Zinc for Crop Production

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Zinc (Zn) is an essential nutrient required in some fertilizer programs for crop production in India. While some soils are capable of supplying adequate amounts for crop production, addition of zinc fertilizers is needed for others. In India, Zn may be needed in fertilizer programs for production of corn, sweet corn, and edible beans. Several research projects have focused on the use of this nutrient, and much of the following information is based on the results of that research.

Key words: Essential nutrient, crop production and soil.

INTRODUCTION

The Role of Zinc in the Plant

The specific role of Zn in growth and development of plants is not known. This nutrient is an important component of various enzymes that are responsible for driving many metabolic reactions in all crops. Growth and development would stop if specific enzymes were not present in plant tissue. Zinc, however, is needed in very small amounts. Plant uptake of this nutrient is calculated in terms of ounces per acre instead of pounds per acre. Therefore, Zn is classified as a micronutrient.

Deficiency Symptoms

Plants fail to develop normally when they are deficient in Zn and certain characteristic deficiency symptoms will appear. With corn, these symptoms usually appear in the first two or three weeks of the growing season. If the deficiency of Zn is severe, these symptoms may last throughout the entire season. A deficiency of Zn in corn is characterized by the development of broad bands of striped tissue on each side of the midrib of the leaf. These stripes begin on the part of the leaf closest to the stalk and appear first on the upper part of the plant (Figure 1). A Zn deficient corn plant also appears to be stunted. The lack of normal elongation in a corn plant is shown in Figure 2.

Zinc deficiency in edible beans first appears as a yellowing of the lower leaves. As the season progresses, this yellowing develops into a bronze or brown color. The leaves have a rusty appearance. For this crop, however, care must be taken to avoid confusing sunburned leaves with Zn deficiency. For both corn and edible beans, suspected deficiency symptoms should be confirmed with plant analysis.

Soil Conditions and the Need for Zinc Fertilizers

Research at the Indian Agriculture Universities as well as other universities has identified soil conditions where a response to Zn fertilizers might be expected. These conditions are:

- **Soil Temperature.** Cool soil temperatures in early spring can intensify the need for Zn. When soils are cold, the organic matter does not decompose and Zn is not released and available for crop growth.
- **Soil Texture.** In India, most of the response to Zn in a fertilizer program will take place on fine-textured soils. Recent research on sandy soils indicates a response to Zn can occur when high yields are grown on sandy soils with low organic matter content. The measured response to Zn fertilization in these situations has been small and has not occurred every year. Use the zinc soil test to determine if Zn is needed in a fertilizer program.
- **Topsoil Removal.** The probability of a response to Zn fertilization increases where topsoil has been removed or eroded away. When soils are eroded, the amount of free calcium carbonate on the soil surface increases.
Figure 1. This young corn plant shows typical zinc deficiency symptoms. Note the broad white stripes on both sides of the midrib of the leaf.

Figure 2. Zinc deficiency creates shortened internodes on the corn stalk. A normal plant (bottom) is shown in contrast to the zinc-deficient plant.
Table 1. The effect of high rates of phosphate with and without the use of Zn corn yield.

<table>
<thead>
<tr>
<th>Fertilizer Applied</th>
<th>Yield</th>
<th>Zn lb/acre</th>
<th>Yield bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₂O₅</td>
<td>40</td>
<td>0</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>320</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>320</td>
<td>10</td>
<td>83</td>
</tr>
</tbody>
</table>

Table 2. Relative levels of Zn concentration in plant tissue for several crops.*

<table>
<thead>
<tr>
<th>Crop</th>
<th>Plant Part</th>
<th>Deficient</th>
<th>Low</th>
<th>Sufficient</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn soybeans</td>
<td>Ear leaf at silking</td>
<td>11</td>
<td>15</td>
<td>20-20</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Most recently mature</td>
<td>11</td>
<td>20</td>
<td>20-20</td>
<td>51</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>Trifoliate at early bloom</td>
<td>11</td>
<td>20</td>
<td>20-20</td>
<td>71</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>Top 6 inches at 1/10 bloom leaves</td>
<td>10</td>
<td>20</td>
<td>20-20</td>
<td>71</td>
</tr>
<tr>
<td>Small grains</td>
<td>Head emergence</td>
<td>11</td>
<td>15</td>
<td>15-70</td>
<td>71</td>
</tr>
</tbody>
</table>

The probability of the need for Zn in a fertilizer program increases as the percentage of free calcium carbonate increases.

- **Previous Crop.** The probability of a response to Zn fertilization increases if either corn or dry edible beans follows a crop of sugar beets.

- **Phosphorus Levels.** There is a known relationship between phosphorus (P) and Zn in soils. Excessive applications of phosphate fertilizers have caused a Zn deficiency in corn and reduced yields. This yield reduction is shown in Table 1. In this study, the soil was highly calcareous (pH = 8.3), and the soil test of both P and Zn was very low. A P-induced Zn deficiency is a concern and may occur only if very high rates of phosphate fertilizer (more than 100 lb. P₂O₅/acre) are used and the soil test for Zn is in the low and very low range.

The P-induced Zn deficiency might be a concern when high rates of manure are applied to crop land. The manure, however, also contains Zn that can be used for crop growth. Therefore, P supplied from manure should not create a Zn deficiency for crop production in India.

**Predicting the Need for Zinc**

The need for Zn in a fertilizer program can be determined through soil tests or plant analysis. Plant analysis can confirm a suspected Zn deficiency. Plant analysis, however, should be used in combination with soil testing before arriving at firm recommendations for using Zn in a fertilizer program. A guide to the relative levels of Zn in the tissue of several important agronomic crops is provided in Table 2. The Zn concentration changes with stage of growth for the various crops. It’s important that crops be sampled at the growth stage listed if interpretation of plant analysis information is to be accurate.

When a soil test indicates the need for Zn, small amounts are needed in a fertilizer program to provide for optimum yield. The Zn status of Indian soils is easily measured by routine soil testing. The DTPA procedure is used by major soil testing laboratories and is a reliable indicator of the need for Zn in the fertilizer program.

**Sources of Zinc**

Several sources can supply Zn when needed. Zinc sulfate is usually used to supply the needed amount of Zn when dry fertilizer materials are used. This material can be either broadcast and incorporated before planting, or used in a starter fertilizer. It blends well with other dry fertilizer materials. Approximately 3 lb. of the zinc sulfate material will supply 1 lb. Zn per acre. A zinc-ammonia complex (10% Zn) can be used to supply Zn when fluid fertilizers are used. This material mixes easily with other fluid fertilizers.

Zinc oxide can correct a Zn deficiency but is slowly soluble and not effective in a granular form. To effectively correct a Zn deficiency, zinc oxide must be finely ground. Spreading any finely ground material is a problem in India because of the wind. So use of finely ground zinc oxide is limited to situations where suspension fertilizers are used. Foliar applications of Zn have not been consistently effective in correcting deficiencies of this nutrient. This method of application should be used on a trial basis.
only. For foliar applications, powdered zinc sulfate can be dissolved in water and applied to the leaf tissue. The amount dissolved should supply 0.5 to 1.0 lb. Zn per acre when a rate of 20 gallons of water per acre is used. A zinc chelate can also be mixed with water. The amount of chelate mixed with water should supply 0.15 lb. Zn per acre when water is sprayed at a rate of 20 gallons per acre.

Summary

Zinc is needed in small amounts for crop production in India and is, therefore, classified as a micronutrient. Field corn, sweet corn, and edible beans are Indian crops that respond to the use of this nutrient. A soil test is the best management practice for predicting the need for adding Zn to a fertilizer program. This nutrient is most effective if applied in a starter fertilizer. Several sources of zinc can be used with both liquid and dry fertilizers to optimize production of corn and edible beans when this nutrient is needed.

REFERENCES


