Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.4, No.10, 2014 www.iiste.org

The Potential of *Amaranthus caudatus* as a Phytoremediating Agent for Lead

*Mohammad M. Abubakar, [2]Umar S. Anka, [3]Mani M. Ahmad, [3]Balarabe U. Getso
[1]Department of Biological Sciences, Federal University Dutse, Nigeria
+2348036165319, mmabubakar2005@gmail.com
[2]Department of Works and Housing, Ministry of Local Government, Kano State, Nigeria
[3]Department of Biology, Kano University of Science and Technology, Wudil
***Correspondance Author**

Abstract
The potential of *Amaranthus caudatus* as a phytoremediating agent was studied, using lead spiked soil to grow the plants. The effect of the concentration of lead on plant growth was studied. The main aim of the study was to assess the accumulation of lead (Pb) in different compartments of the plant. The plants were grown in soils treated with solutions corresponding to 25, 50, 75 and 100 ppm of Pb. The plants were than separated into roots, stems and leaves and dried at 60^0C in a convection oven for 48 hours.The metals from the plant were extracted using wet digestion process. Pearson's coefficient correlation analysis was used to measure the relationship between Pb concentration in the soil and in plant tissues. The highest concentration was recorded in the roots of plants at 50 ppm concentration. *A. Caudatus* plants exposed to 25 ppm of Pb showed highest increase in root and stem growth. The lowest root growth was observed in plants exposed to 100 ppm of Pb. There is a negative relationship between the concentration of Pb in the soil and that in the above ground plant tissues.
Key Words: Accumulation, Amaranthus, Lead**,** Phytoremediation,

1. Introduction

The increasing urbanization coupled with the exponential growth of human population over the past 30 years have resulted in environmental build-up of waste products, of which heavy metals are of particular concern. Lead(Pb) is an important heavy metal posing threats to environmental quality and human health, because it is being used for a wide range of industrial, urban and agricultural applications (Appel and Ma, 2002). Conventional methods applied to clean up Pb from the environment are mostly expensive and in some cases harmful to the environment (Opeolu *et al*; 2005).
Phytoremediation is the use of plants to clean up a contamination from soils, sediments or water. This technology is environmental friendly and cost effective (Tangahu *et al*; 2011). Successful phytoremediation require plants that are capable of producing high biomass, while accumulating large amounts of heavy metals (Tu *et al*; 2002). Vegetables of the family Amaranthaceae have been found to absorb Pb from the soil (Yusuf *et al*; 2002, Opeolu *et al*., 2005 and Mellem, 2008).

Amaranthus caudatus, is a popular edible plant in Nigeria with high nutritional value (Odegba and Sadiq, 2002). This plant was chosen because it was widely cultivated all year round and can attain maturity within a number of days. The aim of the study is to assess the accumulation of Pb in different compartments of the plant. And to examine the effect of Pb concentration on the growth of the plant.

2. Methodology

2.1 Growing A. caudatus plants
The inflorescences of A. caudatus were collected from a vegetable garden in Kano. The seeds were removed and stored in plastic bottles. The seeds were allowed to germinate for one week in potting soil. The soil collected had a loam texture, with the following physico – chemical parameters; pH 7.07, moisture contents 16% Potassium; 125 ppm, Phosphorus 92 ppm, Calcium 1290 ppm, Magnesium 760 ppm, Sodium 102 ppm, Lead 12ppm.
Twenty uniform seedlings all having reached a 5 leaf stage in growth were planted at uniform distances apart in pots and placed in a green house.

2.2 In vitro metal exposure
Lead nitrate [Pb (NO_31_2)] was used to prepare solution that was used to spike (treat) the soil, for the culture experiments. Soil treated with solutions corresponding to 25, 50, 75 and 100 ppm of Pb was prepared. And twenty seedlings were transplanted on separate pots and an untreated pot was used as a control. The pots were placed in trays to prevent any leachate from being lost. (Giordani *et al.*, 2005)

2.3 Metal analysis

Three plants from each treatment were harvested after 5 days without damaging the roots and revised in distilled water. The plants were than separated into roots, stems and leaves and dried at 60^0C in a convection oven for 48 hours.

The metals from the plant were extracted using wet digestion process described by Wang *et al.,* (1999).

2.4 Data Analysis

Pearson's coefficient correlation analysis was used to measure the relationship between Pb concentration in the soil and in plant tissues.

3. Results and discussion

The growth response of *A, caudatus*, at five leaf stage is presented in fig. 1 and 2. The concentration of Pb in plant parts ranged from 2ppm to 172ppm (Table 1).

The highest concentration was recorded in the roots of plants at 50 ppm concentration. The concentration was generally higher in roots than in other parts of the plant. This is possibly because of low translocation from roots to shoots. Results from studies with other species also revealed similar pattern. Malkowski *et al*., (2002) observed same in maize. A few plant species have been reported to accumulate Pb to high concentrations in the aerial parts. These plants are called hyperaccumulators (Jarvis and Leung, 2002).

The highest bioaccumulation factor was recorded in plants exposed to 50 ppm concentration of Pb. It was therefore evident from the results that the ability of the plant to take up Pb from the soil optimally is only possible at 50 ppm, which has a bioconcentration factor of 2.6.

Plants exposed to 100 ppm of Pb showed highest concentration in leaves relative to other concentrations. This is because plants have limited ability to transport Pb to aerial parts. Similar results were observed in *Thlaspi rotundifolium* and *Thlaspi caerulescens* by Reeves and Brooks, (1983).

A. Caudatus plants exposed to 25 ppm of Pb showed highest increase in root and stem growth. This is because at higher doses of Pb, growth rate of plants is slowed. This finding is similar to the observation made by Kibria *et al*., (2010) and Kopittke *et al*., (2007). Nehnevajova (2005) reported reduction in dry weight of cowpea and sunflower respectively with increase in dose of Pb.

The lowest root growth was observed in plants exposed to 100 ppm of Pb. This is probably because high doses of Pb might inhibit growth in plants. In a similar study on *A. dubius* it was observed that plants exposed to Pb at 25 and 75 ppm showed uniform growth rate and slightly lower growth rate at 100 pmm (Mellem, 2008).

There is a negative relationship between the concentration of Pb in the soil and that in the stem and leaves. However the relationship with the roots is positive (Table 2).

References

Appel C. and Ma, L. (2002). Heavy metals in the environment concentration, pH and surface charge effects on Cd and Pb sorption in three tropical soils *journal of environmental Quality* (JEQ) vol. 21: 154 – 155.

Giordani, C; Cecchi, S. and Zanchi, C. (2005) phytoremediation of soil polluted by Nicked using Agricultural crops. *Environmental Management,* 36: 675 – 681.

Jarvis, M. D and Leung, D. W. M. (2002) Chelated lead transport in *Pinus radiata*: an ultrastructural study. *Environ. Explor. B. F*., 48: 25 – 32.

Kopittke, P.M; Asher, C. J., Kopittke, R. A. and Menzies, N.W (2007). Toxic effects of Pb^{2+} on growth of cowpea (*Vigna unguiculata*). *Environ. Pollut*. 150: 250 – 287.

Kibria, M. G; Osman, K.T., Islam, M; and Ahmammad, M. J. (2010). Effect of Applied Lead on the growth and Accumulatin of Lead in Indian Spinach in three textural groups of soils. *The Chittagong University. J.B. Sci*; Vol. 5 (1 &2): 113 – 124.

Malkowski, E; Kita, A., Galas, W., Karez, W. and Kuperburg, J. M. (2002). Lead distribution in corn seedlings (*Zea mays* L.) and its calcium. *Plant Growth Regul*. 37: 69 – 76.

Mellem, J. J. (2008). Phytoremediation of Heavy metals using *Amarantus dubius*. M. Sc. thesis Durban University of Technology, Durban, South Africa. 78 – 88.

Nehnevajova, E (2005). Non GMO Approach for the improvements of heavy metal accumulation and extraction of high yielding crop species for efficient phytoextraction of contaminated soil. Ph.D. thesis. School of Architecture, Civil and Environmental Engineering, Swiss Federal Institute of Technology Lausanne (EPFL).

Odegha, V.J and Sadiq A.O. (2002). Effect of speed engine oil on the growth parameters, chlorophyll and protein level of *Amaranthus hybridus*. The *Enviromentalist*, 22:23-28.

Opeolu, B.O., Bamgbose, O., Arowolo, T. A. and Kadiri, S. J. (2005). Phyto-remediation of Lead-contaminated soil using *Amaranthus cruentus*. Paper presented at the farm management Association of Nigeria conference, Asaba, Nigeria. October 18 – 20.

Reeves, R. D. and Brooks, R. R. (1983). European species of *Thlaspi* L. (craciferea) as indicators of nickel, and zinc. *J. Geochem. Explor*., 18: 275 – 283.

Tangahu, B. U; Abdullah, S.R.S; Basri, H., Idris, M., Anuar, N and Mukhsin, M (2011) A Review on Heavy metals (As Pb, and Hg) uptake by plants through phytoremediation. *International journal of Chemical Engineering*. Vol. 2011:

Tu, C; Ma, L. and Bhaskar B. (2002). Plant and Environment interactions Arsenic Accumulation in the hyper accumulator Chinese Brake and its utilization potential for phyto-remediation. *Journal of environmental quantity (*JEQ) vol. 31:1671-1675.

Wang, X., Zhuang, Z., Sun, D., Hong, J., Wu, X., Lee, F; Yang, M. and Leung, H. (1999). Trace metals on traditional Chinese Medicine. A preliminary Study using ICP–MS for metal determination and as speciation. *Atomic Spectroscopy*, 20: 86 – 91.

Yusuf A.A; Arowolo, T. and Bamgbose O. (2002). Cd, Cu and Ni levels in vegetables from industrial and residential Areas of Lagos city Nigeria. *Global journal of Environmental Sciences* vol. 1:1-3.

Table 1. Concentration of Pb in plant parts

Pb Conc.	Root	Stem	Leaves	Bcf
25ppm	14 ± 4	8 ± 1	9 ± 1	1.2
50 ppm	172 ± 3	29 ± 4	13 ± 2	2.6
75 ppm	125 ± 2	19 ± 2	6 ± 1	2.0
100 ppm	32 ± 2	12 ± 1	14 ± 2	0.5
Control	3 ± 1	2 ± 1	2 ± 1	0.1

Table 2. Correlation coefficient between concentrations of Pb in soil and in plant compartments.

Pb Conc.	Root	Stem	Leaf
25 ppm	0.912**	0.331	0.179
50 ppm	0.925**	0.445*	0.345
75 ppm	0.929**	0.402*	0.191
100 ppm	0.936**	0.329	0.399
Control	0.311	0.219	0.192

**** Highly significant**

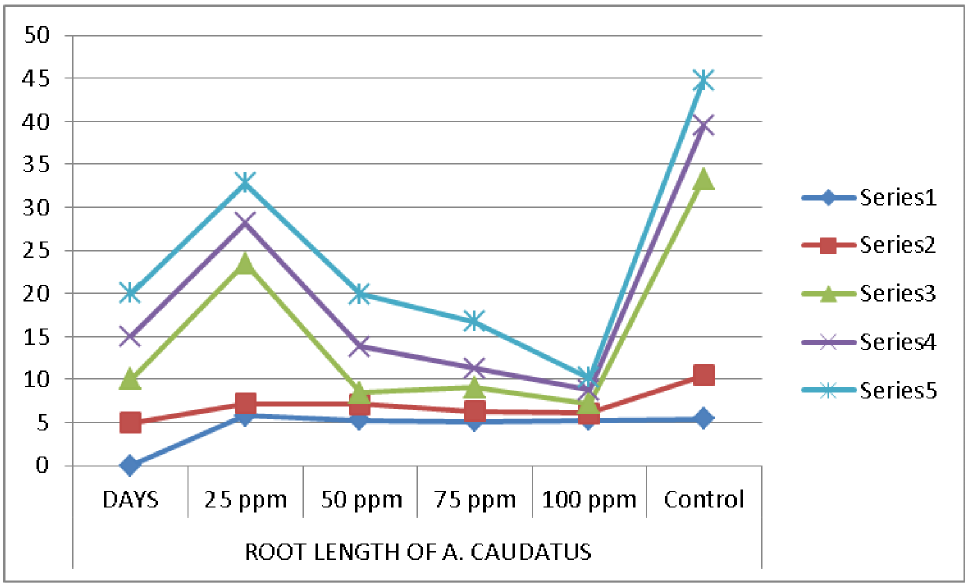

Figure 1. Root length of A. caudatus at day twenty

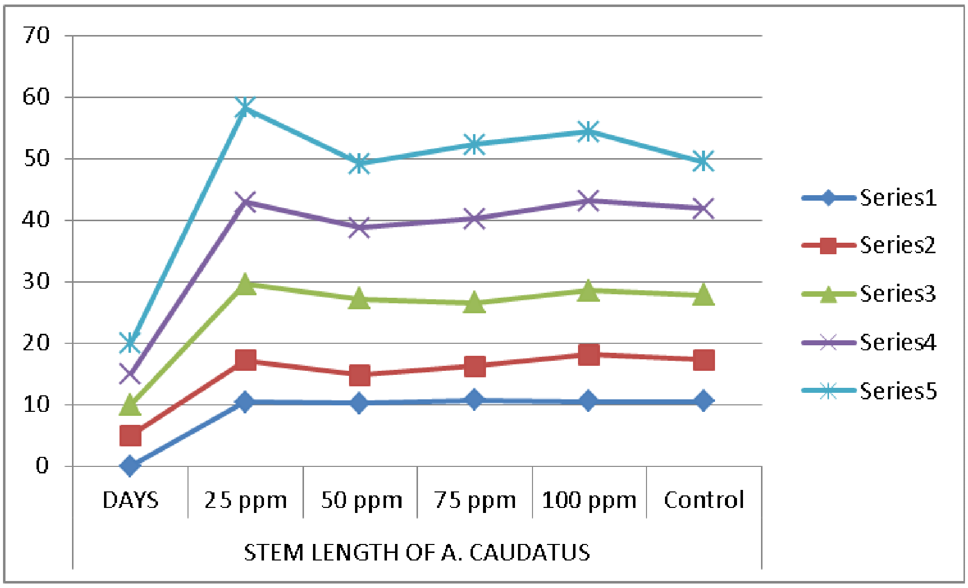

Figure 2. Stem length of A. caudatus at day twenty