International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:2, No:7, 2008

Investigation of Heavy Metals Uptake by Vegetable Crops from Metal-Contaminated Soil

Azita Behbahaninia, and Seid Ahmad Mirbagheri

***Abstract*—**The use of sewage sludge and effluents from wastewater treatment plants for irrigation of agricultural lands is on the rise particularly in peri-urban areas of developing countries.

The reuse of nutrients and organic matter in treated wastewater and sewage sludge via land application is a desirable goal. However, trace or heavy metals present in sludge pose the risk of human or phytotoxicity from land application. Long-term use of sewage sludge, heavy metals can accumulate to phytotoxic levels and results in reduced plants growth and/or enhanced metal concentrations in plants, which consumed by animals then enter the food chain. In this research, the amount of heavy metals was measured in plants irrigated with wastewater and sludge application. For this purpose, three pilots were made in a Shush treatment plant in south of Tehran. Three plants species, spinach, lettuce and radish were selected and planted in the pilots.First pilot was irrigated just with wastewater of treatment plant and second pilot was irrigated with wastewater and sludge application .Third pilot was irrigated with simulated heavy metals solution equal 50 years of irrigation. The results indicate that the average of amount of heavy metals Pb, Cd in three plant species in first pilot were lower than permissible limits .In second pilot, Cadmium accumulations are high in three species plants and more than the standard limits. Concentration of Cd , Pb have exceed their permitted limits in plants in third pilot . It was concluded that the use of wastewater and sludge application in agricultural lands enriched soils with heavy metals to concentrations that may pose potential environmental and health risks in the long-term.

***Keywords*—**Soil, contaminate, heavy metals, wastewater, sludge, plants.

I. Introduction

DURING last decade, there is a growing concern about usable water resources decrease. Currently, the world is moving towards water crisis. Water shortage is an important concern in arid areas such as Africa, Southern Asia and Middle East and even in some parts of the world which it may lead to a war crisis [1].On the other hands continued population growth, increased per capital water consumption and increased water requirements for industry and irrigation result in considerable decrease of usable water resources. Therefore, treated wastewater recycling into the hydrological cycle is of significant importance and has many benefits [2]. The major uses of treated wastewater are in agricultural irrigation, industrial activities and groundwater recharge. Although the concentration of heavy metals in sewage effluents are low, long-term use of these waste waters on agricultural lands often results in the build-up of the elevated levels of these metals in soils [3]. Extent of build-up of metals in wastewater-irrigated soils depends on the period of its application [4]. Crops raised on the metal contaminated soils accumulate metals in quantities excessive enough to cause clinical problems both to animals and human beings consuming these metal rich plants [5].The benefits of sludge and effluent include water, organic matter, phosphate, nitrogen. Risks include the toxic metals which should be minimized wherever possible [6]. Since food chain contamination is one of the major routes for entry of metals into the animal system, monitoring the bioavailable pools of metals in contaminated soils has generated a lot of interest [7].

The large city of Tehran in Iran produces about 2 millions m^3/day of wastewater, which is planned to be treated in wastewater treatment plants and the effluent and sludge from treatment plants is going to be used for the irrigation of crops is more than one hundred thousands hectare of agricultural lands is the plains south of Tehran. This is the main reason to research, the effects sewage sludge and effluents from treatment plants on heavy metals accumulation in plants. In this land agricultural vegetables is cultivated regularly and there is a risk that most of crop species is polluted, furthermore crop species exercise differentially in accumulating metals in their issue.

II. Procedure

In this research, the amount of heavy metals was measured in plants irrigated with wastewater and sludge application. For this purpose, three plots, each size 2 by 6 were made in a Shush treatment plant in south of Tehran. The plots had been moldboard plowed and disked each time and thereafter .Some chemical physical properties of the soil measured before the sludge and effluent application. The concentration of Cd and Pb in the effluents and sludge also, were measured before irrigation. Three plants species, alfalfa, basil and cress were selected and planted in the plots. First plot was irrigated just with effluent from wastewater of treatment plant and second plot was irrigated with simulated heavy metals solution equal 50 years of irrigation. Third pilot was irrigated with

Paper submitted July 2, 2008. This work was supported by Azad University, Science and research, Wastewater treatment plant, Shosh, South of Tehran, Iran.

Azita Behbahaninia, PhD student, Environmental Science, is with Islamic Azad University, Science and Research Campus, Tehran Iran (phone: +98-9121323734; fax:+98-21-88950037; e-mail : Azitabehbahani@yahoo.com).

S. A. Mirbagheri is with Civil and Environmental Engineering Department, K. N. Toosi University of Technology, Tehran, Iran (e-mail: Seyedahmad_mirbagheri@yahoo.com).

wastewater and sludge application. The plots were cultivated at spring 2007. In September 2007 soil samples were taken from each plot. Plant samples were dried at 70 C in hot air oven, and then the samples were converted to ash in 450 C by electrical furnace. The samples digested in a HNO3 and HCl [8]. Pb and Cd in the plant digests were determined an atomic absorption by spectrophotometer (AAS,Perkin Elmer model 560).

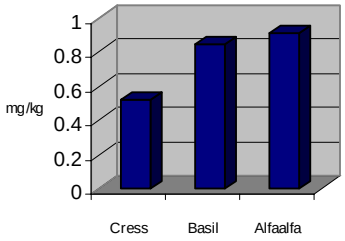

Fig. 1 The mean concentration of Pb in plants-plot 1

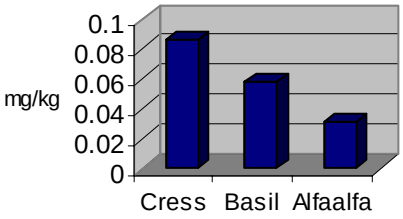

Fig. 2 The mean concentration of Cd in plants-plot 1

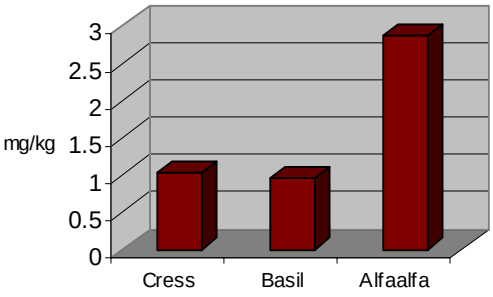

Fig. 3 The mean concentration of Pb in plants-plot 2

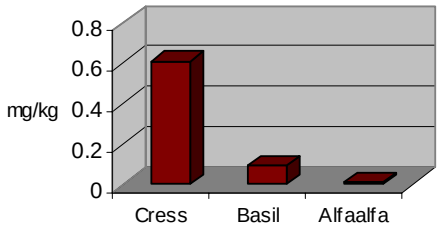

Fig. 4 The mean concentration of Cd in plants-plot 2

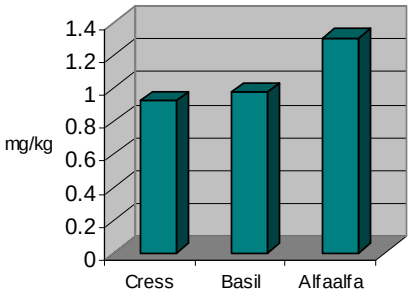

Fig. 5 The mean concentration of Pb in plants-plot 3

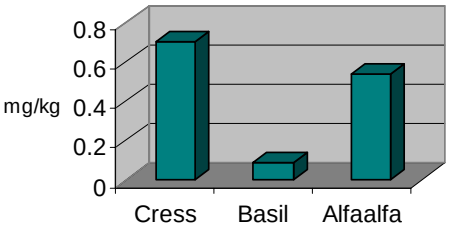

Fig. 6 The mean concentration of Cd in plants-plot 3

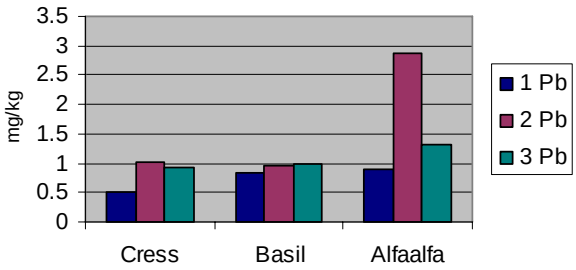

Fig. 7 The comparison of Pb in plants in different plots

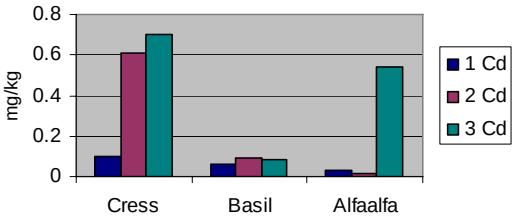

Fig. 8 The comparison of Cd in plants in different plots

III. Results

The mean concentrations of Pb and Cd in vegetables in different plots are shown in Fig. 1 to Fig. 6.

The results indicate that the average of amount of heavy metals Pb, Cd in three plant species in first plot were lower than permissible limits .In second plot, Cadmium accumulations are high in Cress species and more than the standard limits. Concentration of Cd, Pb has exceeded their permitted limits in plants in third plot.

The comparison mean concentrations of heavy metals in plants in plots are shown in Fig. 7 to 8. According to Fig. 7

the most concentration of Pb was found in Alfalfa, 2.858 mg/kg in plot 2 and the least in Cress 0.520 mg/kg in plot 1. Fig. 8 shows the most concentration of Cd, Cress 0.611 mg/kg in plot 2 and the least, Alfalfa 0.013 mg/kg in plot 1. Standard permissible limits for Pb and Cd in Iran is 0.5mg/kg and 0.1 mg/kg. Therefore from the above-mentioned results and analyses carried out on the plants, it could be concluded that vegetables under sewage sludge application in plot 3 uptake heavy metals more than permissible limits. In general, care should be exercised for irrigation of raw edible vegetables people may be reluctant to use the vegetables irrigated by wastewater effluent, although most of them don't know about this concern. Sledges higher toxic metal contents should not be applied to agricultural land.

It was concluded that the use of wastewater and sludge application in agricultural lands enriched soils with heavy metals to concentrations that may pose potential environmental and health risks in the long-term.

REFERENCES

[1] N. Jaafarzadeh, Effect of wastewater of Shiraz city for crops irrigation on heavy metal increase in soil and plants.Proceedings of the second national water and soil congress, Published by agricultural education and development organization, Tehran, Iran, 396, 1996.

[2] K. Naddafi, N. Jaafarzadeh, M. Mokhtari, B. Zakizadeh and M.R. Sakian. Effects of wastewater stabilization pond effluent on agricultural crops. Int. J. Environ. Sci. Tech. , Vol. 1, No. 4, pp. 273-277, Winter 2005.

[3] R.K. Rattan, S.p.Datta, A. K. Singh. Effect of long term application of sewage effluents on available water status in soils under Keshopure Effluent Irrigation Scheme in Delhi, J. Water manage.vol.9 pp.21-26, 2001.

[4] R.L. Bansal, V.k. Nayyar and P.N. Takkar. Accumulation and bioavailability of Zn,Cu, Mn and Fe in soils polluted with industrial waste water, J. Indian Soc.Soil Sci. Vol.40 pp.796-799, 1992.

[5] K.G.Tiller, Essential and toxic heavy metals in soils and their ecological relevance, Trance. XIII Congr. Inter.Soc.Soil Sci.Vol .1, pp 29-44, 1986.

[6] L. Chaney. Crop and food chain effects of toxic elements in sludges and effluents.Proceeding of the joint conferences on Recycling Municipal Sludges and Effluents on Land July, 1973.

[7] R.K. Rattan, S.p. Datta, P.K. Chhonkar, K.Suribabu and A.K.Singh. Long-term of irrigation with sewage effluents on heavy metal content in soils, crops and groundwater. Agriculture, Ecosystem and Environment J. pp.1-21.

[8] AOAC, Official methods of Analysis, Chater 9, pp. 22, 2000.