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Heavy Metal Pollutant as a Stress for Tomato Plant

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Abstract

Heavy metals known to be accumulated in plants adversely affect human health. The present study aims to control the heavy metal pollution in soil and to enhance the plant growth by compost and *Trichoderma harzianum*. Tomato plant was selected for this study. Experiment was organized in completely randomized design in different sets i.e., 1st set received only inoculum of *T. harzianum* (TH), 2nd set of treatment received 10 ppm of Mg and Zn alone, 3rd set received Zn/Mg + compost + TH and 4th set was incurred by C + TH. While, control treatment contained compost only. The experiment was conducted in growth room at 25°C with 16h photoperiod. Results revealed that metal alone (Mg and Zn) showed the drastic effect on plant growth. Both the metals significantly inhibited the growth of tomato plant. While, the polygonal interaction of compost-metal-fungi-plant showed significant increase in plant shoot, root length and biomass as compared to other treatments. The growth trend was found as: Compost + Zn/ Mg + TH > Compost + TH > Compost + Zn + Mg > Compost + Zn/ Mg. The result revealed that both the bio-control (Compost and TH) could be used to control the heavy metal pollution in soil.

INTRODUCTION

Heavy metals occur naturally as chemical elements in the earth's crust and surface soils in varying concentrations (Ward, 1995; Alloway and Ayres, 1997), but of concern is their emissions through industrial, man's agricultural and urban activities into the environment and consequently into soils that serve as ultimate sink. Furthermore, the persistent accumulation of heavy metals in soils is of great concern because they constitute health threat and toxicity problems to human life and environment (Purves, 1985; Wild, 1994). Heavy metal contamination of soils through anthropogenic sources from the vicinity of industrial sites have also been reported by various researchers (Onianwa and Fakayode, 2000; Martley *et al.*, 2004; Kachenko and Singh, 2006; Ngoc *et al.*, 2009). As one of the consequences of heavy metal pollution in soil, water and air, plants are contaminated by heavy metals. Many authors examined the inhibitory effect of heavy metal compounds on growth and the performance of photosynthetic apparatus of plants. There are two aspects on the interaction of plants with heavy metals: (i) heavy metals show negative effects on plants, and (ii) plants have their own resistance mechanisms against toxic effects and for detoxifying heavy metal pollution (Cheng, 2003).

Every metal and plant interacts in a specific way, which depends on several factors such as type of soil, growth conditions, and the presence of other ions. In the present research work, the toxic effect of heavy metals (Mg and Zn) on the growth of tomato plant were studied and the heavy metal pollution was mitigated through *Trichoderma harzianum* and compost by soil amendment.

METHODOLOGY

Trichoderma harzianum was procured by First Fungal Culture Bank of Pakistan, Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan. The fungi were sub-cultured on 2% MEA (2 g Malt extract and 2 g Agar) in Petri plates. These were identified through cultural and morphological characteristics and pure fungal cultures were stored at 4±°C for further use.

This experiment was conducted in plastic pots to evaluate the effect of heavy metal (Mg and Zn) on the growth of tomato. For that, 200 gms of sterilized sandy loam soil was filled in plastic pots. The soil was contaminated with heavy metal solution separately. The sterilized seeds of tomato were imbibed in the fungal inoculum of *T. harzianum* for overnight. The experiment was set as different treatments like: 1^{st} set of treatment received only fungal imbibed seeds. 2^{nd} set of treatment received both imbibed seeds and compost. 3^{rd} set of treatment received two doses of metal i.e., Mg and Zn separately. Fourth set of treatment received each of two doses of metal, compost and fungal inoculum. The experiment was conducted in completely randomized design (CRD) with three replicates using tomato. The seeds were sown in the pots and kept in the growth room in dark at 20±2°C for germination. After germination, the plants were kept in growth room at 25°C with 16h day length and watered regularly. The plants grown without any treatment served as control. Plants were harvested after 3weeks. Data on various morphological traits such as plant height, shoot length, root length, shoot fresh and dry weight, and root fresh and dry weight was recorded from 30 plants from each treatment and averages were calculated.

RESULTS AND DISCUSSION

The results showed that the heavy metal stress in soil significantly inhibit the plant growth. Both metallic i.e., Zn and Mg exhibited deleterious effect on shoot and root length as well as the on the plant biomass (fresh and dry weight). Whereas, the simultaneous action of both the compost and *T. harzianum* (TH) significantly inhibit the toxicity of heavy metal on plant growth and showed maximum plant growth (Table 1). The maximum plant growth trend was found as compost + Zn/ Mg + TH > compost + TH > compost + Zn + Mg > compost + Zn/ Mg.

CONCLUSION

Hence it was revealed that the use of metal based fungicides/pesticides is toxic for the plant growth, so we should use environment friendly bio-control agents like fungi and through organic amendment like compost to overcome the disease and heavy metal pollution in soil.

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Table 1: Effect of TH and compost on the growth of tomato variety Sehar grown under heavy metal stress.

Treatments	Plant fresh wt (mg)	Plant dry wt (mg)	Shoot length	Root length	% increase in biomass
Compost	229±9.1	34.4±2.3	25.1±1.1	11.5±0.1	
Compost+TH	255±8.7	38.1±1.7	27.3±1.9	13.2±0.4	10.7
Compost	226±2.5	34.3±3.3	24.2±1.3	11.5±1.2	
Compost+Zn	196±6.3	29.7±6.2	23.5±2.3	11.5±0.8	-13.6
Compost+TH	243±2.9	36.9±4.5	24.5±2.2	12.5±0.6	6.7
Compost+Zn+TH	271±3.6	41.1±1.5	26.5±0.4	13.2±0.9	19.8
Compost	226±4.4	34.33±2.3	25.5±1.1	11±0.5	
Compost+Mg	198±3.5	30.09±4.4	26.5±1.4	13±0.3	-12.3
Compost+TH	245±4.6	37.24±2.3	26.5±2.2	13.5±0.4	8.4
Compost+Mg+TH	261.5±2.7	39.62±2.3	26.5±1.2	14±0.2	15.42
Compost	225±5.5	34.2±1.3	24.5±2.2	11.5±0.1	
Compost+Zn	196±3.2	29.7±2.4	23.5±2.5	11.5±0.5	-13.6
Compost+Mg	199±6.7	31.04±4.3	26.5±1.2	13±0.3	-9.2
Compost+Zn+Mg	237±2.4	36.02±2.4	25.5±2.4	12.5±0.2	5.32

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