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ZINC for minnesota soils

Agricultural Extension Service • University of Minnesota

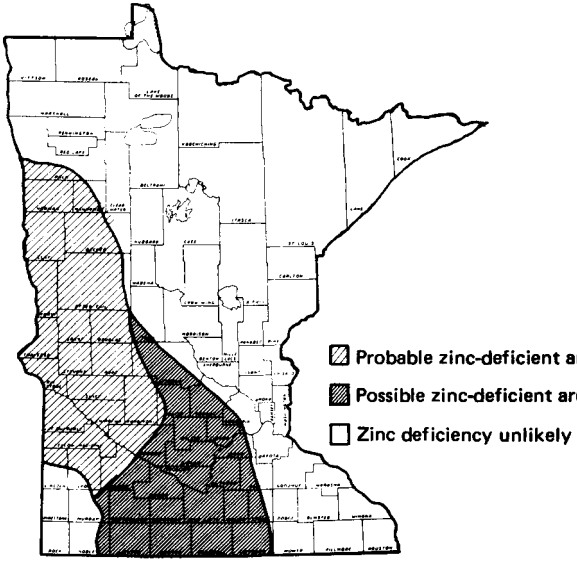
Zinc deficiency on corn first was verified in Minnesota in 1960 on a farm with pH 8.3 in Swift County in the western part of the state. Figure 1 is a map showing areas of the state identified since then through field research as possibly having zinc shortages. Corn is the major crop where deficiencies cause problems.

Conditions and areas of Minnesota where problems occur

Since 1960, research at the University of Minnesota has identified the following as contributing to zinc deficiencies:

1. High soil pH. Each unit increase in soil pH decreases the amount of zinc in the soil solution 100 times. Minnesota soils with a pH of 7.0 or less are not likely to be zinc deficient.
2. Very high soil phosphorus. Zinc availability is reduced as the level of extractable soil phosphorus increases.
3. Cool soil temperatures in early season because of high moisture intensify the deficiency.
4. Preceding crop. If sugar beets were the previous crop, the probability of zinc deficiency increases.
5. Crop to be grown. Field corn and dry edible beans are the crops most likely to respond to zinc in Minnesota.
6. Soil test summaries show that sufficient zinc occurred in only 45 percent of the samples in northwest Minnesota, and only 54 percent were sufficient in the west central and southwest part of the state.
7. Usually the deficiency is observed in small areas of a field.
8. Problems are less frequent as one travels eastward in the state.

Figure 1. Zinc deficiency on corn in Minnesota



Plants' demand for zinc

Plants seldom absorb more than 3 ounces of zinc per acre for normal growth, but larger amounts are needed in the soil because roots don't reach all areas. Some plant species either need less zinc or can forage better than other plants. Pasture grasses and small grains have a very low zinc content but seldom respond to zinc additions. Alfalfa has a high zinc content and does not respond readily. Table 1 shows relative response of several crops to zinc.

Table 1. Response of several Minnesota crops to zinc

Low response	
Wheat	Alfalfa
Rye	Peas
Oats	Clovers
Pasture grasses	
Moderate response	
Sugar beets	Potatoes
Sudan grass	Barley
Soybeans	Tomatoes
Highly responsive	
Field corn	Flax
Sweet corn	Sorghum
Edible beans	Onions

Deficiency symptoms

When plants are zinc deficient, they fail to develop to natural size. Symptoms can appear in the first 2 or 3 weeks of corn growth. Corn develops a broad band of striped tissue on each side of the leaf midrib. These stripes begin on the inner half of the leaf closest to the stalk and show on the lower part of the plant first. By contrast, symptoms of striping caused by iron or magnesium deficiency run the full length of the leaf.

On soybeans lower leaves show yellowing and later a bronzing effect. When lower leaves show deficiencies first, it demonstrates nutrient mobility. Zinc moves toward the upper younger leaves.

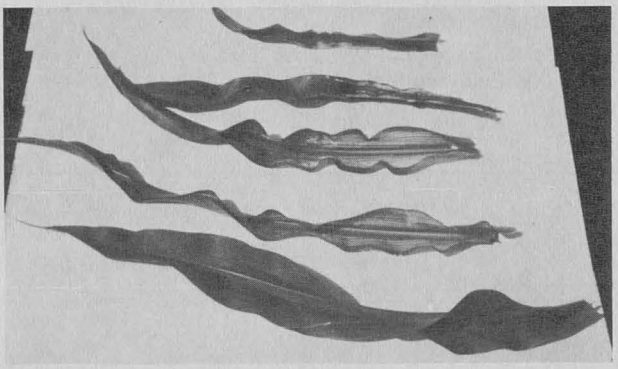
If alfalfa is deficient in zinc, it will have bronze spots on the lower leaves. Crop zinc deficiency in alfalfa is rare.

Zinc in fertilizer

Zinc is commonly added by mixing the material with the regular fertilizer. Zinc sulfate granules often are mixed in dry blends, and zinc chelates are used in liquids. Table 2 shows several zinc carriers and their contents.

Table 2. Zinc carriers and their contents

Carrier	Formula	Percent zinc
Zinc sulfate	$Zn\ SO_4\ H_2O$	36
Zinc chelate	Na_2Zn EDTA	14
Zinc chelate	Na Zn HEDTA	9
Zinc oxide	ZnO	78
Raplex zinc	Zn PF	10



This closeup of zinc deficient corn shows a healthy leaf at the bottom and leaves from progressively more zinc-deficient plants at the top.

Zinc-deficient corn in the field.

Zinc in manure

Zinc in manure has increased over its content of 20 years ago because of additions made to animal feed. In Michigan the percentage of zinc in poultry manure was found as high as 3 pounds per ton. High rates used annually on the same field could become excessive for zinc. In Minnesota experiments, however, high rates of cattle and hog manure revealed no zinc excesses in plants.

Zinc in municipal sludges

Zinc levels in municipal wastes vary. Some zinc levels may be so high that caution is necessary to avoid excesses. Analysis for zinc, as well as other heavy metals, must be conducted if problems are anticipated. Zinc levels in municipal waste waters are not a problem.

Soil tests for zinc

The University of Minnesota uses the DTPA test developed at Colorado State University. Table 3 shows the test interpretation.

Table 3. Zinc soil test levels and relative yield increases expected from soil additions

Soil test ppm	Relative level	Yield increase expected from zinc additions
Less than 0.5	Low	Probable
0.5 to 1.0	Medium	Possible
More than 1.0	High	Unlikely

Plant analysis

Zinc status can be evaluated by plant tissue analysis which is offered by several commercial laboratories. It is important to keep crops in the sufficient range, a level essential for high yields.

Table 4. Relative levels of plant zinc content* for several crops

	Deficient	Low	Sufficient	High
	ppm			
Corn at tassel	11	15	15 to 70	70 +
Soybean leaves	11	20	20 to 50	50 +
Alfalfa tops	11	20	20 to 70	70 +
Sugar beet leaves	10	20	20 to 70	70 +
Small grain (When head emerges from boot)	11	15	15 to 70	70 +

*From soil testing and plant analysis, SSSA 1973 and Ohio data.

Recommendations

Zinc should be applied at a rate of 8 to 20 pounds per acre, or 20 to 60 pounds of zinc sulfate. Granulated zinc sulfate is a commonly used source. Because low rates are difficult to apply, most zinc applications are made in combination with regular fertilizers. Broadcast application appears to be slightly more effective than row application at least over several years. One application of a recommended rate has shown significant effects on yield 5 years later. Normally effects last 3 to 4 years if zinc is applied as recommended. Annual applications of zinc are not recommended unless applied at low rates. Zinc chelates should be applied at 1 to 2 pounds per acre when broadcast and perhaps half that when applied in the row.

If zinc deficiency occurs in early season, a foliar spray can be effective. Leaf injury is possible, and only light applications are recommended. Zinc can be applied as zinc sulfate at 0.5 to 1 pound per acre or 0.15 pound of zinc chelate mixed in 20 gallons of water. A second application may be necessary.

Summary

Zinc deficiencies are not difficult to diagnose when one learns the leaf symptoms and soil characteristics associated with it. Also private laboratories offer soil and plant tissue tests to confirm cases that may not have pronounced symptoms.

In areas where zinc shortages are a problem, fertilizer dealers have zinc materials in stock and know about application techniques. Materials are not expensive, and correcting the deficiency could be very profitable.

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