THE RELATIVE EFFICIENCY OF ZINC CARRIERS ON GROWTH AND ZINC NUTRITION OF CORN

by B. PRASAD and M. K. SINHA*

Punjab Agricultural University, Ludhiana, Punjab, India**

KEY WORDS
Corn Diffusion coefficient Organic manure Zn–DTPA Zn–EDTA Zn-fulvate

SUMMARY
A comparison of different zinc carriers showed that application of Zn–DTPA, Zn–EDTA, Zn-fulvate and ZnSO₄ significantly increased the dry matter yield and zinc uptake by corn over the control treatment where no zinc was applied. The chelates in particular enhanced to a greater extent the uptake of both native and applied sources than that observed with ZnSO₄ as the zinc carrier. Both the dry matter yield and zinc uptake by corn showed a positive and significant relationship with self-diffusion coefficient of zinc showing thereby that diffusion contributed mainly the supply of Zn from the ambient soil matrix to plant roots. The effectiveness of the chelates varied depending on their capacity to retain Zn in a soluble form in the soil solution.

It is evident that zinc nutrition of plants in alkaline and calcareous soils can be more effectively regulated by both synthetic and natural chelates or organic manures which contain substantial amount of complexed zinc.

INTRODUCTION
Both synthetic and natural chelates augment the availability of micronutrient cations to plants from the soil by enhancing both diffusive and convective flow of nutrients to surface of plant roots ² ⁴ ⁷ ⁹ ¹⁰. Anderson reported ¹ the relative effectiveness of different zinc carriers in augmenting crop growth to vary in the order: Zn–DTPA > Zn–EDTA > Zn–EDDHA > ZnSO₄ > Zn-Rayplex (polyflavonoid). The slight superiority of Zn–DTPA over Zn–EDTA in a calcareous soil near pH 8.0 is predicted from chelate-stability-diagram ⁴.

The objectives of this study were (i) to investigate the relative efficiency of both

* Present addresses: Associate Professor of Soil Science and University Professor of Soil Science and Agricultural Chemistry, Rajendra Agricultural University, Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar, India.
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natural and synthetic zinc chelates in augmenting the growth and zinc nutrition of corn (ii) to determine the contribution of the diffusive transport of Zn from the bulk of soil mass to plant root surface which in turn affects the dry matter production and zinc uptake by the corn crop.

EXPERIMENTAL

Greenhouse study

A pot culture experiment was conducted to compare the relative efficiency of different zinc chelates in augmenting the growth and zinc nutrition of corn (Zea mays L.). The characteristics of the soil used are presented in Table 1. DTPA extractable micronutrients were determined according to method described by Lindsay and Norvell.

The treatments included five different sources such as Zn-DTPA, Zn-EDTA, Zn-citrate, Zn-fulvate and ZnSO₄, each supplying three levels of zinc (1.25, 2.5, and 5 ppm). All the sources were tagged with the $^{65}$Zn isotope (20 μCi/mg Zn) to determine the relative contribution of the applied and native sources of Zn to plant growth. Zn-fulvate was prepared by adding AR grade ZnSO₄ tagged with $^{65}$Zn in equimolar quantities. The molecular weight of fulvic acid was 906 whereas ratio Zn/fulvic acid was 1:1.

Plastic buckets were filled with 3 kg of processed soil. A basal dose of 45 mg N, 45 mg P₂O₅ and 45 mg K₂O per pot from AR grade inorganic salts, urea, KH₂PO₄ and KCl respectively were added in solution form and thoroughly mixed with soil. Six healthy seeds of corn were sown in each pot at proper moisture conditions. After germination; plants were thinned to three eliminating week plants. One more dose of nitrogen @ 45 mg N/pot was applied after 30 days of crop growth.

The crop was harvested after 45 days growth. The plants were washed in 0.1 N HCl followed by washing with deionized water. Samples were dried in an oven at 65°C for 48 hours, weighed and ground in a stainless steel blender. Representative samples were digested in the tri-acid mixture (HNO₃: H₂SO₄: HClO₄ = 10: 3: 1) and total zinc determined on atomic absorption spectrophotometer. An aliquot (2 ml) of the plant extracts and the zinc carriers was analysed for radioactive zinc on a well type scintillation head on a gamma ray spectrometer and the following calculations were made:

(i) Percent Zn derived from the applied source = 
\[
\frac{\text{Sp. act. of samples at zero hour} \times 100}{\text{Sp. act. of the added source at Zero hour}}
\]

(ii) Percent utilization of the applied source = 
\[
\frac{\text{mg Zn in plant from applied/pot} \times 100}{\text{mg Zn in added to soil/pot}}
\]

The data obtained from the greenhouse study were processed and analysed statistically.

Table 1. Chemical characteristics of alkaline soil

<table>
<thead>
<tr>
<th>Mechanical composition (%)</th>
<th>Textural class</th>
<th>C.R.C. (meq/100 g)</th>
<th>pH</th>
<th>O.C.</th>
<th>DTPA-extractable micronutrients (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Silt</td>
<td>Clay</td>
<td>Fe</td>
<td>Cu</td>
<td>Zn</td>
</tr>
<tr>
<td>80.6</td>
<td>8.6</td>
<td>9.4</td>
<td>Loamy sand</td>
<td>6.2</td>
<td>8.4</td>
</tr>
</tbody>
</table>