Source: Nutri-Facts Copper: http://www.ipni.net/publication/nutrifacts-na.nsf/0/F516E471D756452D85257E3400610DCC/$FILE/NutriFacts-NA-10.pdf

Copper (Cu) is one of eight essential plant micronutrients. When Cu is deficient, common crop responses to its application include reduced disease, increased crop growth and improved quality. Commonly applied Cu sources include fertilizer, animal manures, biosolids, and pesticides.

Copper in Plants

Copper has an essential function in human health and for plant growth. Its essential status for plant nutrition was not recognized until 1931. Normal Cu concentrations in plants range from 5 to 20 ppm.

Plant roots absorb the divalent form (Cu2+; cupric) and can readily reduce it to the monovalent form (Cu+; cuprous). The ease of converting Cu back and forth between the cupric and cuprous forms gives Cu unique functions in the plant. Copper plays roles in photosynthesis and respiration, including the final transfer of electrons to oxygen. Copper helps form lignin in cell walls, which provide support to hold plants upright. It is particularly important to the formation of viable pollen, seed set and stress resistance.

Copper in Soils

Total Cu in soils commonly ranges between 1 to 40 ppm, but the Cu concentration dissolved in the soil solution is much lower. The availability of Cu in soils for plant uptake is affected by the following characteristics:

- *Organic matter*. Copper is more tightly bound to organic matter than any other micronutrient. Plant Cu deficiencies often occur in crops growing on peats, mucks, and soils with more than 8% organic matter. Critical concentrations of soil test Cu (DTPA-extractable Cu) are much higher in these soils than in mineral soils.
- *Texture*. Plants growing in sandy-textured soils are more likely to be deficient than those growing in loams and clays. Clay-textured soils generally hold more Cu in exchangeable form, available to crops. Other soil components, such as oxides and carbonates, can further reduce Cu availability.
- *Soil pH*. Copper solubility decreases as pH increases to 7 and above. Higher pH increases the strength by which Cu is held by soil clays and organic matter, thus making it less available to crops.
- *Nutrient balance*. High concentrations of zinc (Zn), phosphorus (P), aluminum (Al), and iron (Fe) in soils can depress Cu absorption by roots and aggravate Cu deficiency. Risks of Cu deficiency also increase with higher rates of nitrogen (N) application.

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Fertilizing Soils with Copper

Source: When additional Cu is required, the most common fertilizer source is copper sulfate, although many other excellent materials are available. Additional sources of Cu include livestock and poultry manures, and municipal wastes or biosolids. Some animal manures contain elevated concentrations of Cu due to its addition to animal feed, or its use in foot baths to prevent foot rot.

Rate: Where crop deficiencies have been identified, the right rate depends on the specific Cu source. Copper fertilizers vary in their Cu content and solubility in soil. For example, rates of 3 to 14 lb/A of Cu as copper sulfate or around 0.5 lb/A of Cu as chelate are used for soil application, with lower rates for foliar application.

Time: Since Cu is tightly retained in soil, the timing of soil applications is flexible and Cu availability can be improved for several years following a single application. Foliar applications are usually limited to emergency situations where the deficiency is identified after planting, or as part of a maintenance foliar fertilization program.

Place: Effectiveness of Cu delivery is increased by thoroughly mixing fertilizers into the root zone or by band application near the seed row. The risk of root injury increases when a high rate of Cu is band applied near the seed.

Copper Deficiency Symptoms

Copper deficiency symptoms vary with the crop. Mild or moderate deficiency may reduce yield or plant growth without clear signs. Copper does not move in the plant, so symptoms appear first in younger growth.

In corn and small grains, young leaves become yellow and stunted; early symptoms may be confused with those of frost or drought. In advanced stages, leaves may brown at the margins similar to potassium (K) deficiency symptoms. In small grains, ergot infection, stem melanosis, take-all root rot, and Fusarium head blight can increase when Cu is deficient. Browning of the head and bending of the stem at maturity are common signs of Cu deficiency in wheat and barley. The heads are often empty and contain shriveled grain.

Copper Toxicity Symptoms

Copper toxicities can occur after repeated applications of manures, biosolids or pesticides that are high in Cu. Symptoms of toxicity include reduced shoot vigor, poorly developed root systems, discolored roots, and leaf chlorosis (yellowing). They can be confused with symptoms of Fe deficiency.

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