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EFFECT OF CADMIUM AND ZINC APPLICATION ON QUALITY OF MAIZE

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SUMMARY

The dry matter yield of maize significantly decreased with the increasing levels of Cd in soil at all levels of Zn; the application of Zn did not effect the yield in general. Both Cd and Zn decreased the reducing, non-reducing and total sugars of maize. Protein content of plants increased with increasing levels of Cd and Zn but the increase was more with Cd than Zn. The free amino acids increased significantly with Cd and decreased with Zn application.

INTRODUCTION

Waste management is very important in many areas, especially where population is heavily concentrated. Sludges and sewer water contain heavy metals which are toxic to plants and human beings. Among the toxic metals, Cd has received considerable attention because it is chemically similar to Zn and easily absorbed by plants (Lagerwerff, 1972). Information on the effects of Cd and interactions with Zn on crop yield is limited. Therefore, an experiment was conducted in pots to study the effect of Cd and Zn application of plant growth and biochemical characteristics in maize (*Zea mays* L.) grown on sewer water irrigated soil.

MATERIALS AND METHODS

A surface (0 to 15 cm) sample of sandy soil (Typic Ustipsamments) which had received sewer water irrigation for eight years was air dried and sieved (2mm sieve). The soil analysis as outlined by Jackson (1967) showed a pH of 8.2, E.C. 0.32 dSm^{-1}, O. C. o.1%, C. E. C. 4.25 cmol (P^{+}) kg^{-1}; N 38.5 $mgkg^{-1}$ and K 47.4 $mgkg^{-1}$. DPTA extractable Zn, Mn, Fe and Cu (Lindsay and Norwell, 1978) were 0.8, 5.7, 3.2 and 0.9 $mgkg^{-1}$, respectively. Total Cd (Lund *et al.*, 1976) was 4.3 $mgkg^{-1}$.

Earthen pots lined with polyethylene sheet were filled with 4kg soil in each pot. The soil was treated with four levels of Cd (5, 10, 25 and 50 mg Cd kg^{-1} soil as $CdCl_2$) and three levels of Zn (5, 25, and 50 mg Zn kg^{-1} soil as Zn So_4 $7H_2O$). A uniform basal dose of 150 mg N, 30 mg P, 50 mg K, 5 mg Mn, 7.5 mg Fe, 2.5 mg Cu kg^{-1} soil was applied through urea, KH_2PO_4, Mn $So_4 H_2O$, Fe So_4 $7H_2O$ and Cu So_4 $5H_2O$. Amount of Cd, Zn and nutrient salts were thoroughly mixed in soil of each pot. All the treatments were replicated thrice in a completely randomized design.

Ten seeds of maize (*cv.* Vijay composite) were sown and after germination five healthy plants were retained in each pot under natural conditions. Crops were irrigated with deionized water as and when required. The plants were harvested 40 days after sowing, washed in distilled water, dried in a draft oven at 65 ± 2°C, weighed and were ground in a Willey Mill for analysis.

Sugars were extracted from the ground plant material with distilled water (Srinivasan and Bhatia, 1953). In the extract, total sugars were estimated by the method of Dubois *et al.* (1956). and reducing sugars by the method as described by snell and snell (1953). Non-reducing sugars were derived from the difference between the total and reducing sugars. The N was estimated according to Lindner (1944) and protein percentage was calculated by multiplying N percentage by 6.25, Free amino acids were analysed by the method of Barnett and Naylor (1966).

RESULTS AND DISCUSSION

The dry matter yield of maize decreased significantly with the increasing levels of Cd in soil (Fig. 1). The negative response of Cd at all levels of applied Zn indicated that Cd was toxic to plants, even in the presence of sufficient Zn and Zn application did not reverse the toxic effect of Cd. Reduction in yield by Cd has also been reported by Haghiri (1972) in wheat and soybean and Mehla *et al.* (1989) in sorghum. The response of Zn was not observed because the

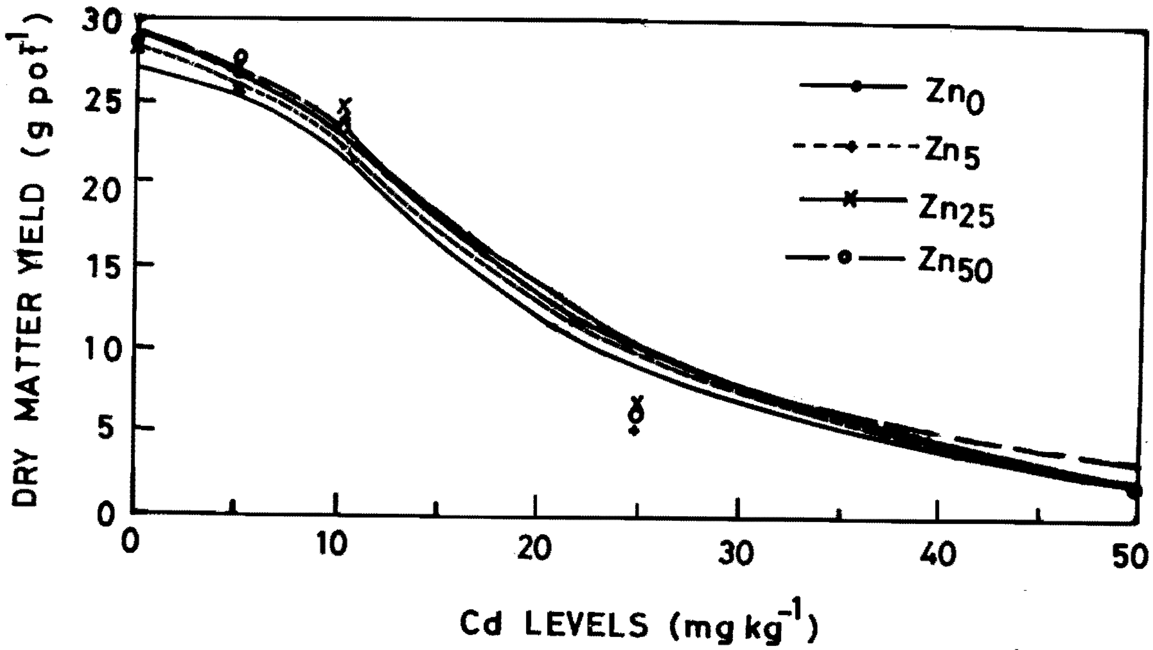

Fig. 1. Influence of different levels of Cd ang Zn on dry matter yield of maize shoots.

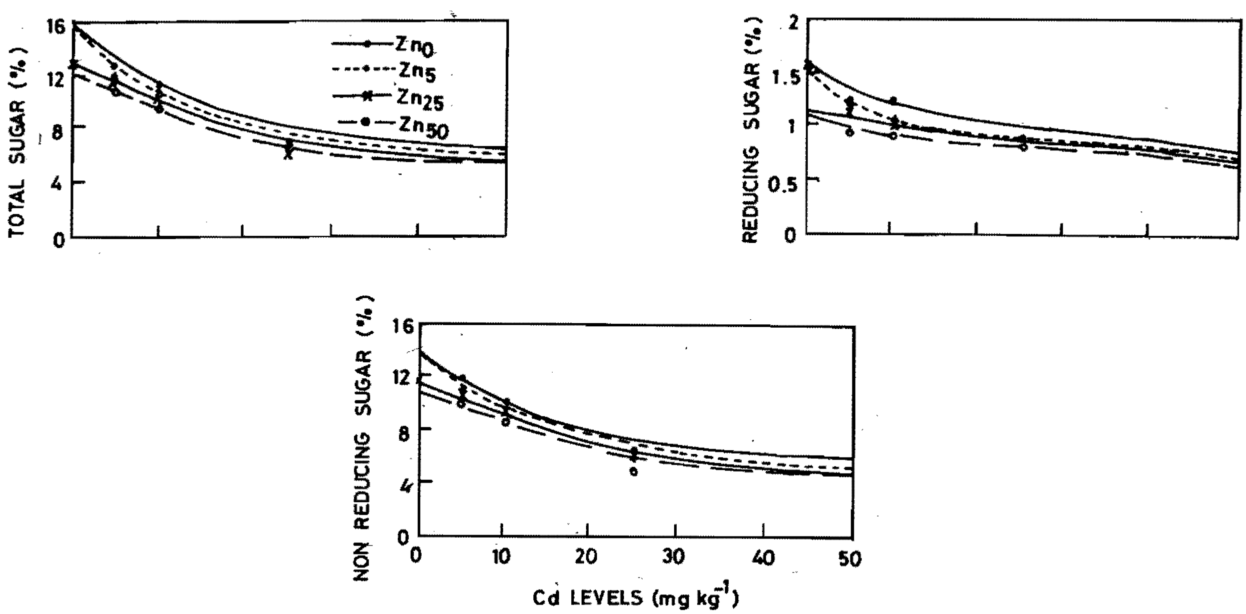

Fig. 2. Influence of different levels of Cd and Zn on sugar content of maize shoots.

available Zn in soil was 0.8 mg kg -1 which was above the critical limit for maize (Singh and Shukla, 1985).

Reducing, non-reducing and total sugar content of maize decreased with the increasing level of Cd and Zn (Fig 2). Mean total sugars decreased from 13.86 to 5.89 per cent from 0 to 50 mg kg^{-1} soil added Cd whereas with the addition of same level of zn. The total sugars decreased from 10.48 to 8.64 per cent. Similarly, reducing sugars decreased from 1.31 to 0.74 per cent with Cd and 1.15 to 0.88 per cent with Zn application. A sharp reduction in sugar content occurred

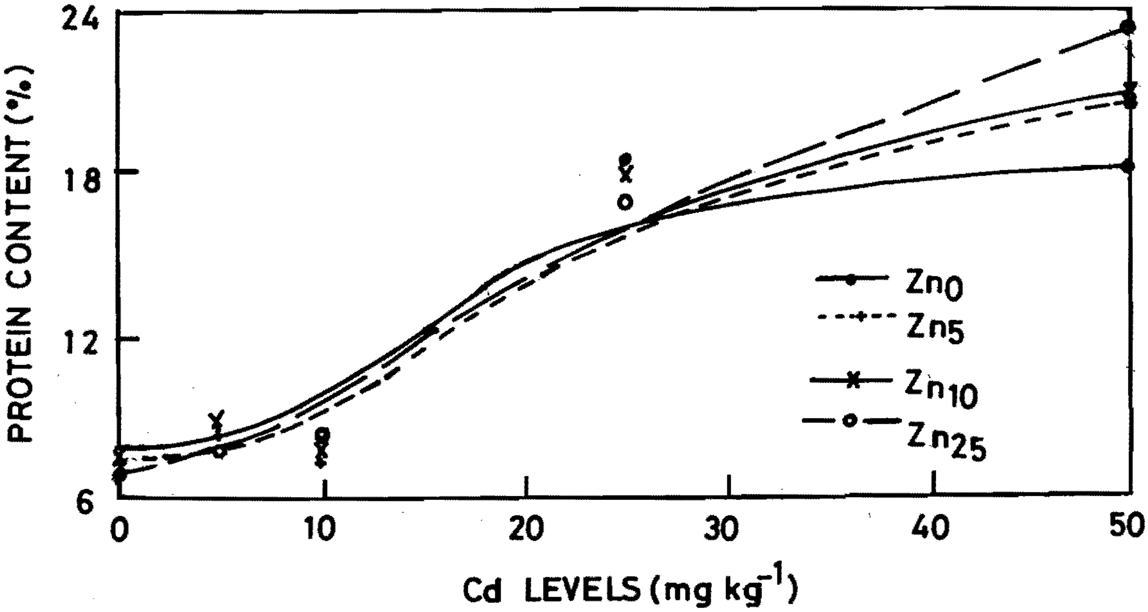

Fig. 3. Influence of different levels of Cd and Zn on protein content of maize shoots.

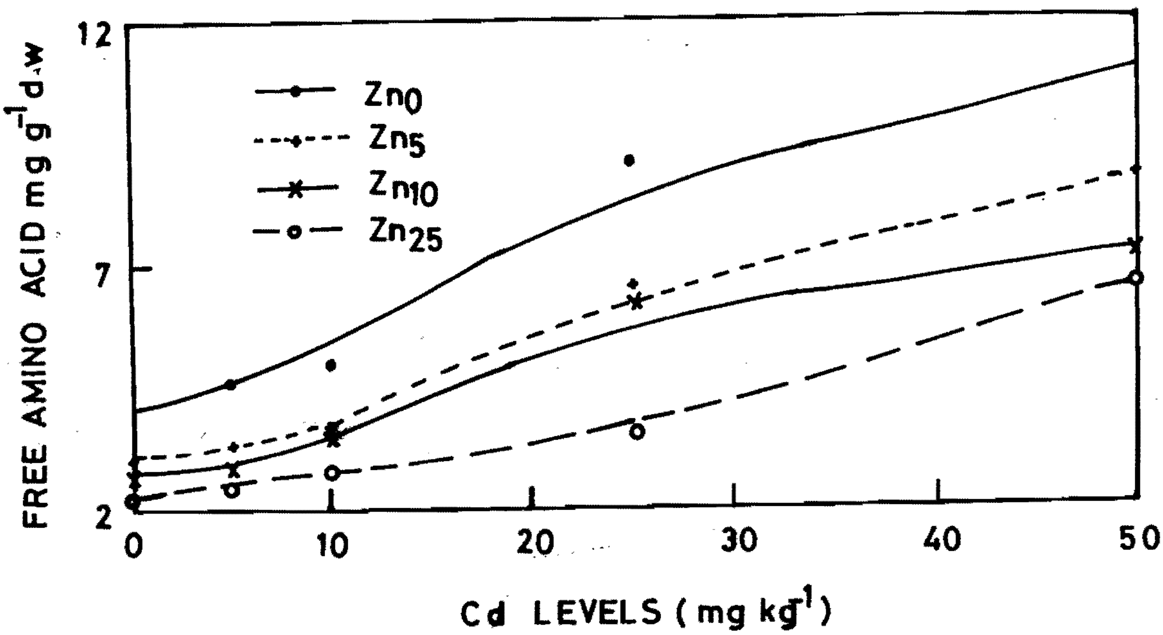

Fig. 4. Influence of different levels of Cd and Zn on free amino acids of maize shoots.

at 25 mg Cd kg $^{-1}$ soil which coincides with the reduction in yield. This indicates that the decrease in sugar content of maize might be due to decreased net photosynthetic rate at high Cd levels as also reported by Wichman *et. al.* (1983). and keul *et al.*, (1979).

The data (Fig. 3) showed that protein content of maize increased significantly with Cd levels. This might be due to the concentration effect because addition of Cd reduced the dry matter yield. The average protein content increased from 7.21 to 20.85 per cent from 0 to 50 mg Cd kg $^{-1}$ soil.

However, Zn application also increased the protein content but the increase was non-significant. With the increase in Zn application, mean protein content increased.

Free amino acids in maize increased significantly with increasing levels of Cd (Fig. 4). Whereas application of Zn decreased the free amino acids, over control. The decrease in free amino acids with Zn application might be due to excess of Zn as Cakmak *et al.* (1989) reported several fold increase in amino acids of bean in Zn deficient soils. The increase in free amino acids was associated with the decrease in yield of plants. This could be due to Cd effects on the process of binding of amino acids and thus formation of true proteins. Due to high concentration of Cd in plants, plants might have not utilized free amino acids for plant growth.

These results indicate that the Cd toxicity in plants can not be overcome by the application of Zn in soil.

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