Effective Zinc Management

An infinitesimal amount of this mighty nutrient goes a long way in helping to product yield gains

How important is zinc? Well, it exists in all living things. It is the 24th most available element in the earth's crust. Two ounces per ton of feed can prevent parakeratosis in hogs. Two ounces will promote healthy egg and chick development. Without it, no crop would grow. Zinc is involved in the necessary functions of plant growth. It helps produce auxins, a growth-promoting substance that controls growth of shoots. Zinc also forms enzyme systems, which regulate plant life.

For a nutrient so vital to plant growth, its deficiency in most soils is one of the true ironies in U.S. agriculture. Surveys of the fifty states report that as high as 92.3 percent of soil samples taken show medium to serious zinc deficiencies! For a very small cost less than a half bushel of corn per acre—these deficiencies could be corrected and add, as this article will show, *substantial* bushels per acre.

For example, sufficient NPK may be applied to a corn crop to reach 175 bu/A. But, owing to a neglected zinc deficiency, only 150 bu/A are harvested. The penalties for insufficient zinc in this case are 1) wasted NPK that could have produced that other 25 bushels, 2) higher costs per bushel of corn grown and 3) lower net profit. This is what we call the "law of the minimum." Skimping on this micronutrient will cost you dearly in terms of yields lost and what you ultimately deposit in the bank. Just one quart/A of liquid zinc in a fluid starter applied on corn can avert this "law of the minimum."

Crop sensitivity

All plants require zinc, but their ability to use available zinc and extract zinc differs (Table 1). It should be noted however that variability is likely to exist within a given species. For example, the Sanilac variety of pea bean is highly susceptible to Zn deficiency whereas the

Table 1. Sensitivity of selected crops to zinc deficiency.

Very sensitive	Mildly sensitive	Insensitive
Beans, lima and pea	Alfalfa	Asparagus
Castor beans	Clovers	Carrots
Citrus	Cotton	Forage grasses
Corn	Potatoes	Mustard
Flax	Sorghum	Pea
Fruit tree	Sudangrass	Peppermint
Grapes	Sugar beets	Safflower
Hops		Small grains
Onions		
Pecans		
Pine		
Soybeans		

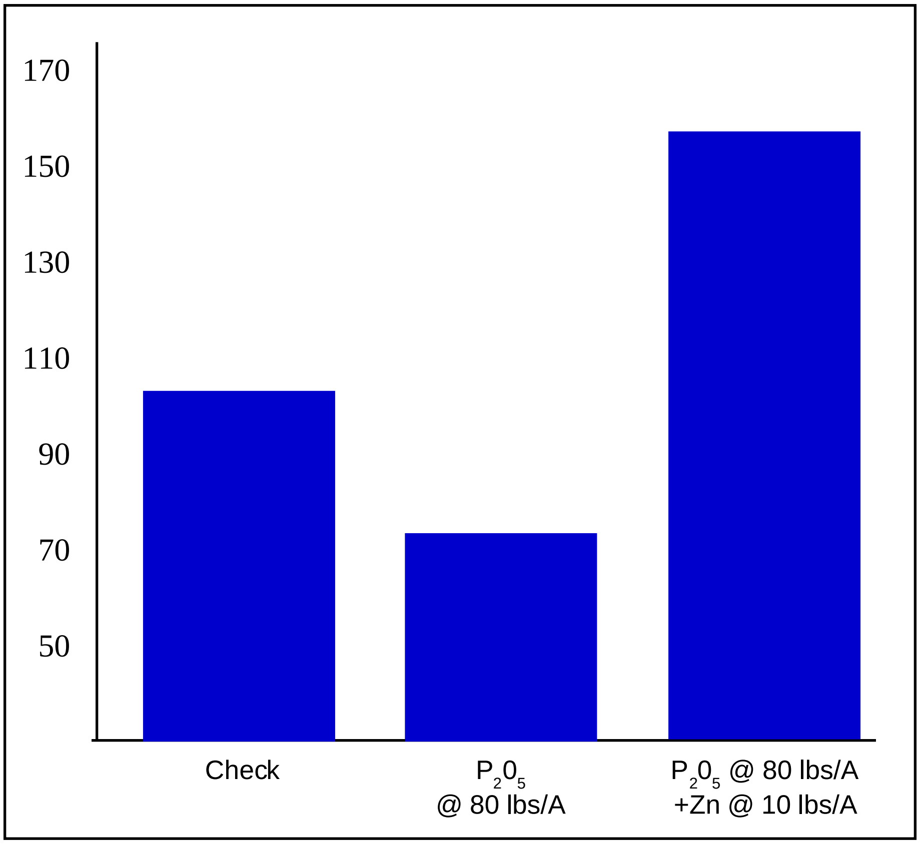

Figure 1. Effect of zinc application in eliminating zinc/phosphorus imbalance and improving corn yield, Kansas State University.

Great Northern variety is quite tolerant. Similarly, Russet Burbank potatoes develop zinc deficiency under certain field conditions where White Rose show no symptoms. Researchers have demonstrated differential zinc uptake of inbred corn lines grown in nutrient solution, indicating genetic control of translocation, use, and requirements of zinc. Thus, the sensitivity of crops to zinc deficiency in the table should be taken as generally representative.

Soil testing

Soil tests for zinc are most often performed using an acid extract such as 0.1 N HCl or a chelating agent such as a DTPA extract. The DTPA with ammonium bicarbonate test is preferred for soils containing free $CaCO_3$ and can be requested. Advantages of the DTPA extraction are that several micronutrients can be analyzed simultaneously and greater control can be exerted on sample longevity. Studies have shown that soils that may be high in total zinc may not be necessarily high in plant-available zinc, as indicated by the extract. Comparisons of five different extracts on Ontario soils, using corn as an indicator crop, showed that no single extract adequately represents all field conditions. This suggests that growers should use tests indigenous to their areas.

Deficiency symptoms

There are a number of visual symptoms in crops that will alert you to zinc deficiencies:

Corn. Yellow streaks between veins. Dead areas in older leaves. Shortening of the internodes. Stunting of the plant. Silking and tasseling delayed. Chalky kernels. Reddish-brown coloration on portions of plant.

Sorghum. Deficiency symptoms in grain sorghum are similar to corn, but

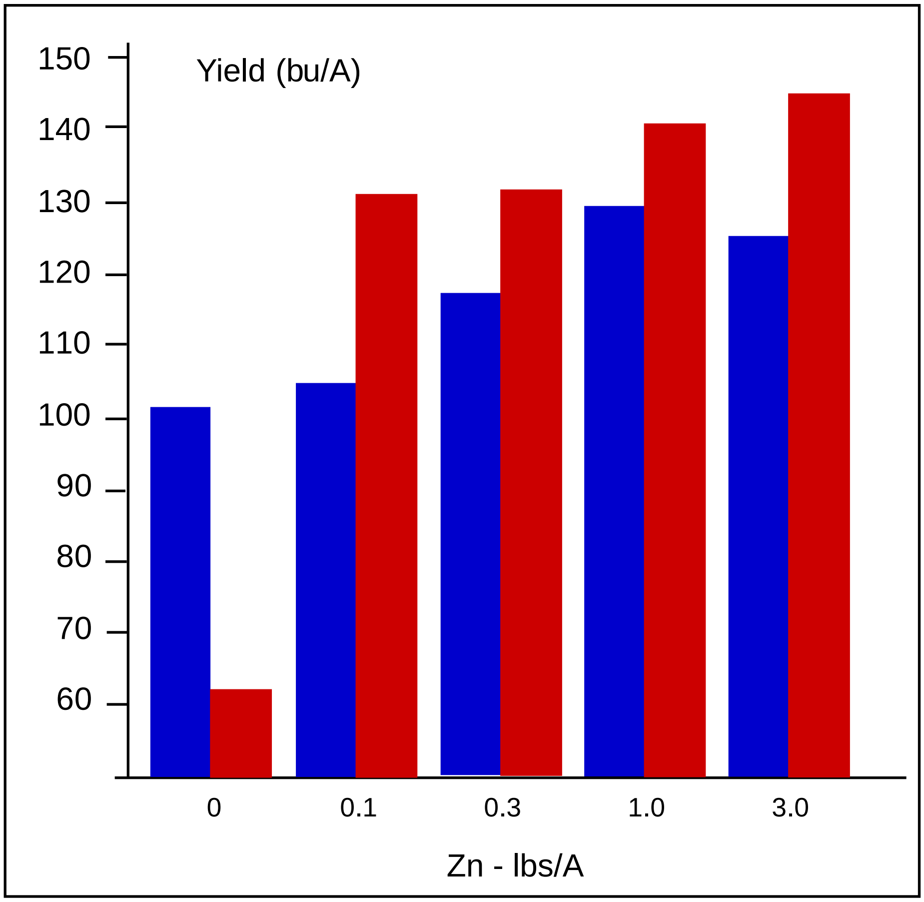

Figure 2. Effect of rate of applied Zn on yield of corn grown on irrigated sandy soils having pH greater than 7, University of Nebraska.

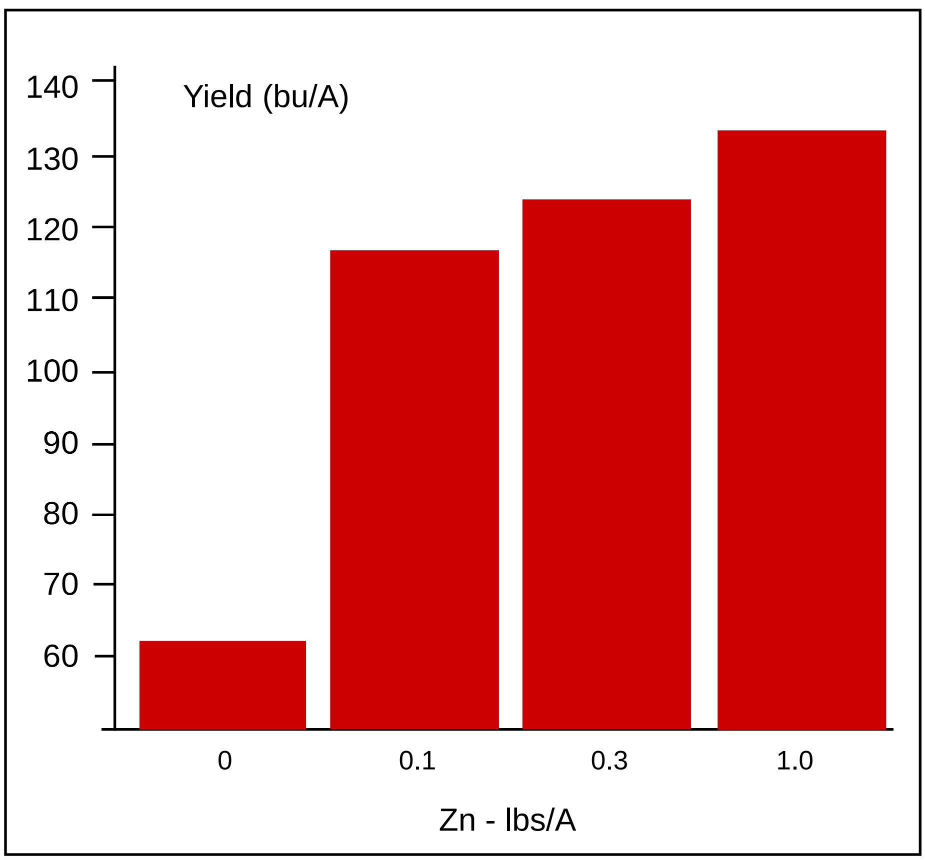

Figure 3. Effect on corn yield when banding zinc near seed, University of Nebraska.

less pronounced. Zinc deficiency appears to retard development and maturation of the heads.

Cotton. Delay in flowering. Reduction in boll size. Plant produces only a few squares and sheds them around time of anthesis.

Soybeans. Interveinal chlorosis. Necrosis of lower leaves. Poor pod initiation and development.

Wheat. Chlorotic and necrotic stripes along each side of midrib. Shortened leaves. Oil-soaked appearance in leaves, followed by collapse of leaves across middle.

Behavior in soil

One of the natural causes of zinc deficiency is tie-up in high-alkaline soils—that is, calcareous or high-pH soils. Zinc deficiency is also found in soils high in organic matter. Sandy soils, soils high in clay content, and soils naturally high in phosphates (which tend to tie up zinc) are also causes of deficiencies. Surface soils contain a greater proportion of available zinc than subsoils. It is a general belief that surface accumulation of Zn is caused by subsurface mining by plant roots, decay of organic matter, and subsequent deposition at the surface. Cool, wet soils can cause zinc deficiency by reducing root growth. Zinc is very sensitive to cold temperatures. The movement of zinc is slower in acidic soils, which may reduce crop absorption from spatial unavailability. Liming of soils raises the pH and may help eliminate some movement problems, but these gains are usually offset because the higher pH increases soil zinc-fixing capacity, especially in soils high in phosphate.

Because of its high insolubility and immobility in the soil, zinc should be applied under the subsoil with a starter fertilizer or by root zone banding.

Man-made deficiencies

Cultural practices can also cause zinc deficiencies in soils.

Fertilization. Heavy applications of phosphate fertilizer several years running can induce a zinc deficiency. Crop uptake is reduced. This may be due to competitive ion effects, fixation of zinc in unavailable forms, or physiological imbalances. Growers should also be aware that N fertilizers can increase crop growth to a point where zinc requirement of plants exceeds availability in soil.

Land renovation. Field areas where top soil is removed can cause zinc deficiency because zinc is always concentrated near the surface.

Soil compaction. Compacted areas will cause zinc deficiencies because of zinc's immobility—it doesn't move with the soil water.

Depletion. High yields and heavy cropping can deplete soils of zinc.

Making it pay

As stated earlier, proper use of zinc in a fertility program can add substantial bushels per acre. We'll look at several examples.

Kansas. In this study, the land was low in P and Zn. Adding 80 lbs/A of a liquid phosphate without zinc actually depressed corn yields when compared to the check, as shown in Figure 1. But correcting the P/Zn imbalance by adding 80 lbs/A of P *with* 10 lbs/A of Zn boosted yields over check by 62.2 bu/A! A good rule of thumb is: if you're low in phosphorus and low in zinc, apply both in your fertilizer program.

Nebraska. The effect of different rates of zinc applied with a fluid starter on corn was shown in this study. Note how one pound of zinc increased corn yields by 29 bu/A over check in 1975 and 77 bu/A over check in 1976 (Figure 2). The crop was grown in an irrigated field on a sandy soil having a pH greater than 7.

In another Nebraska study, it has been shown how even an infinitesimal amount of Zn banded near the seed in a fluid starter program can give spectacular responses. Note how only *one-tenth* of a pound of zinc applied per acre increased corn yield 57 bu/A when compared with check (Figure 3)! A mere dollars worth of zinc placed below and to the side of the seed nearly *doubled* the yield.

Zinc in fluids

During the early period when fluid and suspension fertilizers began to gain in popularity, researchers Mortvedt and Giordano reported that ZnO in fluid fertilizers was more effective than ZnO incorporated with granular fertilizer. Distribution was markedly superior in fluids.

Other studies in Kansas have shown 12- to 20-bu/A increases in corn yield where zinc was banded with polyphosphates at planting time, versus yield *losses* when zinc was added to dry fertilizers and broadcast. Superior distribution, placement, and incorporation paid off with an element whose nasty property is high insolubility.