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PHYTOREMEDIATION OF LEAD AND NICKEL BY *BASSIA SCOPARIA*

Mohammed E. Al Defferi[1], Qassim A. AL-Janabi[2], Sama A. Mustafa[2] and Ali K. AL-Muttarri[1]

[1]Babylon University, Environmental research and studies center, Iraq.
[2]AL-Qasim Green University, Environmental Sciences College, Iraq.

Abstract

The soil pollution is consider as a major concern in the present time since it effect the food that human consume and the runoff will pollute the water bodies. This study was conducted to test the ability of *Bassia scoparia* to up-take the load of lead and Nickel from the soil. Samples of soil were taken from Hilla city and all the chemical and physical properties of the soil were tested, the soil is sandy loam. The first step was to test the parameters of the soil, content and texture, then the study measure the concentration of lead and nickel in the plant in two mean section: the shoot system and the root system, the plant show good ability to uptake the heavy metals from the soil. The concentrations of the studied heavy elements were found to be the highest concentration in the root system compared with the shoot system.

Key words **:** Phytoremediation, *Bassia scoparia,* Nickel, Lead.

Introduction

Soils are critical environment where rock, air and water interface. Consequently, they are subjected to a number of pollutants due to different anthropogenic activities (Industrial, agricultural, transport etc). The chemical composition of soil, particularly its metal content is environmentally important, because toxic metals concentration can reduce soil fertility, can increase input to food chain (Krishna and Govil, 2007). In the past, soil contamination was not considered as important as air and water pollution, because soil contamination was often with wide range and was more difficult to be controlled and governed than air and water pollution. However, in recent years the soil contamination in developed countries becomes to be serious (Su *et al.*, 2014). Lead is not naturally present in the human body and, as it currently exists in the environment, has been identified as a health threat. In particular, there exists extensive evidence that even at low dosages, lead may contribute to mental retardation and learning disabilities in children under the age of seven exposed to lead hazards (EPA, 1998). Nickel is generally uniformly distributed in the soil profile and typical soil nickel contents vary widely based on the parent rock. Major concern for the impact and distribution of nickel in soils arises apparently from the role of soil as an ultimate sink for heavy metals and the consequence transfer through the food-chain to crops, fruits and vegetables grown in contaminated soils and their possible consumption by animals or humans (Iyaka, 2011). Remediation techniques include: (i) ex-situ (excavation) with chemical agents, (ii) chemical immobilization/ stabilization method to reduce the solubility of heavy metals, (iii) electrokinetics (electromigration), (iv) covering the original polluted soil surface, (v) dilution method (mixing polluted soils with surface to reduce the concentration of heavy metals), (vi) phytoremediation by plants such as woody trees (Wuana *et al.*, 2010). *Bassia scoparia* (Kochia) During early stages of growth, Bassicascoparia is palatable and has high forage value for all classes of livestock and can be hayed or grazed, Kochia can be used for control of soil erosion, Kochia has been shown to bioaccumulate cesium-137 and may be able to be used for remediation of hydrocarbon contaminated soil (Casey, 2014). Many studies has been conducted to remove heavy metals from soil by using the plants, many plants have been used to remove lead from soil (Huang *et al.*, 1997), the use of *Alternanthera philoxeroides, Sanvitalia procumbens* and *Portulaca grandiflora* were tested for their ability (Cho-Ruk *et al.*, 2006). Ehsan, *et al.* (2016) studied the potential of an ornamental plant *Catharanthus roseus*, while Revathi, *et al.,* (2011) unstudied the ability of Sorghum plant to accumulate lead. This study was conducted to test the effectiveness of the *Bassia scopria* to remove lead and chromium from contaminated soils by phytoremediation.

Materials and Methods

Sample collection

The samples were collected from the top soil at depth of 0-15cm and were kept in labeled plastic bags, the samples were collected randomly from one farm vegetated with corn, located in the opposite side of the University of Babylon at Al-Tajia region, about 6 miles distance from the center of Babylon province. All samples were passed through 2mm (mesh) sieve and then and then transferred to laboratory, where they were aired and used to determine the physical and chemical properties of the soil.

Experimental work

The samples were contaminated artificially, at first, by adding calculated amount of $PbCl_2$, $NiCl_2$ each one alone and then a collection of the two contaminant at concentration of 50 mg/L and 100mg/l respectively for all the three type of experiments. Three replicates were used for each experiment. For each sample an amount of 350gm of soil were kept in pots and planted by *B. Scoparia*. Three replicates of *B. Scoparia* were planted on in untreated (uncontaminated) soil as control. The water capacity of soil in pots were determine and all pots were irrigated with tap water up to 20% of the soil capacity on daily bases (Hamish *et al.*, 2011). The soil electrical conductivity and pH were measured in a suspension of water and soil (1:1) ratio (U.S.S.L. Staff, 1954), the texture of soil was determine by using the hydrometer method (Black, 1965), as well as, the following soil properties were tested: Organic matter (Jackson, 1958), Available potassium (Hesse, 1971), Ammonium, nitrate and nitrite (Bremner and Keeney, 1965), available phosphorus (Page *et al.*, 1982), the calcium carbonate $CaCO_3$ (Jackson, 1958), Cation exchange capacity (CEC) was measured (Papanicolaou, 1976). After 70 days of the plants were harvest separately for each experiment. Each plant were separated into two parts generally shoot and root system (stem and leaf or vegetable growth). The dry weight of the plant parts was also determine.

Digestion of plant samples

The dried samples were grinded by electrical moter and pass through 40mm (mesh) sieve, then a 0.5gm of the sample was transfer to the digestion tube, 5ml of concentrated nitric acid (HNO_3) was added to the sample. The samples were kept in digestion tube for 16 hours and then transferred to oven and kept there for an one hour at 100°C, after that 3 ml of bichloric acid (70%) was added to the sample, the samples were refluxed on 200°C for 30 minutes tile the solution become clear. After that the samples were transferred to the centrifuge (at speed of 2000 rpm for 10 minutes) then washed with water and acid and let to dry before measure. The sample size was completed up to 50ml by D.W. and kept in special bags until measure by using the atomic adsorption spectrometer (Onder *et al.*, 2007, Antonijevic *et al.*, 2008).

Results and Discussion

This study was done to test the ability of the *Bassia scoparia* to remove or decrease the heavy metals load of the soil, at first the texture of the soil was tested and the result is shown in table, the soil was sandy-loam which has the ability to absorb the heavy metals on its surface, which will decrease the availability of heavy metals to absorbed by the plant and consequently decrease the overall removal of heavy metals. The first experiment was done to find out the ability of the plant to increase its upload of lead in both shoot and root system three individual plants were kept in normal untreated soil as control, another six individual plants were kept in treated

Table 1: Some chemical and physical characteristics of soil studied.

Soil properties		
pH		7.6
Ec (ds/m)		3.9
Organic matter (g/kg)		36
Texture		Sandy Loam
Mechanical analysis	**Clay (g/kg soil)**	28
	Silt (g/kg soil)	480
	Sand (g/kg soil)	492
CEC meq/100 g		9.38
Available P^+ (mg/kg soil)		12.95
Available Nitrogen (NH^+_4 + $NO^É_3$) (mg/kg soil)		35.89
Available K^+(mg/kg soil)		25
$CaCO_3$ (g/kg)		23

Table 2: The dry weight of *Bassia scoparia* shoot and root.

Treatment	Dry weight of shoot	Dry weight of root
Control	5.2	1.9
Lead (50 ppm)	5.2	1.7
Lead (100 ppm)	5.1	1.7
Nickel (50ppm)	5.3	2.0
Nickel (100ppm)	5.2	1.8
Lead + Nickel (50 ppm)	5.0	1.8
Lead + Nickel (100 ppm)	4.9	1.7

soil with pb, the results show to have a moderate ability to up take pb from the soil in compare with control the pb uptake was increase from 1.2ppm in control to 1.7ppm in concentration 50ppm and 2ppm in concentration 100ppm of pb in soil respectively in shoot system of *Bassia scoparia* fig. 1, the results of our study is similar to the findings of (Sasaki *et al*., 2003, Carvalho *et al*., 2001, Coleman *et al*., 2001, Wong *et al*., 2001, Ingole and Bhole, 2003).

The fig. 2, show that the *B. Scoparia* was able to uptake the pb from the soil and accumulated in their roots, the roots of plants grown in soil treated with concentration of 100ppm of pb was more effective in accumulating pb in their root more than the roots of plant grown in soil treated with 50ppm of pb and that can be explain by the fact that the increase of the pb load in soil made it more available for uptake by the plants (Olge *et al*., 2009).

The *Bassia scoparia* show less affinity to uptake nickel and accumulated Ni in their shoot, the increase in the uptake of the Ni was not that significant as the Ni concentration increase in the soil from 0.4ppm in the shoots of *Bassia scoparia* planted in soil treated with 50ppm of Ni to 4.5ppm in the plant grown in soil treated with 100ppm of Ni, as shown in fig. 3. These results are consistent with (Sasaki *et al*., 2003), where he observed the accumulation of some heavy elements in the roots and leaves of *Phragmites australis* more than in the soil, which helps to be used as an indicator of contamination of elements on contrary, the roots of *Bassia scoparia* was more effective in removing Ni from the soil and the increase in the Ni load in the soil increase the uptake of the Ni from the soil in control with 0.4gm to 1.8 and 2.2 in soil treated with 50 ppm and soil treated with 100ppm of Ni respectively, as shown in fig. 4. This is due to the fact that high concentrations of heavy elements are tolerated and stackable within the specific Hermel tissues (Carvalho *et al*., 2001, Memon *et al*., 2001).

After that the effects of the two contaminant on each other when they presented in soil together, as shown in

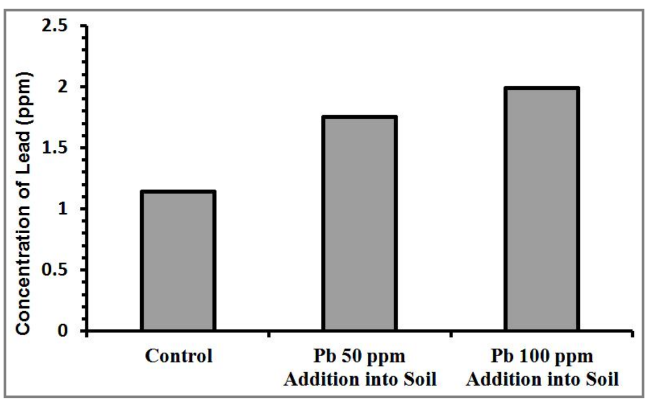

Fig. 1: Concentration of Lead on Shoots of *Bassia scoparia*

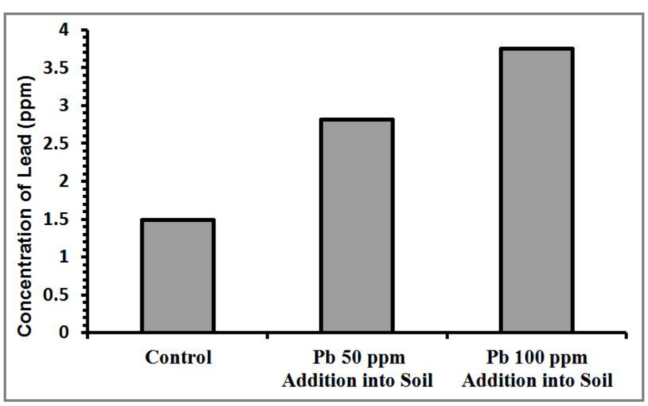

Fig. 2: Concentration of Lead on Roots *Bassia scoparia*

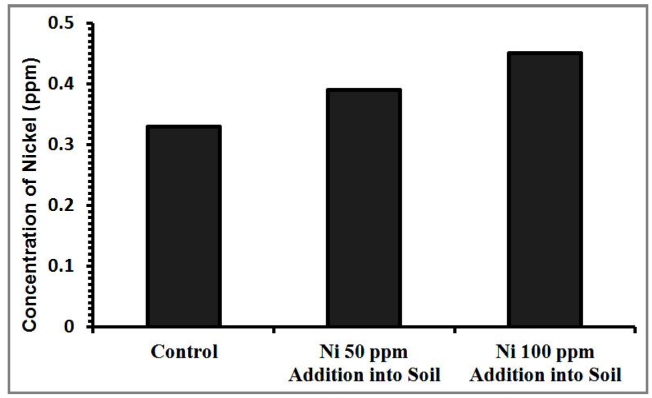

Fig. 3: Concentration of Nickel on Shoots *Bassia scoparia*

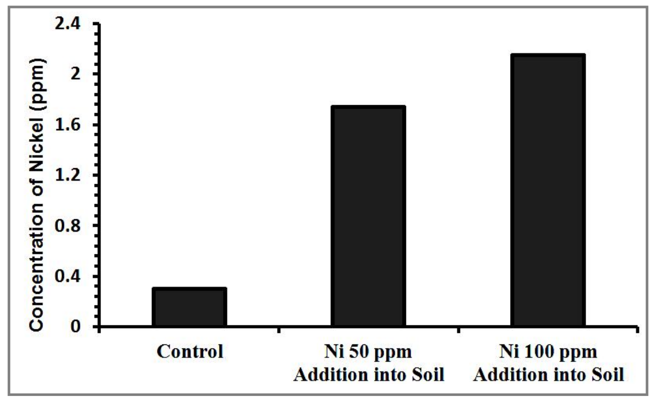

Fig. 4: Concentration of Nickel on Roots *Bassia scoparia*

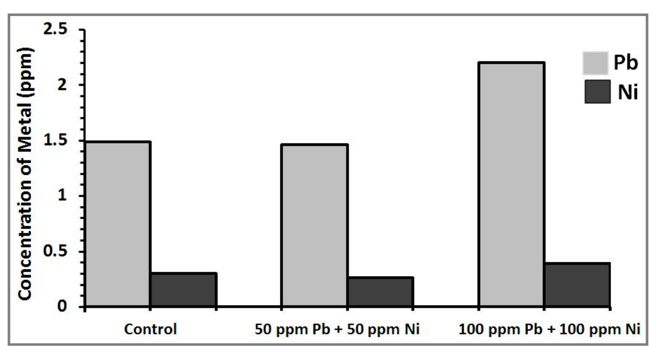

Fig. 5: Concentration of Lead and Nickel on Shoots *Bassia scoparia*

fig. 5 at the concentration of 50ppm there was a competition between the two contaminant to be up taken by the plant so it was almost similar to the control, while when applied at concentration of 100ppm the Ni lead to increase of Pb accumulation in the shoot from 1.5 ppm in the control to 2.2 ppm when grown in soil treated with 100ppm of lead as well as 100 ppm of nickel together. The high concentration of lead in the group of vegetables compared to the root of the plants studied and this difference may be due to the ability of these plants to collect lead in the group Khodria This is noted both (Mukhtar *et al*., 2010, Chehregani and Malayer, 2007).

Conclusion

Pollution by heavy metals has been of great concern in the last decades because of their health hazards to man and other organisms when accumulated within a biological system. It is evident that Phytoremediation has benefits to restore balance to a stressed environment, this study demonstrated the potential of *Bassia scoparia* to remediate Pb, Ni contaminated soil. The plant show good ability to uptake the heavy metals from the soil. The concentrations of the studied heavy elements were found to be the highest concentration in the root system compared with the shoot system.

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