A2528

Understanding Plant Nutrients

Soil and Applied Zinc

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Most of the zinc in soils exists in unavailable forms. Soil may contain 2–25 parts per million (ppm) of exchangeable and organic zinc, with a larger portion held in iron and manganese oxides and other nonavailable forms. High concentrations of exchangeable zinc (>100 ppm) may be toxic to many agronomic crops.

Crops generally take up less than 0.5 lb/a of zinc, yet when zinc is deficient, crop yields are reduced markedly. Plants vary considerably in their requirements for zinc. Crops with high zinc requirements include corn, onion, and spinach. Those with medium requirements are barley, beans, beet, canola, cucumber, lettuce, lupine, potato, radish, sorghum-sudan, soybean, tobacco, and tomato. Other crops have low zinc requirements and seldom exhibit zinc deficiency. In Wisconsin, zinc deficiencies have been observed on corn, snap bean, and a few other vegetable crops.

ZINC REACTIONS IN SOILS

Zinc ions (Zn^{++}) are held on the surface of clay and organic matter particles. Soil organic matter holds zinc in a chelated form. Chelation is a process by which certain metals are held within the structure of large organic molecules. Because zinc is held on soil particles and by chelation, it does not move through the soil and is not leached under most conditions.

The primary factors affecting zinc availability are soil texture, soil pH, soil phosphorus, and weather conditions.

Soil Texture

Scalped or severely eroded soils are more apt to be zinc deficient than well-managed soils. Also, sands, sandy loams, and organic soils are more likely to be zinc deficient than silty or clayey soils. This is due largely to the fact that sandy and organic soils originally contain low total zinc levels. Severe soil compaction can also reduce zinc availability.

Soil pH

Soil acidity (pH) influences the availability of zinc more than any other factor, with lower zinc solubility as the pH increases. Therefore, zinc deficiency usually is limited to soils with a pH above 6.5. Overliming of soils, especially sands, may induce zinc deficiency.

Soil Phosphorus

High levels of phosphorus may induce zinc deficiency in some cases. Apparently the phosphorus precipitates zinc either in the soil or at the root-soil interface, or it interferes with zinc metabolism within plant cells. Avoid overuse of phosphorus fertilizer, particularly when soil zinc is low. When high soil phosphorus is a result of heavy manure application, zinc deficiency will not likely occur, since the manure will also add zinc to the soil.

Weather Conditions

Zinc deficiency symptoms more often appear early in the season during cool, wet weather. Under these conditions, plants absorb less zinc. When the temperature increases and the soil dries out, plants often grow out of the deficiency.

FERTILIZER SOURCES OF ZINC

Several sources of zinc fertilizer are commercially available. The most common sources and the approximate amounts needed to correct a zinc deficiency are listed in Table 1. All of these sources are effective, but zinc sulfate is used most often because of its relatively high solubility and low cost. Because crops require low rates of zinc, it is most effective to apply it in combination with N-P-K fertilizers.

If a zinc deficiency occurs during the growing season, apply zinc in a foliar spray. This should be an emergency treatment, however. A soil treatment before or at the time of planting usually is more effective. To avoid plant injury during foliar applications, limit the quantity of zinc to 0.6 lb/a of zinc sulfate or 0.15 lb of zinc chelate in 20 gal of water. More than one foliar application may be required for severe deficiencies.

Table 1. Fertilizer sources of zinc.

SOURCE	PERCENT ZINC	— APPLICATION RATE — BAND	BROADCAST
		—— lb/a of elemental zinc ——	
Zinc chelate	14	.5–1	1–2
Zinc oxide	78	2–4	4–8
Zinc sulfate	36	2–4	4–8

DIAGNOSTIC TECHNIQUES

Deficiency Symptoms

Zinc functions as an enzyme activator in carbohydrate metabolism and protein formation. Deficiency symptoms usually appear first on relatively young leaves early in the growing season. On corn, a broad band of bleached tissue appears on either side of the midrib. The deficiency begins at the base of the leaf and usually stays in the lower half of the leaf.

In broadleaf plants, zinc deficiency results in a shortening of internodes (rosetting) and a decrease in leaf size (little leaf). Snap bean develops a yellowing between the leaf veins (interveinal chlorosis). However, it is very difficult to distinguish between zinc and manganese deficiencies in this crop.

Soil Analysis

Soil test for available zinc quite accurately predicts whether zinc fertilizer is needed. The interpretations given here apply provided the lab uses procedures recommended by the University of Wisconsin-Madison. Soils containing less than 1.5 ppm of available zinc are likely to be deficient and should be treated with zinc fertilizer. Soils containing 1.6–3.0 ppm zinc are considered low. Apply zinc to these soils if you are growing crops with a high zinc requirement (corn, beans, onion).

Plant Analysis

Analysis of plant tissue also gives a good indication of zinc needs. Because zinc levels in the plant may change with age, it is important to indicate the stage of maturity at sampling when sending samples to the laboratory. An interpretation of zinc analyses for some major Wisconsin crops is presented in Table 2. See Extension publication *Plant Analysis: A Diagnostic Tool* (A2289), 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 2. Zinc plant-analysis interpretations for common Wisconsin field crops.

			INTERPRETATION				
CROP	**PLANT PART SAMPLED**	**TIME OF SAMPLING**	**DEFICIENT**	**LOW**	**SUFFICIENT**	**HIGH**	**EXCESSIVE**
			ppm				
Alfalfa	Top 6 inches	Bud	<10	10–20	21–70	71–100	>100
Corn	Earleaf	Silking	<15	15–25	26–75	76–150	>150
Oat	Top leaves	Boot stage	<5	5–20	21–70	71–100	>100
Soybean & snap bean	First trifoliate	Early flower	<15	15–20	21–50	51–75	>75

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