A2527

Understanding Plant Nutrients

Soil and Applied Copper

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Copper (Cu) was proven to be an essential element in 1931. The copper content of soils ranges from 2 to 100 parts per million (ppm), with an average value of about 30 ppm. Most of this is in unavailable mineral form. Crops remove less than 0.1 lb/a of copper per year. Beet, lettuce, onion, spinach, sunflower, and tomato have relatively high copper requirements. Alfalfa, corn, small grains, and some vegetables have medium copper requirements.

Copper deficiencies are rare in Wisconsin. Most verified cases have involved small grains, lettuce, or onion grown in acid organic soils. Copper toxicity in some sandy soils has resulted from repeated use of copper-containing fungicides over many years.

COPPER REACTIONS IN SOILS

Available copper in soils is held mainly as a cation (Cu^{++}) on surfaces of clay minerals or in association with organic matter. Copper present as an impurity in silicate minerals or carbonates is largely unavailable. Organic matter and soil pH are the predominant factors influencing copper availability.

Organic Matter

Copper availability decreases as organic matter in soil increases. Organic matter binds copper more tightly than any other micronutrient. This not only reduces fixation by soil minerals and leaching, but also reduces availability to crops. Organic soils, therefore, are more likely to be deficient in copper than are mineral soils. Plants grown on newly reclaimed acid organic soils occasionally exhibit copper deficiency symptoms the first few years. After the organic matter begins to decompose when the soils are drained, sufficient copper is released to support normal crop growth.

Soil pH

Increasing the soil pH by liming increases the amount of copper held by clay and organic matter, thereby decreasing copper availability. If you are growing crops on soils with a pH above 7.5, occasionally check for copper deficiency using plant analysis.

FERTILIZER SOURCES OF COPPER

When plant analysis verifies low copper in crops, apply the amount of elemental copper indicated in Table 1. Copper fertilizers are available in inorganic and organic forms (Table 2).

Follow recommended rates of copper fertilization closely. When 30 lb/a of actual copper has been applied, discontinue applications to avoid the development of copper toxicity. Copper can be broadcast or banded in soils or applied as a foliar spray. Broadcasting with N, P, or K is the most common method of application. Applications of recommended amounts are good for 5–8 years, depending on the soil and crop.

Table 2. Fertilizer sources of copper.

SOURCE	FORMULA	PERCENT COPPER
Copper chelate	$Na_2CuEDTA$	13
Copper sulfate	$CuSO_4{\cdot}5H_2O$	25
Cupric oxide	CuO	75
Cuprous oxide	Cu_2O	89

Table 1. Copper fertilizer recommendations.[a]

	SANDS		LOAMS, SILTS, CLAYS		ORGANIC SOILS	
CROP	BROADCAST	BANDED	BROADCAST	BANDED	BROADCAST	BANDED
	lb/a of elemental copper					
Lettuce, onion, spinach, tomato	10	2	12	3	13	4
Alfalfa, barley, canola, carrot, cauliflower, celery, clover, corn, oat, radish, sudan grass, wheat	4	1	8	2	12	3
Asparagus, beans, broccoli, cabbage, cucumber, mint, pea, potato, rye, soybean	0	0	0	0	0	2

[a]*Recommendations are for inorganic sources of copper. Copper chelate can also be used at 1/6 the rates recommended above. Do not apply copper unless plant analysis has verified a deficiency.*

COPPER TOXICITY

The repeated use of Bordeaux mixture ($CuSO_4 \cdot 5H_2O$ + $Ca(OH)_2$) as a fungicide on potatoes, snapbeans, and orchard crops has led to instances of copper toxicity. Once developed, this condition persists for many years because of the low solubility of copper. Toxic levels of copper reduce seed germination, shoot vigor, and iron availability.

Hog manure and some sewage sludges contain high levels of copper. Repeated applications of high-copper sewage sludge or hog manure may also lead to toxicity. Monitor soil copper levels closely when these materials are being applied.

DIAGNOSTIC TECHNIQUES

Deficiency Symptoms

Copper-containing enzymes play important roles in photosynthesis, respiration, and formation of lignin. Inadequate copper levels can lead to reduced starch production, reduced nodulation and nitrogen fixation in legumes, delayed flowering and maturity, and pollen sterility.

Copper deficiency reduces plant vigor, and until the deficiency becomes severe, the symptoms are not well defined. In small grains, grain yield decreases more than straw yield and increased lodging may occur. The tips of older leaves become necrotic (brown, dead tissue), and younger leaves may remain unrolled. With severe deficiencies, the growing point of cereals may die, resulting in increased tillering. In broadleaf plants, the upper portion wilts, the growing point may die, and the top leaves turn bluish green.

Soil Analysis

A reliable soil test for copper has not been developed for Wisconsin soils. The rarity of copper deficiency does not justify the research required to calibrate a soil test. Use plant analysis to confirm suspected copper deficiencies.

Plant Analysis

Analysis of plant tissue provides a good assessment of copper availability. Table 3 gives the interpretive ranges of plant-tissue copper for several common crops. Each interpretation refers to a specific plant part and stage of maturity. See Extension publication A2289, *Using Plant Analysis as a Diagnostic Tool,* for more information.

ADDITIONAL INFORMATION

These publications in the *Understanding Plant Nutrients* series are available from your county Extension office:

Soil and Applied Boron	(A2522)
Soil and Applied Calcium	(A2523)
Soil and Applied Chlorine	(A3556)
Soil and Applied Copper	(A2527)
Soil and Applied Iron	(A3554)
Soil and Applied Magnesium	(A2524)
Soil and Applied Manganese	(A2526)
Soil and Applied Molybdenum	(A3555)
Soil and Applied Nitrogen	(A2519)
Soil and Applied Phosphorus	(A2520)
Soil and Applied Potassium	(A2521)
Soil and Applied Sulfur	(A2525)
Soil and Applied Zinc	(A2528)

Table 3. Copper plant-analysis interpretations for common Wisconsin crops.

			INTERPRETATION				
CROP	PLANT PART SAMPLED	TIME OF SAMPLING	DEFICIENT	LOW	SUFFICIENT	HIGH	EXCESSIVE
			ppm				
Alfalfa	Top 6 inches	Bud	<3.0	3.0–7.0	7.1–30.0	30.1–50	>50
Corn	Earleaf	Silking	<2.0	2.0–5.0	5.1–20.0	20.1–50	>50
Oat, wheat	Top leaves	Boot stage	<3.0	3.0–5.0	5.1–20.0	20.1–50	>50
Potato	Top leaves	Flowering	<2.0	2.0–5.0	5.1–30.0	30.1–50	>50
Soybean	First trifoliate	Flowering	<5.0	5.0–9.0	9.1–30.0	30.1–50	>50

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