Secondary Plant Nutrients: *Calcium, Magnesium, and Sulfur*

Calcium, magnesium, and sulfur are essential plant nutrients. They are called "secondary" nutrients because plants require them in smaller quantities than nitrogen, phosphorus, and potassium. On the other hand, plants require these nutrients in larger quantities than the "micronutrients" such as boron and molybdenum.

Calcium, magnesium, and sulfur are generally adequate in most Mississippi soils with favorable pH and organic matter levels. They affect pH when applied to the soil. Calcium and magnesium both increase soil pH, but sulfur from some sources reduces soil pH. Compounds containing one or more of these nutrients are often used as soil amendments rather than strictly as suppliers of plant nutrition.

Calcium

The primary function of calcium in plant growth is to provide structural support to cell walls. Calcium also serves as a secondary messenger when plants are physically or biochemically stressed.

Calcium deficiencies rarely occur in Mississippi soils. Soils with favorable pH levels are normally not deficient in calcium. Acid soils with calcium contents of 500 pounds per acre or less are deficient for legumes, especially peanuts, alfalfa, clovers, and soybeans. At this level, limited root system crops such as tomatoes, peppers, and cucurbite would also need additional calcium. Soluble calcium is available as the Ca2+ ion and is needed for peanuts at pegging time and for peppers and tomatoes to prevent blossom end rot.

Available calcium can be lost from the soil when it is (a) dissolved and removed in drainage water, (b) removed by plants, (c) absorbed by soil organisms, (d) leached from the soil in rain water, or (e) absorbed by clay particles. Deficiency symptoms include death at the growing point, abnormally dark green foliage, weakened stems, shedding flowers, and any combination of these.

Limestone is the primary source of calcium in Mississippi. Other common sources include basic slag, gypsum, hydrated lime, and burned lime. These sources are recommended for peanuts, peppers, and tomatoes. In peanuts, they prevent pops and encourage pegging. In tomatoes and peppers, they prevent pops and blossom end rot. Hydrated lime and burned lime contain more readily available calcium than do basic slag and gypsum. Gypsum does not affect soil pH even though it contains calcium.

Magnesium

Magnesium is adequate for crop production in most Mississippi soils except the coarse sandy soils of the Coastal Plains and the heavy dark clays of the Blackbelt Prairie. Magnesium is absorbed as the Mg2+ ion and is mobile in plants, moving from the older to the younger leaves. It leaches from the soil like calcium and potassium.

Magnesium is the central atom amid four nitrogen atoms in the chlorophyll molecule, so it is involved in photosynthesis. It serves as an activator for many enzymes required in plant growth processes and stabilizes the nucleic acids.

Interveinal chlorosis is a deficiency symptom in crops such as legumes, corn, sorghum, cotton, and certain leafy vegetables. (Interveinal chlorosis is a yellowing between the veins while the veins remain green.) The leaves may become pink to light red and may curl upward along the margins.

To correct magnesium deficiency in soil, use dolomitic lime when lime is needed; use soluble sources of magnesium when lime is not needed. Magnesium supplementation may be needed for cotton production in the Blackland Prairie.

Cattle are often affected by grass tetany when forage magnesium content is low. Other factors include nitrogen, calcium, and potassium levels, stage of growth (usually in spring), whether or not cattle are lactating, and seasonal conditions. Dolomitic limestone is recommended as a liming material where grass tetany has been a problem. Give grazing animals supplemental magnesium and calcium when grass tetany is an issue. For more detailed information on grass tetany issues, see Extension Publication 2484 Mineral and Vitamin Nutrition for Beef Cattle.

The most common soluble sources of magnesium to use as fertilizer are magnesium sulfate (containing 10% Mg and 14% S, also known as Epsom salt), sulphate of potash magnesia (containing 11.2% Mg, 22% S, and 22% K2O, commercially sold as K-Mag), and magnesium oxide (containing 55% Mg, also known as magnesia).

Sulfur

Sulfur is needed in fairly large quantities by most crops. It is an essential building block in chlorophyll development and protein synthesis. Sulfur is required by the rhizobia bacteria in legumes for nitrogen fixation. In general, crops remove about as much sulfur as they do phosphorus. Grasses remove sulfur more efficiently than legumes, and clovers often disappear from pasture mixtures when sulfur is low.

The sulfate ion, SO4, is the form primarily absorbed by plants. Sulfate is soluble and is easily lost from soils by leaching. As sulfate is leached down into soil, it accumulates in heavier (higher clay content) subsoils. For this reason, testing for sulfur in topsoil is unreliable for predicting sulfur availability during a long growing season.

Many coarse-textured, sandy soils and loworganic matter, silty soils throughout Mississippi are sulfur deficient for crop production. Many acid soils contain metallic sulfides that release sulfur as weathering occurs.

Sulfur deficiency symptoms show on young leaves first. The leaves appear pale green to yellow. The plants are spindly and small with retarded growth and delayed fruiting. For a rapid correction of a deficiency, use one of the readily available sulfate sources.

Sulfur may be recommended for major crops in Mississippi at 8–10 pounds per acre annually in some situations. Check with local MSU Extension Service offices or area agronomists for more crop- and sitespecific information.

There are many sources of fertilizer sulfur available. Organic matter is the source of organic sulfur compounds and is the main source of soil sulfur in most Mississippi soils. Other sources of sulfur are rainfall and fertilizers that contain sulfur. Some readily available sources include ammonium sulfate (21% N and 24% S), potassium sulfate (50% K20 and 17.6% S), gypsum (32.6% CaO and 16.8% S), and zinc sulfate (36.4% Zn and 17.8% S).There are several other sulfate sources as well as less available sources of sulfur in the elemental or sulfide form.

Elemental sulfur is a good acidifying agent. An application of 500 pounds of sulfur per acre on sandy loam soil reduces the pH from 7.5 to 6.5. It takes about 3 pounds of lime to neutralize the acidity formed by 1 pound of sulfur.

References

Maathuis F.J.M. (2009) Physiological functions of mineral macronutrients. Current Opinion in Plant Biology 12:250-258.

McCauley A., Jones C., Jacobsen J. (2009) Plant nutrient functions and deficiency and toxicity symptoms, Montana State University Extension Service, Bozeman, MT. pp. 16.

Table 1. Average percentage of chemical content of major sources of calcium, magnesium, and sulfur.

Material	Calcium	Magnesium	Sulfur	Other
	percentage			
Calcium				
calcitic lime	31.7	3.4	0.1	
dolomitic lime	21.5	11.4	0.3	
gypsum	22.5	0.4	16.8	
basic slag	29.0	3.4	0.3	No longer a P source
Magnesium				
magnesium sulfate	2.2	10.5	14.0	
sulfate of potash magnesium		11.2	22.7	22 K_2O
magnesium oxide		55		
Sulfur				
ammonium sulfate	0.3		23.7	21 nitrogen
potassium sulfate		1.2	17.6	50 K_2O
gypsum	22.5	0.4	16.8	
magnesium sulfate	2.2	10.5	14.0	
zinc sulfate			17.8	36.4 zinc
prilled sulfur			33–99	

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