Colorado State University
Extension

Zinc and Iron Deficiencies

Fact Sheet No. **0.545** Crop Series | **Production**

by D.G. Westfall and T.A. Bauder*

Zinc and iron deficiencies affect certain field crops, vegetables, trees and ornamentals in Colorado. These micronutrient deficiencies are recognized by plant symptoms and by soil tests. The purpose of this fact sheet is to help farmers and other agricultural workers identify zinc and iron deficiencies by field observations and soil tests and to make recommendations for correction of these deficiencies.

Zinc Problems

Zinc deficiencies may occur in all areas of the state and are frequently associated with the following situations:

- Zinc deficiency has been recognized on corn, sorghum, sudan, sorghum-sudan hybrids, pinto beans and potatoes in Colorado. Different susceptibility levels among varieties have been recognized.
- No deficiencies have been recognized on wheat or alfalfa.
- Response to zinc is much greater under high yield conditions.
- Zinc deficiencies frequently are associated with areas where the topsoil has been removed by leveling for irrigation, erosion or terrace channel construction.
- Soils deficient in zinc frequently are low in organic matter, are sandy and/or have an alkaline pH (pH greater than 7.0).
- High available soil phosphorus levels produced by fertilization or native in the soil may induce a more severe zinc deficiency on soils low in available zinc.
- Zinc deficiency is much more severe in years with cold, wet springs than in years of warm, dry springs.

*D.G. Westfall, Colorado State University professor emeritus, soil and crop sciences; and T.A. Bauder, Extension specialist, water quality. Original author: Hunter Follett, former Colorado State Univeristy professor, soil and crop sciences, deceased. 12/2011

Visual zinc deficiency symptoms differ among crops, but characteristic symptoms can be recognized. Fields generally are not affected uniformly. Deficient areas are normally the areas where topsoil has been removed. Zinc deficiency shows early in the growth of plants.

Young corn and sorghum plants exhibit a broad band of white to translucent tissue on both sides of the leaf midrib starting near the base of the leaf. Generally it does not extend to the tip; the midrib and outer margin remain green. Occasionally, a reddish-brown cast may develop in the chlorotic (white or yellow) leaf tissue.

Plants tend to be stunted due to a shortening of the internodes. Pinto beans exhibit a general stunting of the young plants. Leaves show a general yellowing of the upper foliage with a browning or bronzing of the older or lower leaves. The leaves of zinc-deficient beans typically have a crinkled appearance. A general downward curl of the leaves also will occur and pod set will be poor. Confirm visual observations by soil tests and/or plant analyses.

Soil Testing for Zinc

Determine the need for supplemental zinc by soil testing. Collect a composite soil sample from the area of the field suspected of being low in zinc. In collecting the sample, avoid using anything galvanized or made of rubber.

Several methods for zinc testing have been proposed. These tests are all based on using a solution of an acid, a chelate or combination of reagents to extract from the soil a portion of the total zinc. This is related, through correlation experiments, to the zinc that plants can extract from the soil. The method used by the Soil Testing Laboratory at Colorado State University is the ammonium bicarbonate, diethylene triamine pentaacetic acid (AB-DTPA) test.

Quick Facts

- Zinc and iron deficiencies may occur in most areas of Colorado.
- Zinc and iron deficiencies can be recognized by plant symptoms.
- Confirm visual observations by soil test and/or plant analysis. Zinc deficiencies can be corrected by the application of zinc fertilizers.
- Soil application of iron fertilizers has not been economically feasible on a field scale, but iron deficiency can be controlled by several other means.

www.ext.colostate.edu

Table 1: Zinc recommendations.*

AD-DTPA extractable zinc as ppm Zn	Irrigated	Dryland
	Fertilizer zinc-pounds per acre Zn	
Sensitive Crops (corn, sorghum, sudan, sorghum-sudan hybrids, beans, potatoes)**		
0-0.9 low	10	5
1.0-1.5 marginal	5	0
> 1.5 adequate	0	0
Other Crops		
0-0.5 low-marginal	5	0
> 0.5 adequate	0	0

*Recommendation is based on the use of zinc sulfate as source of zinc.
**Following sugar beets, increase soil test categories by 50% (low = 0 - 1.4 and marginal = 1.5 - 2.2).

Correcting Zinc Deficiencies

Zinc deficiency is readily corrected by application of zinc fertilizers (Table 1). Considerable research with zinc has been conducted by Colorado State University, as well as other universities, during the last 20 years. The following recommendations for zinc fertilization are based on this research data.

Zinc fertilizer applications can be either banded at planting or broadcast pre-plant with little difference in response when applied at an adequate rate. Generally, broadcast-plowdown is the most effective method of application. Banding may be preferred in situations of shallow or minimum tillage. One application of 5 to 10 pounds Zn per acre, 15 to 30 pounds of zinc sulfate (36 percent Zn) should be sufficient for two or three years of production. However, test the soil again to adjust the zinc recommendation for following years.

Figure 1. Zinc deficiency in corn.
Credit: H. Follett

In season, zinc deficiency may be corrected by spraying the crop with a 0.5 percent zinc sulfate solution (1 percent for potatoes) at the rate of 20 to 30 gallons per acre. A 0.5 percent solution is prepared by adding 4½ pounds zinc sulfate (36 percent Zn) to 100 gallons of water. Include a surfactant (wetting agent). Foliar applications are effective in greening foliage but are not as effective in producing yield response. Consider them as a salvage measure.

The most common inorganic source is zinc sulfate. It is considered an excellent source of zinc whether applied as a granular material in a bulk blend or incorporated into solid or liquid fertilizers. Zinc oxide is another inorganic source of zinc that is effective when incorporated into solid or liquid fertilizers. Avoid applying granular zinc oxide on calcareous soils due to its low solubility. Zinc fertilizers should be at least 40-50% water soluble to supply adequate plant available zinc. Organic zinc sources (chelates) also are available and generally are more effective per pound of zinc than inorganic sources. Some of these materials have been shown to be three to five times as effective as the inorganic sources. Effective zinc chelates may be used at about one-third the rate of inorganic products.

Manure applications are quite effective in eliminating zinc deficiency problems when applied at the rate of 15 to 20 tons per acre.

Iron Problems

Iron deficiencies may occur in all areas of the state and are frequently associated with the following situations:

- Iron deficiency appears in irregular areas of the field associated with areas of high soil pH, free calcium carbonate and low organic matter.
- Areas frequently have had the topsoil removed by erosion or leveling.
- Iron deficiencies are worse in cool, damp springs. Deficiency symptoms are frequently most severe on young seedlings.
- Sorghum, corn, potatoes and pinto beans are the most severely affected crops. Wheat and alfalfa are the least sensitive. Varietal differences in susceptibility have been recognized within each species.
- Iron deficiency also may be a problem in certain lawns, shrubs, ornamentals and orchards (particularly peach trees).

Iron-deficient fields, when viewed from a distance, exhibit irregularly-shaped yellow areas. Because iron is not translocated in the plant, deficiency symptoms appear on the new growth first. Iron deficiency on individual plants is characterized by yellow leaves with dark green veins (interveinal chlorosis). On corn and sorghum, this gives the plants a definite striped appearance. If the condition is severe, the whole plant may be affected and turn a very light yellow or even white. In many cases where moderate deficiencies occur early in the season, plants tend to recover later.

Table 2: Interpretation of the AB-DTPA extractable iron test.

Test values in ppm[1]	Irrigated and dryland
0-3.0	low
3.1-5.0	marginal
above 5.0	adequate

[1]Values below 10.0 ppm are classified as deficient for turf and many ornamentals.

Soil Testing for Iron

The AB-DTPA extraction procedure used for zinc allows the determination of iron on the same extract. Collect soil samples for the iron test from the areas of the field that are suspected of being deficient. Collecting a composite sample from the entire field will not reflect the condition in the eroded or leveled areas. The AB-DTPA extractant brings into solution a portion of the iron in the soil that is related to that potentially available for plant uptake. The test levels have been interpreted through experiments and observations of plant growth on soils with a range of extractable iron levels (Table 2).

Figure 2. Iron deficiency in corn.
Credit: International Plant Nutrition Institute

Correcting Iron Deficiency

Soil application of iron-containing compounds to eliminate iron deficiency has not been economically possible on a field scale. Iron chelates are available that will correct iron deficiency at application rates of 5 to 10 pounds of metallic iron per acre, but they are too expensive to use on field crops.

Ferric sulphate and ferrous sulphate are not effective as soil applications at economically feasible rates. Some products under development may be useful for soil application. Because the problem of iron deficiency is associated with high pH and excessive calcium carbonate in the soil, the possibility of lowering the soil pH to correct the problem has been suggested. The rate of sulphur necessary to accomplish this on calcareous soils is not economically feasible (1 pound S for every 3 pounds of $CaCO_3$). Iron oxide fertilizers are highly water insoluble. Fertilizer containing this form of iron will not be available to plants in Colorado soils.

Iron deficiency can be controlled by several means other than soil application. On medium testing soils, selection of a crop or crop variety less sensitive to iron deficiency can be effective. Manure or sewage sludge at the rate of 15 to 20 tons per acre on a dry weight basis may be effective for several seasons.

Applying iron as a foliar spray is effective in restoring green color to plants, but may not restore top yields. Iron sprays are most effective when applied to young plants and when repeated at 10-day to two-week intervals. Ferrous sulphate or iron chelates can be used as a spray. Iron deficiency is best corrected by spraying the crop with a 2 percent ferrous (iron) sulfate solution (1 percent for potatoes) at the rate of 15 to 30 gallons per acre beginning 10 to 15 days after crop emergence. Repeat application at 10-day intervals if yellowing of foliage persists.

A 2 percent solution is prepared by adding 16 pounds iron sulfate (20 percent iron) to 100 gallons of water. Include a surfactant (wetting agent). For best results, apply spray when leaves will remain moist for a period of time. Use chelates at lower concentrations; 7 to 10 pounds per 100 gallons of water. Some chelates will cause leaf burn if applied in too high a concentration. Check the recommendation on the label for rate.

Iron fertilization is recommended only for those field crops that are sensitive to low soil iron levels: corn, sorghum, sudan, sorghum-sudan hybrids, beans and potatoes. Since a soil treatment is not effective, spray the crop with iron when it becomes apparent that the crop is actually iron efficient.

For More Information

Zinc plant availability as influenced by zinc fertilizer sources and zinc water-solubility. Amrani, D. Westfall, G. Peterson

Making Better Decisions: Zinc Fertilizer Efficiency Ratios. T. Shaver and D.G. Westfall