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Copper and zinc induced changes in soybean *(Glycine max* (L.) Merr.)

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ABSTRACT

Heavy metals are one of the most important pollutants released to the aquatic environment by the various industrial activities. The use of these wastewater for irrigation results accumulation of heavy metals in soil and plants. So, the present investigation deals with the various concentrations (0, 5, 10, 25, 50, 100, 200 and 300 mg/l) of copper and zinc on germination studies of soybean. The different concentrations of copper and zinc were used for germination studies. The seedlings were allowed to grow upto seven days. The studied morphological traits increased at 5 mg/l concentration and these parameters are gradually decreased with the increase of copper and zinc concentrations.

KEYWORDS: Copper, zinc, heavy metals, soybean

INTRODUCTION

Nowadays, the living organisms face a variety of Pollution problems the major environmental pollutants which are discharged into the atmosphere [1]. Various heavy metal ions including Cd, Cr, Pb, Cu, Hg and Zn are released into the environment due to rapid growth of industries, urbanization, from the burning of fuels, industrial wastes, pesticides and use of agrochemicals, agricultural runoff and mining activities [2]. Five heavy metals (Fe, Mn, Zn, Cu and Mo) are essential for the growth of all higher plants. These metals serve as mineral nutrients for plants at low levels and become toxic at elevated level [3]. The toxicity will appear as retardation in growth of plants [4]. Copper and zinc are included in essential micronutrients for plant growth. Copper is usually released to the fields due to agricultural activities or from industries [5]. It is widely used in dyes, paints, pigments, ceramics, pesticide and some therapeutical preparation as well. They are also the main components of various industrial effluents. While the polluted water with heavy metals is used for irrigation, they are absorbed and accumulated in different of the parts which result in reduced growth and metabolism [6]. The excess amount of copper in irrigation water accumulated in soil may be toxic to plants. At higher concentrations, any heavy metals including copper affects the plant growth [7-9].

Zinc is an essential micronutrient to the plants and It is required in trace amounts to carry out various enzymatic reactions in the cell [10]. It has been reported that zinc sulphate has been the main source of zinc for correcting Zn deficiency of field crops [11]. However, zinc at toxic concentrations affects the growth and metabolism of green plants [7,12,13]. Apart from this, several industrial units discharged continuously and entered into the nearly water sources. However, the research work on the effect of heavy metals (zinc and copper) on germination studies of soybean (*Glycine max L. Merr.*) is very meagre. Hence, the present paper deals with the effects of these heavy metals on germination and growth behaviour of Soybean an important a Leguminous crop of this area.

These industrial wastewater are being used for irrigation due to scancity of good water to Agriculture crops. Among various kinds of Pollution, the problem of heavy metal Pollution in the aquatic and aerial environment is gradually increasing in the environment.

MATERIALS AND METHODS

The seeds of soybean (*Glycine max* (L.) Merr.) were procured from Department of Pulses, School of Genetics, Tamil Nadu Agricultural University, Coimbatore. The seeds were surface sterilized with 0.2% mercuric chloride and then washed with distilled water. Twenty seeds were evenly placed in petriplate lined with filter paper. The various concentrations (control, 5, 10, 25, 50, 100, 200 and 300 mg/l) of copper and zinc solution were prepared individually and used for germination studies. The seeds treated with distilled water served as control. The germination percentage, root length, shoot length, fresh weight and dry weight were recorded on seven days old seedlings. The vigour index [14], tolerance index [15] and percentage of phytotoxicity [16] of seedlings were also calculated.

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RESULTS AND DISCUSSION

Copper and zinc are essential micronutrients to plants and it may promote the germination and growth at lower concentration. The higher concentrations of Cu and Zn reduced the germination studies parameters. Results of the effects of copper and zinc on germination percentage, root length, shoot length, fresh weight, dry weight, vigour index, tolerance index and percentage of phytotoxicity of soybean at different concentrations are given in Tables 1 and 2 Figures 1 and 2. Maximum germination percentage (100%) was observed at 5 mg/l concentration and the minimum germination percentage was noticed (50%) at 200 mg/l concentration. All the growth parameters increased at 5 mg/l concentration and then decreased with the increase of copper and zinc concentrations. Copper is identified as more toxic than zinc in soybean.

Table 1: Effect of Copper on germination studies of soybean (*Glycine max* (L.) Merr.)

Concentration of $CuSO_4$ (mg/l)	Germination (%)	Root length (cm/seedling)	Shoot length (cm/seedling)	Fresh weight (g/seedling)	Dry weight (g/seedling)	Vigour index	Tolerance index	Percentage of phytotoxicity
Control	98.0±4.9	10.5±0.47	19.60±0.14	0.905±0.14	0.370±0.03	2793.00±139.65		
5	100.0±5.0	11.5±0.57	22.46±1.07	1.468±0.17	0.285±0.03	3296.00±164.8	1.2105±0.06	- 12.9473±0.6
10	88.0±4.5	9.2±0.41	19.00±0.85	0.785±0.14	0.123±0.03	2268.00±13.4	0.8631±0.04	10.5263±0.5
25	80.0±3.9	7.8±0.34	16.00±0.75	0.628±0.13	0.185±0.02	1700.4±85.02	0.7157±0.03	21.0526±1.0
50	75.0±3.5	6.5±0.27	15.00±0.70	0.580±0.12	0.088±0.02	1365.00±68.25	0.5789±0.02	26.3157±1.3
100	65.0±3.2	5.0±0.25	13.8±0.69	0.400±0.09	0.065±0.02	1222.00±61.1	0.5263±0.02	27.3684±1.3
200	50.0±2.5	3.8±0.19	10.50±0.52	0.383±0.08	0.048±0.01	715.00±35.75	0.4000±0.02	44.7368±2.2

± Standard deviation
No germination was observed at 300 mg/l

Table 2: Effect of zinc on seed germination studies of parameters of soybean (*Glycine max* (L.) Merr.)

Concentration of $ZnSO_4$ (mg/l)	Germination (%)	Root length (cm/seedling)	Shoot length (cm seedling)	Fresh weight (g/seedling)	Dry weight (g/seedling)	Vigour index	Tolerance index	Percentage of phytotoxicity
Control	98.0±4.9	10.2±0.5	21.5±1.0	1.308±0.1	0.385±0.03	3106.6±155.3		
5	100.0±5.0	12.8±0.5	22.60±1.0	1.478±0.1	0.290±0.03	3346.00±167.3	1.0535±0.05	- 5.6585±0.2
10	96.0±4.6	10.0±0.5	20.0±1.0	0.980±0.1	0.093±0.03	2806.00±140.3	0.9375±0.04	2.4390±0.1
25	85.0±4.2	9.8±0.5	18.20±0.9	0.728±0.1	0.088±0.03	2452.8±122.6	0.8928±0.04	6.3414±0.3
50	78.0±3.7	9.0±0.4	17.8±0.8	0.523±0.1	0.068±0.02	2070.00±103.5	0.875±0.04	13.1707±0.6
100	65.0±3.5	7.0±0.3	16.5±0.8	0.200±0.1	0.040±0.02	1575.00±78.75	0.5351±0.02	19.5121±0.9
200	50.0±2.5	5.8±0.2	13.8±0.6	0.185±0.09	0.038±0.01	930.00±46.5	0.5128±0.02	37.5609±1.8

± Standard deviation
No germination was observed at 300 mg/l

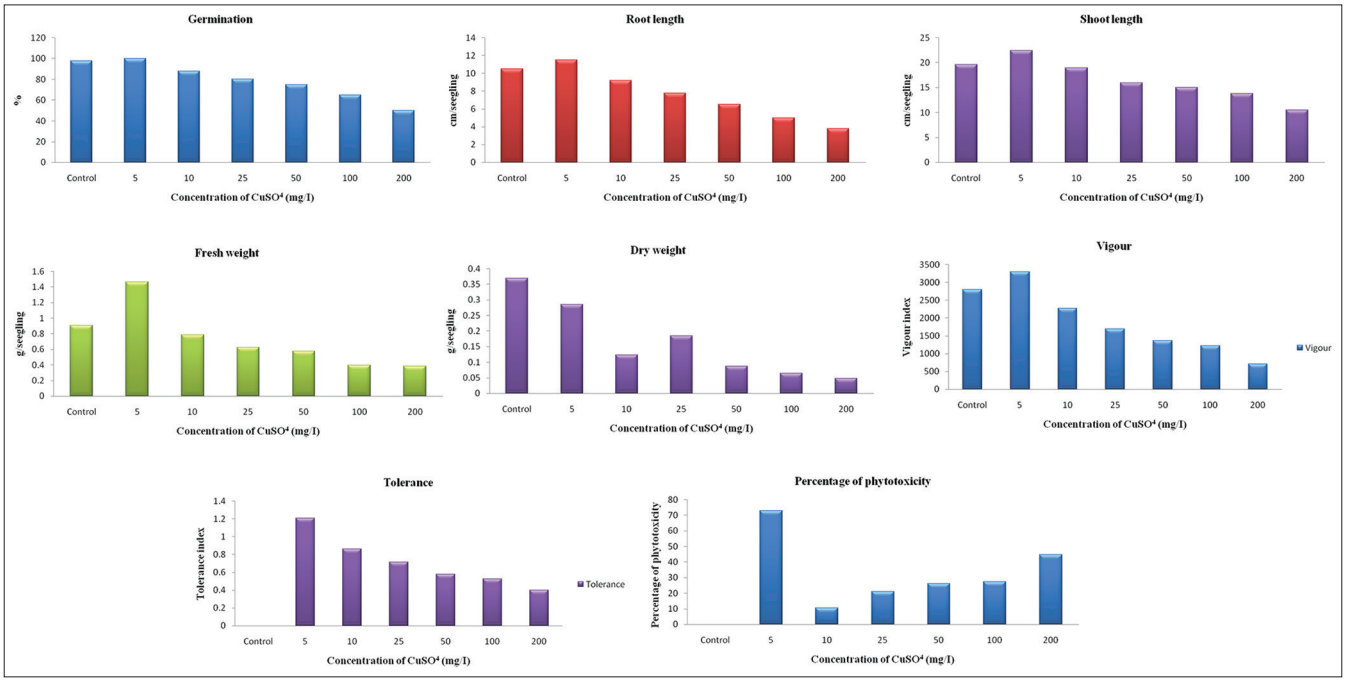

Figure 1: Effect of copper on germination studies of soybean (*Glycine max* L.)

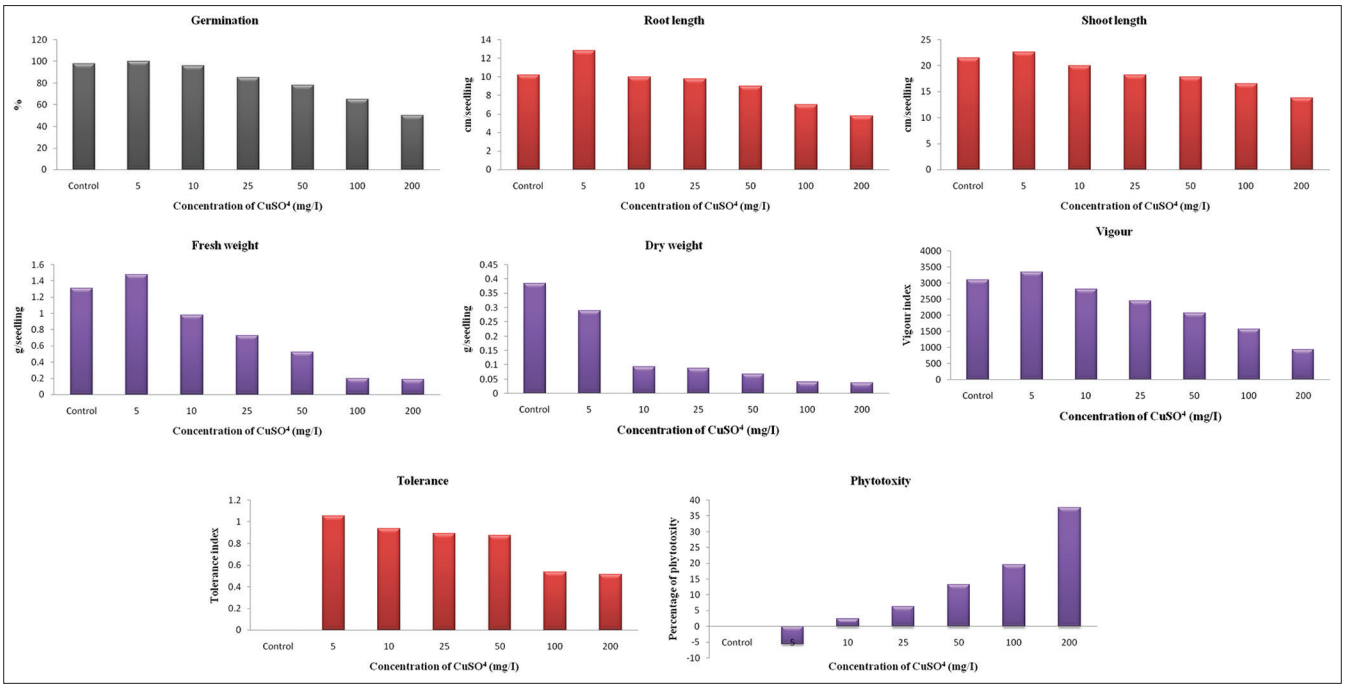

Figure 2: Effect of zinc on seed germination studies of parameters of soybean (*Glycine max*)

Copper is an essential trace element for plant growth. However, it acts as growth inhibitors when plants are cultivated in copper contaminated soil. The lower concentration of copper stimulated the elongation of root and shoot: The inhibition of germination at higher concentration is due to accumulation in seeds at the time of soaking and it may also have adverse effects on seedling growth [7]. The germination, seedling length, number of lateral roots, fresh and dry weight of *Solanum melongena* was analysed. All the parameters are found to be decreased with the increasing concentrations of copper [9]. Banu *et al.* [17] also found a significant reduction in root and shoot length in chromium treated plants possibly due storage of these metals in plant tissues and their interaction with the minerals. When heavy metal ions are present at elevated level in water and soil, they will be absorbed by plants resulting in malfunction of metabolism and thereby growth will be affected [18]. The dry phytomass yield decreased at higher level of zinc solution and that might be lead to poor growth of seedlings [19-21.

CONCLUSION

Copper and zinc are the essential micronutrients necessary for all organisms, but it becomes toxic when this metal intake is at higher level. From the present study, it is inferred to that the various concentrations of copper and zinc upto 300 mg/l have different effects on the initial growth of soybean. The morphological parameters increased at 5 mg/l concentrations and then decreased with the increase of copper and zinc concentrations. It is also concluded that proper recycling or treatments are needed to byproducts and effluents before releasing to nearby land or water bodies. By this way, we can save our environment from pollution hazards.

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