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THE EFFECT OF METAL IONS CD (II), AND CR (VI) ON THE RATE OF GERMINATION OF SEEDS AND THE GROWTH PROCESS OF LEPIDIUM SATIVUM SPECIES

BY

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Abstract. This paper represents an analysis of the results obtained at various researches on heavy metals in the soil and their influence on plant growth. To highlight the effect of heavy metals, on research we have taken *Lepidium sativum* species which is an annual plant, it is easy to grow and has a pleasant taste. It is characterized by high strains (about 20 cm) and thin, oval shaped leaves). Some of the most dangerous pollutants, according to the World Health Organization are heavy metals. Evacuating heavy metal particles resulted from technological processes, causes pollution to the environment of different intensities, depending on the distance from the emission source, the direction of the prevailing winds or the topography of the land. The behavior of potentially toxic metals in biogeochemical cycles of terrestrial ecosystems are producing long-term implications mainly affecting the productivity of agricultural and forestry soils, nutrition cycles of plants and animals and soil dynamics.

After depositing heavy metal particles on the ground it occurs a sharp increase in the concentration of heavy metals, toxic levels, with negative effects on plant development, growth and animal health.

Keywords: heavy metals; lead; cadmium; phytotoxicity; *Lepidium sativum.*

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1. Introduction

"Heavy metals" category includes several elements: Cd, Cu, Cr, Co, Fe, Hg, Mn, Mo, Ni, Pb, Zn wich are defined by the mechanical properties (conductivity, ductility, stability in the form of cations), atomic number greater than 20 and greater density of 5.6 kg/dm^3, (Buzgău (Pereş), 2013). Lead, Zn and Cd in soil becomes a threat when present in high enough concentration to adversely affect the human health and the environment. In some cases, soils are so contaminated that it can maintain a functioning ecosystem. Cadmium in soil is a risk both for human receptors, and to the environmental problems because of its relatively high toxicity and assimilation in plants.

Cadmium (Cd) is a metal with high toxicity to organisms.

It is present in the soil particularly in the form of cadmium carbonate ($CdCO_3$) compound that exerts a major control of the solubility of cadmium in soil with high pH, and gleyed soil (under reducing conditions) is present predominantly in the form of cadmium sulphide. However draining these soils and returning them to oxidizing conditions lowers the pH which aims at increasing the mobility of cadmium.

Soil pollution with Cd occurs in particular by heavy rain, sewage sludge storage and use of phosphate fertilizers in farming. In acid soils, cadmium is more mobile and less likely to be strongly adsorbed by particles of minerals, clay and sand.

The absorption depends on the concentration of cadmium, pH, soil type, contact time and concentration of complex ligands. The average cadmium concentration is of 0.11 ppm in the soil and in the unloaded soil is of 0.1,..., 1 ppm.

Chromium (Cr) is a hard metal, white silver colour, resistant to corrosion, is easy to process in its native form. Chromium is a widespreaded

metal in the earth's crust, but only in the form of chemical combination, chromium ($FeCr_2)O_4$) with a chromium content of 0.033%.

2. Materials and Methods (TD_Pavel VL. 2012)

To test the phytotoxic effects of the metals Cr(VI) and Cd(II) stock solutions were prepared for each compound with a concentration of 1,000 mg/L in distilled water. The diluted working solutions were made with the following concentrations: 30, 60, 90, 120, 150 and 300 mg/L.

Heavy metal solutions were used in the phytotoxicity tests, taking 3 ml of each metal ion, which were soaked in Whatman filter paper arranged in Petri dishes. This way it can simulate the interaction between the liquid phase (solution) soil in which they are studied various concentrations of heavy metals, according to existing environmental factors.

As test species it was used Lepidium sativum (Hren) by making seed germination tests (Delgado *et al*., 2010) for three days of exposure. Lepidium sativum is a sensitive test species, widely used in toxicity tests due to its fast development and is very cheap (Montvydiene & Marciulioniene, 2004).

2.1. Germination Test

These tests consist in determining the inhibitory effect of liquid samples "contaminated" with the metal on the germination and growth potential of the species Lepidium sativum (Hren). Each sample was counted for every 20 Lepidium sativum seeds that they were distributed on filter paper in Petri dishes. Then solutions were added at the concentrations mentioned above. Also, three replicates were carried out for the blank test where the filter paper was wetted with distilled water.

The Petri dishes were covered with a lid and left at room temperature for three days, under conditions of alternating light/dark (14 h/10 h) to start the sprouting process.

At the end of three days of exposure of Lepidium sativum seed the caps have been removed and the first observation was made on the general plant and certain symptoms of withering, drying root or leaf discoloration.

Subsequently, the plantlets were removed from the Petri dishes they were deposited on a clean surface and measurements were made. The measurements for determining the length of the development is root, stem length, the mass of the wet material and dry mass of the stem. The inhibitory effect of the contaminants is determined by comparing test group with control group.

Seed germination capacity and the stem length of Lepidium sativum in distilled water (blank sample) were 91 ± 5% and 5.9 ± 0,97 cm. Also, the length of the roots was 5.5 ± 0.8 cm, and the dried biomass 0.190 ± ± 0.051 (Table 1.). The results were analyzed by one-dimensional analysis of variance (ANOVA).

Table 1

The Influence of Metal Ions on the Rate of Germination, Length of Root and Stem and the Dry Biomass as Well of Lepidium Sativum Species

Nr. crt.	Substance	Concentration mg/L	Germination rate, [%]	Root lenght* cm	Stem length* cm	Dry biomass* g
1.	Cr(VI)	30	86 ± 6	5.3 ± 0.55	5.6 ± 0.48	0.165 ± 0.035
		60	83 ± 7	5.0 ± 0.4	5.3 ± 0.27	0.153 ± 0.039
		90	72 ± 7	4.7 ± 0.59	5.0 ± 0.64	0.141 ± 0.02
		120	60 ± 4	4.3 ± 0.25	4.9 ± 0.64	0.123 ± 0.017
		150	58 ± 6	4.0 ± 0.38	4.7 ± 0.58	0.096 ± 0.070
		300	49 ± 7	2.1 ± 0.28	4.5 ± 0.5	0.069 ± 0.026
2.	Cd (II)	30	87 ± 5	4.9 ± 0.8	5.5 ± 0.6	0.148 ± 0.036
		60	70 ± 4	4.5 ± 0.9	5.3 ± 0.6	0.126 ± 0.19
		90	65 ± 5	3.9 ± 0.7	4.7 ± 0.5	0.113 ± 0.045
		120	57 ± 7	3.4 ± 0.3	4.1 ± 0.5	0.097 ± 0.05
		150	49 ± 7	2.9 ± 0.4	3.8 ± 0.4	0.070 ± 0.03
		300	41 ± 6	1.8 ± 0.52	3.6 ± 0.5	0.048 ± 0.021
3.	Control	0	91 ± 5	5.5 ± 0.8	5.9 ± 0.97	0.190 ± 0.051

* Values represent the average of three replicates ± ds.

The standard error of the estimates did not exceed 8% (Montvydiene and Marciulioniene, 2004). The EC 50 value which represents the concentration of metal ions which induce inhibition in Lepidium sativum germination and growth by 50%, were estimated by linear regression and confirmed by the experimental curves with an error of ± 5%.

2.2. Results and Discussions

The purpose of these tests was to investigate the effect of heavy metals Cd(II), and Cr(VI), used at different concentrations, on the germination and the growth process of the species Lepidium sativum, a firststage analysis of bioremediation processes.

The effect of metal ions Cd(II) and Cr(VI) on the rate of germination of the seeds and the growth process of Lepidium sativum species.

The data obtained in this experiment is the average number of three replicates and are shown in Table 1.

From the obtained results we have the following:

a) metal ions have an inhibitory effect on the seed germination process of Lepidium Sativum, (Fig. 1). The degree of inhibition depends on the ion concentration and tested in aqueous solution. At low concentrations, up ato 20,...,25 mg/L, the effect of inhibition of the germination process is lower, probably by acting metal ions as micronutrients, whereas at concentrations of 250,...,300 mg/L was observed inhibition of germination by about 50% compared to the control;

b) the toxicity of tested metal ions is found in the degree of growth and root length (Fig. 2). The development of the roots is affected by both the metal ion and its concentration. At concentrations of 300 mg/L both Cr(VI) and Cd(II) causes a reduction in the length of roots of seedlings by about 61%,...,68% compared to the control.

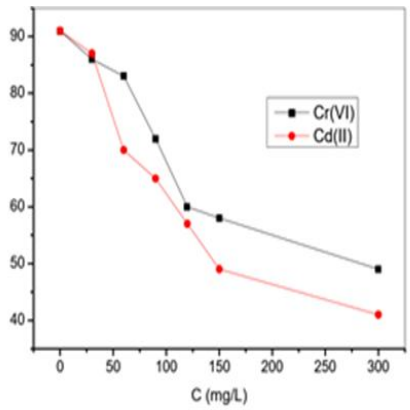

Fig. 1 – Influence of metal concentration on *Lepidium sativum* germination.

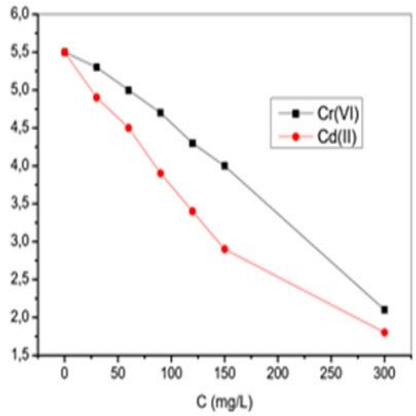

Fig. 2 – Influence of metal concentration on rate *Lepidium sativum* root lenght.

c) at very low concentrations of the tested heavy metals (20,…,25 mg/L), the stem length of Lepidium sativum seedlings is less affected (Fig. 3), but with increasing concentration of chemical substances, their length decreases in proportion to the dose, such as the concentration of 300 mg/L of Cd (II) the stem length is decreased by approximately 38%.

d) the quantity of dry biomass obtained in the experiments reflects the toxicity of the tested metal ions which is dependent on the type of metal ion and its concentration (Fig. 4).

Studies have shown that Lepidium sativum extract is able to absorb Cd(II), and Cr(VI) from soils. The accumulation of two types of metal ions depend upon the soil type and its characteristics.

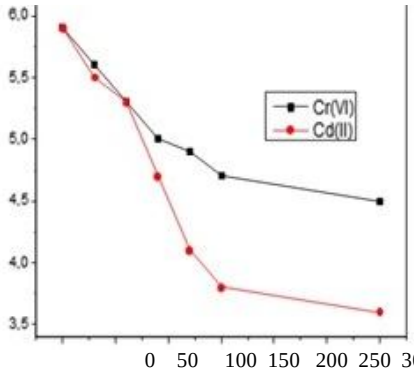

Fig. 3 – Influence of metal concentration on *Lepidium sativum* stem lenght.

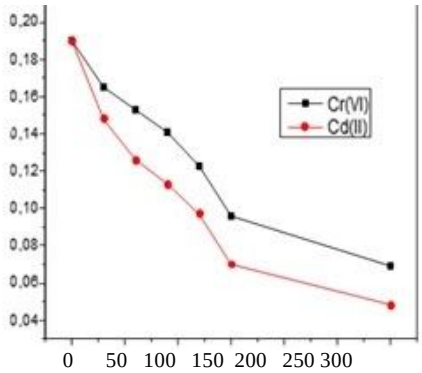

Fig. 4 – Influence of metal concentration of *Lepidium sativum* biomas.

3. Conclusions

Chromium compounds are highly toxic and detrimental to plant growth and development. While some crops are not affected by low levels of chromium, it is toxic to most plants above 100 mg/kg of dry matter. Chromium is a non-essential element for plant metabolism, they do not have specific absorption mechanisms. Therefore, it is assumed that the absorption of chromium is achieved by the same mechanism as the essential metals.

The toxic effects of chromium are mainly dependent on the metal species, which determines its uptake, translocation and accumulation. The path of transport of Cr(VI) is an active mechanism involving the transport of essential anions such as sulfate (Cervantes *et al*., 2001). Fe, S and P are known also as competing ions of chromium transport mechanisms.

The toxic effects of cadmium on the aerial organs of the plants include plant wilting, leaf chlorosis and necrosis, abnormal functioning of the stomata, the gas exchange disturbance, hormonal imbalance, the production of oxidative stress, and increased peroxidation of membrane lipids.

Plants use different mechanisms to cope with cadmium contamination, which include metal chelating, protein synthesis, enzymatic and nonenzymatic synthesis of antioxidants, organic acids, and the combination of plant roots to form mycorrhizae with microorganisms**.**

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EFECTUL IONILOR METALICI Cd(II) ŞI Cr(VI) ASUPRA RATEI DE GERMINARE A SEMINŢELOR ŞI A PROCESULUI DE CREŞTERE LA SPECIA *LEPIDIUM SATIVUM*

(Rezumat)

În urma depunerilor pe sol a particulelor încărcate cu metale grele se produce o creştere accentuată a concentraţiei metalelor grele, la nivele toxice, cu efecte negative asupra dezvoltării plantelor, creşterii animalelor şi sănătăţii oamenilor.

Cadmiul (Cd) – este un metal cu o puternică acţiune toxică asupra organismelor.

Poluarea solului cu Cd are loc în special prin ploi torenţiale, depozitarea nămolului din canalizări pe terenurile agricole şi utilizarea fertilizatorilor fosfatici.

Cromul (Cr) este un metal dur, de culoare albă argintie, rezistent la coroziune, în forma nativă fiind uşor de prelucrat. Cromul este un metal destul de răspândit în scoarţa pământului dar numai sub formă de combinaţii chimice, cromit ($FeCr_2$)O_4) cu un conţinut în crom de 0,033%.

În urma analizelor efectuate se observă,efectele ionilor metalici cadmiu şi crom asupa speciei Lepidium sativum (hreniţă) şi anume: au efect inhibitor şi asupra procesului de germinare a seminţelor de Lepidium Sativum, influenţează gradul de creştere a lungimii rădăcinilor şi chiar concentraţiile mici, ale metalelor grele testate (20,...,25 mg/L), lungimea tulpinilor plăntuţelor de Lepidium sativum sunt afectate.

Studiile au demonstrat că Lepidium sativum este capabilă să extragă şi să absoarbă Cd(II) şi Cr(VI) din soluri. Acumularea celor două categorii de ioni metalici depinde însă de tipul de sol şi de caracteristicile acestuia.