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TOXIC EFFECTS OF COPPER AND ZINC ON GERMINATION AND SEEDLING GROWTH OF SOME TREES

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A significant ($p<0.05$) reduction in seed germination due to copper toxicity at 800 ppm was observed in *A. lebbeck* and *L. leucocephala*. A significant ($p<0.05$) effect on root length in *A. lebbeck* was observed at 500 ppm of copper treatment as compared to similar concentration of zinc treatment. Higher concentration of zinc element also decreased the seedling dry weight at 1100 ppm treatment in *A. lebbeck* and *L. leucocephala*. Shoot length of *L. leucocephala* was more affected by copper treatment at 1100 ppm as compared to same concentration of zinc. The lower dose of copper at 200 ppm was found effective in decreasing the seedling growth of *L. leucocephala* and *A. lebbeck*. Seedling growth rather than seed germination appears to be the sensitive stage for both tree species when treated with copper and zinc as compared to control. *L. leucocephala* was highly affected to copper and zinc toxicity, while *A. lebbeck* was less affected. According to tolerance test it was found that tolerance against zinc was higher as compared to copper.

Keywords: Germination, Seedling growth, Tolerance, Toxicity, Trees, Copper and zinc treatment.

Introduction

Environmental pollution is a constant threat to humanity. The manufacturing of useful products such as dye stuffs, pigments, drugs, agrochemicals, plastics, batteries, zinc recovery operations, electroplating and metal surface cleaning agent and discharge of untreated effluents from these industries are causing a wide range of environmental problems (Rehan *et al* 1995). Reports on zinc toxicity have been carried out by many workers (Niazi and Ahmed 1984; Khalil *et al* 1989; Kumar 1989; Veer 1989; Taylor *et al* 1991; Parker *et al* 1991).

Copper is one of the most widely used alloying metals. Over, 1000 copper alloys are recognized of which more than half are known as brass (mainly copper and zinc) or bronze (Cu and Sn). Copper forms a large number of compound in which its oxidations state is +1 (Cuprous) and +2 (Cuprics) and it may form a few unstable compounds in which its valance is +3. Copper is an important metals because of its high electrical conductivity, mallability, ductility and resistant to atmospheric corrosion. Its alloys like brass and bronze are used for making utensils and other articles (Mehra and Mathur 1998). Copper sulfate is used in huge quantity in the textile industries (Ansari 1984). Copper is found surprisingly toxic element. Copper is an effective fungicide. In soils, copper is mainly present in divalent form. Most of copper released from minerals by weathering and taken up by plants is bound by the humus. The chief source of copper in the soil parent material is primary mineral, $CuFe_2S$ and minerals of the basic igneous rocks. In water logged soils, copper is also present as Cus and Cu_2. Copper is a constituent of certain oxidizing reducing enzymes. Copper forms a part of the enzyme systems and is necessary for the formation of growth promoting substances. Copper deficiency is common on peat leading to growth abnormalities such as rapid wilting and weak stalks, spiraling of leaves and no grain formation. For rapid results the crop may be sprayed with a solution of copper oxycloride and the soil sprayed with a copper sulfate solution (Fitzpatrick 1983). Among the heavy metals, zinc is a major inorganic pollutiant, which has shown inhibitory and promotory effect on the growth along with accumulation in plants (Iqbal *et al* 1998).

Karachi is the largest city of Pakistan. The total amount and complexity of toxic pollutant in the environment increasing day by day due to discharge of untreated che micals in the environment. The toxic substances discharged from the industries adversely affecting the growth of plants. Monocotyledonous species, viz. *Paspalidium geminatum, Chloris barbata and Aeluropus lagopoides* around the Lyari river was found disturbed due to discharge of industrial and domestic sewage (Iqbal *et al* 1998). Iqbal *et al* 1998 have observed the availability of copper concentration above the toxic permissible limit of 150 ppm in the area, which ranged from 200-240 ppm. High concentrations of heavy metals (Lead, Copper, Iron, Zinc, Nickel and Cadmium) was found in the leaves of some roadside plants and soils in the Karachi city (Ara *et al* 1996; Khalid

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et al 1996). The present study was undertaken with a view to find out the toxic effect of copper and zinc on seed germination and seedling growth of some trees.

Materials and Methods

Albizia lebbeck (L.) Bth. and *Leucaena leucocephala* (Lam.) de-wit. are commonly planted in Sind, Baluchistan and the Punjab plains in Pakistan. The healthy seeds of *L. leucocephala* and *A. lebbeck* were collected from the campus. The seeds were slightly rubber with sand paper to enhance early seed germination. The seeds were surface sterilized with 0.2% mercuric chloride for one minute to prevent any fungal contamination. The petridishes and filter papers were sterilized in autoclave to reduce the chances of any fungal contamination. Thereafter, the seeds were washed with distilled water and transferred to medium sized petridishes (90 x 20 mm) and placed on filter paper at room temperature. There were three replicates and in each replicate, 10 seeds were kept. The surface sterilized seeds were placed at different concentrations of copper sulfate and zinc nitrate (200, 500, 800 and 1100 ppm). In the control, no treatment was given except distilled water. The germination of seeds were recorded daily and noted the emergence of radicle. After 10 days, seed germination percentage, root, shoot and seedling length were noted. Seedling dry weight was determined by drying the plant materials in an oven at 80°C for 24 hours.

Data obtained were statistically analyzed by ANOVA and Student Newman Keul's Range Test.

Results and Discussion

The results are presented in Figs 1-5. The reduction in growth of both tree species was found in copper and zinc treated plants. Copper was found highly toxic to both trees as compared to zinc treatment. The reduction was more in *L. leucocephala* and *A. lebbeck* in case of copper than zinc treatment. Seed germination and seedling length of *A. lebbeck* were found significantly ($p<0.05$) reduced at 800 ppm copper treatment as compared to control. The treatment of copper at 1100 ppm concentration also significantly ($p<0.05$) reduced the seedling growth and dry weight in *A. lebbeck* (Fig 1). Reduction in seed germination of *A. lebbeck* was observed at 200 ppm copper treatment. However, increase in concentration of copper at 800 ppm produced a toxic effect on seed germination in *A.*

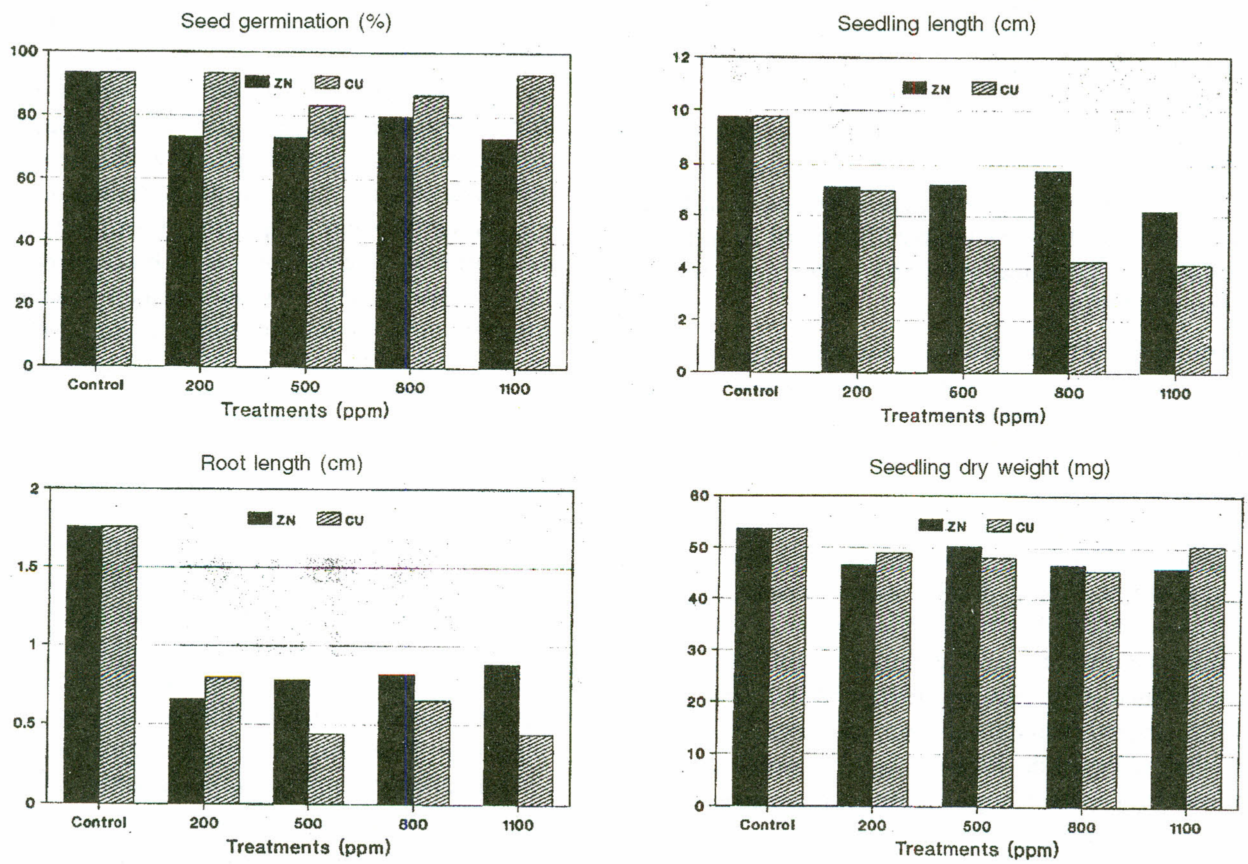

Fig 1. Effects of copper and zinc and seed germination, seedling length, shoot length, root length, seedling dry weight and root/shoot ratio for *Albizia lebbeck*.

lebbeck. A significant ($p<0.05$) decrease in seed germination at 1100 ppm of copper treatment was found in *L. leucocephala* (Fig 2). Shoot and root growth were also found highly affected by copper and zinc treatment at 1100 ppm in *L. leucocephala*.

High percentage of decrease in root growth (80.07%) and shoot length (54.59%) was observed in *L. leucocephala* at 1100 ppm of copper treatment as compared to control. The high percentage of decrease in root length (75%), Shoot length (57.5%) and seedling growth (57.8%) was found in *A. lebbeck* at 1100 ppm concentration of copper. The tolerance indices of both tree species were responded different to both metals treatments. *L. leucocephala* and *A. lebbeck* were found highly affected at the high concentration of copper and zinc. As the concentration of copper and zinc was increased, the tolerance in plants was greatly decreased.

Copper is toxic at both low and high concentration whereas zinc is toxic only at higher concentration. The reason for reduce root growth in metals treatment could be due to metals reducing the mitotic cell in meristematic zone and these meristematic cells are found at the stem and root apices. Their activity results in primary growth and for the formation of primary structure of plant. In this region, the cell start to absorb water by osmosis. At this stage the cell walls are quite soft and as the vacuole expands, it will make the cell longer. The growth of both trees were found inhibited due to copper and zinc metal toxicity. According to tolerance test it could be seen that tolerance against zinc was higher as compared to copper. Tolerance against copper and zinc was higher in *A. lebbeck* than *L. leucocephala*. The tolerance against heavy metal to *A. lebbeck* might be due to physiological association of the tolerance mechanism, to these metals. The indices of tolerance for both copper and zinc application showed that *L. leucocephala* seedling were less tolerant at higher concentrations. The indices of tolerance for *L. leucocephala* at 1100 ppm were 19.92 and 46.86 for copper and zinc treatment respectively. Copper and zinc greatly reduced the germination of *A. lebbeck* and L. *leucocephala* seeds particularly at the higher concentrations. Shoot and root length and seedling dry weight of *L. leucocephala*

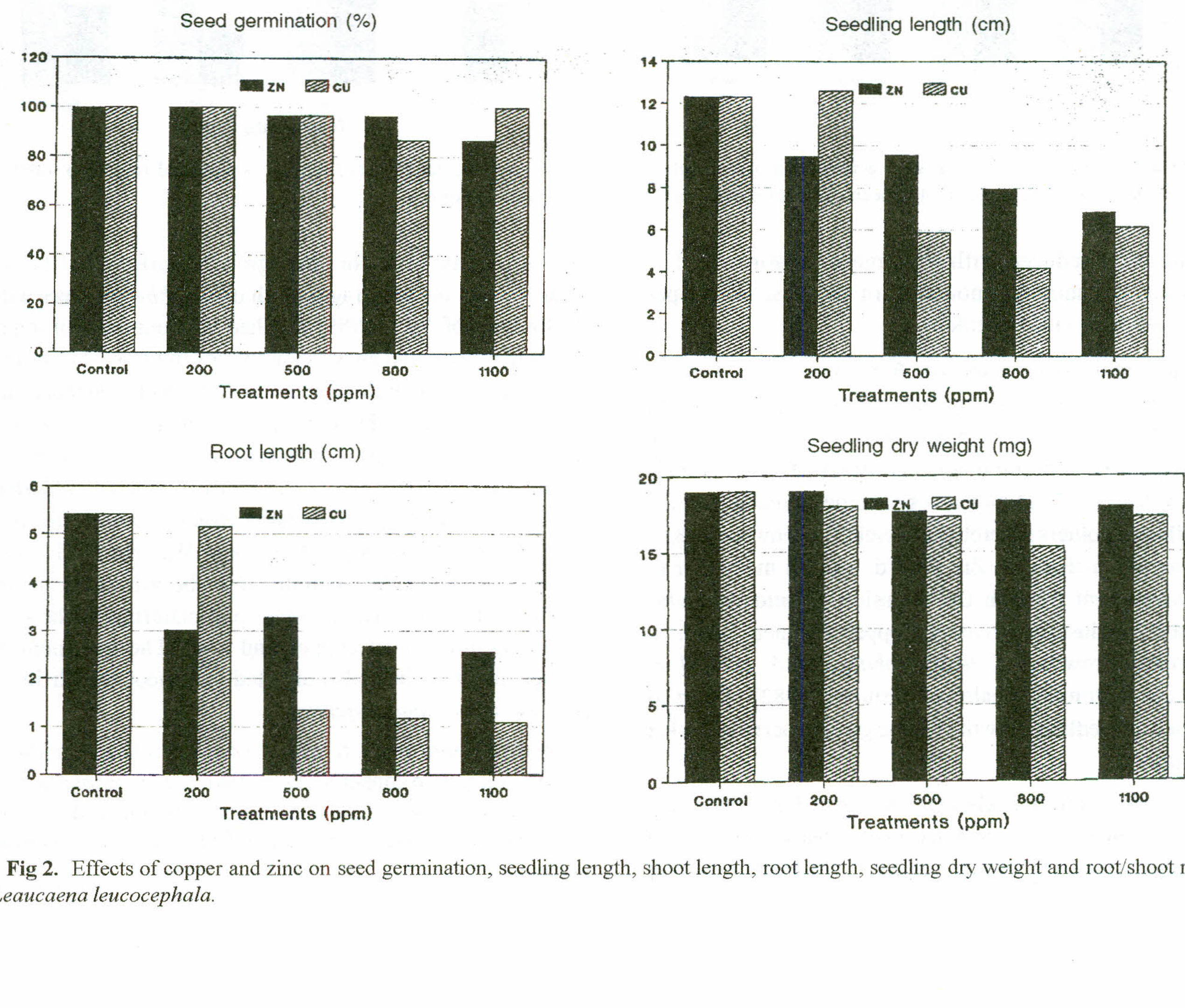

Fig 2. Effects of copper and zinc on seed germination, seedling length, shoot length, root length, seedling dry weight and root/shoot ratio for *Leaucaena leucocephala*.

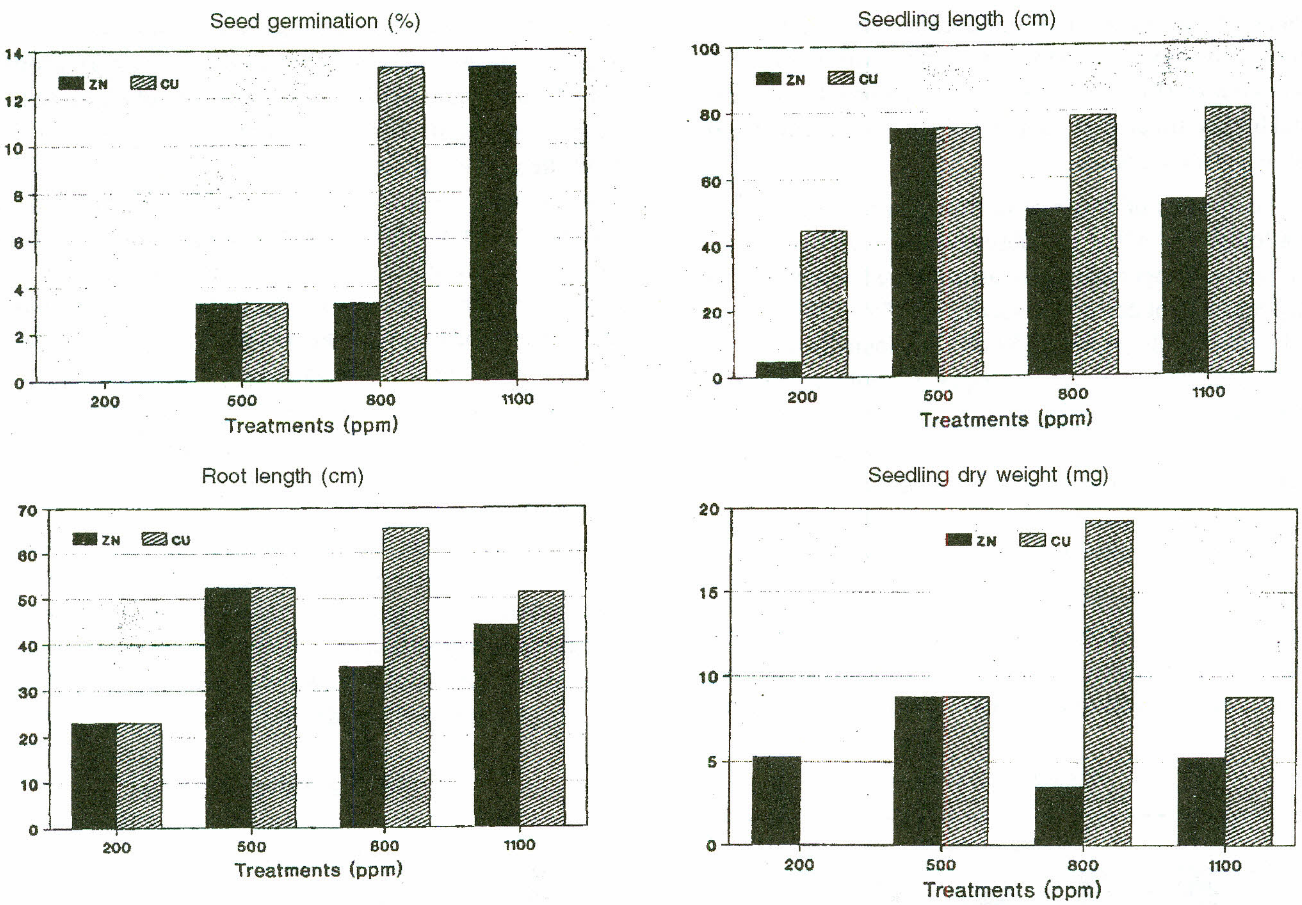

Fig 3. Percentage decrease in seed germination, root length, shoot length, seedling length, seedling dry weight and root/shoot ratio of *Leaucaena leucocephala* at different concentration of copper and zinc as compared to control.

seedling were reduced with both metal treatments. The reduction was more pronounced in the case of copper application than zinc treatment.

The trace elements have specific functions, all of them are known to be involved in enzyme action. They form plant tissue. Plant under stress condition are most likely to be adversely affected by high concentrations of heavy metals (Chaney *et al* 1977). Deficiencies of some elements and the toxic effects of others severely limit yield (Greenwood 1982). Many metals such as Fe, Zn, Pb, Cd, and Cu may enter in the environment through the emission of auto vehicular exhaust and industrial activities. Copper treatment inhibited the seedling growth of *L. leucocephala* and *A. lebbeck* at higher concentration. Heale and Ormord (1982), observed inhibition in seedling growth of some gymnosperm by nickel and copper.

Plants require inorganic elements for growth but excessive amounts become toxic. Germination of *L. leucocephala* seed was highly affected by copper and zinc. The high amount of zinc was found toxic for plant growth (Parker *et al* 1991). Reduction in the seedling growth of *A. lebbeck* agrees with the findings of Veer (1989) who had also found inhibition in seedling growth and enzymes activities in *Phaseolus aureus* CV R-851 by zinc. Reduction in root length of *A. lebbeck* and *L. leucocephala* might be due to accumulation of zinc and copper in the substrate. Excessive amount of toxic element usually caused reduction in plant growth (Mehra and Mathur 1998). Cereal grains and vegetable usually contain zinc less than 50 $\mu g\ ml^{-1}$ in tissue (Berry and Wallace 1981). The decrease in seed germination might be attributed to the accelerated breakdown of stored food materials in the seed by the application of copper and zinc. The treatment of copper and zinc had also affected the shoot length in *A. lebbeck* and *L. leucocephala.*

From the present study, it may be concluded that A. lebbeck is more tolerant to copper and zinc than *L. leucocephala.* It is also suggested that *A. lebbeck* should be planted around such industries which emit Cu and Zn in the environment as pollutants.

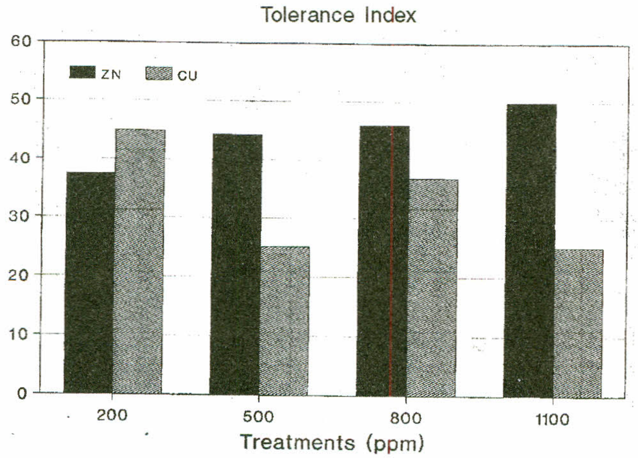

Fig 4. Indices of tolerance for *Albizia lebbeck* at different concentrations of copper and zinc.

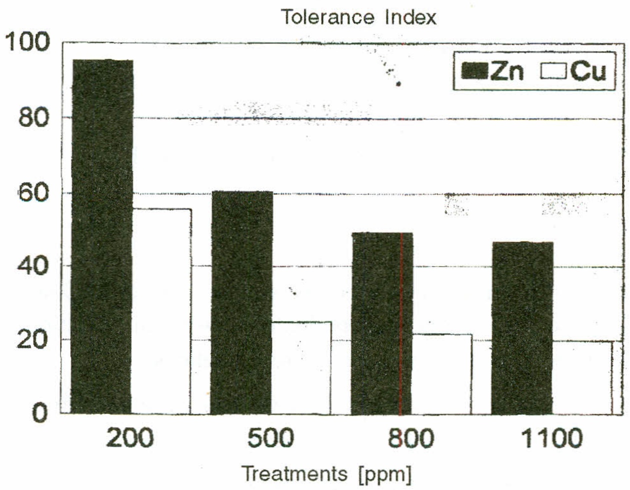

Fig 5. Indices of tolerance for *Leaucaena leucocephala* at different concentrations of copper and zinc.

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