RELATIVE COMPARISM OF HUMANURE EFFECT ON SELECTED SOIL HEAVY METALS AFTER PLANTING AND AT HARVEST IN OWERRI NIGERIA

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ABSTRACT

A study was conducted at the Centre for Agricultural Research and Extension, Federal University of Technology Owerri. To evaluate the relative comparism of impact of humanure on selected soil heavy metals at 45days after planting and at post harvest in Owerri Nigeria. Five treatments were used for the experiment, the treatments comprised of T1=Control (0t/ha), T2=NPK (240kg/ha), T3=Humanure (10t/ha), T4= Humanure (15t/ha), T5= Humanure (20t/ha). The experiment was laid in a Randomized Complete Block Design (RCBD) with treatments replicated three (3) times to give a total of fifteen (15) plots. Data collected on selected soil heavy metals were: Cadmium (Cd), lead (Pb), Copper (Cu), Chromium (Cr), Nickel (Ni) and Zinc (Zn). Raw data obtained was analyzed using analysis of variance (ANOVA) and significant means were separated using Fisher least significant difference (F-LSD) at probability level of P=0.005.The results obtained indicated that application of humanure at 10t/ha, 15t/ha and 20t/ha did not increase the solubility of selected soil heavy metals beyond the FEPA and WHO standard at 45days after planting and at post harvest. The result of selected heavy metals (Cd, Pb, Cu, Cr, Ni and Zn) declined at post harvest compared to the result at 45days after planting. This could be as a result of soil decompositing the degraded humanure in a form of chemical reaction that lead to its deformation and subsequent reduction in concentration. Therefore humanure could be regarded as a good source of organic manure and farmers should do away with its use as the humanure has proved to be a good replacement to mineral fertilizer.

KEYWORDS

Heavy, Humanure, Impact,Metal, Soil.

1. INTRODUCTION

Humanure are by products of human methabolism and are formed everyday in human society (Wagne andaquel,2011). Annually, high quantity of humanure is produced due to rapid increase in Global population and urbanization (Balkhair and Ashraf, 2016) and recently, scientists are encouraging the use of organic wastes for soil enrichment in farming because wastes can supply virtually all the nutrients required by plants and improve soil physical and biological conditions for sustainable crop production and environmental safety (Ekpe *et al,* 2016). However, humanure also contains contaminants such as heavy metals, organic compounds and human pathogens which should be considered when used as fertilizer (Wagne and Raquel, 2011).

There are many methods of treating humanure and these include composting, incineration and chemical treatment(Ahansazan *et al*,2014). Treated human excreta contains organic matter and nutrients such as zinc (Zn), copper (Cu) and iron (Fe) for soil and plant improvement (Ali *et al*,2013).According to Tangahu *et al*,(2011), heavy metals are elements with metallic properties and an atomic number greater than 20.Ali *et al*,(2013) classified heavy metals as useful iron (Fe), copper(Cu), zinc (Zn), manganese (Mn) and nickel(Ni) and non useful cadmium (Cd), lead(Pb), Arsenic, mercury (Hg) and chromium(Cr).They also reported that heavy metal accumulation in soil posses serious risk/hazard to the environment, which in turn affects human health. Studies have shown that application of human excreta to the soil without proper treatment aggravated the accumulation of heavy metals which in turn transfer them to the edible part of the crops (Bouring *et al*, 2014) and (Balkhaira and Ashraf, 2016).However, the concentration of certain heavy metals in small quantity are nutritionally essential for a healthy life example iron, copper, manganese and zinc and some of these are referred to as trace elements and some of them are found naturally in fruits and vegetables, but in excess posses great danger to crops, humans and environment generally. It is therefore important to check the concentration of heavy metals in organic waste used to substitute for inorganic fertilizer to prevent solving one problem and creating a bigger one in the process. This study therefore investigated the relative comparism of impact of humanure on selected soil heavy metals at 45days after planting and at harvest in Owerri Nigeria.

2. MATERIAL AND METHODS

2.1. Site Description

The study was carried out at Federal University of Technology Centre for Agricultural Research and Extension Farm Owerri, from October 2019 to January 2020. The study site is located on latitude $5^0$23'4264"N and Longitude $6^0$57'4264"E. The study site has a humid tropical climate, annual temperature of 27-$29^0$and annual rainfall of 2,500mm (Okonkwo and Mbajiorgu, 2010).Which runs from March to December with its peak in July, through October and November. The dry season last from December to March with a dry dust and cold intervals. The soil of the study area is classified as Ultisols using the USDA soil classification and Acrisol (FAO/UNESCO), (Eshett and Anyahucha, 1992).The Ultisols, (Acrisols in the FAO\UNESCO World Soil Map) are highly acidic, coarse textured and highly leached upland soils. The soil has low mineral reserve and is therefore, low in fertility (Eshett, 1993).

2.2. Land Preparation

A total land area of 123.5m^2 (13×9.5) was used for the study. The experimental site was manually cleared using machetes, spade and hoe. Measuring tapes, pegs and ropes were used in mapping out the treatment plots. Fifteen experimental plots measuring 2.5m×2m was used for the experiment. Each plot was separated by 0.5m to prevent treatments from interfering with each other.

2.3. Experimental Materials and Treatments Allocation

Humanure treatment was sourced from works layout Owerri and was cured for one month before application to the soil. The NPK fertilizer was sourced from Agricultural Development Program (ADP) Owerri. The Treatments comprised of;

T1 - Control at 0t/ha,
T2 - NPK` 20:10:10 at 240kg/ha,
T3 - Humanure at 10t/ha,
T4 - Humanure at 15t/ha
T5 - Humanure at 20t/ha.

2.4. Experimental Design/Field Layout

The experiment was laid out in a randomized complete block design (RCBD) with treatments replicated three times as shown in figure 1.

2.5. Soil Sampling

Soil samples were collected at 0-30cm soil depth using a core sampler attached to a soil Augar according to International Institute of Tropical Agriculture, (1975) method of free sampling. Samples collected were air dried, crushed and sieved using 2mm sieve in preparatory for the determination of selected soil heavy metals.

2.6. Laboratory Analysis

The laboratory analysis was carried out at Soil Science Laboratory of Federal University of Technology Owerri, Imo State and selected soil heavy metals (Pb, Cr, Cd ,Ni, Zi and Cu) were analyzed using Perk-Elmen A Analyst Absorption Spectrophotometer (AAS).

2.7. Statistical Analysis

Data generated were subjected to a standard statistical Analysis of variance (ANOVA) based on the procedure outlined by Gomez and Gomez (1984). Significant means was separated using Fisher least significant difference (F-LSD) at a probability level of 5%.

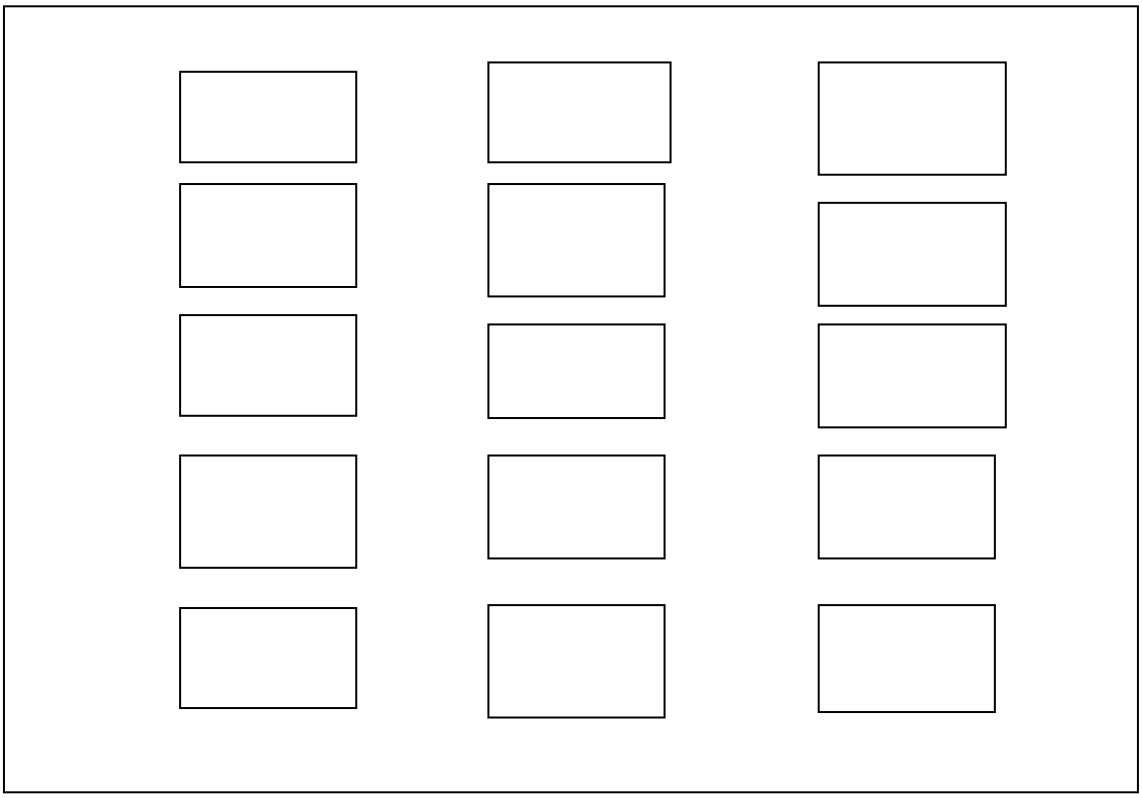

Figure 1: Field layout of the Experimental Site

3. RESULT AND DISCUSSION

3.1. Selected Heavy Metals of Experimental Soil before Humanure Application

The selected soil heavy metal concentration of the experimental soil before application of humanure treatment are presented in Table 1

Table 1. Pre-planting Soil Analysis

Soil Heavy Metalsand Units of Measurement	Value	FEPA Standard
Lead (mg/100g)0.145		5.0
Copper(mg/100g)	0.008	8.0
Chromium(mg/100g)	0.010	7.0
Cadmium(mg/100g)0.005		10.0
Nickel(mg/100g)	0.109	NF
Zinc(mg/100g)	0.042	NF

The result of the analysis of selected soil heavy metals on the experimental soil before the application of humanure treatment showed that lead concentration of the experimental soil before humanure application was low with value of 0.145 mg/100gcompared to the FEPA standard of 5.0mg/100g (Table 1).The concentration of copper (0.008mg/100g) of the experimental soil before humanure treatment application was also low compared to the FEPA standard of 8.0mg/100g.Chromium and Cadmium also recorded lower value of 0.010 and 0.005mg/100g compared to the FEPA standard of 7.0 and 10.0mg/100g respectively. Nickel and Zincalso recorded lower values compared to WHO standard of 6.5 and 15.0 mg/100g respectively,(Ogundele *et al*, 2015).

3.2. Selected Heavy Metals in Humanure Used for the Study

The selected heavy metals in humanure used for the research are presented in Table 2.

The result of the analysis of humanure used in the study showed the concentration of selected heavy metals contained in the humanure used for the study after one month of aerobic composting. The concentration of Pb (1.80/100g) was below the FEPA standard of (5.0 mg/100g), Cd recorded 0.48mg/100g, which was below the FEPA standard of (10.0 mg/100g). Cu recorded 3.60 mg/100g which was also below the permissible limit of FEPA 8.0mg/100g), Cr recorded 1.20 mg/100g and was below the FEPA standard (7.0 mg/100g). Zinc and Nickel recorded 2.30 and 2.70 mg/100g respectively which were below WHO permissible limit for Zinc 15.0 mg/100g and Nickel 6.5mg/100g.Ogundele*et al*, (2015)

Table 2. Selected Soil Heavy Metals in Humanure Used for the Study

Soil Heavy Metals/UnitsValues	
Zinc (Zn) (mg/100g)	2.30
Lead (Pb) (mg/100g)	1.80
Copper (Cu) (mg/100g)	3.60
Cadmium (Cd) (mg/100g)	0.48
Chromium (Cr) (mg/100g)	1.20
Nickel (Ni) (mg/100g)	2.70k

3.3. Effect of Humanure on Selected Soil Heavy Metal at Forty Five (45) Days after Planting and at Post Harvest

The results of effect of humanure on selected soil heavy metals at forty five (45) days after planting and at post harvest are presented in Table 3 and Table 4.

Table 3. Effect of Humanure on Selected Soil Heavy Metal at Forty Five Days after Planting

Treatment	**T1**	**T2**	**T3**	**T4**	**T5**	**F-LSD** (0.05)	**FEPA STD**
Pb	0.143^{a}	0.252^{c}	0.233^{b}	0.267^{d}	0.274^{d}	0.008	5.0
Cu	0.008^{a}	0.014^{b}	0.009^{a}	0.019^{c}	0.024^{d}	0.001	8.0
Cd	0.006^{a}	0.021^{c}	0.012^{b}	0.021^{c}	0.030^{d}	0.010	10.0
Cr	0.009^{a}	0.013^{b}	0.021^{c}	0.030^{d}	0.038^{e}	0.002	7.0
Ni	0.111^{a}	0.125^{c}	0.119^{b}	0.124^{c}	0.128^{d}	0.002	NF
Zn	0.044^{a}	0.057^{b}	0.061^{c}	0.080^{c}	0.111^{d}	0.003	NF

T1 = Control, T2 = NPK at 240kg/ha, T3 = Humanure at 10t/ha, T4 = Humanure at 15t/ha, T5 = Humanure at 20t/ha, Pb = Lead, Cu = Copper, Cd = Cadmium, Cr = Chromium, Ni = Nickel, Zn = Zinc.
NOTE: Figures with same superscript are not significantly different.

Table 4: Effect of Humanure on Selected Soil Heavy Metals at Post Harvest

Treatment	**T1**	**T2**	**T3**	**T4**	**T5**	**F-LSD** (0.05)	**FEPA STD**
Pb	0.140^{a}	0.245^{d}	0.224^{b}	0.230^{c}	0.250^{e}	0.012	5.0
Cu	0.006^{a}	0.010^{b}	0.006^{a}	0.010^{b}	0.016^{c}	0.002	8.0
Cd	0.003^{a}	0.010^{b}	0.005^{a}	0.015^{c}	0.022^{d}	0.002	10.0
Cr	0.007^{a}	0.010^{a}	0.014^{b}	0.020^{c}	0.024^{d}	0.003	7.0
Ni	0.181^{a}	0.118^{c}	0.113^{b}	0.114^{b}	0.119^{c}	0.003	NF
Zn	0.044^{a}	0.045^{a}	0.055^{b}	0.060^{c}	0.061^{c}	0.012	NF

T1 = Control, T2 = NPK at 240kg/ha, T3 = Humanure at 10t/ha, T4 = Humanure at 15t/ha, T5 = Humanure at 20t/ha, Pb = Lead, Cu = Copper, Cd = Cadmium, Cr = Chromium, Ni = Nickel, Zn = Zinc.
NOTE: Figures with same superscript are not significantly different.

3.3.1. Lead (Pb) mg/100g

The result of analysis of treatment on soil Pb at forty five (45) after planting (Table 3) showed that there were significant differences when the control plot was compared with the treatments. The control plot produced 0.109, 0.09, 0.124 and 0.131 mg/100g less in Pb than the NPK treated plot, 10t/ha, 15t/ha and 20t/ha humanure treated plot respectively. Also when the NPK treated plot was compared with the humanure treated plots at forty five (45) after planting the 10t/ha humanure treated plot, produced 0.019 less in Pbcompared with the NPK treated plot whereas the 15t/ha and 20t/ha humanure treated plot produced 0,015 and 0.022 mg/100g more in lead compared with the NPK treated plot. However, when the humanure treated plots were compared with one another at forty five (45) after planting. The 20t/ha humanure treated plot recorded the highest value of Pb and no significant differences were observed in the 15t/ha and 20t/ha. All the values recorded in the treated plots were below the FEPA standard (Table 3). Also, the result at post harvest(Table 4) showed that there were significant differences when the control was compared with the treated plots and when the treated plots were compared with one another. The control plot record 0.105, 0.084, 0.09, and 0.11 mg/100g less in lead compared with the NPK treated plot, 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. When the NPK treated plots was compared with the humanure treated plots at post harvest, the NPK treated plot recorded 0.021 and 0.015 mg/100g more in lead compared with the 10t/ha and 15t/ha humanure treated plot and 0.005mg/100g less in lead compared with the 20t/ha humanure treated plot. Also when the humanure treated plots was compared with one another at post harvest, lead concentration in soil increased as the rates of application increased, the 10t/ha, 15t/ha and 20t/ha recorded 0.224, 0.230 and o.250 mg/100g respectively. All the values obtained from the treated plots were below the FEPA standard (Table4). Again, when the concentration of Pb in soil at forty five (45) days after planting were compared with the concentration of Pb at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. All the values obtained at forty five (45) days after planting and at post harvest were lower compared to the FEPA standard (Table 3). This shows that aerobic composting of humanure lowers the availability of heavy metals which makes them less available in the soil (Garcia *et al*, 1990)

3.3.2. Copper (Cu)mg/100g

The results of the effects of treatments on soil copper at forty five (45) after planting (Table 3) showed that there were significant differences when the control plot were compared with the 15t/ha and 20t/ha humanure treated plots. The control plot produced 0.011 and 0.016 mg/100g less in Cu compared with the 15t/ha and 20t/ha humanure treated plots respectively. There was no significant difference when control was compared with the 10t/ha humanure treated plot. Also when NPK treated plot was compared with the humanure treated plots, the NPK treated plot recorded higher value than the 10t/ha humanure treated plot. Whereas the 15t/ha and 20t/ha humanure treated plots recorded 0.005 and 0.010 mg/100g more when compared with the NPK treated plot respectively. When the humanure treated plots were compared with each other at forty five (45) after planting, soil copper increased as the humanure rates increased. The increased soil copper in all the treated plots is by far below the FEPA soil permissible limit of 8.0 mg/100g, (Table 3). Also, the result obtained at post harvest showed that there were significant differences when the control plot was compared with the NPK treated plot, 15t/ha and 20t/ha humanure treated plot. The control plot recorded 0.004, 0.004 and 0.010mg/100g less in copper compared with the NPK treated plot, 15t/ha and 20t/ha humanure treated plots respectively. There was no significant difference observed when the control plot was compared with the 10t/ha humanure treated plot. When the NPK treated plot was compared with the humanure treated plots at post harvest, there was significant difference observed in the 15t/ha humanure treated plot. The NPK treated plot recorded 0.004mg/100g more in copper compared with the 10t/ha humanure treated plot and 0.006 mg/100g less in copper compared with the 20t/ha humanure treated plot. Again, when the humanure treated plots were compared with one another at post harvest,soil copper increased as the rates of application increased. The 20t/ha humanure treated plot recorded the highest value of copper content in the soil at post harvest. However, when the values of copper concentration in soil at forty five (45) days after planting were compared with the values obtained at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. This could be as a result of soil decompositing the degraded humanure in a form of chemical reaction that lead to its deformation and subsequent reduction in concentration. All the values recorded at forty five (45) days after planting and at post harvest were below the FEPA standard of 5.0mg/100g (Table 3).

3.3.3. Cadmium (Cd)mg/100g

Significant differences were observed when the control was compared with the treated plots and when the humanure treated plots where compared with one another at forty five (45) after planting. The control plot produced 0.015, 0.006, 0.015 and 0.024mg/100g less in Cdcompared with the NPK, 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. When the NPK treated plot was compared with the humanure treated plots at forty five (45) after planting, the 10t/ha humanure treated plot produced 0.009mg/100g less in Cd compared with the NPK treated plot. There was no significant difference observed when NPK treated plot was compared with the 15t/ha humanure treated plot at forty five (45) after planting. However, when the NPK treated plot was compared with the 20t/ha humanure treated plot, the NPK treated plot recorded 0.009mg/100g less in Cdconcentration compared with the 20t/ha humanure treated plot.Also when the humanure treated plots were compared with one another the 20t/ha humanure treated plot recorded the highest Cd concentration in soilat forty five (45) after planting. The results of Cd concentration at post harvest are shown in (Table 4),the result showed that there were significant differences when the control plot was compared with the NPK treated plot, 15t/ha and 20t/ha humanure treated plots. The control plot recorded 0.007, 0.012 and 0.019mg/100g less in cadmium compared with the NPK treated plot, 15t/ha and 20t/ha humanure treated plots respectively, no significant difference was observed in the 10t/ha humanure treated plot. Also when the NPK treated plot was compared with the humanure treated plots at post harvest, the NPK treated plot recorded 0.005mg/100g more in cadmium compared with the 10t/ha humanure treated plot and 0.005, 0.012 less in cadmium compared with the 15t/ha and 20t/ha humanure treated plots. When the humanure treated plots were compared with one another, the 10t/ha recorded 0.010 and 0.017 less in cadmium than the 15t/ha and 20t/ha humanure treated plots. The 20t/ha humanure treated plot recorded the highest value (0.022mg/100g) of cadmium concentration in soil at post harvest. However, when the values of Cd concentration in soil at forty five (45) days after planting were compared with the values obtained at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. All the values recorded at forty five (45) days after planting and at post harvest were below the FEPA permissible limit, (Table 3)

3.3.4. Chromium (Cr) mg/100g

The result on effect of treatments on soil Cr at forty five (45) days after planting showed that there were significant differences when the control was compared with the treatments and when the treatments were compared with one another. The control plot produced 0.012, 0.021, 0.029mg/100g less in Cr compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plot respectively. Also there was significant difference when the NPK treated plot was compared with the humanure treated plots at forty five (45) days after planting. The NPK treated plot produced 0.008, 0.017 and 0.025 mg/100g less in Cr compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. When the humanure treated plots were compared with one another at forty five (45) days after planting, the highest value was recorded in the 20t/ha treated plot. Furthermore, there were significant differences when the control plot was compared with the humanure treated plots at post harvest, the control plot recorded 0.007, 0.013 and 0.017mg/100g less in chromium compared with the 10t/ha,15t/ha and 20t/ha humanure treated plots respectively. When the NPK treated plot was compared with the humanure treated plots at post harvest, the NPK treated plot recorded 0.004,0.010 and 0.014mg/100g less in chromium compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. Again, when the humanure treated plots were compared with one another at post harvest, the 10t/ha recorded 0.006 and 0.010mg/100g less in chromium compared with the 15t/ha and 20t/ha humanure treated plots. Chromium in soil increased with increased rate of humanure application. However, when the Cr concentration in soil at forty five (45) days after planting were compared with the concentration at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. All the values obtained at forty five (45) after planting and at post harvest were below the FEPA standard of 7.0 mg/100g, (Table 3).

3.3.5. Nickel (Ni) mg/100g

The result obtained at forty five (45) after planting showed that Ni concentration increased with increasing rate of humanure application. There were significant differences when the control was compared with the humanure treated plots. The control produced 0.008, 0.013 and 0.017 mg/100g less in soil Ni compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. There were also significant difference when the NPK treated plot was compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plot at forty five (45) after planting. The NPK treated plot produced 0.006 and 0.001mg/100g more in Ni compared with the 10t/ha and 15t/ha humanure treated plots respectively, whereas the 20t/ha humanure treated plot produced 0.003 mg/100g more in soil Ni compared with the NPK treated plot. However, when the humanure treated plots were compared with one another, the 20t/ha recorded the highest value of Ni compared with the 10t/ha and 15t/ha humanure treated plots at forty five (45) after planting. Furthermore, there were significant difference when the control plot was compared with the humanure treated plots at post harvest, the control plot recorded 0.032, 0.033 and 0.036 mg/100g less in Nickel than the 10t/ha, 15t/ha and 20t/ha humanure treated plots. When the NPK treated plot was compared with the humanure treated plots at post harvest, the NPK plot recorded 0.005 and 0.004mg/100g more in Nickel than the 10t/ha and 15t/ha humanure treated plots respectively. There was no significant difference when the NPK plot was compared with the 20t/ha humanure treated plot at post harvest. Again, when the humanure treated plots were compared with one another at post harvest, the 10t/ha and 15t/ha recorded 0.006 and 0.005mg/100g less in Nickel concentration compared with the 20t/ha humanure treated plot respectively. However, when the Ni concentration in soil at forty five (45) days after planting was compared with the concentration at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. All the values obtained at forty five (45) days after planting and at post harvest were below the WHO permissible limit of 6.5mg/100g for nickel concentration in soil, Ogundele *et al*, (2015).

3.3.6. Zinc (Zn) mg/100g

The result of the effect of humanure on zinc concentration at forty five (45) days after planting showed that there were significant differences when the control was compared with the humanure treated plots, the control plot produced 0.017, 0.036 and 0.067mg/100g less in Zn compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. Significant difference were also observed when the NPK treated plot was compared with the humanure treated plot at forty five (45) days after planting, the NPK treated plot produced 0.004, 0.023 and 0.054 mg/100g less in Zn than the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. When the humanure treated plots were compared with one another at forty five (45) days after planting, soil Zn increased with increasing rate of humanure application and the highest value of Zn (0.11mg/100g) was recorded in the 20t/ha humanure treated plot while the control recorded the least value (0,044mg/100g).Furthermore, there were significant differences when the control plot was compared with the humanure treated plots at post harvest, the control plot recorded 0.015, 0.020 and 0.021 mg/100g less in zinc compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. There was no significant difference observed when the control plot was compared with the NPK treated plot at post harvest. Also significant differences were observed when the NPK treated plot was compared with the humanure treated plots at post harvest. The NPK treated plot recorded 0.010, 0.015 and 0.016 mg/100g less in zinc compared with the 10t/ha, 15t/ha and 20t/ha humanure treated plots respectively. Again, when the humanure treated plots were compared with one another at post harvest, there were no significant difference observed in the 15t/ha and 20t/ha. The 10t/ha recorded 0.005 and 0.006 mg/100g less in zinc compared with the 15t/ha and 20t/ha humanure treated plots respectively. However, when the concentration of Zinc at forty five days after planting was compared with the concentration at post harvest, the values obtained at post harvest were lower compared with at forty five (45) days after planting. All the values obtained at forty five (45) days after planting and at post harvest were below the WHO permissible limit of 15.0mg/100g for zinc in soil, Ogundele *et al*, (2015). This result confirms the findings of (Ayten *et al*, 2010) that organic amendments reduce the toxicities of heavy metal to soil.

3.3.7. Conclusion and Recommendation

This study has shown that application of humanure to the soil at the rate of 10t/ha, 15t/ha and 20t/ha did not increase the solubility of selected heavy metal (Cd, Pb, Cr, Cu, Ni and Zn) concentration in soil above the FEPA and WHO standard. Therefore the use of humanure should be adopted by farmers and its value should not be underestimated.

REFERENCES

[1] Ahansazan B.H., Afrashteh, Ahansazan N and Ahansazan Z.(2014).Activated sludge process overview. International Journal of Environmental Science and Development

[2] Ali, H., Khan E. and Sajad M.A, (2013). Phytoremediation of heavy metals-concepts and application. Chemosphere 91(7):869-881

[3] Ayten, N., Oguz, C. T., Sema, C. C and Ridvan, K., (2010).Effects of Heavy metals on soil enzyme activities.

[4] Balkhair K. S and Asharf M. A (2016). Field accumulation risks of heavy metals in soil and vegetable crop irrigated with sewage water in western region of Saudi. Arabia. Saudi Journal of Biological Sciences 32(1):32-44

[5] Bouring M. L., Algoui-sosse X., Laffray N., Rauof M., Benbrahim P. M., Badot and Alaoui- Sosse (2014)Evaluation of sewage sludge effects on soil properties, plant growth, mineral nutrition state and heavy metal distribution in European larch seedlings. Arabian Journal for science and Engineering 39(7):5325-5335

[6] Ekpe I. I.,Okere S. E., Agim L. C., Ahukemere C. M., Ihemtuge S. C, Okoye C., Onura M.D. and Nwaigwe M.O.,(2016).Effect of organic waste on soil heavy metal concentration and growth characteristics of cucumber (Cucumis sativus L.) in an Ultisol.

[7] Eshett, E. T and C. N Anyahucha (1992).Effects of low lime rates application on nodulation and grain yield of cowpea (Vignaunguiculata L. walp) and selected biochemical properties of sand Ultisol in Owerri, South East Nigeria.

[8] Eshette, E.T (1993), Wet lands and Ecotone studies on land Water National Institute of Ecology, New Delhi and international scientific publication, New Delhi, Pp: 232-234.

[9] Garcia, C., Hernandez, T. and Costa, F (1990). The Influence of composting and maturation processes on the heavy metal extractability from soil organic wastes. Biological wastes 31, 291 – 301.

[10] Gomez, A. K and Gomez, A. A (1984). Statistical procedures for Agricultural Research Second Edition John Wiley and sons inc. New York, U.S.A 462.

[11] IITA (1975).Institute for Tropical Agriculture Ibadan Nigeria annual report p.199.

[12] Ogundele, D. T., Adio, A. A and Oludele, O. E (2015). Heavy metal concentrations in plants and soil along heavy metal traffic roads in North Central Nigeria. Journal of Environment and analytical toxicology 5:334.Dol :10 4172/2161 -0525.1000334.

[13] Okonkwo G. I, Mbajiorgu C. C (2010).Rainfall intensity- Duration - Frequency Analysis for South Eastern Nigeria. Agricultural Engineering International CIGR Journal 12:22-30.

[14] Tangahu B.V.S., Abdullah R. S., Basri H., Idris M., Anuar N. and Mukhisim (2011).A review on heavy metals (As, Pb and Hg) uptake by plants through photo-remediation. International Journal of Chemical Engineering (1):1-31

[15] Wagner B. and Raquel G, (2011). Imparts of sewage sludge in tropical soil:Vol 2011,Article ID 212807.Pg 1-11