Copper

Evaluating Micronutrient Needs of Soils and Crops in New Jersey

Fact Sheet FS720

Cooperative Extension

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Function of Copper in Plants

In plants, copper has essential roles in several metabolic processes including photosynthesis and respiration. Copper is a constituent of some plant enzyme systems. The formation of lignin, a constituent of plant cell walls, requires copper.

Copper Deficiency Symptoms

Visible expressions of copper deficiency are sometimes related to lack of lignin formation in cell walls. Lignin deposition in cell walls is important to normal plant structure and blocks entry of fungal mycelia. Inadequate lignin formation may result in twisted leaves and stems in copper deficient plants. Greater susceptibility to lodging and attack from powdery mildew may be associated with copper deficiency.

Knowledge of copper deficiency symptoms can help identify the deficiency, but symptoms vary with the crop. Distorted or twisted young leaves and withered leaf tips are typical symptoms in many plants. Rosetting (many leaves clustered into a short length of stem), necrotic spotting, and terminal dieback are associated with copper deficiency in some crops. When copper deficiency occurs in corn, the youngest leaves become yellow and stunted. As the deficiency becomes more severe, the young leaves pale and the older leaves die back. In small grains, the younger leaves of copper-deficient plants turn pale green and eventually wither and die at the tips. In many vegetable crops, young leaves may be permanently wilted. Leaves develop a bluish-green cast, become chlorotic and curl. Plants fail to flower. Carrot roots and onion bulbs develop poor pigmentation.

Copper Toxicity Symptoms

The most common symptom of copper toxicity is stunted root growth – poor root development, less branching, unusual thickening and dark coloration. Leaves on plants with copper toxicity may exhibit chlorosis.

Plant Tissue analysis

Tissue analysis is an effective tool to evaluate a plant's copper nutritional status. Evaluation of tissue nutrient status should be based on a specific plant part sampled at a specific growth stage. The normal plant leaf concentration range is 7-20 ppm of copper in the dry matter. Deficient plants usually have less than six ppm copper. Copper toxicity has been associated with leaf levels exceeding 25 ppm. Because roots are particularly sensitive to copper toxicity with relatively little being translocated to the shoots, leaf copper concentrations may not be diagnostic of toxicity.

Sufficiency ranges for copper and plant sampling procedures for many different crops are listed in the Plant Analysis Handbook aesl.ces.uga.edu/publications/plant/.

Soil Analysis

Relatively little research has been conducted to interpret soil tests for copper. Soil analysis, however, can help to identify soils that are low in copper and may be deficient, or soils that may have excessive levels of copper. Additional information provided by plant tissue analysis, soil organic matter content, soil type, and soil pH should be used in combination with the soil test level to evaluate the copper status of soils.

Rutgers Soil Testing Laboratory uses the Mehlich-3 soil test method and rates soils tested for copper as low, adequate or high. Soils are normally considered to have sufficient or adequate levels of copper when the soil test level is 0.5 ppm or greater. Soils that test low in copper will not necessarily be responsive to copper fertilization. Other soil factors, along with the crop to be grown, should be considered before making a copper application.

Copper toxicity may be a concern when the soil test level is high (>250 ppm).

Occurrence of Copper Deficiencies

Copper deficiency in New Jersey is not common. It is most often associated with crops grown on peats and mucks (organic soils, i.e., Histosols). Where the problem appears on mineral soils, it will most likely be on very sandy soils which have been heavily cropped. Lakewood, Sassafras, Woodstown, Colts Neck, and Whippany soils have relatively low contents of copper and are the most likely soil candidates for copper deficiency under intensive farming.

New areas of organic soils brought into production are often susceptible to copper deficiency. Organic soils that were previously fertilized with 20 to 40 lb/A of copper are seldom deficient because crop removal of copper is small, and

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soil copper is not readily leached. Copper sprays and dusts (Bordeaux), which were widely used for fungicidal purposes on potatoes, tomatoes and apples have left very high residual levels of copper in some of New Jersey's soils. In some cases, these very high residual levels of soil copper have reduced the yields of crops such as lettuce, escarole and endive.

Factors Affecting Copper Availability

Copper nutrition is affected by many soil properties. The most important are considered to be organic matter content, pH and texture. Applications of some types of manure or sewage sludge biosolids may result in elevated levels of soil copper. Plant availability of copper may be decreased in soils with excessive levels by liming or the addition of organic matter.

Soil Organic Matter Content

A large portion of soil copper occurs in organically bound forms. Copper is more strongly bound to well decomposed organic matter than any other micronutrient. Deficiencies are most prevalent in crops grown on organic soils that have not been previously fertilized with copper.

Adding a fresh supply of active organic matter to mineral soils as compost generally provides enough copper to meet the needs of most crops.

Soil pH

The solubility of copper and sorption on soil colloids are influenced by pH. Plant availability of copper increases as soil pH decreases (becomes more acidic). Copper uptake by plants generally decreases as soil pH increases.

Soil Texture

The supply of copper in excessively leached sandy soils is generally low. The sand (quartz) size fraction of soils generally has a low copper content. Finer textured soils (for example loams, silt loams, clays) are more likely to release copper during mineral weathering.

Interactions With Other Elements

Interactions with other plant nutrients can affect copper uptake. Both phosphorus and iron have been found to restrict copper uptake by plants. High concentrations of zinc and aluminum in the soil solution may also intensify copper deficiency.

Sensitivity to Copper Deficiency

Some plants are more susceptible to copper deficiency than others. Knowledge of crop susceptibility (Table 1) to copper deficiency may help to predict the likelihood of the deficiency on a specific soil. Crops that are highly sensitive to copper deficiency include alfalfa, lettuce, oat, onion, spinach, sudangrass, beets, and wheat. Crops that are more tolerant of low levels of soil copper include asparagus, beans, pasture grasses, peas, potato, rye and soybean.

Copper Fertilizers

There are many copper sources that make suitable fertilizer materials (e.g., copper sulfate, copper ammonium phosphate, copper frit, cupric oxide, and CuEDTA). Copper sulfate (25% copper) is the most commonly used copper fertilizer. Copper sulfate is soluble in water and is compatible with most fertilizer materials.

Method and Rate of Application

The methods of providing copper fertilizer for correction of deficiencies include soil and foliar applications. Soil application before planting is usually favored over foliar application. Application of copper in foliar sprays is used mainly for emergency treatment of deficiencies identified after planting.

Organic soils that have been identified by plant tissue and soil analyses to be deficient in copper should receive a broadcast application of 10-15 lb/A of copper as copper sulfate (that is, 40-60 lb/A of copper sulfate). Use one-half of the organic soil rate for low organic-matter content sandy soils where a need has been established. Broadcast copper fertilizer should be thoroughly mixed into the root zone. Band applications require lower rates than broadcast applications. On organic soils, band 3 to 6 lb/A of copper and on minerals soils use 1-2 lb/A of copper as copper sulfate.

Soil-applied copper has long-lasting residual effects. A broadcast application corrects copper deficiencies for a least five years and possibly much longer because crop removal of copper is very small. For most crops, 20 or more years of cropping would be required to remove 1 lb/A of copper.

When copper deficiency is detected in the field after planting, foliar applications of 0.25 to 0.5 lb/A of copper as copper sulfate can be effective at correcting the deficiency. Foliar treatment should begin as soon as deficiency symptoms appear. A second foliar application applied about two weeks later is often beneficial in cases of severe copper deficiency.

Table 1. Susceptibility of Plants to Copper Deficiency

High Sensitivity	Medium Sensitivity	Low Sensitivity
Alfalfa	Barley	Asparagus
Lettuce	Broccoli	Bean
Oats	Cabbage	Lupines
Onions	Carrots	Pasture grasses
Spinach	Cauliflower	Peas
Sudan grass	Celery	Potatoes
Table beets	Corn	Rape
Wheat	Cucumbers	Rye
	Parsnips	Soybean
	Radishes	
	Sorghum	
	Tomatoes	
	Turnips	

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