Comparative Effects Of Compost And Poultry Manure On Bioavailability Of Pb And Cu And Their Uptake By Maize(*Zea mays* L.)

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Abstract: The contamination of soil with heavy metals will have adverse effects on soil ecology, agricultural production, animal and human health as well as groundwater quality. There is a growing trend towards the development of site-specific risk assessment technologies in which the necessity for remediation is linked to human health and/or ecological risk factors associated with the contaminated site. Thus, in-situ immobilization and phytoremediation are becoming increasingly an attractive remediation options. This study examined the effects of compost and poultry manure on bioavailability and uptake of **Pb** and **Cu** by Maize (*Zea mays* L.) biomass. The experimental soil was contaminated with **Pb** and **Cu** at different rates of concentration (0, 500, 1000, and 1500 ppm), incubated for one week and amended by compost and poultry manure. Three viable maize seeds were sown in the pots each containing 3kg of amended contaminated soil sample, replicated four times, and latter thinned to two seedlings per pot. The **Pb** and **Cu** contents of the seedlings, harvested 8-week after germination, were determined using AAS. All the data generated were subjected to analysis of variance, where F-values were significant at P=0.05. The means were separated by LSD with the use of Genstat Discovery. Compost and poultry manure played significant roles on bio-availability and uptake of **Cu** metal compared to the uptake of **Pb** metal. Therefore, both amendments are recommended for cleansing a **Cu** contaminated soil. Application of compost enhanced bioavailability, uptake and, consequently, resulted in high dry matter yield in both Pb and Cu degraded soil. Highest yield was found at 1500 ppm compared to control. Also, the results showed that poultry manure fixed or absorbed **Pb** metals, the highest concentration of which were found around the root zones of the plant, compared to the compost material.

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1.0 Introduction

Several chemical and organic materials have been tested for their effectiveness in immobilizing heavy metals, and remarkable success has been achieved in cleaning up polluted water and soil with some of them (Karaca, 2004). These materials include chemical fertilizers, agricultural limestone, mineral rock phosphate, and a wide range of agricultural processing wastes including peels, husks and pods (Cao, 2004, Alvarenger, 2008). They also have the ability to bind metals with minimal social ecological disturbance, such materials can be used when the contaminated area is large, and the treatment can be sustained effectively over a long period of time (Lombi *et al.,* 2004; Bolan *et al,* 2005).

Application of organic wastes as soil amendments has raised concerns about their potential harmful effects on the environment. Although, many organic amendments are considered rich sources of plant nutrients, some, however, contain high levels of heavy metals that may be toxic to the soil and the ground water resources (Smith *et al,* 1995). However, it has been suggested that organic amendments, such as composts and manures, can immobilize lead (Pb), cadmium (Cd), and zinc (Zn) in contaminated soil. This result has been interpreted as indicating that organic matter adds sorption phases to soils, which reduce metal availability to plants (Li *et al.* 2001).

Hower, the contribution of inorganic fraction of the wastes cannot be ignored, as they may contain 30% to 60% inorganic fractions, i.e. iron (Fe), manganese (Mn) and aluminum (Al) oxides, silicates, phosphates and carbonates. The inorganic fractions of the organic amendments have shown to immobilize Pb in soil amended with organic wastes (Lombi *et al.* 2004).

According to the United Stated Environmental Protection Agency (USEPA), Pb is the most common heavy metal contaminant in the environment (Islam *et al.* 2007). It is a non-essential element in metabolic processes and may be toxic even when absorbed in small amounts. However, Pb is strongly adsorbed to soil particles (Song *et al.* 2009), organic matter, carbonate and phosphate minerals (Li *et al.* 2005), and hydrous Fe and Mn oxides (Basta *et al*. 2005). Copper is an essential element for plant growth. It is a component of numerous enzymes especially those involve in electron floe, catalyze redox reaction in mitochondria and chloroplast (Lolkema and Vooijs, 1986; Harrison *et al*., 1999; Hansch and Mendel, 2009), However its high concentration in the soil could be detrimental to plant growth as it causes chlorosis, inhibition root growth and destroy plasma membrane permeability resulting into ion leakage (Ouzounidou *et al.,* 1992; Berglund *et al*., 2002; Bouazizi *et al*., 2010).

Many reports have shown that metals added as inorganic salts are more phyto-available compared to the organic forms of metals e.g. through organic wastes applications (Singh, 1998). Organic matter and sesquioxides of biosolids increase the sorption capacity of the soil, which reduces metal availability.

Excessive application of chemical fertilizer in agricultural soil had caused serious environmental degradation, such as deterioration of soil physical structures, nutrients imbalance, and water eutrophication. Compost and poultry manure can be alternative sources of fertilizer in organic farming. They can also be used to immobilize heavy metals from soil. Therefore this study evaluated the influence of compost and poultry manure addition to changes in bioavailability of Pb and Cu.

Materials And Methods

3.1 Study area description

The experiment was carried out at the screen house, located at the back of the Department of Agronomy, University of Ibadan (UI), Ibadan, and Oyo State. The site was situated on latitude 7° 30N and longitude 3° 54'E

3.2 Sample collections

Soil samples used for this experiment were collected randomly with a soil auger from the back of the green house in Agronomy Department within the surface layer (0-15 cm). These soil samples were bulked together to form a composite sample. They were then air-dried, crushed lightly, passed through a 2 mm sieve and incubated for two weeks during which soil moisture was maintained at about 60% water holding capacity. The incubation was carried out to have a homogenized soil sample, and 3kg of sieved soil were weighed into each of the pot used for the experiment in the greenhouse. A total of 56 pots were filled with the experimental soil. The compost used was an anaerobically digested municipal solid waste from Aleshinloye market, Oyo State, Ibadan. The poultry manure was collected from a poultry unit in Ibadan.

3.3 Determination of physiochemical parameters

Particle size analysis was determined using hydrometer method as outlined by Gee and Or (2002). Soil pH was determined both in water (1:1 soil-solution ratio) and in KCl (1:10 soil-solution ratio), using a digital pH meter with glass electrode (Black, 1965). Electrical Conductivity (EC^+) was determined with an EC-meter on the saturated paste. Organic Carbon content was analyzed by Walkley-Black method (Walkley & black, 1934). Total Nitrogen was evaluated by the Kjeldhal analytical procedure, which measured the amount of organic plus ammonium nitrogen present. Available soil phosphorus was determined by the Bray and Kurtz (1945) method. Exchangeable cations (Ca^{2+}, Mg^{2+}, K^+& Na^+) were determined by extraction with 1N ammonium acetate. Ca^{2+} and Mg^{2+} were evaluated with Atomic Absorption Spectrophotometer (AAS), while K^+ and Na^+ were determined using Flame Photometer. Micronutrients were determined also with AAS after extraction with 0.1N HCl. Total Lead (Pb) and Cu concentration were extracted using tri-acid mixture (HNO_3:H_2SO_4:$HClO_4$) in the ratio 5:1:1, following the method described by Allen *et al* (1986) then measured using Flame Atomic Absorption Spectrophotometer.

3.4 Pollution treatments

Lead (Pb) and Copper (Cu) were added to the soil in the following concentrations 0, 500ppm, 1000 ppm and 1500ppm. These concentrations were prepared from Pb $(NO_3)_2$ and Cu $(NO_3)_2$ $3H_2O$ salts. In order to ensure uniformity, 10:1 (w/v) soil-solution ratio was employed, whereby 300ml, each of the three levels, were applied to contaminate the soil in the pots and incubated for two weeks.

3.5 Amendment treatments

After I4 days of pollution treatments, 15 g of Poultry manure and 30g of Compost were added to the contaminated soil in the following combinations: Soil + no treatment, Compost + with 500ppm $Pb(NO_3)_2$, Manure+ 500ppm $Pb(NO_3)_2$, Compost + 1000ppm $PbNO_3$, Manure+1000ppm $PbNO_3$, Compost + 1500ppm $PbNO_3$, Manure+ 1500ppm $PbNO_3$, Compost + 500ppm $Cu(NO_3)_2$, Manure + 500ppm $Cu(NO_3)$, Compost treated soil with 1000ppm Cu $(NO_3)_2$, Manure +1000ppm Cu $(NO_3)_2$, Manure +1500ppm Cu $(NO_3)_2$, Compost + 1500ppm Cu $(NO_3)_2$.

3.6. Pot experiment

Maize seeds were sown a week after applying compost and poultry manure. Water was added throughout the experiment to sustain 60% water holding capacity. The parameters assessed include: Metal concentrations in shoot and root of the plant, Dry matter yield of the plant, Plant height and Leaf number.

Readings were taken every two week after planting, and the experiment was terminated 8-week after planting. The plants were separated into shoot and root, oven-dried to constant weight at 70°C. Fresh and dry weights were taken, while the dried parts were grounded and kept for metal evaluation in the lab.

3.7: Experimental Design

Thirteen treatments were laid out in a Completely Randomized Design (CRD) with four (4) replications for each of the three (3) levels of Pb and Cu nitrate salt solutions with poultry manure and compost, making a total of forty eight (48) pots and four (0ppm) pots of control. The overall total of pots was 52.

3.7 Statistical Analysis

Data generated was subjected to analysis of variance (ANOVA) test where the F-values were significant at P = 0.05. The means were separated by Least Significant Difference (LSD) using Genstat discovery.

Chapter Four

Results

4.1: Pre-planting soil physical-chemical analysis

Table 4.1 shows the results of the physical and chemical properties of the soil used for the experiment. The pH of the soil, both in KCl and in water, was found to be slightly acidic; 6.4 and 6.8 respectively. Soil pH is considered as one of the most important factors determining the concentration of metals in the soil solution, their mobility and availability for plants' uptake.

With regard to the fertility status of the experimental soil, the total nitrogen content (4.3 gN/kg), available phosphorus (47 mg/kg) and Organic Carbon content (19.5 g/kg) were found to be high. The exchangeable cations; Ca, Mg, K, and Na values were high. This could be an indication of a fertile soil. The soil is texturally classified as sandy-loam, non-saline with electrical conductivity (EC^+) 2.36 dS/m (DEPI 2010.), and a high ECEC (25 cmol/kg). The soil had relatively low concentrations of Pb (51 mg/kg) and Cu (10 mg/kg).

Table 4.1: **Pre-planting Soil Physical and chemical properties.**

Parameters	Soil Test Values
pH (H_2O)	6.8
pH (KCl)	6.4
Total N (g/kg)	4.3
Available P (mg/kg)	47
Organic Carbon (g/kg)	19.5
Exchangeable bases (cmol/kg)	
Ca	21.4
Mg	1.2
K	1.0
Na	1.2
H^+	0.2
Al^{3+}	0.0
ECEC	**25**
Micronutrient analyses (mg/kg)	
Fe	162
Mn	14
Cu	10
Heavy metal analysis (mg/kg)	
Pb	51
Particle size analyses (g/kg)	
Sand	766
Silt	86
Clay	148
Textural Class	***Sandy-loam***
EC^+ (µs/cm)	2.36

4.2: Chemical analyses of Compost and Poultry manure.

The compost and poultry manure used were locally sourced materials. The results of the analyses were as shown in table 4.2. The pH of the materials, both in water and in KCl, was moderately alkaline. The concentration of **Pb** was found to be very low in both compost and poultry manure (19.7 mg/kg & 6.2 mg/kg respectively), while **Cu** concentration was nearly negligible in both materials. The effective cation exchange capacity (ECEC) in both compost and poultry manure was low (10.2 & 7.6 cmol/kg respectively).

4.3: Treatments Effect on Plant Height

Table 4.3 shows the effects of the different concentration rates on the height of the maize plant. Generally, there was an increase in plant height for all the treatment levels observed over the control (0 ppm) throughout the growing periods.

At 2 and 4 WAP, the plant height showed no significant difference ($p>0.05$) in all the concentration levels, including the control, for treatment **C+Pb**. At 6 and 8 WAP, significant differences were observed ($p<0.05$). However, no differences in plant height existed among concentration levels 500, 1000, and 1500 ppm at 6 and 8 WAP. Furthermore, there was a significant difference in plant height ($p<0.05$) in the different concentration levels of Pb applications at 2 WAP for **M+Pb** treatment. While the highest growth height was recorded at 0 ppm, followed by 1500 ppm level, the least height was found at 1000 ppm. However, no significant difference was observed among 500, 1000, and 1500 ppm concentration levels. At 4 WAP, there were no any observable significant differences ($p>0.05$) in all the concentration levels. At 6 WAP, plant's growth was significantly different. The height of the plant in concentration levels 500, 1000, and 1500 ppm were highly enhanced over the control (0 ppm) which recorded the least growth height. The same trend relatively occurred at 8 WAP.

Moreover, for **C+Cu** treatment, control recorded the highest plant height at 2 WAP, followed by 500 and 1000 ppm respectively (between which no significant height difference was observed), and the least height was observed at 1500 ppm level. At 4 WAP, there were no significant differences in all concentration levels. And at 6 and 8 WAP, there was no difference significantly in 500, 1000, and 1500 ppm concentration levels; however, plant height at these levels were highly significant over the control levels.

4.4: Treatment Effect on Number of Leaves per Plant

Table 4.4 shows the effects of different treatments on number of leaves per plant. At 2, 4, 6 and 8-WAP, no significant differences ($p>0.05$) in leaf number were observed in all the concentration levels for **C+Pb** treatments.

In **M+Pb** treated soil, there was no observable significant difference in leaf number at 2 WAP, but differences existed at 4 WAP, where the highest leaf number was recorded at 500 ppm followed by 1500 ppm and least at the control level. At 6 and 8 WAP, highest number of leaf was found at 500 ppm also, and the least was recorded at the control level.

Moreover, for **C+Cu** treated soil, no significant difference in leaf number was observed at 0, 500, and 1000 ppm at 2 WAP, but the leaf numbers at these levels were more compared to 1500 ppm. At 4 and 6 WAP, there was no statistical significant difference in leaf number; but at 8 WAP, highest number of leaves was recorded at 1500 ppm and least number was found at the control-0 ppm. In treatment **M+Cu**, there was no significant difference in leaf number at 2 WAP; but differences were observed at 4 WAP, where 1500 ppm recorded the highest number of leaves and the least leaf number was at the control level. There were no significant differences at 6 and 8 WAP in levels 500, 1000, and 1500 ppm, but all were significantly higher than the 0 ppm control level.

Table 4.2: Chemical analyses of the Compost and Poultry manure

Parameters	Compost	Poultry Manure
pH (H_2O)	8.6	8.5
pH (KCl)	8.3	9.0
Total N (%)	1.0	0.8
Total P (%)	0.5	0.3
Exchangeable bases (%)		
Ca	2.5	3.0
Mg	7.4	4.4
K	0.2	0.2
Na	0.1	0.2
ECEC	10.2	7.6
Micronutrient analyses (mg/kg)		
Fe	3.6	0.6
Mn	0.0	0.0
Cu	0.02	0.02
Heavy metal analysis (mg/kg)		
Pb	19.7	6.2
EC^{+} (dS /m)	2.34	4

EC – Electrical Conductivity, ECEC – Effective Cation Exchange Capacity

Table 4.3: Plant Height over the Growth Period

		Weeks after planting (cm)			
Treatments	**Levels**	**2**	4	6	8
C+Pb	0ppm	51	80.7	99.5b	115b
	500ppm	54.7	99.8	130.3a	161.7a
	1000ppm	54.2	96.8	143.2a	171.5a
	1500ppm	58.9	97.3	126.7a	162.1a
	LSD	**NS**	**NS**	**15.85**	**13.1**
M+Pb	0ppm	51a	80.7	99.5bc	115b
	500ppm	45.3ab	86.4	122.9a	161.7a
	1000ppm	40.2bc	84.8	119.8a	156.6a
	1500ppm	47.9ab	88	114.8ab	150.8a
	LSD	**8.05**	**NS**	**17.38**	**14.59**
C+Cu	0ppm	51a	80.7	99.5b	115b
	500ppm	43.4ab	86.3	122.8a	165.7a
	1000ppm	44.2ab	75.3	120a	166.6a
	1500ppm	39.6bc	81.6	114.1a	168.1a
	LSD	**9.8**	**NS**	**18.85**	**10.89**
M+Cu	0ppm	51	80.7b	99.5c	115c
	500ppm	48.6	96.6a	138a	178.9a
	1000ppm	45.8	92.4a	129.5ab	171.1ab
	1500ppm	55.7	92.8a	120.8b	163.2b
	LSD	**NS**	**11.22**	**16.18**	**8.27**

Means with the same letter along the columns are not significantly different using LSD at 5% level of probability.
LSD- Least Significant Difference, NS- Not significant, WAP- Weeks after Planting
C+Pb- Lead (Pb) contaminated soil treated with Compost; M+Pb- Lead (Pb) contaminated soil treated with Manure.
C+Cu- Copper (Cu) contaminated soil treated with Compost; M+Cu- Copper (Cu) contaminated soil treated with Manure

Table 4.4: Mean Number of Leaves per Plant

			Weeks after planting (cm)		
Treatments	**Levels**	**2**	**4**	**6**	**8**
C+Pb	0ppm	4.75	6.75	8.75	9.75
	500ppm	5.0	7.25	8.0	9.25
	1000ppm	4.5	7.5	8.75	10.75
	1500ppm	4.75	7.0	9.25	10.75
	LSD	**NS**	**NS**	**NS**	**NS**
M+Pb	0ppm	4.75	6.75b	8.75b	9.75c
	500ppm	4.75	7.75a	10.25a	12a
	1000ppm	4.25	6.75b	9.75ab	10.75b
	1500ppm	4.25	7.5ab	8.75b	10.75b
	LSD	**NS**	**0.802**	**1.177**	**0.917**
C+Cu	0ppm	4.75a	6.75	8.75	9.75bc
	500ppm	4.25ab	7.0	8.75	10.5b
	1000ppm	4.25ab	6.75	8.75	10.5b
	1500ppm	4.0bc	7.25	8.75	11.75a
	LSD	**0.667**	**NS**	**NS**	**1.218**
M+Cu	0ppm	4.75	6.75c	8.75b	9.75b
	500ppm	4.75	8.0a	10a	11.25a
	1000ppm	4.5	7.5b	9.5a	11.0a
	1500ppm	4.5	8.5a	9.75a	10.75a
	LSD	**NS**	**0.969**	**1.134**	**1.112**

Means with the same letters along the columns are not significantly different using LSD at 5% level of probability.
LSD- Least Significant Difference; NS- Not significant; **C- Compost; M- Manure**

4.5: Concentration of Pb & Cu in the Root of the Maize Plant

Table 4.5 shows the concentration of heavy metals (**Pb &Cu**) in plant root. While the highest significant concentration of **Pb (**88.1mg/kg) was found at 1500 ppm of compost treatment, the highest **Cu** concentration (53.1mg/kg) was recorded at 500 ppm compared to control. On the other hand, there was no observable significant difference in the concentrations of **Pb** in poultry manure amended soils. However, a significant **Cu** concentration

(79.5mg/kg) was recorded with the application of 1500ppm of Cu and lowest value of copper uptake in maize root was found in the control treatment.

However, both compost and poultry manure played similar role in the absorption of **Cu** metal by the root of the plant.

Table 4.5: Metal Concentrations (mg/kg) in the Root of the Plant

Treatments	Levels	Pb		Cu
Compost	0ppm	21.3bc		6.8cde
	500ppm	33.6b		53.1a
	1000ppm	60.3ab		31.5ab
	1500ppm	88.1a		24b
	LSD	**44.14**		**15.65**
Manure	0ppm	21.28		6.8def
	500ppm	142.51		34.5bc
	1000ppm	167.98		34.8b
	1500ppm	67.92		79.5a
	LSD	**NS**		**16.36**

Means with the same letters along the columns are not significantly different using LSD at 5% level of probability.
LSD- Least Significant Difference
NS- Not significant

4.6: Metal Concentrations in the Shoot of the Plant

Table 4.6 shows the concentrations of the metals in plant's shoots. There was no difference significantly in the concentration of **Pb** in plant shoot in all the levels for both Compost and poultry manure treated soil**.** However, significant differences were observed for **Cu** concentration in the shoot. In the soils amended with compost, highest **Cu** concentration (29.19mg/kg) was found in the control experiment followed by the 1500 ppm of Cu treated soil; while poultry manure amended soil recorded highest **Cu** concentration (64.2) at 1500 ppm compared to control.

Both compost and poultry manure application decreased translocation of metals to above ground maize biomass. Hence, application of high quality organic materials decrease uptake by aboveground plant biomass.

Table 4.6: Concentrations of the Metals (mg/kg) in the Plant's Shoot

Treatments	Levels		Pb		Cu
Compost	0ppm		19.3		29.19a
	500ppm		15.5		23.2bc
	1000ppm		11.3		22.1bd
	1500ppm		25.2		25.02b
	LSD		**NS**		**3.741**
Manure	0ppm		19.3		29.19b
	500ppm		19.9		28.6bc
	1000ppm		64.2		28.3bd
	1500ppm		19.6		33.36a
	LSD		**NS**		**2.873**

Means with the same letters along the columns are not significantly different using LSD at 5% level of probability.
LSD- Least Significant Difference; NS- Not significant

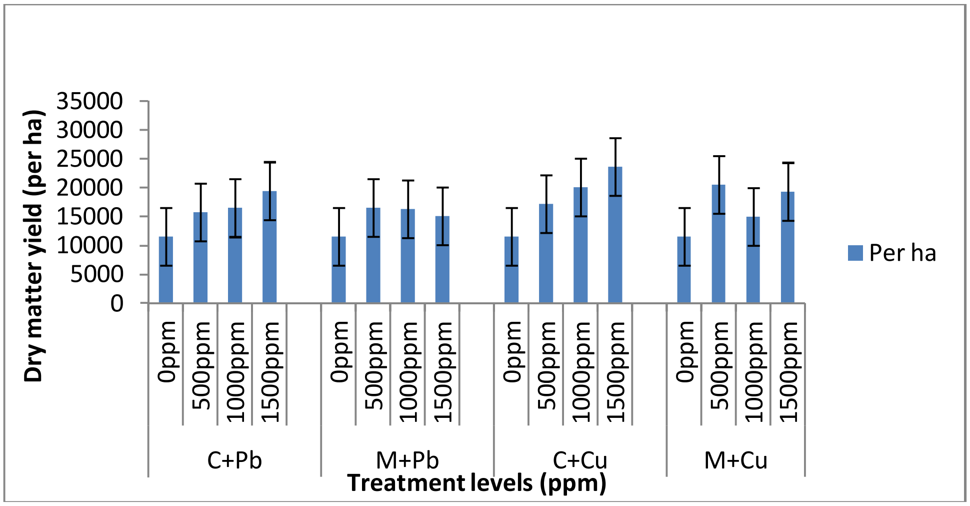

Figure 1: Effect of compost and Poultry manure of Cu and Pb polluted soils on dry matter yield of maize
C- Compost
M- Manure

4.7: Effect of different concentration levels on Dry Matter Yield of Maize

Figure 1 shows the dry matter yield of maize plant. It was evident from the figure below that the different concentration levels had influence on dry matter yield of maize plant.

Apparently, addition of compost to **Pb** contaminated soils (C+Pb) showed a direct proportional increase in dry matter yield of maize plant as the concentration levels increased. In the case of manure amended **Pb** degraded soil (M+Pb), dry matter yield was inversely proportional to the concentration levels. As the concentration levels increased (from 500-1500 ppm), dry matter yield decreased. This was not; however, the case for poultry manure amended **Cu** degraded soil (M+Cu), in which the highest dry matter yield was observed at 500 ppm followed by 1500 ppm compared to control.

Discussion

Pre-planting soil, manure and compost physical-chemical analysis

The pH of a soil plays a significant role in influencing the speciation and bioavailability of heavy metals. Adsorption of metal cation increases with increase in pH. The experimental soil is slightly acidic therefore mobility and bioavailability of metals in this soil may not be effectively enhanced. This is similar to the report of Alkorta *et al* (2004), that in highly acidic soils, mobility of metallic elements is much higher than in soils with neutral or alkaline reaction. Mobility of metals in soils with low pH decreases in the order: Cd > Ni > Zn > Mn > Cu > Pb.

With regard to the fertility status of the experimental soil, the soil used for this experiment is fertile as it had adequate supply of total nitrogen content, available phosphorus and Organic Carbon content according to FFD, 2012. However, Ledin (2000) stated that only the ammonium form of nitrogen decreases the pH, which consequently increases the availability of heavy metals to plants. Thus, nitrogen levels in plant have no peculiar effect on metal accumulation. On the other hand, the presence of phosphorus in the soil is an important factor limiting the uptake of metallic elements by plants, because the higher content of readily soluble forms may precipitate, sparingly, the soluble phosphates of Zn, Cd, Pb and Cu (Alkorta *et al,* 2004).

The exchangeable cations; Ca, Mg, K, and Na values were adequate based on the report of FFD (2012) which is also an indication that the soil is fertile soil. Plants take up heavy metals from the soil in a similar way as the macronutrients and micronutrients through the root system. The rate of uptake by the roots of metallic elements depends on the chemical form in which they appear in the soil (Liang *et al,* 2009). Insufficient amount of micronutrients in the soil often results in excessive accumulation of several heavy metals in plants. These elements may be introduced into the soil through organic and mineral fertilizers.

The soil texture was sandy-loam, non-saline with electrical conductivity (EC^{+}) 2.36 dS/m (DEPI 2010.), and a high ECEC (25 cmol/kg). Sandy soil is distinguished by a low sorption capacity and weakly absorbs heavy metals. This means that its ability to accumulate metallic elements is limited, leading to their movement to both ground and surface water (Sheoran *et al*, 2009). The was characterize with low concentrations of Pb and Cu which was below the level recommended by Environmental Protection Agencies (USEPA, 2002).

Chemical analyses of Compost and Poultry manure.

The pH of the compost and poultry manure used were moderately alkaline and, as a result of this alkalinity nature, mobility of metals might not be effectively enhanced. This corresponded with the study of Prasad *et al.*, (2003) who reported that in alkaline medium, there is the possibility of heavy metal complex anions with increased mobility and bioavailability. However, the intensity of root uptake of metal by plants usually decreases with increasing soil pH to about pH 6.5-7.5.

The addition of both manure and compost to the soil will be expected t to play indifferently a major role either in bioavailability or immobilization process because the concentration of Pb was low in both material and Cu concentration was nearly negligible in both materials too.

Cation exchange capacity is one of the important parameters in determining metal availability. The Electrical Conductivity (EC^+) for compost and poultry manure were low (slightly saline) and this may enhance metal uptake. Therefore, both organic amendments contained low levels of toxic Pb and Cu metals and found suitable for use as ameliorants.

Treatments Effect on Plant Height

The non-significant difference in plant height at 2 and 4 weeks after planting with the could be due to the slow mineralization of the amendment so that its effect was not yet pronounced in the plant growth. However significant difference in plant height observed at 6 and 8WAP between the control and all the different concentration. The higher plant height recorded at 1000ppm could be

This could be attributed to the fact that, organic amendments like, manure, compost and bio solids had been reported to reduce the availability of heavy metals in polluted soils because of their high organic matter content and high levels of P and Fe (Brown et al., 2003). That was why some of the plant height was increased in some of the Pb and Cu polluted soil especially at 1000 and 1500ppm concentrations that have been amended with compost and manure. Also, Pečiulytė *et al*, 2006 had reported that high organic matter content in soil improved plant resistant to heavy metals and their growth in metal polluted soil.

Treatment Effect on Number of Leaves per Plant

The number of leaves consistently increased throughout the growing period without any significant influence of different concentration levels. Though some of the treatments with higher concentrations of metals had more leaves than those with lower concentrations of Pb and Cu. Though Manivasagaperumal *et al.* 2011 reported that plant treated with low level of copper showed a significant increase in root length and leaf area. This was a deviation from what was observed in this experiment because no of leaves increases under treatments that had higher concentrations of both metals with a decrease with those under the control experiment except at weeks 2 and 4 WAP. According to Zhang *et al.* (2004), the presence of toxic metals (e.g. Cu) in the soil had negative impact on the ability of maize plant to absorb nutrients necessary for leaf development. However, application of organic amendments to heavy metal degraded soil, like in this report, enhanced uptake of essential nutrients necessary for plant metabolisms, including leaf development (Brown et al., 2003)

Concentration of Pb & Cu in the Root of the Maize Plant

Lead concentrations in maize shoot were higher under the treatments with 1500ppm of compost treatments and no significant different in metal uptake in maize plant was also observed. Significant difference was however observed in Cu uptake in maize in poultry amendment soils.

After being taken up by roots, the localization of **Pb** was greater in the roots than in any other parts of the plant because **Pb** binds strongly to the carboxyl groups of the carbohydrates galacturonic acid glucuronic acid in the cell wall, which restricted its transportation via the apoplast (Rudakova *et al*, 1988). The application of organic materials to soil can build up **Pb** stable complexes which are not able to enter plant cells. These changes were not consistent with the changes in the amount of total Pb in soil; and were higher in poultry manure-treated soil compared to soils treated with compost materials.

Effect of different concentration levels on Dry Matter Yield of Maize

The highest dry matter yield was recorded at 500 ppm compared to the control as shown in figure 1, could be attributed to the fact that the concentration of Cu and Pb was not as high as in treatment with 1000 and 1500ppm. The report of Kupper *et al.,* 1996; Sonmez *et al*., 2006 had it that excess metals have adverse effect on root and shoot length and leaf area because of their toxic effect on photosynthesis, respiration and protein synthesis. This will in turn leads to retardation in normal growth hence reduction in total dry matter.

Hussain *et al.,* 2013 also reported that Fresh and dry weights of both roots and shoots of maize were also reduced at all treatments with increase in Lead treated soil. Furthermore, in compost amended **Cu** contaminated soils (C+Cu), a direct proportional increase in dry matter yield was observed as the concentration gradient increased. This reported was in support of the previous findings of (Lidon and

Henriques,1993; Mocquot *et al*., 1996; Xiong *et al*., 2006) indicating that application of Cu will slightly increase Dry weight of plant at lower concentration, while excess concentration of Cu will reduced biomass. The increase in dry matter yield observed at500 and 1500ppm with poultry amended Cu degraded soil (M+Cu). This was in corroboration with the findings of Manivasagaperumal *et al.* 2011 that reported that higher concentration of Cu decreases the growth yield, dry matter production and nutrient content of greengram.

Conclusion

The findings of this research study have shown that compost, as an organic material, played an effectively role on bioavailability and uptake of **Pb** and **Cu**, but to a lesser degree compared to poultry manure. However, compost and poultry manure enhanced bio-availability and uptake of **Cu** metal compared to the uptake of **Pb** metal by maize. Therefore, both amendments are recommended for cleansing a **Cu** contaminated soil. Although, the application of high quality organic compost will enhance high dry matter yield in a Pb or Cu contaminated environment.

Furthermore, it was obvious from the results that poultry manure fixed or absorbed **Pb** metals, which were found around the root axis of the plant compared to the compost material. Therefore, poultry manure is better recommended for remediating **Pb** contaminated soils.

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