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Treating Agricultural Soils Contaminated with Cadmium and Copper Using Plant Species

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Abstract This field study was conducted on four types of plants, namely sun flower *Helianthus pumilus* L., turnip, *Brassica rapa* L. carrots *Daucus caro* L. and Indian mustard *Brassica juncea* L, to find out the ability of these plants on resisting the toxicity of heavy elements from agricultural soils. The results of the concentration elements of cadmium and copper for the root system showed that the highest value of cadmium was 0.466 mg. Kg^{-1} in the mustard plant treated without fertilization, whereas that for copper was 19.750 mg. Kg^{-1} observed in the turnip. As for the bioconcentration factor, the results for the cadmium and copper components were recorded. The highest mean values for the bioaccumulation factor were 0.242 ± 0.02 in the Indian mustard and 0.908 ± 0.028 in the turnip.

Keywords Cadmium, Copper, Plant specie

1. Introduction

Soils can be contaminated with many inorganic chemical compounds which, upon entry to the soil, become part of it and thus affect all forms of life. These inorganic compounds are toxic to humans and animals when they are present in the soil with high concentrations, with their toxicity varying based on the type of toxic element they include [1]. The most important sources of agricultural soil pollution with heavy elements come from fertilizers used to stimulate the life of plants. The use of these elements is incompatible with the global rules and regulations. The pesticides used excessively in agriculture and combustion products include coal and crop residues, as well as the use of part of the silt from treatment plants [2]. Exposure of agricultural soil to pollution with heavy elements and those pollutants they are mixed with causes agricultural soil to lose its fertility and results in the killing of bacteria responsible for the decomposition of the organic materials and stabilizing the soil nitrogen. In addition, plants absorb these elements found in the soil which then reach the human beings through the food chain [3]. The severity of the heavy elements is due to the fact that they are transitional elements with the ability to form fixed complexes with a large group of organic and inorganic compounds present in the bodies of living organisms [4]. The bioconcentration factor (BCF) indicates the efficiency of the plant in withdrawing or extracting heavy elements from the soil and concentrating them in its tissues [5]. It reflects the ratio between the concentration of the element in the root to that in the soil [6], where the higher the value of BCF the more suitable is the plant for extraction [7].

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2. Materials and Methods

Field work

This study was conducted in one of the fields with an area of 400 square meters in the district of Bani Saad, which belongs to the city of Baquba, for the autumn season 2018, where the field was a part of a survey of agricultural lands Concentration of elemental cadmium and copper. The land was divided into 4 sections for planting of 4 types of plants, each section including 6 transactions, 3 for each of the fertilizer and non-fertilization groups. The land of the experiment was plowed in two perpendicular plows by means of a flip-flop plow, smoothed with the use of disc combs, and divided into plates with dimensions of 4 x 5.2 m. The seeds of sunflower were manually planted on 9/7/2018, turnip and carrots on 8/18/2018, and mustard on 7/9/ 2018, by placing 3 seeds in each hole. The land of the experiment was irrigated immediately after planting, with the first three irrigations made in close intervals with a rate of one irrigation every two days, then irrigation continued at a rate of two irrigations per week until the physiological maturity stage. Plants were reduced to a single plant per a hole when they reached a height of 20 cm, and experimental units were grassed whenever needed. The first dose of the liquid fertilizer (Alga seaweed) was added 30 days after planting, while the second dose was added 15 days after the first one.

Estimation of elements in the soil

According to a previous method [8], 1 g of soil samples were taken and 3: 1 ml of nitric acid and hydrochloric acid were added and left for 24 hours after the mixture was placed on a hot plate for 45 minutes. These steps were performed in the Hood Cabin VK-15 Fe. The solution was then transferred to a volumetric flask and the volume was brought up to 100 ml by adding ion free-distilled water. Concentrations of the elements were then measured using an ICP - OES type Ultima 2 JY according to a previous method [9].

Estimation of elements in the root

Plant samples were digested according to a previous protocol [10], by taking 0.5 g of crushed samples, adding 10 ml of sulfuric acid for 24 hours, placing the mixture on a hot plat for one hour at a temperature of 150 C, and adding 0.5 ml of perchloric acid with raising the temperature to 250 C for half an hour. These steps were performed in the Hood Cabin type VK-15 Fe, after which the mixture was stransferred to a 50 ml volumetric flask and the volume was completed using ion-free water. The concentrations of cadmium, copper, nickel and lead were measured using an ICP-OES type Ultima 2 JY according to a previously described method [9].

Bioconcentration factor

The bioconcentration factor is used to determine the amount of heavy element that the plant absorbs from the soil. It is an indicator that shows the ability of the plant to collect the heavy element in its tissues and is calculated using the following equation.

$$BCF = (Metals)root /(Metals)soil \quad (1)$$

3. Results and Discussion

Concentration of elemental cadmium and copper in the root system

Table (1). Concentration of Cd and Cu (mg.Kg^{-1}) in the root of the study plants

plants	treatment	concentration	
		Cd	Cu
Sunflower	fertilization	0.100±0.00	5.800±0.23
	non-fertilization	0.100±0.00	0.88±5.166
Turnip	fertilization	0.100±0.00	4.966±0.77
	non-fertilization	0.133±0.03	19.750±15.5
Carrots	fertilization	0.100±0.00	8.433±1.76
	non-fertilization	0.100±0.00	17.233±10.3
Indian mustard	fertilization	0.100±0.00	3.700±0.00
	non-fertilization	0.466±0.31	4.766±0.97

The results in table 1 show that the mean concentration of cadmium in the root ranged between (0.466±0.31 - 0.100±0.00) mg. Kg^{-1}, The Indian mustard non-fertilizing recorded a treatment the highest concentration, followed by turnip non-fertilization and then the rest of the plants. The men concentration of copper ranged between (19.750±15.5 - 0.88±5.166) mg. Kg^{-1}, whereas the turnip non-fertilizer recorded the highest concentration and the Sunflower non-fertilizer the lowest concentration. This may be due to the transport of cadmium and copper from the root to the vegetative system, leaving low concentrations in the root.

Bioconcentration factor (BCF)

It is noted from table 2 that there were no statistically significant differences between the me theans upon using the organic fertilization and the lack of it, however, the differences between the mean of plant species were significant for the mean bioconcentration factor, with the highest value was for cadmium in mustard (0.242 ±0.02) and the lowest mean bioconcentration factor value was in sun flower (0.123 ±0.02). These differences can be attributed to the difference in the type of plants used in the study from the types used in other studies. As for the absence of significant differences between fertilization and non- fertilization, it indicates that cadmium does not need the presence of chelating substance during its entry into the plant.

Table (2). The values of the bioconcentration factor for cadmium in plants grown in two fertilized and non-fertilized soil

The plants	Treatment		mean
	Non-fertilization	fertilization	
Sunflower	0.136±0.03	0.109±0.03	0.123±0.02
Turnip	0.189±0.03	0.233±0.03	0.212±0.02
Carrots	0.161±0.03	0.142±0.03	0.152±0.02
Indian mustard	0.955±0.03	0.172±0.03	0.242±0.02
mean	0.202±0.01	0.162±0.01	-------
L.S.D	Plant: 0.525	Treatment: N.S	Collinearity N.S

*(P< 0.05)

Table (3). The values of the bioconcentration factor for copper in plants grown in two fertilized and non-fertilized soil

The plants	Treatment		mean
	Non-fertilization	fertilization	
Sunflower	0.078±0.40	0.121±0.40	0.099±0.28
Turnip	1.68±0.40	0.132±0.40	0.908±0.28
Carrots	0.338±0.40	0.206±0.40	0.272±0.28
Indian mustard	0.144±0.40	0.118±0.40	0.131±0.28
mean	0.561±0.20	0.144±0.20	------
L.S.D	Plant: N.S	Treatment: N.S	Collinearity N.S

*(P< 0.05)

Table 3 shows that there were no significant differences between the means of the plant treatments and fertilization factors for the bioconcentration factor of the copper element, as the highest value of the mean bioconcentration factor in the turnip plant reached (0.908 ±0.28), while the sunflower plant recorded the lowest value of (0.099 ± 0.28). These differences may be due to several reasons, including the increase in the value of pH that reached to 8.72, which could lead to a lack of suitability of the element for the plant and increases the strength of the adsorption of copper on the colloidal surfaces of the soil grains. Another reason can be the excessive use of phosphate and nitrogen fertilizers, which act on reducing the absorbed quantities of copper.

4. Conclusions

The Indian mustard plant has the ability to withdraw and accumulate cadmium in the root system by measuring the elements concentration in the root system and calculating the bioconcentration factor.

The results indicated that the turnip plant has the ability to withdraw and accumulate copper element in the root system and calculating the bioconcentration factor.

REFERENCES

[1] Al-Khatib, Alsayed Ahmed. (2004). Soil pollution. The Egyptian Library for Printing, Publishing and Distribution. The Egyptian Arabic Repulic.

[2] Seddik, Hassan and yasri, Nael. (2010). Environmental chemistry. Directorate of university books and publications. Aleppo university publications –Faculty of Science.

[3] Abd Almonem, Issam Muhammad and Alturki, Ahmed bin Ibrahim. (2012). Heavy elements are their sources and damage to the environment. Publication of the most promising research center in biological control and agricultural information – qassim university – Saudi Arabia.

[4] Al-Sayed, Jamal Owais. (2007). Chemical pollutants of the environment. Dar Alfajr for publishing and distribution. Cairo-Egypt.

[5] Sajad, M.A., Khan, M.S. and Ali, H., 2019. 42. Lead phytoremediation potential of sixty-one plant species: An open field survey. Pure and Applied Biology (PAB), 8(1), pp. 405-419.

[6] Yoon, J. M., Van Aken, B. and Schnoor, J. L. (2006). Leaching of contaminated leaves following uptake and phytoremediation of RDX, HMX, and TNT by poplar. International Journal of Phytoremediation., 8(1): 81-94.

[7] Blaylock, M. J., Salt, D. E., Dushenkov, S., Zakharova, O., Gussman, C., Kapulnik, Y., Ensley, B. D. and Raskin, I. (1997). Enhanced accumulation of Pb in Indian mustard by soilapplied chelating agents. Environ. Sci. Tech., 31; 860–865.

[8] Cottenie, A., Verloo, M., Kiekens, L., Velghe, G., & Camerlynck, R. (1982). Chemical Analysis of Plant and Soil laboratory of analytical and Agrochemistry. State University Ghent, Belgium, 100-129.

[9] EPA. (1991) Methods for the detemination of metals in environmental samples office of research and development wasshington DC 20460.

[10] AOAC (Association of Official Analytical Chemists) (1995). Official methods of Analysis of the AOAC. W. Hortwitz (ed.), 15 edn. Washington: D.C., AOAC, 858 p.

[11] Yoon, J., Cao, X., Zhou, Q., & Ma, L. Q. (2006). Accumulation of Pb, Cu, and Zn in native plants growing on a contaminated Florida site. Science of the total environment, 368(2-3), 456-464.