G82-596 Use and Management of Micronutrient Fertilizers in Nebraska

George W. Rehm
University of Nebraska - Lincoln

E.J. Penas
University of Nebraska - Lincoln

G82-596-A

NebGuide

Published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

Use and Management of Micronutrient Fertilizers in Nebraska

This NebGuide focuses on the use of the micronutrients zinc and iron.

G.W. Rehm, Extension Soils Specialist
E.J. Penas, Extension Soils Specialist

Of the 16 elements known to be essential for plant growth, 7 are used in very small amounts and are classified as micronutrients. These are zinc (Zn), iron (Fe), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo) and chlorine (Cl).

Micronutrients are supplied to plants from two sources: 1) soil minerals and 2) organic matter. They are released as the soil minerals break down over a period of time by weathering. The major portion of the micronutrients made available to plants, however, probably comes from the breakdown (mineralization) of the organic matter.

Research studies have demonstrated that Nebraska soils can supply all of the micronutrients needed for plant growth except zinc and iron on some, but not all soils, and boron for alfalfa and sugar beets in a few isolated situations.

Crop Sensitivity

Not all crops grown in Nebraska respond equally to a certain level of zinc or iron in the soil. For example, corn may respond to zinc fertilizer at a low level of zinc, but alfalfa will not. The sensitivity of various crops to a low level of soil zinc is shown in *Table I*; the sensitivity of crops to iron is listed in *Table II*.

Various Nebraska crops respond in different ways to zinc and iron. Therefore, the management of these two micronutrients is discussed in separate sections.

Table I. Sensitivity of crops to low levels of available zinc in soil.		
Sensitive	**Moderately tolerant**	**Tolerant**
corn	grain sorghum clover	alfalfa barley
field beans	potatoes forage sorghum	oats millet
sweet corn	soybeans sugar beets sudan grass	rye wheat grasses

Table II. Sensitivity of crops to low levels of available iron in soil.		
Sensitive	**Moderately tolerant**	**Tolerant**
field beans	corn	barley
forage sorghum	alfalfa	grasses
grain sorghum	clover sweet corn	millet
soybeans		potatoes
sudangrass		oats rye wheat sugar beets

Expecting a Response to Zinc

It's important to point out that most soils in Nebraska contain adequate amounts of zinc for crop production. The soil test for zinc is the best guide to use in determining the need for a zinc fertilizer. In general, zinc may be needed for sensitive crops where:

1. The soil is calcareous (pH is higher than 7.3 because of excess lime).
2. The topsoil has been removed either through erosion, land leveling or terrace building.
3. Soils are very sandy with a low organic matter content.

There have been some observations that applying high rates of phosphorus without zinc on calcareous soils with a low zinc level can reduce corn yields. If zinc is included with phosphorus in these situations, yields are improved. It should be emphasized that this reduction in corn yields brought about by the use of phosphorus occurs only on soils in Nebraska with a low or marginally adequate level of zinc and a high pH.

Fertilizer Sources of Zinc

There are a number of materials that can be used to supply zinc in a fertilizer program. These can be divided into four groups: 1) organic chelates; 2) organic non-chelates; 3) soluble inorganics; and 4) insoluble inorganics.

The chemical characteristics of zinc sources in one group are completely different from those in another. From the standpoint of fertilizer use, the mobility of the various carriers (sources) is very important. The mobility of the members of each of the four groups is illustrated in *Figure 1*.

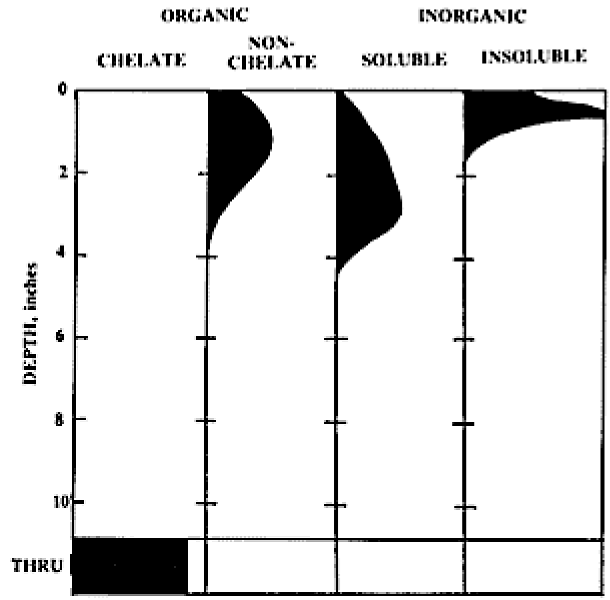

Figure 1. Distribution of zinc added to the top inch of soil in columns of Thurman loamy sand after leaching with 20 inches of water.

The zinc chelates are mobile in soils and will move with the soil water. The insoluble inorganic zinc carriers (zinc oxide, zinc carbonate) are not mobile, and must be applied as small, finely divided particles, broadcast and thoroughly incorporated so the plant roots will come in contact with the zinc fertilizer. Organic non-chelated zinc carriers and the soluble inorganic carriers are soluble but not very mobile in the soil. These carriers need to be placed in the root zone to assure root-zinc contact.

Placement of Zinc Fertilizers

The mobility of the various carriers has a strong influence on the way in which zinc fertilizers are applied for crop production. When the dry sources of zinc are considered, all materials are equally effective for crop production except for the granular formulations of the insoluble inorganic compounds. All sources of zinc have been shown to be equally effective for crop production in Nebraska where the zinc carrier is dissolved or suspended in a fluid fertilizer.

For the most part, zinc fertilizers can be either broadcast and incorporated into the soil or applied in a band at planting. In general, the rate of zinc suggested for a broadcast application can be reduced by half when the zinc fertilizer is placed in a band near the seed.

Plant nutrients supplied in a fertilizer are usually applied at rates sufficient to grow the current crop. With zinc, however, it may be more practical to raise the zinc level of the soil, thus assuring an adequate supply for several years. This approach requires that relatively high rates of zinc be broadcast and incorporated. Granular zinc sulfate or finely ground zinc oxide can be used for this purpose.

For those who irrigation, applying a liquid source of zinc with the irrigation water is a possibility. The zinc source used for this practice must be mobile. The chelated materials are the mobile sources of zinc, and are thus appropriate sources for this practice. RESEARCH, HOWEVER, HAS SHOWN THAT SOIL-APPLIED ZINC IS THE MOST EFFECTIVE PLACEMENT FOR THIS NUTRIENT. THEREFORE, APPLYING ZINC WITH IRRIGATION WATER SHOULD BE CONSIDERED AS AN EMERGENCY MEASURE *ONLY* AFTER A DEFICIENCY OF ZINC HAS BEEN IDENTIFIED IN THE FIELD.

Effectiveness ratios, such as 10:1 or 5:1, are often quoted for some zinc sources. Research has shown that these ratios do not hold true for crop production in Nebraska. This ratio may be 5:1 in very rare cases, but is usually near 1:1 if the materials are applied properly.

Expecting a Response to Iron

Most Nebraska soils probably contain adequate amounts of iron for plant growth. In some soils, however, conditions restrict the use of iron by a plant. As a result, a condition called iron chlorosis develops rather than iron deficiency.

Iron chlorosis is commonly associated with high lime, high pH soils. However, this chlorosis condition will also appear on soils that do not contain excess lime. Chlorotic soybeans, sorghum and alfalfa can occur on soils with excess salts, sodium or a high water table.

Correcting Chlorosis

The correction and/or elimination of iron chlorosis has always been a major problem with no easy solution. In the past, applying fertilizers containing iron has not corrected the situation, and is usually not economical. New products for this purpose have been developed in recent years and offer hope for the future.

New fertilizer materials and more specific placements are being researched to reduce iron chlorosis in crops. Methodology and recommendations are not finalized yet, but current research emphasizes seed or row placement of materials which quickly acidify a small zone of soil without causing plant injury. Some new, experimental chelates applied directly with the seed at costs of less than $10 to $20/A also seem promising.

Foliar applications of iron can be used for corn, sorghum, soybeans, and field beans. To avoid serous yield reductions, make the first application when the chlorosis first appears. Soybeans may need to be sprayed when the first full trifoliate develops, and corn and sorghum may require spraying when 6 inches high. Because so little plant area is covered, repeated spraying is necessary. Foliar application of 1% ferrous sulfate sprays can be used because they are inexpensive, but they are not very effective. Combinations of seed or row-applied materials with one or two foliar sprays may be the best approach; however, research is not to the point of specific recommendations yet.

Management practices other than fertilizing may be more important in correcting iron chlorosis. Some that may be helpful include:

- Tiling to provide drainage and aeration in wet areas where iron chlorosis is a problem.
- Variety selection (soybeans, corn); some varieties of soybeans and corn are more tolerant to iron chlorosis than others.
- Avoid over-irrigating on high sodium and lime soils.
- Whenever possible, grow crops that are more tolerant to iron chlorosis.

Micronutrient Toxicities

It is possible to apply excessive amounts of the micronutrients and this can result in a subsequent reduction in yield.

Special attention should be given to the application of boron. Excessive rates can produce barren stalks in corn. Since the expected response to applying boron is very rare, it's best not to include this nutrient in the fertilizer. Irrigation water contains some boron, so it's especially important to be concerned about excessive boron under irrigationd conditions.

If micronutrients are applied at excessive rates, the amount in the soil can reach toxic levels and reduce yields. Excessive rates of copper, a heavy metal known to accumulate in the soil, are of major concern.

File G596 under: SOIL RESOURCE MANAGEMENT
D-7, Fertility
Issued April 1982; 15,000 printed.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.