Zinc Fertility in Crop Production

Function in Plants

- Zinc (Zn) is an element used by crops in small quantities (usually less than 0.5 lbs/acre).
- Zinc has several important functions in plants, including major roles in enzyme reactions, photosynthesis, DNA transcription, and auxin activity.

30
Zn
Zinc
65.38

Availability in Soil

- Most zinc in soils is held in unavailable forms, such as metallic oxides and other mineral complexes.
- Plant-available zinc exists as the cation Zn^{2+} in soil solution.
- Zinc concentration in soil is affected by the composition and weathering of the parent material, soil organic matter level, soil pH, and concentrations of other nutrients.
- Course-textured and highly weathered soils generally have lower concentrations of available zinc. Newer soils that have not been weathered and soils that originate from igneous rocks are likely to contain greater amounts of zinc.
- Decomposition of soil organic matter can increase zinc availability by forming soluble organic zinc complexes. Soils with low organic matter or highly eroded topsoil generally have less available zinc.
- Muck or peat soils may also show deficiencies, as strong natural chelation can make zinc unavailable.
- Zinc is most soluble and therefore available to the plant at a pH of 5 to 7. Zinc is less soluble in alkaline soils due to increased adsorption to clay minerals.

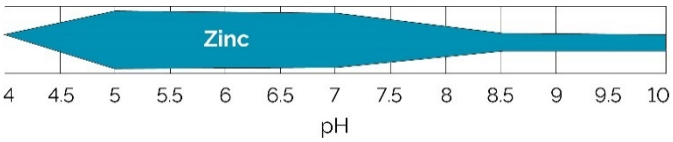

Figure 1. Relative availability of zinc by soil pH.

- Antagonism with other cations such as iron (Fe^{2+}) and copper (Cu^{2+}) can inhibit plant uptake of zinc.
- High levels of phosphorus in a soil, often associated with excess manure application, can cause the appearance zinc deficiencies in crops on marginally zinc-deficient soils.

Deficiencies in Crops

- Crops vary in frequency of zinc deficiencies and response to zinc fertilization.
  - Corn, sorghum, and rice are among the most responsive crops.
  - Deficiencies are less common in soybeans, cotton, and alfalfa.

Figure 2. Zinc deficiency in corn is characterized by interveinal striping in center of the leave surrounded by green margins.

- Early Zn deficiency may be induced by cold, wet soil conditions that limit corn root growth and available zinc. In such cases, Zn deficiency may be exhibited on early leaves, but not on later leaves.

Deficiency Symptoms

- Fields showing Zn deficiency are seldom affected uniformly. Zinc deficiency symptoms may also vary from field to field, depending primarily on the timing and severity of the deficiency.
- During the second or third week in the growing season, symptoms of Zn deficiencies may begin to show up. If the deficiency is severe, the symptoms may persist.
- In corn, pale and light green stripes will be present in the newer leaves on the half closer to the collar. Nodes will be spaced closer together than a healthy plant. Severe deficiencies can be identified by broader bands of pale tissue, wilting, and necrosis in the leaves.
- In soybeans, yellow to brown chlorosis will be visible on uppermost leaves. This is often mistaken for sunscald and iron deficiency. A tissue sample will validate the deficiency in the crop.

Figure 3. Corn leaf showing zinc deficiency symptoms

Corn Following Sugarbeets Syndrome

- Corn planted following sugarbeets can exhibit zinc deficiency due to a reduction in the population of soil mycorrhizae which aid in the absorption of phosphorous (P) and zinc (Zn) into the roots.
- Even at high or very high soil test levels, starter fertilizer is recommended in this rotation scheme.
    - When applying any form of Zn in direct contact with the seed, check with the supplier to ensure that the application will not be toxic to the seed and negatively impact germination.

Testing for Zinc

- Soil testing for Zn deficiency is among the most reliable of all micronutrients, this method is most often recommended to determine zinc sufficiency. Plant analysis may also be used.
- Soil test providers may have specific instructions for soil and plant sampling for zinc.
- Avoid using tools or containers galvanized or made of rubber when collecting samples, as these materials contain zinc.
- A sufficient amount of zinc is about 20-70 ppm in the plant tissue. A soil test of 0.8-1.0 ppm would imply that zinc is sufficient in the field.
- If a deficiency is found, recommendations are generally to apply 1 to 2 pounds actual zinc per acre as a banded application, or 5 to 10 pounds as a broadcast application.

Figure 4. Corn leaf showing zinc deficiency symptoms

Forms of Zinc

There are many fertilizer sources of zinc effective in correcting zinc deficiencies. These sources can be grouped as:

- Soluble inorganic products
    - Zinc sulfate (35% Zn)
        - Dry material that can be broadcast or banded as a starter
        - Easily mixed with other dry fertilizers
    - Zinc ammonium complex (10% Zn)
        - Liquid fertilizer
        - Will blend with other fertilizers
- Insoluble inorganic products
    - Zinc oxide (78%-80% Zn)
        - Ground into dust as the granular form; only somewhat soluble
        - May be applied as a suspension
    - Zinc carbonate (52% Zn)
- Zinc oxysulfate (20-25% Zn, 10-70% water solubility)
- Organic chelates (12% Zn) – ZnEDTA and ZnHEDTA
- Organic non-chelates (natural organic complexes)

Table 1. Common zinc fertilizer sources.

Zinc Fertilizer	% Zinc	Comments
Zinc sulfate ($ZnSO_4$)	~ 35%	Most common zinc fertilizer. Water soluble. May be banded, broadcast and foliar-applied
Zinc-ammonia complex	10%	May be included with liquid starters like 10-34-0
Zinc oxide (ZnO)	70-80%	Low solubility. Must be finely ground to be effective
Zinc oxysulfates	variable	ZnO partially acidulated with sulfuric acid to increase solubility
Synthetic zinc chelates (e.g., ZnEDTA)	9-14%	Up to five times more effective than soluble inorganic sources on a zinc content basis
Organic residues	variable	Manure and other organic residues are very good sources of zinc

Applying Zinc

Application Methods

- Banding zinc fertilizer two inches to the side and two inches below the seed allows immediate uptake of the nutrient and is placed far enough away from the seedling to prevent damage.
- Broadcasting and incorporating Zn before planting can supply nutrients for the growing season. This method is also desirable if the farmer would like to apply enough Zn for several years.
- Foliar applications are usually reserved for unexpected deficiencies. This method is uncommon due to inconsistent application results.

Responses to Applications

- Responses to Zn application will be the greatest in corn, slightly in soybeans, and minimal in alfalfa, wheat, oats, and other grasses.
- Fallow syndrome from not growing crops the previous year will increase the crops response to fertilizer application. The mycorrhizal fungi will not be able to assist in breaking down Zn from the soil and making it available to plants. Applied fertilizer will be available to the plant.

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