Cornell University
Cooperative Extension

Agronomy Fact Sheet Series Fact Sheet #113

Copper (Cu)

Introduction

Copper (Cu) is one of several essential micronutrients needed by both plants and animals. It has powerful antimicrobial properties and is commonly used in livestock and crop production. This fact sheet presents information on copper use, deficiencies, toxicities, and tests in crop production and livestock agriculture.

Copper in Agriculture

Crop Production: Plants utilize Cu for production of chlorophyll and seeds, but it is also used for enzymatic reactions required for crop growth. Plants with sufficient Cu can resist fungal attacks due to stronger cell walls. Plants take up copper in the Cu^{2+} ionic form. Copper is naturally present in soil, but it is not readily available to plants because the positively charged Cu^{2+} ions bind tightly to negatively charged organic matter and soil minerals. This low mobility also means that Cu does not readily leach through the soil profile.

Copper-based pesticides are used in crop production because of their low cost, low mammalian toxicity, prolonged residual effects, and relatively high toxicity to plant pathogens.

Livestock: Copper is needed in animal diets for white blood cell function, healthy nerve fibers, pigmentation, and for bone, wool, and body growth. In addition, because of its fungicidal and bactericidal properties copper sulfate is used to control foot lesions.

Crop Production

Deficiency: Copper deficiency in crops may lead to reduced seed size and decreased yields. Symptoms of a deficiency appear in younger leaves first and include (but are not limited to) wilting or limpness, curled pale yellow leaves, death of leaf tip, and delayed maturity (Figure 1). Copper availability is greatest in low pH soils. Deficiencies are more likely to occur in high pH (calcareous) soils, muck (organic) soils, very coarse sandy soils, or heavy clay soils. Small Wheat is sensitive to Cu deficiency, more so than other field crops.

If a deficiency is likely, Cu can be added as copper sulfate or as part of a micronutrient fertilizer mixture, applied to soil or as a foliar application. Copper sulfate meets organic crop production standards because it is naturally occurring. Fields that receive manure are unlikely to be deficient.

Figure 1: Healthy (left) to severely copper deficient wheat heads (right) showing melanosis (Source: IPNI).

Toxicity: Copper toxicity is not common in New York. However, toxicity levels can be reached when fields are repeatedly fertilized with biosolids or sewage sludge high in Cu. A toxic concentration of Cu in soil affects seed germination, root system development and plant vigor, but the amount of Cu needed to reach toxic levels depends on the plant species. For example, corn is slightly more sensitive than wheat, barley, and oats. Copper present in the soil in toxic amounts can also impact soil microbes and earthworms that are beneficial to soil health and crop production.

Livestock

Deficiency: Copper deficiency in livestock may occur when animals consume diets low in Cu or ingest feed high in Cu antagonists such as zinc, iron, molybdenum, and sulfur, which interfere with copper absorption. Symptoms of Cu deficiency depend on the species and may include poor growth, loss of hair color, weakness, diarrhea, and anemia. Copper deficiency in animals is found in New York and

the Northeast. Diagnosis and management are complicated, and a veterinarian should be consulted.

Toxicity: Copper toxicity in livestock may occur when diets high in Cu are fed to animals. Copper dietary requirements and tolerance vary greatly across livestock species. Sheep are very susceptible to toxicity. In addition to intake of Cu through mineral supplements in feed, animals can accumulate Cu through intake of crops treated with Cu-based fertilizers or pesticides, or forage contaminated with soil or manure.

Copper Tests

Animal Testing: The liver copper test (Table 1) can be conducted on live or deceased animals to assess Cu status in livestock. However, this test is costly, difficult, and not 100% accurate; individual animals can develop a deficiency while liver Cu is within the expected range.

Table 1: Sheep and cattle liver copper concentration status in ppm of dry weight.

Status	Liver Cu sheep	Liver Cu cattle
	ppm	ppm
Deficient	0.5-4	<33
Marginal	5.0-20.0	33-125
Adequate	25-100	125-300
High	100-500	600-1250
Toxic	250-1000+	>1250

Soil Testing: Soil testing of pasture and crop fields can help to identify the potential for a Cu deficiency or toxicity in plants. To identify potential deficiency issues for crop growth it is recommended to test soil for DTPA-extractable Cu (regular soil depth of 0 to 8 inches). The DTPA extraction typically extracts about 30% of the total amount of Cu in the soil. Results < 4 ppm could signal potential for crop deficiencies.

Copper toxicity to roots could occur when total Cu exceeds 50 ppm in sandy soils up to 150 ppm for silty-clay or clay soils. Soils higher in organic matter have a higher toxicity cutoff (i.e. allows for higher Cu soil test levels without measurable root toxicity). Muck soils can tolerate even higher concentrations than listed.

Tissue Testing: Plant tissue testing can reveal potential deficiencies. Different parts of plants are tested depending on the species. Plant samples should be taken at a specific growth stage, given that Cu concentration can vary among growth stages (Table 2). It is recommended to collect a soil sample when tissue sampling, as information such as soil pH, organic matter, and plant available nutrients can provide a better diagnostic. To troubleshoot an area in a field, taking samples from healthy crop tissue and from a nearby suspected deficient area can help to identify an issue.

Table 2: Normal ranges for copper for common field crops in New York.

Crop	Plant sampling time	ppm
Corn	Seedling stage	6-20
	Prior to tasseling	4-20
	Maturity	4-20
Small grains*	Seedling to tillering	4-15
	Flag leaf maturity	4-15
Soybeans	Prior to flower	4-15
	Early bloom	4-30
	Prior to pod set	4-30
Alfalfa	Early bloom	4-30

*Rye/oats/wheat/barley.

Conclusion

Copper has many uses and benefits for livestock and crop production, but it is complicated to identify and manage problems that may be associated with Cu deficiency/toxicity. Testing of dietary feed ingredients (and water) for Cu and antagonist minerals, and formulating diets according to accepted guidelines, should minimize potential for deficiency/toxicity. If toxic levels are suspected in soil, the DTPA test should be specifically requested as this is not part of a normal agronomic soil test package.

Additional Resources

- Copper Development Association Inc. (2020). Copper Compounds. CDA, McLean, Virginia 22102 USA. https://www.copper.org/resources/properties/compounds/

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information

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