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COPPER FOR CROP PRODUCTION

George Rehm and Michael Schmitt

Copper (Cu) is an essential nutrient for plant growth, but because only a small amount is needed, it is classified as a micronutrient. Most Minnesota soils contain adequate amounts of this nutrient for optimum crop yields. Organic or peat soils are exceptions and Cu might be needed in a fertilizer program when small grains are grown on these soils. Wheat is the most sensitive to Cu deficiency. Although barley and oat crops are less sensitive, Cu use will increase their yield when grown on organic soils.

Role in Plant Growth

Copper is an important component of proteins found in the enzymes that regulate the rate of many biochemical reactions in plants. Plants would not grow without the presence of these specific enzymes. Research projects show that copper:

- **promotes seed production and formation**
- **plays an essential role in chlorophyll formation**
- **is essential for proper enzyme activity**

Deficiency Symptoms

In Minnesota, evidence of Cu deficiency has appeared when small grains are grown on organic soils in the northern part of the state. Symptoms of Cu deficiency are almost never seen in production fields in the remainder of the state.

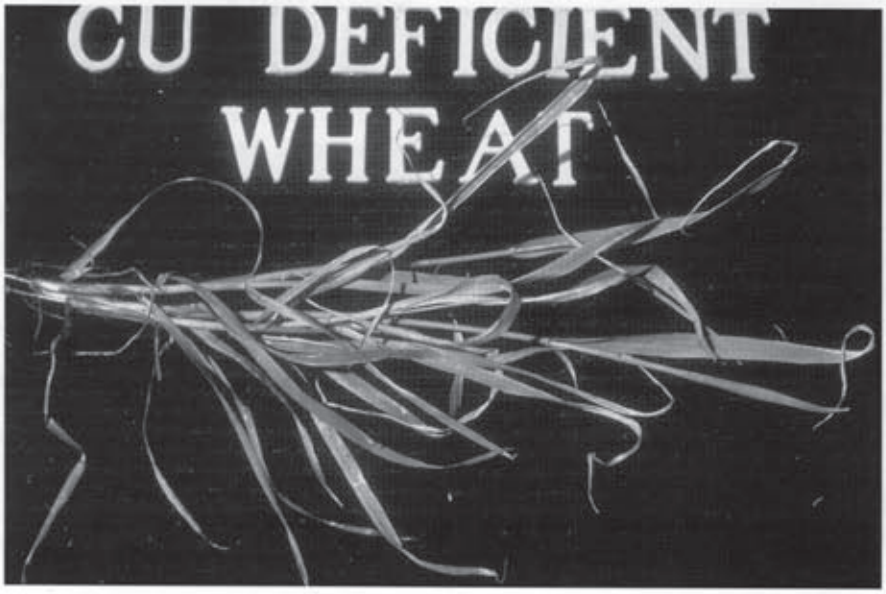

Figure 1. A wheat plant deficient in copper is shown here. The leaf tips die back and they are twisted.

These deficiency symptoms are characterized by a general light green to yellow color in the small grain crop. The leaf tips die back and the tips are twisted. A typical deficiency symptom for wheat is shown in **Figure 1.** If Cu deficiency is severe enough, growth of small grains ceases and plants die after reaching the tillering growth stage. Wheat will not have grain in the head. Deficiency symptoms have only been observed when small grains are grown on peat soils.

Copper in Soils

The amount of Cu available to plants varies widely by soils. Available Cu can vary from 1 to 200 ppm (parts per million) in both mineral and organic soils as a function of soil pH and soil texture. The finer-textured mineral soils generally contain the highest amounts of Cu. The lowest concentrations are associated with the organic or peat soils. Availability of Cu is related to soil pH. As soil pH increases, the availability of this nutrient decreases.

Copper is not mobile in soils. It is attracted to soil organic matter and clay minerals. The amount of available Cu is measured by extracting the soil with a DTPA solution. The concentration of Cu in the extract is then measured. This procedure is the most reliable and accurate for measuring Cu in soils.

Table 1. Interpretation for concentrations of Cu in plant tissue.

Crop	Plant Part Sampled	Time of Sampling	Deficient	Low	Sufficient	High	Excessive
					ppm Cu		
alfalfa	top 6 inches	bud	<3.0	3.0-7.0	7.1-30.0	30.1-50	>50
corn	ear leaf	silking	<2.0	2.0-5.0	5.1-20.0	20.1-50	>50
soybeans	top trifoliate	flowering	<5.0	5.0-9.0	9.1-30.0	30.1-50	>50
wheat	top leaves	boot	<3.0	3.0-5.0	5.0-20.0	20.1-50	>50

Predicting the Need

The need for Cu in a fertilizer program can be predicted from either plant analysis or soil testing. Interpretations for various concentrations of Cu in plant tissue are summarized in **Table 1.**

The results of the analysis of plant samples can indicate what has happened in the past, but cannot reliably predict future needs for Cu. The results of a soil test are a much better predictor of the need for Cu in a fertilizer program. Copper recommendations based on soil tests are listed in **Table 2.**

Table 2. Soil test interpretation and recommendations for Cu to be used for small grain production on organic soils.

Copper Soil Test*	Cu to Apply: Broadcast & Incorporated	Cu to Apply: Foliar Applied
ppm	lb. Cu/acre	
0.0-2.5	6-12	0.3
2.6-5.0	trial only	0.3
more than 5.0	0	0

*Amount of Cu extracted by the DTPA procedure

The recommendations listed in **Table 2** are for organic (peat) soils only. Yield response to Cu when crops are grown on mineral soils (sandy loam, loam, clay loam, etc.) in Minnesota has not been measured so Cu is not recommended for mineral soils.

Fertilizer Sources and Management

The recommended rates of Cu listed in Table 2 are suggestions for either broadcast or foliar applications for small grain crops grown on organic soils. The rates suggested for broadcast applications are intended to correct deficiencies and should be incorporated before seeding. At this time, use of Cu is not recommended for either wild rice or grass grown for either seed or hay production.

Foliar applications of Cu can be an effective way to correct Cu deficiencies in small grains. The stage of growth at the time of application has a major influence on the effectiveness of the treatment. Results from research in northwestern Minnesota indicate that applications at the tillering stage are most effective in correcting deficiencies. Copper sulfate is the most commonly used material for foliar applications.

Soil applications of Cu last for many years. Copper becomes attached to the soil organic matter and is not moved through the soil by water. Leaching is prevented, but the Cu is still available to plants. If the soil test for Cu is in the high range, annual applications of Cu are not needed.

Since large amounts of Cu in soils can be toxic to plants, it is important to accurately control applications. To avoid toxicity problems, annual applications of Cu should certainly be less than 40 lb. per acre. Toxicity problems are difficult to correct.

Summary

The micronutrient Cu is an important consideration when growing small grains on organic (peat) soils in Minnesota. The soil test for Cu is an excellent predictor of the need. Broadcast applications incorporated before planting are recommended to correct a deficiency. Foliar applications are suggested if deficiency symptoms appear during the growing season. The use of Cu, however, is not recommended for mineral soils.

George Rehm, Extension Soil Scientist
Michael Schmitt, Extension Soil Scientist

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