PHYTOTOXIC EFFECT OF HEAVY METAL IONS ON THE ROOT NODULE FORMATION AND PLANT GROWTH OF *Vigna unguiculata*

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Abstract: Effect of five heavy metal ions; cadmium, cobalt, lead, manganese and copper were investigated on leguminous plant species cowpea (*Vigna unguiculata*). The plant growth characters are seriously affected by a concentration of 0.3, 0.6 and 0.9 ppm of Cd(II), Pb(II), Co (II) and Cu(II); but the concentration of manganese favor the plant growth characters. The root and shoot growth of the cowpea plant is decreased by various concentration of heavy metal ions. The plant could not germinate in the soil containing 0.9 ppm concentration of Cd(II) and Pb(II). The formation of root nodules was also severely affected by the presence of heavy metal ions in the soil. The different heavy metals used in this study were found to vary in their phytotoxic effects with Cd being the most toxic and Mn the least toxic. Soils contaminated by heavy metals probably lead to substantial lose in dry matter and seed yield of cowpea plant.

KeyWords: *Vigna unguiculata;* Cowpea plants; Heavy metal ions; Root growth; Shoot growth; Root nodule formation.

Introduction

Contamination of agricultural soil by heavy metal ions has become a critical environmental concern due to their potential adverse ecological effects[1,2]. Such toxic elements are considered as soil pollutants due to their widespread occurrence, and their acute and chronic toxic effect on plants grown of such soils[3].

Heavy metals with adverse health effects in human metabolism (including lead, cadmium, and mercury) present obvious concerns due to their persistence in the environment and documented potential for serious health consequences[4]. Acute heavy metal intoxications

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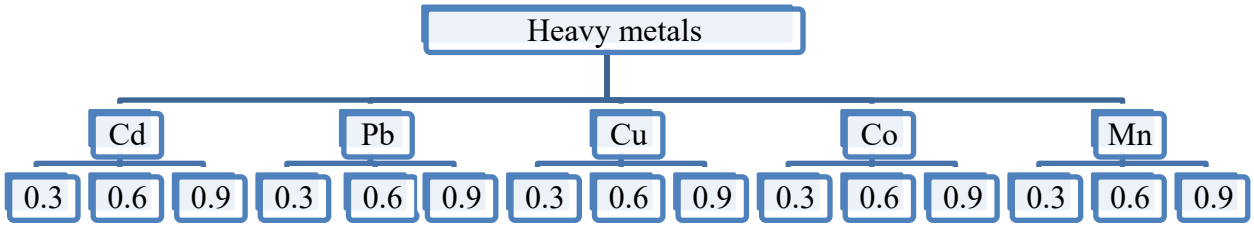
may damage central nervous function, the cardiovascular and gastrointestinal (GI) systems, lungs, kidneys, liver, endocrine glands, and bones. Chronic heavy metal exposure has been implicated in several degenerative diseases of these systems and may increase the risk of some cancers[5].

Once the soil is destructed by heavy metals, metals found naturally within the soil or accumulated as a result of anthropogenic activities, it becomes uninhabitable for microbial communities or unsuitable for crop production[6]. On the other hand, *Rhizobia* among soil bacteria has been the organism of great interest for agronomist in general and legume growers in particular primarily due to their ability to provide nitrogen to plants. Considering the benefits of *Rhizobia* in nitrogen economy and the role of legumes in animal and human health, attention in recent times has been paid onto understanding how metals could affect the very survival of *Rhizobia* either present as free-living organism or when they are in intimate relationship with legumes. Heavy metals are inhibitory to *rhizosphere*, microorganisms, and processes mediated by them, like nitrogen-fixing ability of *Rhizobia* are lost when they are in symbiotic association with the legume host growing in metal-enriched[7].

Present investigation aims to analyze the effect of cadmium, cobalt, lead, manganese and copper on plant growth characters (root length and shoot length), crop productivity (fresh weight and dry weight) and nodulation parameters (total numbers of root nodules per plant cambered to control) of legume plant cowpea (*Vigna unguiculata*).

Materials and Methods

The soil in which the experiments have been conducted was a sandy clay loam and had received no exogenous input of metals. The soil was sieved and homogenized and the test heavy metals were added as the solutions. Effect of five heavy metal ions; cadmium, cobalt, lead, manganese and copper were investigated on leguminous plants species cowpea (*Vigna unguiculata*). Effects of these metals were studied on 0.3, 0.6, and 0.9 ppm concentrations. For the test of host plant productivity, after 45 days the plants were uprooted and the number of nodules per plant, root length, shoot length, fresh and dry weight were recorded in different concentration of heavy metal treatment.



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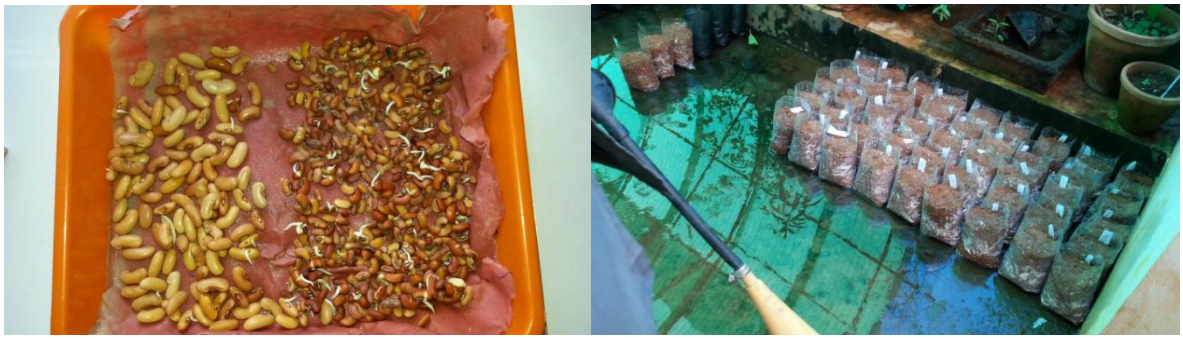

Seed germination and preparation for sowing of seeds

Results and Discussion

Effect of heavy metals on root growth

The data corresponding to the root growth of the cowpea (*Vigna unguiculata)* and the dose of the heavy metal are reported in Table.1. In all doses (0.3, 0.6 and 0.9 ppm) Cd, Pb, Cu and Co decreased the root growth except for Mn as compared to the root growth of the control. The maximum effect is reported on cadmium. At 0.9 ppm concentrations no germination was reported in Cd. At 0.9 ppm concentrations of Pb, Cu and Co the length of root were 0, 18.5 and 16.4 cm respectively.

Effect of heavy metals on shoot growth

The effect of heavy metals on shoot growth of the cowpea (*Vigna unguiculata)* and the dose of the heavy metal ions are reported in Table.1. In all doses (0.3, 0.6 and 0.9 ppm) Cd, Pb, Cu and Co decreased the shoot growth except Mn as compared to the shoot growth of the control. In manganese maximum shoot growth was reported (116.5 cm). At 0.9 ppm concentrations no germination was reported in Cd. At 0.9 concentration of Pb, Cu and Co the length of root were 0, 12.5 and 9 cm respectively.

Effect of heavy metals on formation and development of root nodules

The result showed that the presence of heavy metal ions severely affect the root nodule formation of leguminous plants leading to the decrease in their nitrogen fixing capacity (Table 1). In the various doses of heavy metal ions (0.3, 0.6 and 0.9 ppm), Cd, Pb, Cu and Co show decreased number of root nodules as compared to control plants except manganese. At 0.9 and 0.6 ppm concentrations of Cd, no nodules were formed (Table 1). These results indicate that the presence heavy metal ions in large concentration severely affect the root nodules and nitrogen fixing capacity of leguminous plants.

Table 1. ***Effect of Different Heavy Metal ionss on Plant Growth Characters and Root Nodule Formation***

Heavy metal	*Concentration (ppm)*	*Shoot Length (cm)*	*Root Length (cm)*	*Total (cm)*	*Root Nodules (No. per plant)*	*Fresh Weight (g)*	*Dry Weight (g)*
Cd(II)	0.3	32.6	19.2	51.9	13.3	3.8	0.8

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	0.6	0	0	0	0	0	0
	0.9	0	0	0	0	0	0
Pb(II)	0.3	39.5	22.6	62.2	14.3	4.6	1.5
	0.6	32.1	18.7	51.0	14	3.7	0.9
	0.9	0	0	0	0	0	0
Cu(II)	0.3	84.5	30.5	115.1	27	6.3	1.5
	0.6	78.7	26.3	105.1	36	5.6	1.4
	0.9	12.5	18.5	31	13	2.9	0.3
Co(II)	0.3	65.2	27.5	92.8	20	5.4	1.5
	0.6	45.4	23.0	68.4	26	4.0	0.8
	0.9	9.0	16.4	22.4	0	0.9	0.5
Mn(II)	0.3	100.3	37.1	137.4	35	8.1	1.4
	0.6	108.1	52.2	160.3	40.3	9.03	1.7
	0.9	116.5	57.6	174.1	51.6	10.3	1.7
Control		123.0	34.3	157.4	38.9	9.5	2.5

Each value is an average of five replicates

Effect of heavy metals on productivity of plants

The data corresponding to fresh and dry weight of the cowpea (*Vigna unguiculata)* and the dose of the heavy metal ions (Table 1) show that in all doses (0.3, 0.6 and 0.9 ppm) Cd, Pb, Cu and Co decreased the fresh and dry weight except for Mn as compared the control. The maximum effect is reported with cadmium and all other heavy metal ions also affect the productivity of plants.

Effect of Cd on plant growth & root nodule formation

0.3 0.6 0.9 Control

Effect of Cobalt on plant growth & root nodule formation

0.3 0.6 0.9 Control

Effect of Cu on plant growth & root nodule formation

Effect of Pb on plant growth & root nodule formation

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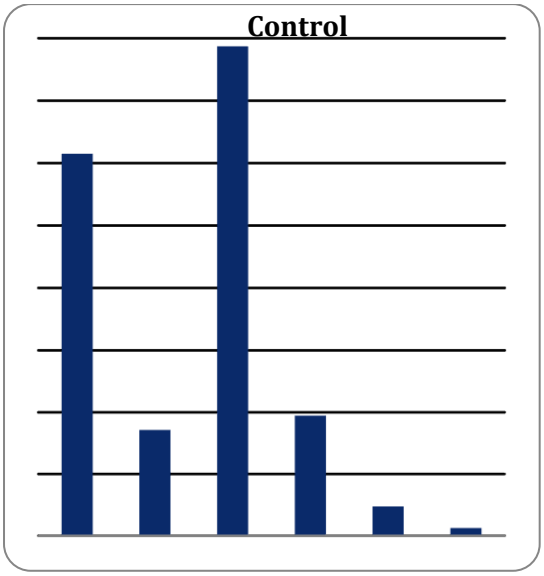
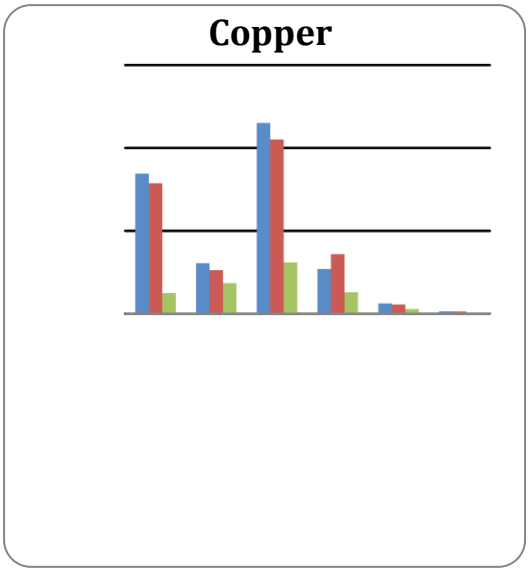
0.3	0.6	0.9	Control	0.3	0.6	0.9	Control

Effect of manganese on plant growth & root nodule formation

0.3	0.6	0.9	Control





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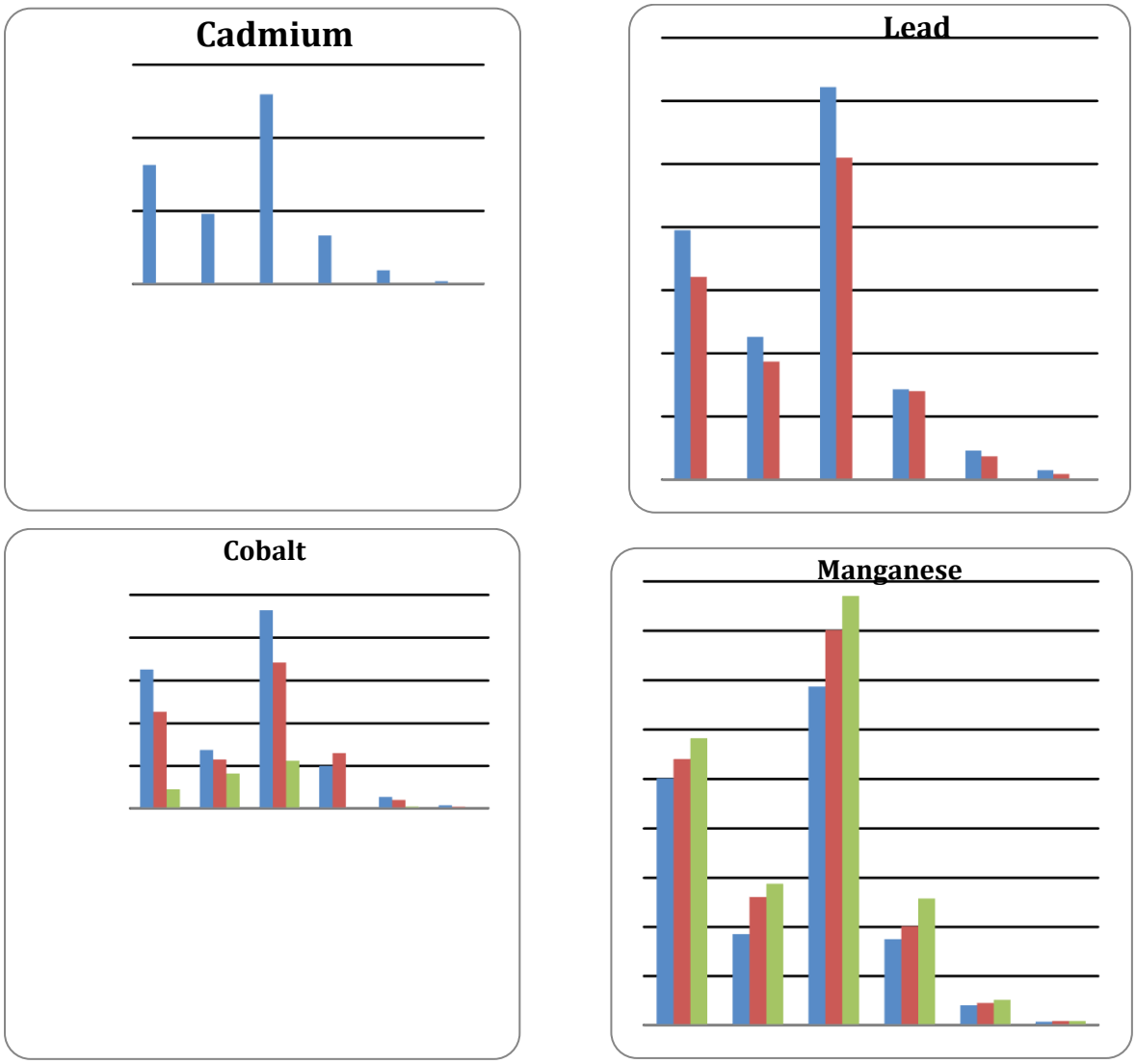

Fig. 1. *Phytotoxic effect of heavy metal ions on the root nodule formation and plant growth*

Conclusion

The plant growth characters of cowpea (*Vigna unguiculata)* are seriously decreased by a concentration of 0.3, 0.6 and 0.9 ppm of Cd, Pb, Co and Cu but the same concentration of manganese favors the plant growth characters. The root and shoot growth of the cowpea plant is decreased by various concentration of heavy metal ions. The plants did not show any capabilities to germinate in the soil containing 0.9 ppm concentration of Cd and Pb ions. The formation of root nodules was also severely affected by the presence of heavy metals in the soil. The ions also affect the nitrogen fixing capacity of leguminous plants like cowpea. It is indicated that at the time of sowing of seed, the soil testing shall be done and the quality of soil must be identified to help for better crop production.

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BACTERICIDAL EFFECTS OF TRANSITION METAL OXIDE NANOPARTICLES: A COMPARATIVE STUDY

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Abstract: Increase in drug resistance among pathogenic bacteria has made the search for new antimicrobials inevitable. The unique physiochemical properties of the nanoparticles combined with the growth inhibitory capacity against microbes has led to the increase in the research on

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