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DIVERSE EFFECT OF CADMIUM AND LEAD ON GROWTH AND YIELD OF CARROT (DAUCUS CAROTA)

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ABSTRACT

The aim of the present study was to investigate the uptake of cadmium and lead by carrot from the soil contaminated with lead and cadmium. Cadmium and lead were artificially added to the soil tank and seeded with carrot seed. After growth and cultivation the samples were randomly selected from the different tanks and subjected to root and leaf analysis through atomic absorption spectrometry (AAS) for Cd and Pb. Along with plant parts, soil was also analyzed for the same. The result showed that the levels ranged from 0.011 to 0.0315 for lead in soil followed by root 0.006 to 0.183 and leaves 0.002 to 0.036. Cadmium concentration ranged from 0.008 to 0.059 in soil and 0.004 to 0.022 was accumulated by root followed by leaf 0.001 to 0.016. Plant samples had concentration of Cd and Pb exceeded the FAO-WHO limits. The maximum concentration of lead and cadmium were found in T_3>T_2> T_1 >T_0. It was found that all the parameters like plant height, number of leaves, number of branches, fresh weight and dry weight (yield) of the carrot decreases with increases in both lead and cadmium concentrations in comparison to control T_o. In the present study it was found that carrot uptakes both the heavy metals (Cd and Pb) which has an inhibitory effect on a carrot.

KEY WORDS: Lead and Cadmium, carrot, soil, growth and yield, AAS, Plant sample.

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INTRODUCTION

Carrot (*Daucus carrota*) is a root vegetable usually orange in colour. The most commonly eaten carrot is a Taproot. Carrot consists of carrotenoids, polyacetylenes and polysaccharides[1]. Also the root of carrot contains cis-heptadeca-1, 9-c; ine-4, 6-diyne 3, 0-diol, an antifungal polyacetylene[2]. Heavy metals are spread in the environment by various industrial and agricultural activities and are generally polytoxic even at very low concentration. Increased availability of heavy metals to plants roots is one of the factors that may be involved in the reduction of production of the crops. Heavy metals not only inhibit root growth, but also hamper many physiological processes, particularly uptake of the nutrients. Heavy metal may reduce the available pool of mineral nutrients in the soil[3]. Vegetables are part of the daily diet in many households forming an important source of vitamins and minerals required for human health. They also act as neutralising agents for acidic substances formed during digestion[4]. As human activities increase, especially with the application of modern technologies, pollution and contamination of the human food chain have become inevitable. Heavy metal uptake by plants grown in polluted soils has been studied to a considerable extent[5-8]. Heavy metals (HMs) such as cadmium and lead present a risk to human health because they are non degradable pollutants, having a large spectrum of effects (e.g., nervous or digestive system disturbances and carcinogenic effects), especially for young children who are more sensitive than adults[9]. Excessive exposure to HMs has been shown to cause various diseases[10]. For most people, the main route of exposure to toxic elements is through dietary intake[11-12].Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements[13]. Metallic accumulation in vegetables may pose a direct threat to human health[14.] It is believed that vegetables can become contaminated with HMs if they grow on soils contaminated by mining, vehicle exhaust, industrial activities and other agriculture activities[15]. The levels of HMs in vegetables and soils and their risk to people are of great public concern[16-17]. Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments[18]. Generally, Cd accumulation in various plant parts in vegetable crops was increased with the increasing cadmium concentrations in the growth medium. Heavy metals in soluble form have high relation to their uptake by plants[19]. Vegetable crops can absorb metals from the soil as well as from deposits on parts of the vegetables exposed to the air from polluted environments[20-21]. The present study aimed at establishing the levels of contamination of lead and cadmium in soil and different parts of the plant.

MATERIALS AND METHODS

MATERIALS

Cadmium chloride, Lead nitrate, nitric acid, Perchloric acid, Double distilled water, AAS.Plant sample, soil sample.

METHODS

The work has been done in the department of Biological Sciences at SHIATS, Deemed to be university, Allahabad. The arrangement of the field was taken in the form of squares approximately 14 by 9 sq.ft and was divided into twenty four small squares four for Cd and four for Pb. Each square was 1.5 lengths, 1.5 width, 1.5 depth arranged in the form of pots. The space between each pot was 1 sq. ft. Each pot was covered with polythene on both sides and bottom. The treatments were given before sowing of seeds. The control was taken individually for both the treatments. Treatments for cadmium (Cd) in the form of cadmium chloride ($CdCl_2$) and lead in the form of lead nitrate $(PbNo_3)_2$.The reading was taken after 30, 60, 90 and 120 Days after period (DAP). The main parameters which were read out are plant height, number of branches, number of leaves, fresh weight and dry weight.

Plant samples and analysis

Plant samples were collected after 120 days for analysis. The samples were dried, first at room temperature for several days and then in hot air oven (60 + 5°C) for 24 or up to 48 hrs. The samples were then crushed and powdered separately in a mortar and pestle. Powdered plant samples were then put separately in well washed, dried and suitably labeled flasks and these samples were then ready for digestion. Digestion mixture of biological sample was a di-acid mixture. Mixture comprised concentrated HNO_3 and $HClO_4$. To one gram of plant material, 5 ml of concentrated HNO_3 was added and kept till night. The next day, 15 ml of di-acid mixture (conc. HNO_3 +$HCLO_4$ in the ratio 3:1) was added and digested on a hot plate till white reddish brown fumes of perchloric acid came out. The samples were slowly dissolved and digested in di-acid mixture. After a few hours, plant sample dissolved completely in the digestion mixture and solution was then evaporated until only about 5 ml was left in the flask. Double distilled water was added to make it 50 ml solution. Digested samples were then transferred into 50 ml tubes for analysis using Atomic Absorption spectrophotometer[22].

Soil samples and analysis

Soil samples were dried at 40°C for 48 h in hot air oven and crushed to pass through a 2 mm nylon sieve. A di-acid mixture was used to find out the heavy metals Cd and Pb in the soil. A known amount (1 g) oven dry soil was weighed and transferred into 100-ml beaker to which concentrated HNO_3 and perchloric acid was added. (5:1). Mixture was placed on a hot plate at 105-110°C for one hour and then the temperature was increased up to 140°C until the sample was completely dry. After cooling, the solution was mixed and filtered through Whatman filter paper No. 42 into a 50-ml volumetric flask. Digested samples were then analyzed for Cd and Pb, by AAS (Atomic Absorption spectrophotometer).

RESULTS AND DISCUSSION

Cadmium: In all the concerned readings, the parameters like plant height, number of branches, number of leaves, fresh weight, dry weight, decreased with increasing the amount Cd concentration. The maximum plant height was found in T_0 as 10.29, 24.33, 40.47 and 57.27 under 30DAP, 60DAP, 90DAP and 120DAP respectively, and the minimum plant height was found in T_3 as 5.13, 14.77, 21.27 and 32.57 after 30DAP, 60DAP, 90DAP and 120DAP. Similarly, maximum number of branches per plant was found in T_0 5.97, 7.15, 7.59 and 8.43 after 30DAP, 60DAP, 90DAP and 120DAP respectively. The other parameters like no. of leaves, fresh weight and dry weight were also found maximum in T_o and minimum m in T_3 treatments as shown in Table 1. The presence of cadmium in the soil decreases the growth of chickpea plants [23]. Higher concentration of Cd significantly reduced number of leaves.This may be attributed to be due to the senescence and death of older leaves and appearance of injury symptoms on the younger leaves at high Cd stress, thereby reducing the number of leaves and leaf area per pot[24]

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Table 1
Effect of cadmium on different parameters of plant (Daucus carota).

Plant Parameters	Treatments	30DAP	60DAP	90DAP	120DAP
Plant height (cm)	T_0	10.29	24.33	40.47	57.27
	T_1	7.33	20.73	35.27	45.43
	T_2	6.2	19.23	28.83	37.2
	T_3	5.13	14.77	21.27	32.57
No. of branches per plant	T_O	5.97	7.15	7.59	8.43
	T_1	5.39	5.65	6.5	7.24
	T_2	5.07	5.22	6.15	6.29
	T_3	4.1	4.51	4.69	5.76
No. of leaves per plant	T_O	11.28	15.03	17.3	21.97
	T_1	10.17	13.17	17.17	21.12
	T_2	9.17	11.17	16.08	20.58
	T_3	8.26	10.5	14.4	16.07
Fresh weight (gm) edible part	T_O	10.03	25.43	46.31	82.28
	T_1	9.33	24.12	44.1	77.49
	T_2	7.49	22.53	40.47	77.1
	T_3	6.51	19.95	37.07	51.26
Dry weight (gm) edible part	T_O	6.06	16.27	29.16	47.32
	T_1	5.34	14.47	25.95	40.88
	T_2	3.82	11.25	21.45	36.3
	T_3	3.22	10.76	19.33	23.29

Lead: Table 2 represents that the parameters discussed in the table showed the maximum and minimum height, no. of branches, no. of Leaves, fresh weight and dry weightinT_o anT_3 respectively. The results showed that the concentration of lead decreases in the said paramete

Table 2
Effect of lead on different plant parameters (Daucuscarota).

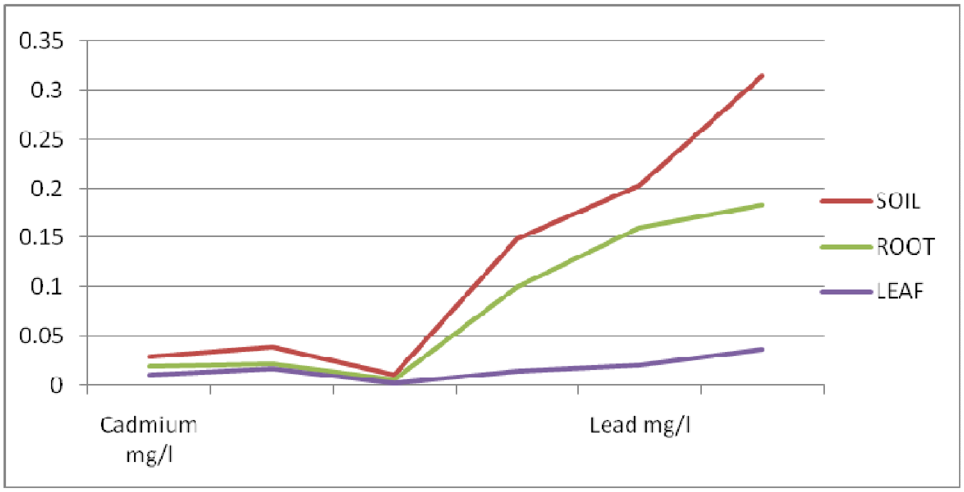
Plant Parameters	Treatments	30DAP	60DAP	90DAP	120DAP
Plant height (cm)	T_0	11.17	24.7	43.07	53.37
	T_1	9.13	22.27	34.2	42.73
	T_2	8.47	18.8	27.13	32.37
	T_3	7.63	13.8	23.6	26.9
No. of branches per plant	T_O	6.52	7.05	8.08	10.05
	T_1	6.42	5.75	6.25	7.43
	T_2	3.17	4.52	4.77	5.27
	T_3	1.88	2.13	2.57	3.42
No. of leaves per plant	T_O	10.14	29.07	18.47	22.2
	T_1	9.82	10.97	8.37	14.17
	T_2	8.8	9.17	10.6	10.97
	T_3	7.43	7.88	8.35	9.52
Fresh weight (gm) edible part	T_O	9.46	42.18	50.17	75.85
	T_1	9	20.94	34.62	46.34
	T_2	7.53	17.19	27.35	36.85
	T_3	6.1	14.22	22.31	24.92
Dry weight (gm) edible part	T_O	5.22	18.45	33.92	44.12
	T_1	4.4	11.35	20.87	30.92
	T_2	3.69	9.54	18.2	24.17
	T_3	2.73	8.49	13.82	18.54

Uptake of cadmium and lead by root and leaf through soil

Different doses of cadmium and lead were applied to soil to determine the uptake by plant parts (root and leaf). Maximum doses of cadmium and lead were applied in T_3 treatment followed by T_2 and T_1. Under AAS it was found that the maximum concentration of cadmium and lead was found maximum in soil followed by root and leaf (soil>root>leaf) as shown in Graph 1. The results showed that the maximum doses present in T_3 treatment decrease the plant parameters.Plants with edible leafy vegetables (e.g. collard greens, swiss chard), herbs (e.g.

cilantro, mint) and edible roots (e.g. carrot, radish, onion) was founded similar levels of lead in leafy vegetables[25]

Graph 1
Uptake of cadmium and lead by root and leaf through soil under different concentrations.



CONCLUSION

The present study conducted that the accumulated cadmium will show the obvious effect to retard the plant growth. The present research also revealed that the cadmium and lead decreased all the plant parameters of carrot. T_3 treatment showed more effect on plant parameters as compared to others. The concentrations of heavy metals (cd and pb) were found higher in soil followed by root and leaf.

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