International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 5 Issue 4, April 2018 | ISSN: 2394-4404

Remediation Potential Of Different Organic Waste Supplemented With Mineral Fertilizer In Heavy Metal Polluted Soils Along Asa River, Ilorin, Kwara State Nigeria

Adegbite, M.A.

Sanda, A.R.

Department of Soil Science, Kebbi State University of Science and Technology Aliero, Kebbi State, Nigeria

Affirnih, K.O.

Department of Agronomy, Faculty of Agriculture, University of Ilorin, Ilorin-Nigeria

Adegbite, A.O.

Paelon Memorial Clinic, No 6 Musa Yaradua Off Kofo Abayomi Street, Victoria Island Lagos State, Nigeria

***Abstract:** Sediments are sources and sink of heavy metals, consequently, sustainable reuse requires low cost and environmental friendly strategies. A pilot field test implementation of organically amended Asa River Sediment was conducted at the University of Ilorin Dam site to evaluate the effectiveness of three selected organic wastes singly or in combination with NPK as bio-stimulating agent using maize as test crop. Randomized Complete Block design in split-split plot arrangement was adopted using three local amendments: abattoir effluent (AE), poultry droppings (PD) and rice husk (RH) at two levels with and without NPK fertilizer. Soil samples collected before and after planting were analysed for heavy metals (Mn, Fe, Pb, Zn, Cu, Co, Ni, Cr, Cd) using Atomic Adsorption Spectrophotometer. The results shows that application of AE was more effective in bioremediating heavy metals in Asa River Sediment with a reduction of 98.93 in soil, 99.78 in plant tissue and 99.97 grain compared to rice husk with 98.66% in soil, 99.76 in plant tissue and 99.97 in grain and poultry droppings with 98.90% in soil, 99.67 in plant tissue and 99.97 in grain respectively. Heavy metals in the remediated soil varied in the order Mn>Fe>Pb>Zn>Cu>Co>Ni>Cr>Cd which were below the maximum permissible limit as set by FAO/WHO. Abattoir effluent is therefore identified to be a cheaper, safer and better organic waste with high remediating potential in heavy metal contaminated environment.*

***Keywords:** Asa River, biostimulation, heavy metals, maize, sediments.*

I. INTRODUCTION

Advancement in technology which focuses on building better standard of living for man has resulted in the exploitation and poor management of natural resources and the consequent environmental pollution arising from such exploitations. Environmental issues such as climate change, land degradation, air and water pollution have become of major concern all over the world (Agwu and Kalu, 2012). In Nigeria, environmental degradation through the indiscriminate disposal of domestic, agricultural and industrial waste without considering the health and environmental implications is alarming. And the present treatment method does not seem to solve the environmental problems arising from it. However, present advances and scientific researches in science are developing more environmentally friendly treatment method of pollutants in the environment (US EPA, 2006).

The severe contamination of soils with heavy metals may threaten the health of humans as well as plants and animals. In addition soil highly contaminated with metals may disrupt the physical, chemical, and biological balance of the soil. Although heavy metals contaminated soils affect the growth of plants, a number of species have adopted to tolerate high concentrations of heavy metals (Liphadzi and Kirkham 2005; Friesl, *et al*.,2006 and George *et al*., 2007).

There is a need to remediate such areas to reduce the risk of food chain contamination. *In situ* immobilization techniques are particularly beneficial compared to the conventional techniques (Zeng *et al*., 2010). Among different techniques, application of organic and inorganic fertilizers reduced the heavy metal availability to the plants (Singh *et al*., 2010). Continuous application of inorganic fertilizers leads to an imbalance in the nutritional properties of the soil, but in combination with organic fertilizers, can mitigate loss of nutrients due to modification of the physico-chemical properties of the soil (Mahmoud *et al*., 2009). Furthermore, recent studies has shown the importance of soil organic matter interms of heavy metal sorption by soils, because of tendency of transition metal cations to form stable complexes with organic ligands (Elliott et al., 1996). Organic matter is known to form strong complexes with heavy metals (Krogstad, 1983). The content of organic matter affects speciation of heavy metals in soil (Lo et al., 1992). High organic matter content was reported to decrease concentrations of Cd and Ni in soil solution (Arnesen and Singh, 1999).

The Asa River is one of the two major rivers in Ilorin, Kwara State, Nigeria. It receives effluents from a beverage, soap and detergent, metal fabricating industries, and domestic wastes amongst others (Eniola and Olayemi, 1999).

The Asa River is used for various purposes; domestic, industrial, farming, swimming and so on, both-within and outside Ilorin town. The sediments of a River constitute a sink to pollutants that get into the water; the aquatic animals feed on the sediments and some of these pollutants get ingested and absorbed.

Therefore, this study was aimed at remediating Asa River Sediment by biostimulating it with three local amendments i.e. poultry droppings, abattoir effluent and rice husk with or without N.P.K. fertilizer.

II. MATERIALS AND METHODS

SITE DESCRIPTION

The research was carried out at the University of Ilorin Dam, Ilorin, Kwara State, Nigeria. The site was located in the Southern Guinea Savanna (SGS) belt at longitude N08^{0}28.049' and latitude E004^{0}39.798', approximately 344.7m above the sea level. The average temperature is 28^{0}C and an annual rainfall is 1100-1400mm per annum.

Sediments were collected from four different locations which include Amilegbe (N08^{0}29' 42.33", E004^{0}33'53.9"), Post office (N08^0 28'29' 16.6", E004^{0}33'39.6"), Unity (N08^0 28' 28'50.3", E004^{0}33'40.6"), Coca-Cola (N08^0 28' 26.7", E004^{0}33'40.6"). These samples were mixed to form a single composite sample. Soil sediments were collected from the dredged part of the river and part of the soil samples were air-dried and sieved through 2mm sieve for pre-planting soil chemical properties analysis and determination of heavy metal concentration contained in the sediment.

The organic amendments used include rice husk, abattoir effluent and poultry dung. Rice husk was gotten from Rice Milling Market at Iyana Oja Gboro, Ilorin, while abattoir effluent was collected from Ilorin Abattoir Center, Ipata market, Ilorin and poultry dung from Unilorin Poultry Unit at the Teaching and Research Farm, Ilorin, Kwara State. All samples were collected in clean bags and plastic containers as appropriate prior to analysis and field incorporation.

LAND PREPARATION

The experimental site was ploughed, harrowed and ridged after clearing. The contaminated soil was deposited at the surface of the soil at a rate of 50kg per plot (given a total of 41, 67 t/ha) to a depth of 30 cm on which planting was done. Each operation had a three days interval. The land was arranged in plots (3m x 4m) with four ridges per plot.

EXPERIMENTAL LAYOUT

Randomized Complete Block design in split plot arrangement was adopted, using three (3) treatments: Rice Husk (RH), Poultry Dung (PD) and Abattoir Effluent (AE) at two levels i.e 1.6 lit/plot (1.3 t/ha), 3.2lit/plot (2.6 t/ha) with or without NPK, having three (3) replicate. The treatment combination followed a randomized arrangement.

PLANTING

Two seeds of Swan 1 maize were planted per hole at a spacing of 75 x 25cm on a 3m x 4m plot having a total of 40holes per plot which gave a plant density of 40stands per plot, where the two end rows served as the border rows.

MANAGEMENT PRACTICES

Organic amendments (i.e abattoir effluent of 1.6 lit/plot (1.3 t/ha), 3.2lit/plot (2.6 t/ha), while rice husk and poultry dung of 10 t/ha and 15 t/ha) were incorporated into the soil at two weeks prior to planting (to ensure decomposition and mineralization), while NPK fertilizer (20:10:10) was applied 3 weeks and 5weeks after planting at a rate of 120 kg per hectare.

Supplementary weeding was done at 3 weeks after planting and six weeks after planting prior to harvesting. The experiment was carried out in dry season and water was supplied through irrigation at an interval of 3days.

CHEMICAL PROPERTIES OF SEDIMENT

Asa River Sediment were analyzed for pH in H_2O and KCl, Nitrogen, Organic carbon, Organic matter, Calcium, Magnesium, Sodium, Potassium, Acidity, Available P, Cat ion Exchangeable Capacity, Iron, Manganese, Zinc, Copper, Cobalt, Chromium, Cadmium, Nickel and Lead.

SOIL CHEMICAL ANALYSIS

The pH was determined by the method outlined by Bates (1954) using an electronically Jenway 3015 pH meter at ratio of 1:2.5 in soil/water and KCl, Exchangeable acidity of the soil was determined by titration method using 1N KCl extract as described by Rhoades (1982). Organic carbon was determined using wet oxidation method of Walkley and Black (1934) as described by Jackson (1996) while available phosphorus was determined using Bray 1 (Bray and Kurtz, 1945) method and Nitrogen was determined using micro-Kjelhdal distillation method by AOAC (1999).

Exchangeable cations of calcium, magnesium, potassium and sodium were extracted with an excess of 1M NH_4OAc (ammonium acetate) as described by Anderson and Ingram, 1993. Effective cat ion exchangeable capacity (ECEC) was calculated by the summation of exchangeable bases (Ca, Mg, K, Na) and exchangeable acidity.

Heavy metals were determined by weighing 5g of air-dried soil sample in a 250ml of plastic bottle fitted with an air tight screw cap. 50ml of 1% ethylenediaminetetracetic acid (EDTA; which was obtained by dissolving 10g of EDTA in 1000mls of water), added and shaken for 1hour. The suspension was filtered using Whatman Filter Paper No. 42. The filtrate was then analyzed using atomic absorption spectrophotometer (AOAC, 1980).

Extraction of heavy metals **(**Cr, Cd, Pb, Ni, Cu, Zn, Co, Mn, Fe) was done by weighing 1g of dried grounded plant tissue and seed into 100ml of beaker and 5ml of nitric acid (HNO_3) and 2ml of perchloric acid ($HClO_4$) and cover with watch glass. It was then digested and heated to a final volume of 3-5ml. 10-15ml of distilled water was added and the digest was filtered through an acid washed filter paper into a 50ml volumetric flask. The filtrate was then analyzed using Atomic Absorption Spectrophotometer (Linder and Harley, 1942).

STATISTICAL ANALYSIS

Analyses of variance was carried out using Genstat and mean values was separated using the Duncans multiple range test (DMRT) at $P \leq 0.05$ as outlined in Kerr *et al.* (2002).

III. RESULT AND DISCUSSION

Chemical Properties	Soil	Abattoir Effluent	Rice Husk	Poultry dung
Organic carbon%	0.5			
Organic Matter %	0.87			
pH in H_2O	9.3			
pH in KCl	8.9			
Acidity	0.4			
Nitrogen%	0.07	1.06	0.67	0.71
Available P	0.046	24.52	26.30	25.38
Exchangeable Ca (Cmol/kg)	2.79	11.58	9.29	13.1
Exchangeable Mg (Cmol/kg)	0.14	0.61	0.97	2.16
Exchangeable K (Cmol/kg)	0.02	0.55	0.31	0.48
Exchangeable Na (Cmol/kg)	0.11			
Cation exchange capacity	3.06			
Chromium mg/kg	25.3			
Cadmium mg/kg	0.5			
Nickel mg/kg	2.5			
Lead mg/kg	9.1			
Manganese mg/kg	350.5			
Iron mg/kg	25,250			
Copper mg/kg	9.65			
Zinc mg/kg	54.7			
Cobalt mg/kg	1.9			

Table 1: Initial chemical analysis of soil and organic amendment

Table 1 below shows the initial soil chemical properties of Asa River sediment, in which the organic matter content of the sediment was ranked low at (0.0.87%), while the nitrogen content of the sediment also ranked as low (0.07). The pH of the sediment showed 8.9 in KCl which means that the sediment was alkaline in nature and available phosphorus was also seen to be extremely low (0.046). Calcium was observed to be low, magnesium and potassium were also observed to be extremely very low and sodium also observed to have low value (0.11). Cation exchange capacity of the sediment was observed to fall below the range considered to be low. The chemical analysis of the sediment showed that the soil is low in terms of fertility. The heavy metal analysis of the sediment revealed that all metals fall below maximum permissible limit as set by USEPA except manganese (350.5mg/kg). Table 1 also revealed that abattoir effluent has a high nitrogen content of (1.06) as compared to rice 0.67 and poultry dung of 0.71% respectively. Table 1 further revealed that rice husk has the highest total phosphorus level of 26.30 (mg/l) which is followed by poultry dung and the least was abattoir effluent, potassium was also observed to be highest at abattoir effluent (0.55) which was then followed by poultry dung and rice husk being the least.

Treat./Levels	Co (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ni (mg/kg)
Control	0.30	58.07	0.04	0.00	1.80	0.45	4.23	0.47	0.10
RH10 t/ha	0.35	66.13	0.08	0.01	1.30	0.85	8.20	0.53	0.10
RH15 t/ha	0.21	47.77	0.04	0.01	1.43	0.64	2.87	0.55	0.07
RH10 t/ha + NPK	0.30	62.83	0.07	0.01	1.50	0.51	2.83	0.42	0.07
RH15 t/ha + NPK	0.34	69.77	0.17	0.003	1.30	0.53	6.17	0.38	0.03
Control	0.30	58.07	0.04	0.00	1.80	0.45	4.23	0.47	0.10
AE 1.3 t/ha	0.18	46.87	0.04	0.01	1.53	0.57	3.00	0.48	0.07
AE 2.6 t/ha	0.24	43.97	0.04	0.01	1.47	0.59	2.37	0.51	0.03
AE 1.3t/ha + NPK	0.34	47.87	0.04	0.003	1.50	0.51	4.33	0.45	0.10
AE 2.6 t/ha + NPK	0.31	44.23	0.12	0.003	1.70	0.52	4.20	0.38	0.00
Control	0.30	58.07	0.04	0.00	1.80	0.45	4.23	0.47	0.10
PD10 t/ha	0.24	55.60	0.04	0.01	1.50	0.82	2.60	0.55	0.07
PD15 t/ha	0.31	47.00	0.07	0.01	1.77	0.86	3.73	0.62	0.07
PD10 t/ha + NPK	0.33	48.00	0.05	0.003	1.37	0.81	2.93	0.50	0.07
PD15 t/ha + NPK	0.24	40.50	0.04	0.00	1.37	0.79	4.13	0.42	0.07
SED	0.066	4.39	0.052	0.002	0.276	0.091	0.590	0.068	0.026
LSD(0.05)	ns	*	Ns	ns	ns	ns	**	ns	Ns
USEPA	50	80	400	3	300	200	NL	50	50

*Keys: NS: Not significant, NL: No limit, PD: Poultry dung, AE: Abattoir Effluent, RH: Rice Husk, USEPA: United State Environmental Protection Agency, *Significant at 0.05%, **Significant at 0.001%, ***Significant at <0.001%, LSD(0.05); Least significant difference across the column*

Table 2: Effect of different levels of organic wastes on heavy metal availability in soil after cropping

Table 2 shows the concentration of each metals analysed after cropping. Cobalt was not significant at p>0.05 interms of the different treatment levels applied. Although there was significant reduction in concentration with the least obtained

ISSN: 2394-4404

at sole application of AE1.3t/ha and the highest at sole application of RH15t/ha. Table 2 further revealed that Mn was significant at $p>0.05$ with the highest concentration obtained at combined application of rice husk and NPK at RH15t/ha + NPK and the lowest concentration observed at PD15t/ha + NPK. Cr was not significant at $p<0.05$ with the highest reduction in concentration observed at control, RH15t/ha, AE1.3t/ha, AE2.6t/ha, 1.3t/ha + NPK, PD10t/ha, PD15t/ha + NPK with RH15t/ha + NPK having the highest Cr concentration after cropping. Cd was observed not to be significant at $p<0.05$ with highest reduction in concentration recorded at control and PD15t/ha + NPK. Similarly, Pb was also not significant at $p<0.05$ with control having the highest reduction in concentration. Furthermore, Zn also was not significant at $p<0.05$ with the highest reduction observed at control and lowest at PD15t/ha. Fe was observed to be significant at $p<0.05$ with the highest reduction in concentration recorded at AE 1.3t/ha + NPK and lowest reduction recorded at RH10t/ha. Cu was not significant at $p<0.05$ with highest reduction in concentration observed at RH15t/ha + NPK and AE2.6t/ha + NPK and the lowest concentration at PD15t/ha. Ni was observed to be significant at $p<0.05$ with highest reduction in concentration observed at AE2.6t/ha + NPK and the lowest reduction observed at control and AE1.3t/ha + NPK. Heavy metals in soil after cropping in table 2 follows these trend: Mn > Fe> Pb> Zn> Cu> Co> Ni> Cr> Cd.

Treat./Levels	Co (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ni (mg/kg)
Control	0.02	7.73	0.027	0.003	0.27	0.60	8.93	0.17	0.033
RH10 t/ha	0.25	6.00	0.057	0.003	0.20	0.97	6.00	0.14	0.033
RH15 t/ha	0.12	6.90	0.023	0.00	0.17	0.95	1.67	0.10	0.00
RH10 t/ha + NPK	0.08	7.45	0.03	0.003	0.20	0.53	2.17	0.14	0.033
RH15 t/ha + NPK	0.05	3.80	0.037	0.007	0.23	1.21	4.67	0.16	0.033
Control	0.02	7.73	0.027	0.003	0.27	0.60	3.93	0.17	0.033
AE 1.3 t/ha	0.09	11.35	0.027	0.007	0.17	0.83	0.83	0.25	0.00
AE 2.6 t/ha	0.10	5.50	0.067	0.00	0.13	0.87	3.60	0.10	0.00
AE 1.3t/ha + NPK	0.09	10.64	0.043	0.00	0.27	0.58	2.83	0.23	0.00
AE 2.6 t/ha + NPK	0.06	1.98	0.013	0.003	0.17	1.33	0.30	0.15	0.00
Control	0.02	7.73	0.027	0.003	0.27	0.60	3.93	0.17	0.033
PD10 t/ha	0.08	6.78	0.013	0.003	0.30	0.72	2.10	0.25	0.00
PD15 t/ha	0.05	12.30	0.027	0.003	0.17	1.06	5.73	0.26	0.00
PD10 t/ha + NPK	0.01	9.27	0.02	0.003	0.20	1.16	7.07	0.19	0.03
PD15 t/ha + NPK	0.29	18.90	0.027	0.003	0.27	1.41	4.30	0.21	0.03
SED	0.106	1.324	0.013	0.004	0.069	0.247	1.541	0.040	0.026
LSD(0.05)	Ns	***	*	Ns	Ns	ns	**	*	ns
WHO	50	30	50	0.5	0.3	50	1000	20	2

*Keys: NS: Not significant, NL: No limit, PD: Poultry dung, AE: Abattoir Effluent, RH: Rice Husk, WHO: World Health Organization, *Significant at 0.05%, **Significant at 0.001%, ***Significant at <0.001%, LSD(0.05); Least significant difference across the column*

Table 3: Effect of different levels of organic wastes on heavy metal uptake by maize tissue after cropping

Table 3 shows that Co was not significant at $p<0.05$, although there was reduction in concentration of cobalt with the highest reduction in concentration observed at PD10t/ha and the lowest reduction at PD15t/ha + NPK in plant tissue. Mn was observed to be significant at $p<0.05$ with the highest reduction in concentration observed at AE2.6t/ha + NPK and the lowest at PD15t/ha + NPK. Cr was also observed to be significant at $p<0.05$ with the highest reduction observed at AE2.6t/ha + NPK, PD10t/ha and the lowest reduction in concentration recorded at AE2.6t/ha. Cd was not significant at $p<0.05$ with the highest reduction in concentration were observed at RH15t/ha, AE2.6t/ha, AE1.3t/ha + NPK and the lowest reduction at RH15t/ha + NPK, AE1.3t/ha. Pb was not significant at $p<0.05$ with highest reduction in concentration observed at AE2.6t/ha and lowest reduction in concentration observed at PD10t/ha. Zinc also was observed not to be significant at $p<0.05$ with highest reduction in concentration recorded at RH10t/ha + NPK and lowest reduction at PD15t/ha + NPK. Fe was observed to be significant at $p<0.05$ interms of the different levels of organic waste applied and the highest reduction in concentration was recorded at AE2.6t/ha + NPK and control having the least reduction in concentration. The different levels of organic waste response to the uptake of Cu was also observed to be significant at $P<0.05$ with highest reduction recorded at RH15t/ha + NPK and AE2.6t/ha whereas PD15t/ha showed the least reduction in concentration of Cu. Table 3 also revealed that Ni was not significant at $p<0.05$ with the highest reduction in concentration observed at RH15t/ha, AE1.3t/ha, AE2.6t/ha, AE1.3t/ha + NPK, AE2.6t/ha + NPK, PD10t/ha and PD15t/ha. Uptake and availability of heavy metals in plant tissue after cropping in table 3 follows the same trend like soil: Mn > Fe> Pb> Zn> Cu> Co> Ni> Cr> Cd.

Treat./Levels	Co (mg/kg)	Mn (mg/kg)	Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ni (mg/kg)
Control	0.06	0.23	0.03	0.00	0.03	1.22	0.17	0.08	0.00
RH10 t/ha	0.04	0.16	0.03	0.00	0.10	0.75	0.1	0.03	0.00
RH15 t/ha	0.04	0.22	0.01	0.007	0.20	1.18	0.27	0.06	0.00
RH10 t/ha + NPK	0.03	0.11	0.03	0.003	0.13	0.94	0.30	0.05	0.00
RH15 t/ha + NPK	0.02	0.20	0.03	0.003	0.07	0.12	0.10	0.06	0.00
Control	0.06	0.23	0.03	0.00	0.03	1.22	0.17	0.08	0.00
AE 1.3 t/ha	0.15	0.15	0.02	0.007	0.03	0.95	0.23	0.06	0.03
AE 2.6 t/ha	007	0.11	0.02	0.003	0.10	1.21	0.13	0.05	0.00
AE 1.3t/ha + NPK	0.08	0.19	0.03	0.003	0.13	1.10	0.00	0.06	0.00
AE 2.6 t/ha + NPK	0.05	0.13	0.04	0.003	0.17	1.01	0.13	0.07	0.00
Control	0.06	0.23	0.03	0.00	0.03	1.22	0.17	0.08	0.00
PD10 t/ha	0.04	0.37	0.04	0.007	0.10	0.96	0.17	0.05	0.00
PD15 t/ha	0.04	0.15	0.04	0.00	0.03	0.88	0.13	0.05	0.00
PD10 t/ha + NPK	0.06	0.19	0.04	0.003	0.07	1.25	0.23	0.07	0.00
PD15 t/ha + NPK	0.10	0.15	0.02	0.00	0.13	0.76	0.03	0.05	0.00
SED	0.042	0.072	0.014	0.004	0.072	0.174	0.114	0.018	0.012
LSD(0.05)	ns	ns	ns	ns	ns	*	ns	ns	Ns
FAO/ WHO	50	500	2.3	0.2	0.3	99.4	425.5	50	67

*Keys: NS: Not significant, NL: No limit, PD: Poultry dung, AE: Abattoir Effluent, RH: Rice Husk, /FAOWHO: Food And Agricultural Organization /World Health Organization, *Significant at 0.05%, **Significant at 0.001%, ***Significant at <0.001%, LSD(0.05); Least significant difference across the column*

Table 4: Effect of different levels of organic wastes on heavy metal uptake by maize grain

Table 4 shows that Co was not significant at $p<0.05$ interms of uptake by maize grain. Highest reduction in Cobalt was observed at RH15t/ha + NPK and the lowest reduction at PD15t/ha + NPK in plant tissue. Mn was not significant at $p<0.05$ with the highest reduction in concentration observed at RH10t/ha + NPK, AE1.3t/ha + NPK and the lowest at PD10t/ha + NPK. Cr was also observed not to be significant at $p<0.05$ with the highest reduction observed at RH15t/ha + NPK. Cd was not significant at $p<0.05$ with the highest reduction in concentration observed at control, RH10t/ha, PD15t/ha, PD15t/ha + NPK and the lowest reduction at RH15t/ha, AE1.3t/ha and PD10t/ha. Pb was observed not be significant at $p<0.05$ with highest reduction in concentration recorded at control, AE1.3t/ha, PD15t/ha and lowest reduction in concentration observed at RH15t/ha. Zinc also was observed to be significant at $p<0.05$ with highest reduction in

ISSN: 2394-4404

concentration recorded at RH15t/ha + NPK and PD10t/ha + NPK while the lowest reduction was observed at RH10t/ha + NPK. Fe was not significant at $p<0.05$ interms of the different levels of organic waste applied and the highest reduction in concentration was recorded at AE1.3t/ha + NPK, with RH10t/ha + NPK recorded the least reduction in concentration. The different levels of organic waste response to the uptake of Cu was also observed to be significant at $P<0.05$ with highest reduction recorded at RH10t/ha whereas PD10t/ha + NPK and AE2.6t/ha + NPK showed the least reduction in concentration of Cu. Table 4 also revealed that Ni was not significant at $p<0.05$ with the least reduction in concentration observed at AE1.3t/ha. Table 4 also follows the same trend of Mn > Fe> Pb> Zn> Cu> Co> Ni> Cr> Cd in maize grain.

`Therefore, the finding of this research has established the fact organic wastes are an effective technique in remediating contaminated soil and this agrees with the findings of Sauvè *et al*., 2003 who asserted that organic matter acted as a primary sorbent of heavy metals in contaminated soils. Basta and McGowen (2004) also opined that addition of organic matter amendments immobilize heavy metals for soil amelioration and as a result, increase pollutant removal efficiency (Wang *et al.* 2012, Clemente *et al.,* 2003). Several researchers have also explored the potential of compost in remediating heavy metals (Roman et al., 2003; Castaldi et al., 2005; Simon, 2005).

Furthermore, elevated or increased heavy metals in plants from the amended soil could be attributed to the high nutrient content of the poultry feed confirm earlier assertion by other investigators Mbah and Asegbeke, (2006).

IV. CONCLUSION

From the result of this study, it can be concluded that organic wastes were found to be effective in remediating Asa River Sediment 99.93% in abattoir effluent, 98.66% in rice husk and 98.90% in poultry dropping) and also in reducing uptake by plant tissue (99.77% in abattoir effluent, 99.76% in rice husk and 99.67% in poultry dropping) and maize grain (99.97% in abattoir effluent, rice husk and poultry dropping).

Abattoir effluent was found to be more effective in bioremediating heavy metal in Asa River Sediment at sole application of 1.3 t/ha and 2.6 t/ha than poultry dropping and rice husk. Abattoir combination with NPK at 2.6t/ha+NPK was also observed to have had the highest reduction in terms of uptake by plant tissue and grain.

Contrary to several researches that had investigated abattoir effluent dumpsite and concluded that this waste is a contaminant, this study therefore shows that abattoir effluent has proven to have remediating potential in heavy metal contaminated soil when applied in a little quantity.

REFERENCES

[1] Agwu, A. and Kalu, A.U. (2012). Bioremediation and Environmental Sustainability in Nigeria. International Journal of Academic Research in Progressive Education and Development, Vol. 1, No. 3 ISSN: 2226-6348

[2] Anderson, J.M. and Ingram, J.S.I. (1993). Tropical Soil Biology and Fertility: A Handbook of Methods. Second edition. CAB International, Wallingford, UK. p.37

[3] Arnesen, A. K. M. and B. R. Singh, 1999. Plant uptake and DTPA- extractability of Cd, Cu, Ni and Zn in a Norwegian alumshale soil as affected by previous addition of dairy and Pig manures and peat. Can. J. Soil Sci., 78: 531–539.

[4] AOAC International (formerly the Association of Official Analytical Chemists), 1999. Official Methods of Analysis. Arlington, VA: AOAC International.

[5] Association of Official Analytical Chemist, (1980). Official Methods of Analysis. 13th edition. AOAC, Washington, DC.

[6] Baste, N.T., and McGowen, S. L. (2004): Evaluation of chemical immobilization treatments for reducing heavy metal transport in a smelter-contaminated soil. Environmental Pollution 127, 73–82.

[7] Bates R.G, (1954). Electromeric pH determination. John Willey and sons Inc., New York, USA., Pp 87-92.

[8] Bray, R.H. and Kurtz, L.T. (1945), Determination of total, organic, and available forms of phosphorus in soils. Soil Science, 59: 39-45.

[9] Castaldi, P., Santona, L., Melis, P. 2005. Heavy metal immobilization by chemical amendments in a polluted soil and influence on white lupin growth. Chemosphere 60: 365-371.

[10] Clemente, R., Walker, D.J., Roig, A., Bernal, M.P. (2003). Heavy metal bioavailability in a Soil affected by mineral sulphides contamination following the mine spillage at Aznalcollar (Spain). Biodegradation 14:199-205

[11] Elliot, H. A., M. R. Liberati and C. P. Huang, 1986. Competitive adsorption of heavy metals by soils. Journal of Environmental Quality, 15: 214–219.

[12] Eniola, K.I.T. and Olayemi, AB., 1999. Impact of effiuents from a detergent producing plant on some water bodies in !lorin, Nigeria. International Journal of Environmental Health Research 9,335-340.

[13] Friesl W., Friedl J., Platzer., K. Horak O., and Gerzabek M.H. Remediation of contaminated agricultural soils near a former Pb/Zn smelter in Austria: batch, pot and field experiments. Environmental Pollution 2006; 144:40-50.

[14] George, A.F. and Snyder, C.J. (2007). Accumulation of heavy metals in Plants and potential phytoremediation of lead by Potato, Solanum tuberosum L. Journal of Environmental Science and Health Part 2007; 42: 811-816.

[15] Kerr AW, Hall HK, Kozub SA (2002). Doing Statistics with SPSS. SAGE Publications Ltd, London. pp. 163-174.

[16] Krogstad, T., (1983). Effect of liming and decomposition on chemical composition, ion exchange and heavy metal ion selectivity in sphagnum peat. Scientific Reports of the Agricultural University of Norway AAS, p. 79.

[17] Linder, R.C. and Harley, C.P. (1942). Scientific Apparatus and Laboratory Methods: A rapid method for determining nitrogen inplant tissues. Science 96:565-566

[18] Liphadzi, M.S. and Kirkham, M.B. (2005). Phytoremediation of soil contaminated with heavy metals:

ISSN: 2394-4404

a technology for rehabilitation of environment. South African Journal of Botany; 71(1): 24-37.

[19] Lo, K. S. L., Yang, W. F. and Lin, Y. C. (1992). Effects of organic matter on the specific adsorption of heavy metals by soil. Toxicol. Environ. Chem., 34: 139–153.

[20] Mahmoud, E., Kader, N. A. E., Robin, P., Corfini, N. A. and Rahman, L. A. E. (2009). Effects of Different Organic and Inorganic Fertilizers on Cucumber Yield and Some Soil Properties. World Journal Agricultural. Science, 5: 408-414.

[21] Mbah CN, Asegbeke JS (2006). Effects of Animal Waste on Physiochemical properties of a Dystic leptosol and maize yield in South Eastern Nigeria. Nigerian Journal of Soil Science, 16: 96-102

[22] Rhoades, J.D. (1982). Cation exchange capacity. In:A.L. Page (ed.) Methods of soil analysis. Part 2: Chemical and microbiological properties (2nd ed.) Agronomy 9:149-157.

[23] Roman, R., Fortun, C., De Sa, M., Almendros, G., (2003). Successful soil remediation and reforestation of a calcic regosol amended with composted urban waste. Arid Land Research and Management. 17: 297-311

[24] Sauvè S, Manna S, Turmel M. C., Roy, A. G. and Courchesne F. 2003. Solid Solution Partitioning of Cd, Cu, Ni, Pb, and Zn in the Organic Horizons of a Forest Soil. Environmental Science and Technology, 37: 5191–5196.

[25] Singh, A., Agrawal, M. and Marshall, F. (2010). The Role of Organic vs. Inorganic Fertilizers in Reducing Phytoavailability of Heavy Metals in a Wastewater-irrigated Area. Ecology. Eng.36: 1733–1740.

[26] Simon, L., 2005. Stabilization of metals in acidic mine spoil with amendments and red fescue (Festuca rubra L.) growth. Environmental Geochemistry and Health. 27: 289-300.

[27] USEPA (US Environmental Protection Agency), 2002. Region 9, Preliminary Remediation Goals.

[28] US Environmental protection Agency (2006). A Citizens guide to Bioremediation http://www.epa. gov/tio. Retreived 12-03-12

[29] Walkley, A., and T.A.Black. (1934). An examination of the Degtjarett methods for determining soil organic matter and a proposed modification of the chromic acid titration method. Journal of Soil Science, 37:29-38

[30] Wang, K., Zhang, J., Zhu, Z., Huang, H., Li, T., He, Z., Yang, X., and Alva, A.(2012). Pig manure vermicompost (PMVC) can improve phytoremediation of Cd and PAHs co-contaminated soil by Sedum alfredii, Journal Soils Sediments, 12, 1089–1099.

[31] Zeng, Y. H., Shaw, W.S., Hung, Y. L., Horng, Y. G., Ting, C. C. and Zueng, S. C. (2010). Remediation Techniques and Heavy Metal Uptake by Different Rice Varieties in Metal-contaminated Soils of Taiwan: New Aspects for Food Safety Regulation and Sustainable Agriculture. Soil Sci. Plant Nutr., 56: 31–52.