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Effect of Chromium Metal on the Uptakes of Mineral Atoms in Seedlings of Bean Plant *Vigna radiata* (L.) Wilckzek

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Abstract: The present investigation has been made to study the effect of chromium metal on the uptake of mineral ions concentration in root and shoots of bean plants. It was found that chromium decreases the uptake of metal ions and causes the accumulation of potassium, sodium, calcium, manganese, iron, magnesium and phosphate in the root as the concentration of chromium get enhanced. But declines in shoots. The reduction in the growth of the plant were observed and root length gets more affected than the shoot.

Key words: Chromium, mineral, root, shoot, growth

INTRODUCTION

Heavy metals are widespread pollutants of great environmental concern as they are non-degradable and thus persistent. Heavy metals are of especial interest in respect to their toxic effect to plants, animals and ultimately to human health. The pollution of aquatic resources, soil and agricultural activities mainly due to the manufacturing mining, waste disposal and use of sewage sludge as a fertilizer. Haneklaus *et al.*[1,2] studied the possibility of some heavy metals accumulation (Pb, Cd, Cr, Fe, Mn, Cu, Zn and Ni), as well as effects on crops biomass of an application sewage sludges. Okamato and Tomatau[3] suggested that and excessive amount of calcium over the cation exchange capacity of a soil might be factor suppressing the sorption of heavy metals to soil. Heavy metals are known to cause several toxic effects on plants such as inhibition of seed germination, reduction in plant growth, yield, altering the metabolic pathways including respiration and photosynthesis by disrupting the cellular enzymes. Trueby and Angelika[4] investigated that heavy metal contents are heavily dependent upon plant growth properties and species; Soil metal contents are only of limited value in predicting plant uptake. Osawa *et al.*[5] studied the Zn concentration in leaves was closely related to growth reduction due to Zn toxicities. They also studied the effect of potassium and Calcium concentration in the nutrient solution on Zinc toxicities in vegetable crops[6-8].

Chromium is toxic metal for plant, commonly used in chrome plating, Steel and alloy manufacturing, leather tanning, film and photography equipments and metal cleaning. It reduced the germination and growth of the plants.

Present study was carried out to relate the effect of chromium on uptake of essential mineral in root and shoot of bean plant.

MATERIALS AND METHODS

Pot experiments were conducted in growth chamber (30°C day and 25°C night) for one week in February 2004. Eight concentrations of chromium solutions viz., O, 5, 10, 50, 100, 150, 200 and 250 ppm were prepared in half strength Hoagland solution. Ten to fifteen seeds of bean, soaked in water for 4 h, were surface sterilized with 0.3% calcium hypochlorite for five minutes and rinsed with distilled water. They were introduced into different pots containing 0, 5, 10, 50, 100, 150, 200 and 250 ppm of chromium based Hoagland solutions. Plants were analyzed after one week. Sodium, potassium, manganese, magnesium, calcium and iron were estimated through dry ash method by flame photometer and atomic absorption. For phosphate content the extracts, prepared by dry ashing method, were shaken with ammonium molybdate and stannous chloride. A blue colored complex with phosphate was obtained. Absorbance was measured at 660 nm by spectrophotometer[9].

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RESULTS AND DISCUSSION

Heavy metal pollution in the aquatic systems has become a serious threat today. The chemical processes that exits are not economical for treating a large volume of water bodies of dilute metal concentration. Aquatic resources are polluted by the industrial sewage sludge, which contain high percentages of toxic metals. The polluted water used for irrigation purpose and producing the bad effect on the crops[10].

Chromium seems to be toxic to the seedling of moung bean plant. It changes the morphology of plant and plant appears more green as compare to control one. It decreases the root length with the increase in the concentration of Cr, where as the shoot length is less affected (Table 1). This growth inhibitory effect may be attributed to the ionic toxicity[11] or due to the osmotic effect[12]. Present investigation shows that potassium ion concentration in the plant were decreases with the increase in concentration of Cr in the shoot of plant but increases in the roots (Table 2). Potassium is very essential for the plant as it involved in the opening of stomata, ionic balance and certain metabolic processes.

These metabolic changes and low energy for the active transport may be the case for accumulation of potassium ion in the roots of the seedling[6]. Similar results are obtained for the other metals ions like sodium, calcium, magnesium and iron (Table 2). Low concentration of manganese in the seedling may be responsible for the retardation of process of photosynthesis which may results in the decrease in the chlorophyll contents.

Table 1: Effect of chromium metal on the morphology of bean plant

Concentration of chromium (ppm)	Root length (cm)	Shoot length (cm)
0	7.70±1.1	27.5±2.1
5	6.50±1.3	26.8±2.3
10	4.50±0.9	21.5±1.4
50	3.90±0.7	19.1±1.3
100	3.36±1.1	17.4±2.1
150	3.20±0.9	16.2±2.2
200	2.90±0.8	15.8±2.1
250	2.65±0.7	14.7±1.3

This inhibitory effect may also be attributed to the decrease in levels of auxine resulting from its enhanced destruction by metal ions[7]. Phosphate is involved in the many metabolic process like NAD and NADP, synthesis of nucleo protein and photosynthesis[8]. The decrease concentration of phosphate ion may also cause the drop in the growth and uptakes of metal ion in the shoot.

At 5-10 ppm, From Table 2 and 3 Cr was found to be tolerable to the seedling and there were slights changes in the metal ion concentration in the plant. Mechanism of tolerance has been studied in several species, yet no clear mechanism has been established so far[11,12] although some mechanisms have been put forward. The most widely acceptable mechanism is according to[6] (1) biochemical detoxification (2) Compartmentalization of the metal with in the cell. (3) limited uptake of ions; Less heavy metal are taken up by tolerant than non tolerant plants, (4) restricted transport from the roots to the shoots, (5) formation of metal binding polypeptides, (6) chelating by organic acid and (7) the plasma lemma have a role in the heavy metal tolerance.

Table 2: Effect of chromium metal on mineral ion concentration in shoot bean plant

Concentration of chromium (ppm)	% age of potassium	% age of sodium	% age of iron	% age of magnesium	% age of manganese	% age calcium
0	2.9±0.9	3.06±1.0	0.52±0.008	0.230±0.100	0.29±0.06	0.32±0.07
5	2.6±0.9	2.90±0.4	0.45±0.070	0.199±0.080	0.24±0.04	0.28±0.04
10	2.2±0.7	2.70±0.8	0.34±0.060	0.140±0.040	0.21±0.05	0.26±0.05
50	1.9±0.8	2.45±0.9	0.21±0.040	0.130±0.005	0.19±0.04	0.24±0.06
100	1.7±0.8	2.01±0.8	0.18±0.030	0.120±0.003	0.17±0.04	0.27±0.04
150	1.7±0.7	1.90±0.6	0.11±0.020	0.100±0.002	0.16±0.02	0.21±0.04
200	1.5±0.6	1.90±0.5	0.09±0.010	0.090±0.002	0.13±0.03	0.18±0.03
250	1.4±0.4	1.72±0.4	0.084±0.01	0.080±0.004	0.12±0.04	0.17±0.04

Table 3: Effect of chromium metal on mineral ion concentration in root of bean plant

Concentration of chromium (ppm)	% age of potassium	% age of sodium	% age of iron	% age of magnesium	% age of manganese	% age calcium
0	2.9±0.9	3.06±1.0	0.52±0.008	0.230±0.100	0.29±0.06	0.32±0.07
5	2.6±0.9	2.90±0.4	0.45±0.070	0.199±0.080	0.24±0.04	0.28±0.04
10	2.2±0.7	2.70±0.8	0.34±0.060	0.140±0.040	0.21±0.05	0.26±0.05
50	1.9±0.8	2.45±0.9	0.21±0.040	0.130±0.005	0.19±0.04	0.24±0.06
100	1.7±0.8	2.01±0.8	0.18±0.030	0.120±0.003	0.17±0.04	0.27±0.04
150	1.7±0.7	1.90±0.6	0.11±0.020	0.100±0.002	0.16±0.02	0.21±0.04
200	1.5±0.6	1.90±0.5	0.09±0.010	0.090±0.002	0.13±0.03	0.18±0.03
250	1.4±0.4	1.72±0.4	0.084±0.01	0.080±0.004	0.12±0.04	0.17±0.04

Table 4: Effect of chromium metal on phosphate ion concentration in root and shoot of bean plant

Concentration of chromium (ppm)	% age of phosphate in shoot	% age of phosphate in root
0	4.870±1.10	4.23±0.78
5	4.430±0.90	4.25±1.02
10	3.870±0.78	4.56±1.10
50	3.050±0.89	5.02±0.98
100	2.450±0.78	5.55±1.04
150	1.187±0.45	5.94±0.98
200	1.150±0.62	6.20±1.10
250	0.463±0.70	6.85±1.13

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