cells, Hill and Johnston (1940) and Wallace (1940) showed in separate research that plants showed increased susceptibility to spray damage when magnesium was deficient. Plants also showed decreased resistance to disease organisms when magnesium was deficient

(Gardner, 1942; Kiselew, 1939; Alvim, 1950; Ryzkow and Smirnowa, 1948; Archangelskaja, 1938; Nemec 1938).

Deficiency

Magnesium is a competitive cation and as such will compete with potassium, ammonium (Kurvits and Kirkby, 1980), calcium and manganese (Heenan and Campbell, 1981) for uptake by plants. Due to this competition, magnesium content in the leafy portion of plants can be low, but this competition many lead to in increase in the magnesium content of fruits or storage tubers (Kirkby and Mengel, 1976).

Magnesium deficiency is revealed above all by the leaf (Jacob, 1958). The leaf is the organ of the plant where organic substances are formed for the plant, therefore, it makes sense that the first symptoms of magnesium deficiency would show up there (Jacob, 1958). First signs show the brightening of leaves; a cloudy distribution of leaf pigment; the leaf pigment no longer fills the whole leaf uniformly; mottling of the leaves occurs with the formation of yellow chlorotic places (Jacob, 1958).

Chlorosis of fully expanded leaves is the most obvious visible symptom of magnesium deficiency (Marschner, 1986). Leaves that are deficient in magnesium may also show a variegated coloration and finally decay of the leaf (Jacob, 1958).

In magnesium deficiency the chloroplasts were not normal in form or color and the plants were pale (Mameli, 1915).

Sources of Magnesium

Magnesium makes up 1.93% of the earth's crust (Tisdale, Nelson and Beaton, 1985). This can range from about 0.1% of the make up in coarse, sandy soils to 4.0% in fine-textured, arid or semi-arid soils (Tisdale, Nelson and Beaton, 1985). Magnesium is slowly available in heavy soils, and can be released by leaching. Vermiculite is a good source of magnesium and in many cases can be a significant source for the plants (Tisdale, Nelson and Beaton, 1985).

In many cases, magnesium is added to plants as a component of other fertilizers. This is one if the reasons that magnesium deficiency is not extremely common. A common fertilizer that may be used is potassium-magnesium-sulfate (Jacob, 1958). As in many cases, this fertilizer, along with others, is more common in field grown crops.

In greenhouse crops, the most common source of magnesium, especially if deficiencies are present, is magnesium sulfate (epsom salts). Epsom salts may be used as a soil application, or as a foliar spray. If foliar application of magnesium is called for, magnesium nitrate is also used (Tisdale, Nelson and Beaton, 1985).

Remember that magnesium competes with calcium for uptake by the plant. Even if the level of magnesium present in the soil seems adequate, if calcium is present in greater than 3:1, the magnesium may not be taken up. This is just one of the complexities that make understanding plant nutrition difficult.

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