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Examining Phytoremediation Capability of some of Cultivars and Pasture Species surrounding Shahrekord Industrial Zone in Absorbing Lead and Cadmium

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ABSTRACT: Phytoremediation capability of some cultivars and pasture species surrounding Shahrekord Industrial park in absorbing lead and Cd elements was conducted in manner of factorial plan with three repetitions as pot experimentation. The experimented treatments consisted of, example lead treatment (4 levels) (0 mg/kg of lead), 50, 150 and 300 ml lead per pot soil; example Cd treatment (4 levels), (0 mg/kg of Cd), 5, 20, 40 ml per pot soil and plant treatment including two cultivar plants: maize (*Zea mays*), wheat (*Triticum spp*.), Portulaca and Djashir (*Prangos ferulaceae*). In this research, experimental soil bed for 192 pots with 5 kl weight were prepared from non-contaminated areas around Shahrekord Industrial park and adjacent to Shahrekord Plain and after full integration 2 kl sample of it were transferred to the laboratory and the concentration of absorbable Cd and lead elements (using DTPA method and atomic absorption device) as well as some of their Physical and chemical features (such as tissue, organic matter, acidity, absorbable concentration of potassium and phosphor elements, percentage of neutralizing material) were measured. Studied traits were as follow, the amount of soil lead, Cd of soil, above ground organs lead, root lead, root Cd and lead and Cd transfer rate. Results showed that increasing heavy metal can increase the amount of metal in soil, root and above ground organs, significantly. Also the accumulation of lead and Cd in root of all experimented plants was more than above ground organs. Amongst experimented plants, maize (*Zea mays*) reported the highest amount of absorption of lead and Cd both in root and above ground organs than other plants. Also maize (*Zea mays*) had the highest transfer rate for lead and Portulaca for Cd.

Keywords: Phytoremediation, lead, Cd, transfer rate

INTRODUCTION

From the past century, the developed and developing countries lifestyle was changed which such a change entailed numerous waste production, uncontrolled utilization of natural resources, changing ecosystem with losing settlements and polluting water, soil and air. Heavy metals can have unfavorable effects on soil ecosystem and biological processes of soil for a long time. These metals in addition to making toxicity for plants and soil microorganisms through deep penetration into underground waters cause ecosystem destruction (McGrath and Zhao, 2003). Phytoremediation is a filtration technique which includes absorption, deformation, and sublimation of contaminant s with the help of plants to remove water, soil and air pollutions. In this method persistent plants which have high biomass, strong root system, and high transition rate were used. Phytoremediation is used by utilizing green plants engineering including grass and xylem species for removing contaminants from water and soil or reducing risk of environmental contaminant s such as heavy metals, rare elements, organic compounds and radioactive materials. Plants need some metals in very low mass, but when the mass of these metals goes beyond what is needed for the plant leads to metabolic disorders and growth inhibition of most of plant species (Padmavathiamma *et al*, 2007).

In general, plants choose one or a combination of the following mechanisms in order to protect themselves from toxicity of heavy metals. These processes can be such as: **(i) Phytoextraction** is a low cost technique by which metals are removed from contaminated soil or they are gathered in different parts of plant.

(ii) Phytodegradation or Rhizodegradation: heavy metals are degraded by proteins and enzymes produced by plants and their coexistent microbes.

(iii) Rhizofiltration: Metals are absorbed by the root of plants.

(iv) Phytostabilization: In this technique immobilized metals and their mobility and absorbency by the plant roots are reduced.

(v) Phytovolatilisation: It is the transpiration of existing contaminants in soil by plants into the atmosphere (Saghir Khan *et al*, 2009). Plants which can absorb and accumulate heavy metals of Zinc and manganese more than one percent of dry weight of above ground organs, heavy metals of nickel, Chrome, Cobalt, copper, lead and aluminum in amount more than one tenth of one percent of dry weight of above ground organs, heavy metals of Cd and Selenium in amount more than one hundredth of one percent of dry weight of above ground organs and heavy metal of mercury in amount more than on thousandth of one percent of dry weight of above ground organs are hyperaccumulators. To the date, more than four hundred plant species from 45 family like Asteraceae, Brassicaceae, Caryophywwaceae, Fabaceae, Lamiaceae etc. which have genetic potential for absorbing high amount of heavy metals in their above ground, were recognized (Shah, 2007).

In some cases, the terms: Phytoremediation and Phytoextraction are seen synonymous mistakenly, while Phytoremediation is a general concept about different techniques of filtration of contaminated areas with heavy metals by plants, and Phytoextraction is a unique filteration technique (Parasad, 2004).

MATERIALS AND METHODS

This study was performed in vase-test from within factorial design framework and with three repetitions. The testes treatments included:(1) lead treatment (4 levels) witness (0 mg/kg of lead), 50, 150 and 300 mg of lead per kilogram of vase soil (2) Cd treatment (4 levels) witness (0 mg/kg of lead), 5, 20 and 40 mg of Cd per kilogram of vase soil (3) plant treatment, including two farmed plants of maize (*Zea maize* L.) and wheat (*Triticum sativum* L.) and two pasture plants of (*Portulava* L) and (*Prrangos ferulaceae)*.

A. Preparing soil sample for study performance

The quantity of the required soil for 192 vases of 5kg contents were obtained from the non-contaminated regions of margin of Shahrekord industrial zone besides Shahrekord plain and after complete mixing, a 2kg sample of the same was transferred to the laboratory and the densities of absorbable nature of lead and Cd elements (using DTPA method and atomic absorption machine) as well as some important physical and chemical features (e.g. texture, organic substance, acidity, absorbable density of *P* and *K* elements, percentage of neutralizing materials, etc.) were measured in the same.

Table 1: Specifications of tested farmed soil.

Metric	Qty.	Unit	Metric	Qty.	Unit
Real density	2.56	g/cm^3	TNV	26	%
Nominal density	1.3	g/cm^3	SP	46	%
Soil texture	Clay	-	OC	0.41	%
Soil pH	7.72	-	Total N	0.05	%
EC	0.739	Des/m	P a.v.a	5.6	Mg/kg
CEC	14	Smol/mg	K a.v.a	250	Mg/kg
Sol lead	2.96	Mg/kg	Cd	0.86	Mg/kg
Zn	0.55	Mg/kg	Fe	3.28	Mg/kg
Mn	7.39	Mg/kg	Cu	0.89	Mg/kg

B. Soil analysis after removal of the plant

In this study, the total density of heavy metals, extractable density with DTPA were subject to studying their changes in different treatments to determine the metals contents in the soil. Some factors are used to study the herbal extraction performance in the plants. Here, the transfer factor has been used which may be calculated as per the following:

$$TF = \frac{metal\ density\ in\ aerial\ parts\ of\ plant}{metal\ density\ in\ plant\ root} \quad (1)$$

RESULTS AND DISCUSSION

A. Studying the effect of treatments on the total density of heavy metals in the soil

Soil lead content: Studying the variance analysis table (Table 2), indicated the existence of meaningful difference in 1% level among the tested treatment in terms of lead soil content. By increasing the lead content in the soil, notwithstanding the different pants lead absorption from the soil, the soil lead content increased. The least soil lead content was reported in witness treatment (0.96 mg) and the lead accumulation in the soil increased through an increase in the different lead contents, so that in 50, 150 and 300mg lead treatment, 45.74, 144.37 and 288.82 mg of lead were placed in separated statistical groups.

Table 2: Results of variance analysis of all treatments on lead soil content.

Change factors	df	Soil lead	Soil Cd	Aerial parts lead	Aerial parts Cd	Root lead	Root Cd	Lead TF	Cd TF
Repetition	2	22.501	0.074	2.231	0.042	29.760	0.005	0.0629	0.098
Sb	3	780462.964^{**}	0.184^{**}	98.653^{**}	0.037^{**}	335.448^{**}	0.070^{**}	0.0502^{**}	0.058^{ns}
Cd	3	2.103^{ns}	14618.521^{**}	0.300^{ns}	0.641^{**}	0.72^{ns}	7.425^{**}	0.026^{ns}	4.404^{**}
Sb * Cd	9	0.396^{ns}	0.077^{ns}	0.064^{ns}	0.006^{ns}	0.124^{ns}	0.022^{ns}	0.015^{ns}	0.069^{ns}
Plant	3	212.160^{**}	2.251^{**}	98.417^{**}	0.204^{**}	54.389^{**}	1.262^{**}	1.850^{**}	0.452^{**}
Sb * plant	9	24.666^{**}	0.043^{ns}	16.802^{**}	0.004^{ns}	7.176^{**}	0.046^{**}	0.241^{**}	0.062^{ns}
Cd * plant	9	0.515^{ns}	0.223^{**}	0.051^{ns}	0.008^{*}	0.336^{ns}	0.0103^{**}	0.021^{ns}	0.186^{**}
Sb * Cd * pant	27	0.402^{ns}	0.019^{ns}	0.085^{ns}	0.001^{ns}	0.421^{ns}	0.014^{ns}	0.016^{ns}	0.056^{ns}
Test error	126	1.556	0.053	0.1080	0.04	1.217	0.015	0.022	0.051
Changes %		1.04	1.46	20.85	21.21	24.86	15.77	31.29	44.68

*and ** Significant at 1 and 5 percent respectively, ns: No significant

According to Table 1, no meaningful difference was seen among the Cd tested treatments in terms of soil lead contents and they were placed in the same statistical group. The soil lead accumulation among the tested plants indicated the existence of meaningful difference in 1% level (Table 1), so that maize was reported with the highest of lead absorption from the soil and the soil lead contents for the same was reported as 117.18 mg. After maize, barley, purslane and wheat with 119.86, 120.65, and 122.2 mg of soil lead placed in separated statistical groups.

The results of the variance analysis table results showed that no meaningful difference was seen on mutual effects between lead and Cd treatments which indicated the smoothness of changes among the treatments.

A meaningful difference was seen of the mutual effect of lead and plant in the 1% level (Table 1). The highest and lowest lead contents in soil were related to 300mg lead treatment of wheat (292.87 mg) and lead witness of maize (0.56 mg) per kg, respectively. In other words, among the tested plants, maize and wheat had the highest and lowest plant refining power in terms of soil lead contents. Observing indicated that no meaningful difference was seen in mutual effect of Cd and plant in terms of soil lead content.

Soil Cd content: According to table 1, the lead different contents indicated no meaningful effect on the soil Cd content and they were placed in the same statistical group. The different Cd contents indicated meaningful effect in 1% level on soil Cd content. By increasing of Cd, the soil Cd level increased notwithstanding the absorption and refining by the plant, the lowest was seen in Cd witness treatment (0.48 mg), following by 5, 20 and 40 mg of Cd with 4.51, 19.2 and 39.03 mg, so they were placed in separated statistical groups. The plant refining power of the tested plants was meaningful in 1% level in terms of soil Cd contents. The highest Cd refining was made by maize reported the minimum soil Cd content (15.52 mg), followed by barley, purselane and wheat with 15.77, 15.89 and 16.06 mg of Cd in soil, respectively, which were placed in separated statistical groups. The less soil Cd content, the higher the refining power of the plant will be. The results of variance analysis indicate lack of meaningful difference between mutual effect of lead and Cd in terms of soil Cd content. Also, no meaningful difference was seen of the mutual effect of lead and plant in terms of Cd content. The mutual effect of Cd in plan was meaningful in 1% level, so that the highest and lowest soil Cd contents were in 40mg Cd treatment of wheat and witness treatment of maize with 39.41 and 0.35 mg, respectively.

Generally speaking, in all levels maize Cd contents was reported of the highest Cd refining, so that it had the lowest soil Cd content and highest Cd refining in witness, 5, 20 and 40mg Cd treatments, respectively with 0.35, 4.29, 18.96 and 38.48 mg.

B. Studying the effect of treatments on the heavy metals density

Aerial body parts lead content: Studying the variance analysis table indicated the existence of meaningful difference in 1% level among the tested treatment in terms of lead soil content with respect to aerial body parts lead content. By increasing the lead content in the soil, the parts lead content increased meaningfully. In fact, the plant has increased its refining power by increased soil lead content. The least parts lead content was reported in witness treatment (1.26 mg) and the lead accumulation in the soil increased through an increase in the different lead contents, so that in 50, 150 and 300mg lead treatment, 3.69, 5.25 and 7.55 mg of lead were placed in separated statistical groups. No meaningful difference was seen among the *Cd* tested treatments in terms of body parts lead contents and they were placed in the same statistical group. Studying the variance analysis table indicated the existence of meaningful difference in 1% level of the mutual effect of lead and plant. The highest and lowest lead contents in aerial body parts were related to 300mg lead treatment of maize (9.39 mg) and lead witness of wheat (1.14 mg) per kg, respectively. In other words, among the tested plants, maize had the highest aerial body parts lead contents per kilogram of dry weight. The mutual effect of Cd in plant for aerial body parts lead contents was not meaningful.

Aerial body parts Cd content: Studying the variance analysis table indicated the existence of meaningful difference in 1% level among the different lead levels with respect to aerial body parts Cd content. By increasing the lead content in the body parts, the parts Cd content increased meaningfully. The least parts Cd content was reported in witness treatment (0.2 mg) and the lead accumulation in the soil increased through an increase in the different lead contents, so that in 505,20,40 mg lead treatment, 0.86, 0.98, 1.07 mg of Cd were placed in separated statistical groups. The mutual effect of lead in Cd for aerial body parts Cd contents was not meaningful. The mutual effect of lead in Cd for aerial body parts Cd contents indicated the existence of meaningful difference in 1% level. The highest Cd contents in aerial body parts were related to maize (1.01 mg) as the 1st statistical group and followed by 5,20,40 mg treatments of 0.74, 0.73 and 0.63, respectively, which placed in different statistical groups. The tested plants indicated the existence of meaningful difference in 1% level with respect to aerial body parts Cd content, so that maize was reported with the highest of aerial body parts Cd content for the same was reported as 0.2 mg. After maize, barley, purslane and wheat with 0.74, 0.98 and 1.07 mg of soil lead placed in separated statistical groups. Mutual effect of lead in Cd for aerial body parts Cd content was not meaningful. Figure 1 shows the effect of 4 levels of cd on height of plants. Mutual effect of lead in Cd for aerial body parts Cd content was meaningful in 1% level. The highest and lowest accumulation of Cd was seen in 50 mg lead treatment of maize (1.11 mg) and witness treatment of wheat (0.55mg). In all lead treatments, the maize Cd accumulation content in aerial body parts were the highest. Meanwhile, the variance analysis table indicated existence of meaningful different in 1% level on mutual effect of Cd and plant, so that the highest and lowest were reported in 40mg Cd treatment of maize (1.37mg) and purselane witness treatment (0.13mg) per kilogram of dry weight of aerial body parts.

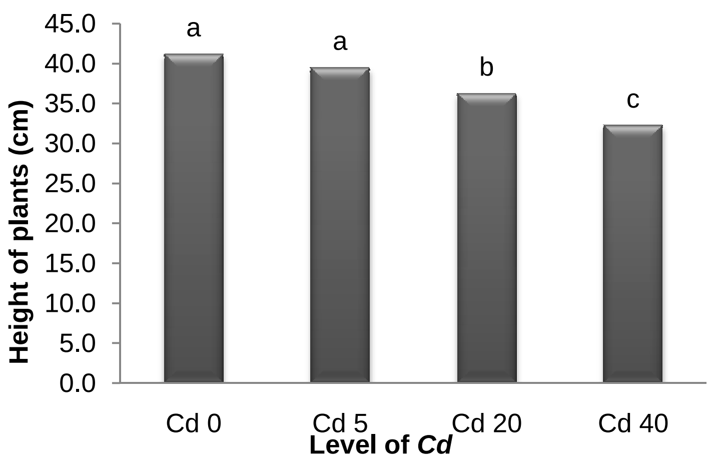

Fig. 1. The effect of treatments (levels of Cd) on height of plants.

C. Studying the effect of treatments on heavy metals density and root weight

Root lead content: Studying the variance analysis table indicated the existence of meaningful difference in 1% level among the tested treatment in terms of lead root content. By increasing the lead content in the soil, the root lead content increased meaningfully. The highest root lead content was reported in 300mg treatment (4.03 mg) and the lead accumulation in the root decreased through an increase in the different lead contents, so that in 150, 50 and witness lead treatment, 2.02, 1.36, and 0.73 mg of lead were placed in separated statistical groups. No meaningful difference was seen among the Cd tested treatments in terms of root lead contents and they were placed in the same statistical group. The tested plants indicated the existence of meaningful difference in 1% level with respect to root lead content; so that maize was reported with the highest of aerial root lead content for the same was reported as 4.16 mg. After maize, barley, purslane and wheat with 1.64, 1.19 and 1.16 mg of root lead placed in separated statistical groups. Mutual effect of lead in Cd for root lead content was not meaningful. Mutual effect of lead in plant for root lead content was meaningful in 1% level. The highest and lowest accumulation of lead in root was seen in 300 mg lead treatment of maize (8.3 mg) and witness treatment of purselane (0.54mg). In all lead treatments, the maize had the highest soil absorption from the soil, so that in witness, 50, 150 and 300mg treatments, a lead accumulation of 0.86, 2.77, 4.7 and 8.3 mg per kg of dry substance were reported. Meanwhile, no meaningful different was seen between mutual effects of Cd in plant.

Root Cd content: Studying the variance analysis table indicated the existence of meaningful difference in 1% level among the tested lead treatment in terms of Cd root content. The lowest root Cd content was reported in witness treatment (0.26 mg) followed by 50, 150, 300 mg lead treatment, with 0.31, 0.3, 0.33 which were placed in separated statistical groups (Fig. 2 and 3).

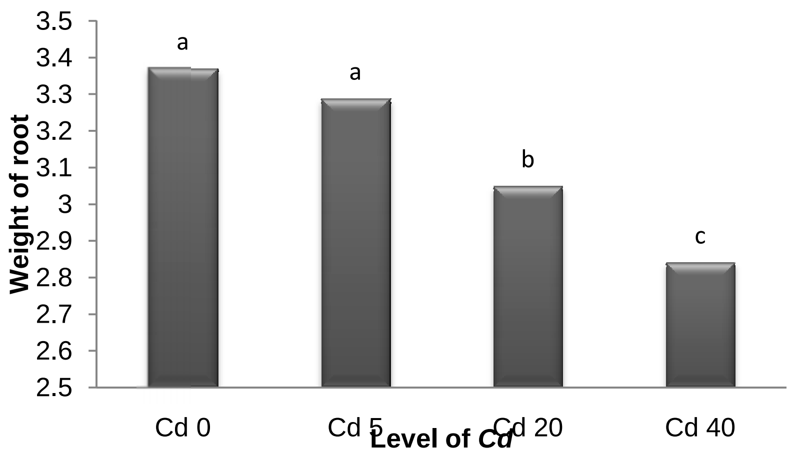

Fig. 2. Effect of 4 levels of Cd on dry weight of root.

A 1% meaningful difference was seen among the Cd tested treatments in terms of roots Cd contents. By increasing the soil Cd, root Cd accumulation meaningfully increased, so that the lowest root Cd was reported to be in the witness treatment (0.17 mg) per kg of dry substance, followed by 5, 20 and 40mg Cd treatments with 0.25, 0.34 and 0.44 mg/kg of dry substance which were placed in separated statistical groups.

Meanwhile, the tested plants indicated the existence of meaningful difference in 1% level with respect to root Cd content, so that maize was reported with the highest of root Cd absorption (0.38mg) and was placed in the first statistical group. After maize, purslane, barley and wheat with 10.33, 0.27, and 0.23 mg of root Cd placed in separated statistical groups. Mutual effect of lead in Cd for root Cd content was not meaningful. Meanwhile, mutual effect of lead in plant for root Cd content was not meaningful. Studying the variance analysis table indicated the existence of meaningful difference in 5% level of Cd mutual effect in plant, in terms of Cd root content. The highest Cd content in plant was reported in 40mg Cd treatment of maize (0.53 mg) and the lowest was in witness treatment of wheat (0.12 mg). Generally, maize had the highest Cd absorption and refining, so that in witness, 5,20 and 40mg treatments, a Cd content of 0.23, 0.34, 0.41 and 0.53 mg/kg of dry substance of root have been reported, respectively.

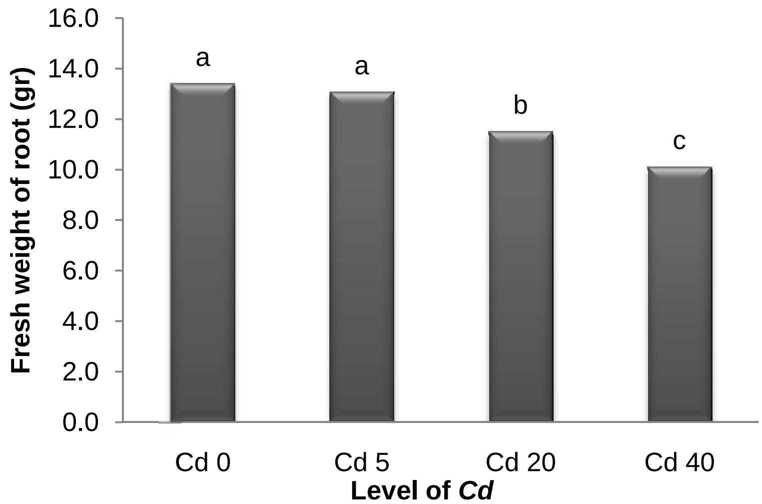

Fig. 3. Effect of 4 levels of Cd on fresh weight of root.

D. Effect of treatments on the factors affecting the heavy metals herbal extraction performance in studied plants

TF describes the movement and distribution of heavy metals in plants. Transferring from the root wall cells is the first stage on absorbing the metals in herbal textures. In facing with the heavy metals, plants are either disposing or accumulating metals. Lack of movement of some of the metals in the root cells is approved as per a TF smaller than 1. A TF bigger than 1in fact indicates the easy transfer of metal from the root to the aerial body parts and eventually high accumulation of heavy metals in plant aerial body parts and is one of the proper factors in herbal extraction and in case the TF smaller than 1 shows the accumulation of such plant (Mcgrad *et al.,* 2001). Among the studied plants, a meaningful difference in the level of 1% was seen in terms of lead TF, in a way that maize had the highest TF (0.76) and placed in a separated statistical group and indicated a meaningful difference with other plants, followed by barley, wheat and purselane with 0.43, 0.42 and 0.3, respectively which were placed in separated statistical groups. Among the studied plants, a meaningful difference in the level of 1% was seen in terms of Cd TF, in a way that purselane had the highest TF (0.65) and placed in a separated statistical group and indicated a meaningful difference with other plants, followed by maize, wheat and barley with 0.49, 0.47 and 0.43, respectively which were placed in separated statistical groups.

E. Studying the effect of treatments on the total heavy metals density in soil

Lead: In their studies, Berrow *et al* (1991) concluded that the heavy metals absorption from the soil by the plants depends on the type and density of metals existing in the soil, biological-availability of the elements and type of herbal species. Considering the total lead density of the soil after herbal refining within 8 weeks after planting and comparing the same with the primary densities in the contaminated soil, it is observed that lead metal reached in witness level fro, 2.96 mg in soil to 0.96mg, i.e. on average, the plants stored 78% lead in witness level whether in root (1.26 mg) or in aerial body parts (0.73mg). In 50, 150 and 300mg lead treatments of soil, any increase in the soil lead resulted in a meaningful increase in the lead accumulation in the root and aerial body parts, as well, so that the lead accumulation in root and aerial body parts reached in 3.05, 7.27 and 11.58 mg in 50, 150 and 300mg lead treatments, respectively, which may indicate that the more poisonous metals in soil increases, the plant refining power also increases. The density of all the metals measured in the soil was seen to be more than of the same in the herbal textures (root or aerial body parts). It indicates that all the metals in the sediments are not available for the plant biologically and the metals absorption by the root is performed with a less density with respect to the soil. One of the factors affecting on the herbal extraction of heavy metals in the soil is the metals availability to be absorbed by the plant (Padmavathiamma *et al*, 2007).

Kabta and Pendias (1994) mentioned that the level of loading and accumulation of heavy metals in soil depend on various factors such as pH, percentage of organic materials, texture and soil cation exchanging capacity.

Density of Cd: Comparing the Cd densities in root and aerial body parts of the studied plants, it was seen that the Cd accumulation in the roots of all the tested plants has been bigger than the same in the aerial body parts of the plant. According to Salt et al (2002), a major part of Cd absorbed by the plant remains in the plant roots and merely a little amount of the same is transferred to the aerial body parts of the plant, where the major parts of the Cd absorbed by the plants is accumulated in the roots.

F. Studying the effect of treatments on the total density of the heavy metals in the plant

Lead: In studying the lead accumulation in the studied plants, it was seen that the highest lead accumulation has been in maize root (5.56 mg), followed by barley (4.78), purselane (4.39) and wheat (3.02 mg). Meanwhile, various figures of lead are accumulated in the plants aerial body parts, for which the highest has been again reported for maize (4.16 mg/kg), followed by barley (1.64), purselane (1.19) and wheat (1.16). In similar results, the lead accumulation was compared in the roots of surgum and sunflower, indicated that surgum root has more lead content in comparison to sunflower (Pospisilova, 2003), while such argument may be acceptable considering surgum and maize familial ties. Prasad and Freitas (2003) indicated that certain plants such as maize and sunflower may accumulate high contents of lead in their body parts, in a way that they may grow in certain soils with a lead density of 16,000 mg/kg. By increasing the average soil heavy metals density, the absorption in the different plant parts (root and leaf) also increases, which may indicate the plant power in absorbing different heavy metals (Pospisilova, 2003). Whereas the herbal extraction performance depends on the more metals accumulation in the plants aerial body parts, therefore in this study considering the more lead density in the maize aerial body parts it may be said that among the tested plants, maize has indicated a more effective role in the lead herbal extraction process in comparison to the other plants. Salt *et al* (2002) expressed that lead accumulation in the barley aerial body parts is quite less than the same in the roots. Therefore, it has been proved that the lead transfer from the root to all aerial body parts of the plants is not significant. Saghir Khan *et al* (2009) specified that the highest lead density was observed in the soil, followed by the root and then aerial body parts of the plant.

Shanker *et al* (2005) pointed out that the higher soil contamination to heavy metals, the more their potential accumulation in the trees body parts will be. Comparing the lead density in the root and aerial body parts of the studied plants, it is seen that lead accumulation in the roots has significantly higher than the same in the aerial body parts of the four studied plants. According to Wallace and Romney theory (1977) often lead accumulation occurs in plants root. Harrison *et al* (1981) studied the lead absorption by the different plants and learned that most of the plants absorb significant amounts of lead through their roots, however, they transfer limited amounts of the same to their aerial parts. Among the relevant plants, highest lead accumulation was seen in maize (4.16 mg / kg of dry substance). In their studies, Parasad (2004) expressed that among the plants textures, metals density is higher in root with respect to the aerial body parts, which indicates metals receiving from sol has been more than the leaf and aerial body parts, as root has direct connection with the soil and extracts metals of biological availability nature from the soil.

Most of the metals are absorbed through the surface on the root cellular wall. Meanwhile, a certain part of the metals absorbed by the root are combined with the combinations existed in the cellular wall. On the other hand, due to the existence of casparin lights in the root and lack of penetrability of the xylems walls, a big part of the metals in the root are not transferred to the other body parts and lower level of the absorbed metals are transferred to the leaf texture (Parasad, 2004). In their studies, Shah (2007) concluded that the soil heavy metals cause a decrease in the growth and performance of the dry substance aerial body parts and herbal refining. Onder and Darsan (2006) stated that lead highly affects formation of leaves, growth of roots and trees branches. In their studies, Celik *et al* (2005) mentioned that the high biomass and proper computability conditions of the herbal specifies may play an important role in refining the soils contaminated to the heavy metals.

Density of Cd: In a study titled adaptability of the plants under the stress of heavy elements, it was said that Cd accumulation in the roots with respect to the trunks is mainly seen in the semi-resistant crops, including surgum (Peterson, 1996) and in the sensitive plants including bean (Obata and Ombashi, 1997). In their studies, McGrath and Zhao (2003), concluded that the highest Cd density in the soil is the highest, followed by plant root and leaf.

Through studying the metals accumulation in the plant textures, Tom and Onder and Dursun (2006) concluded that a quite little amount of heavy metals such as Cd accumulates in the leaf textures and most the absorbed metals are accumulated in the plant root. The results of this study indicated that increasing the Cd density application results in a decrease in the plat height. Potentially, the increase in the Cd ion in the plant growth base results in a decrease in the plant water contents through affecting the tonoplast hydro canals, followed by a decrease in cellular lengthening and length of the aerial body parts. Additionally, a decrease in the plants aerial body parts not only is affected by genotype, but also certain environmental factors such as different densities of the heavy metals may also affect the same. Similar results have been presented by McGrath *et al* (2002), Marchiol *et al* (2007) and Shanker *et al* (2005). Tallio *et al* (2003) showed that, applying the 0, 10 and 100 mg of Cd per kg of soil, by increasing the Cd density in the soil, the level of absorption of this plant also increases.

CONCLUSION

Considering the comparison among the data resulted from the Cd different levels, the highest Cd contents in the aerial body parts is in 40mg of Cd density, while the minimum of the same is in the witness (zero) density. The results indicated that the Cd content increase has resulted in an increase in the level of this element in the aerial body parts thereof. Considering the comparison among the data resulted from the mutual effects between the plant and different level of Cd, the highest root Cd content is in 40mg of Cd density, while the minimum of the same is in the witness (zero) density. The results showed that an increase in the Cd contents results in an increase in the contents of this element in the root, while these results are along with the results of Zimdahl (1975) and Kayser *et al* (2000). Meanwhile, Spirochova *et al* (2003) stated that the maize plant is from amongst those plants which have higher Cd contents in the root in comparison to the aerial body parts. Considering the test results, maize may be applied a suitable plant to clean the contaminated soils.

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