Mosaic®
AgriSight®
TRUSTED CROP NUTRITION EXPERTISE℠
ISSUE 14: 2018

Magnesium for Balanced Crop Nutrition

Magnesium (Mg) is one of three secondary macronutrients, along with calcium and sulfur, required for balanced crop nutrition. Often overlooked, Mg deficiencies can lead to reduced crop growth and yield.

Magnesium's Role in the Plant

Magnesium plays a critical role in various functions within the plant, and can have a substantial effect on plant growth and yield.

Structural Component of Chlorophyll:

Magnesium is the central atom of the chlorophyll molecule. Sufficient plant nutrition, which includes Mg, maintains high levels of chlorophyll, resulting in healthy, green leaf tissue.

Key Driver of Photosynthesis:

Photosynthesis is the process by which plants provide energy from intercepted sunlight for growth via the production of carbohydrates. The presence of magnesium in chlorophyll is needed for photosynthetic reactions, and thus carbohydrate production, to occur.

Transportation of Carbohydrates:

Transportation of carbohydrates from leaves to actively growing tissues of plant roots, shoots and reproductive organs requires adequate levels of Mg. A deficiency of Mg can reduce root or shoot growth (Fig. 1), and potentially seed weight.

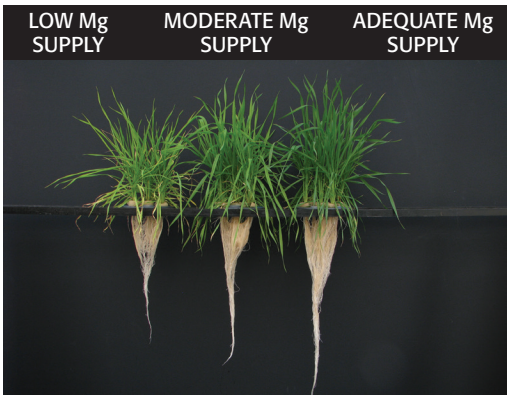

Fig. 1. Shoot and root growth of wheat plants with low, moderate and adequate magnesium supply. (Source: Cakmak, 2013, ***Plant and Soil***)

For example, a recent publication indicated a reduction in seed weight of wheat from 41 mg/seed to 24 mg/seed in a low-Mg environment (Fig. 2).

Fig. 2. Wheat seeds from plants grown with low Mg (left) and adequate Mg (right) fertilization. (Source: Ceylan, et al., 2016, ***Plant and Soil***)

Heat-Stress Tolerance:

Since plants with low Mg or potassium (K) supply are not able to maintain an optimum level of photosynthesis, the light energy absorbed for photosynthesis begins to accumulate in the leaves. This excessive light energy damages leaf tissue. Adequate plant-available Mg maintains optimum photosynthesis and reduces crop stress from high solar radiation and high temperature (Fig. 3).

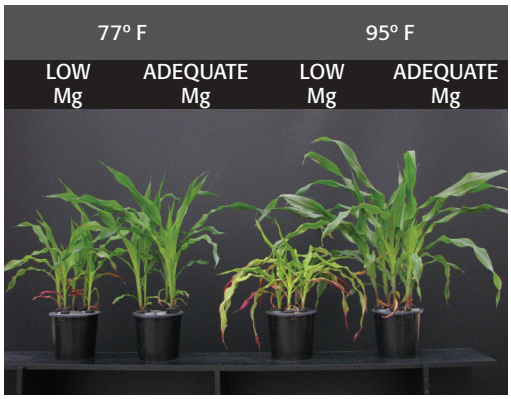

Fig. 3. Effect of Mg supply and temperature on corn growth and development. (Source: Mengutay, et al., 2013, ***Plant and Soil***)

Magnesium plays a critical role in various functions within the plant:

- Structural component of chlorophyll
- Key driver of photosynthesis
- Transportation of carbohydrates
- Heat-stress tolerance

Fig. 4. Leaves of corn showing Mg deficiency symptoms due to decreased Mg supply.

Magnesium Deficiency

Magnesium is somewhat mobile within the plant, and typically translocated from older to younger tissues; therefore, Mg deficiencies usually appear first in older leaves. Low Mg concentration in plants will induce interveinal chlorosis (Fig. 4). When Mg deficiencies are severe, reddening of the leaf tissue can also occur. The following explores a few of the most common soil and environmental factors that can affect the occurrence of Mg deficiency in plants:

Cropping System:

Magnesium deficiency is a growing concern, especially in intensive crop production systems. Under such cropping systems, high amounts of Mg are taken up by the crop. Because removed Mg is typically not replenished annually, intensive cropping systems can quickly deplete soil Mg reserves.

Soil pH and Type:

Acidic and/or coarse-textured soils are most likely to experience Mg deficiency. Low cation exchange capacity in sandy soils can permit Mg leaching through the soil profile, especially where excessive precipitation or irrigation is received.

Soil Cations:

Magnesium is taken up by the plant as the Mg^{2+} ion. It can be found in soil solutions, on clay surfaces and within clay layers. Mg on clay surfaces (exchange sites) becomes soluble when replaced by another cation present in the soil solution. Some research suggests that repeated use of fertilizers high in cations (e.g., K^{+}, NH^{4+}, Ca^{2+}, etc.) can displace Mg on the exchange sites (cation exchange capacity), and may induce Mg deficiency. Under such situations, applying fertilizers containing both Mg and K, such as K-Mag® (0-0-21.5-10.5Mg-21S), can minimize or avoid the risk of Mg deficiency in plants.

Crop Need and Mg Fertilization

Corn, potato, sugarcane and sugar beet are among the highest Mg-demanding crops in North America.

Fertilization rates of magnesium usually range from 10 to 40 pounds of Mg/acre. Perhaps as important as application rate is the consideration of Mg solubility. Nutrient sources that are highly soluble can be prone to leaching in acidic and/or coarse-textured soils compared to compounds with low solubility (oxides and carbonates), which may require months or years before Mg is converted to a plant-available form. Therefore, understanding the differences in Mg solubility among fertilizers will help retailers and producers understand the most appropriate nutrient source for their individual needs.

Conclusion

Magnesium has a diverse and critical role in various plant functions. These functions, including photosynthesis, transportation of carbohydrates to different growing tissues (roots, shoots and reproductive organs), and stress-tolerance mechanisms, explain why decreases in yield may occur with inadequate Mg nutrition. Particular attention to Mg nutrition is warranted in 1) intensive cropping systems, 2) acidic soils or coarse-textured soils and 3) when fertility programs require repeated use of nutrient sources with high concentrations of other cations.

Further Readings

Cakmak, I. (2013): Magnesium in crop production, food quality and human health. *Plant Soil.* 368:1–4.

Cakmak, I. and Kirkby, E.A. (2008): Role of magnesium in carbon partitioning and alleviating photooxidative damage. *Physiol. Plant.* 133:692–704.

Cakmak, I. and Yazici, A.M. (2010): Magnesium: A forgotten element in crop production. *Better Crops.* 94:23–25.

Ceylan, Y., Kutman, U.B., Mengutay, M. and Cakmak, I. (2016): Magnesium applications to growth medium and foliage affect the starch distribution, increase the grain size, and improve the seed germination in wheat. *Plant Soil.* 406:145–156.

Dibb, D.W. and Thompson W.R. (1985): Interaction of potassium with other nutrients. In "Potassium in Agriculture." 22:515–533.

Mengutay, M., Ceylan, Y., Kutman, U.B. and Cakmak, I. (2013): Adequate magnesium nutrition mitigates adverse effects of heat stress on maize and wheat. *Plant Soil*. 368:57–72.

Mikkelsen, R. (2010): Soil and fertilizer magnesium. *Better Crops.* 94:26–28.

Römheld, V. and Kirkby, E.A. (2010): Research on potassium in agriculture: Needs and prospects. *Plant Soil.* 335:155–180.

The Mosaic Company
3033 Campus Drive
Suite E490
Plymouth, Minnesota 55441
800-918-8270
www.CropNutrition.com