

Effects of Soil Amendments on Bioavailability of Lead in Soil Spiked with Lead Nitrate

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Abstract: Soil organic matter may increase the fixation of trace metals, promotes their bioavailability or produces no effect on the trace metals. In this study, the use of cow dung and human faeces as greenhouse amendments on soil spiked with lead nitrate was investigated. Four replicates each of 0, 1000 and 5,000mg of lead nitrate were applied alone or in combination with 0, 5000, 10000 and 20000mg of cow dung or human faeces separately to 3kg soil and mixed thoroughly in plastic pots perforated at the base (Wong and Lau, 1985). The soil samples were watered with tap water for two days. Two cowpea seeds per pot were planted. Watering was continued until the plants were harvested. Lead in water soluble and exchangeable fractions were extracted with deionized water and 1M ammonium oxalate respectively. Concentrations of Pb^{+2} in soil extracts were determined by Atomic Absorption Spectrometry. The water soluble lead before planting and after harvest decreased highly significantly (Pr < 0.01) at all levels of lead nitrate applied to soil in presence of cow dung or human faeces. Although there was a strong decreasing trend with increasing weight of cow dung or human faeces, no significant differences in exchangeable lead before planting (Pr = 0.10 > 0.05) and after harvest (Pr = 0.07 > 0.05) were observed. In presence of cow dung or human faeces, concentrations of Pb^{+2} in various soil fractions decreased in the order exchangeable lead before planting > exchangeable lead after harvest > water soluble lead before planting > water soluble after harvest. The decrease of concentration of water soluble and exchangeable Pb^{+2} with increase in applied organic amendment to soil, was attributed to the association of lead with organic matter. Zimdahl and Skogerboe (1977) reported that the ability of organic matter to retain Pb^{+2} and lower its solubility in soil is due to its great absorptive capacity. The mean concentrations of Pb^{+2} in water soluble fractions before planting and after harvest in presence of cow dung and human faeces were 3.17 and 2.21, 3.73 and 2.66mg/kg respectively. The corresponding mean concentrations of Pb⁺² in the exchangeable fractions were 16.05 and 17.44, 16.62 and 18.33mg/kg respectively. These values are below the recommended values of the World Health Organization (40 -250mg/kg) and Food and Agricultural Organization (36 - 250mg/kg) for water soluble and exchangeable Pb^{+2} in soil.

Keywords: Cowpea; Cow dung; Human faeces; Water soluble lead; Exchangeable lead; Organic Matter; Bioavailability, pH

1. Introduction

A wide variety of amendments are often utilized to improve the physical condition of soils used as greenhouse potting media. These amendments which range from relatively expensive peats and vermiculites to inexpensive materials such as pine bark and sawdust are generally selected for their physical and chemical characteristics, uniformity and cost. When amendment is applied to the soil, the fate of elements in the amendment must be considered.

The influence of soil organic matter on the availability of trace metals is not well understood While some workers (Cheng and Quellette, 1971; Davies, 1956; Hassel, 1974; Hodgson, 1963; Rajagopal *et al.*, 1974; Shuman, 1975) reported that organic matter increases the fixation of these metals in soil, others claimed that it promotes their availability (Bloomfield *et al.*, 1976;

Elliott and Blaylock, 1975; Ghanem *et al.*, 1971). Some authors found that organic matter has no influence on the availability of heavy metals (Lundblad *et al.*, 1949). MacLean *et al.*, (1969), Karamanos *et al.*, (1976) and Hassel, (1974) found that organic matter has a negative effect on Pb solubility, while Bloomfield *et al.*, (1976) demonstrated that this metal could be solubilized as an organic complex in a true solution and/or colloidal solution.

Cow dung is the undigested residue of herbivorous matter excreted by bovine animal species such as cow, yak, bison buffalo and water buffalo (Hornby, 2006). The colour of cow dung ranges from greenish to blackish, often darkening soon after exposure to air. Cow dung when combined with soiled bedding and urine is often used as <u>manure</u>. Abubakar *et al* (2004) reported that tomato seedlings treated with a mixture of cow dung and urine resulted in significantly higher plant height, greater dry weight, lesser root-knot indices and reproductive factor. Seedlings treated with urine alone produced lower plant height and dry weight, which were only higher than those of the inoculated, untreated control. The observed increase in growth of tomato grown in treated soils compared to the untreated soils may be attributed to the increase in nutrients supply to the soil, resulting from the addition of cow dung and urine (Abubakar *et al*, 2004).

Human faeces also known as stool is the waste product of human digestion which varies significantly in appearance depending on the state of the digestive system influenced by diet and health. The main composition of human faeces is water, indigestible food material sloughed-off intestinal cells, bacterial and various organic compounds (Andersson *et al*, 1982). Many pathogens that enter the human body orally are enteric. They have been found to be excreted unevenly in faeces and many people without any clinical symptoms can be emitting pathogens. Human faeces are thus very liable to spread enteric micro-organisms to other persons. From the point of view of hygiene, it is extremely important to avoid all circumstances where fresh, unhygienized faeces can contaminate human food, water, or other persons directly (Malkki, 1999).

Human faeces is considered a valuable nutrient source in China, Japan, Korea and some countries of Africa and South-America (Ugland, 1999). Composting and separating toilets have enabled the reclamation of human excreta and the use of the nutrients contained in it as fertilizer and soil conditioner. In Sweden, organic farmers have expressed interest in using human urine as liquid manure because of the content of macronutrients and the low heavy metal content (Linden, 1997).

2. Materials and Methods

2.1 The Study Area

The soil sample and cowpea seeds (*Vigna unguiculata*) used for this study were collected from International Institute of Tropical Agriculture (IITA) farm in Wase village, Minjibir Local Government Area of Kano State. Figures 1 to 3 show the locations of sampling and planting sites.







Figure 2: Map of Kano State Showing the Study Local Government Area





2.2 Instruments, Apparatus and Reagents

All equipment and instruments used in this research were calibrated before conducting the experiments. All glassware used were thoroughly washed with detergents and tap water and then rinsed with deionized water. Suspected contaminants wares were cleaned with 10% concentrated nitric acid (HNO₃) and metal surfaces rinsed with deionized water.

In preparation of reagents, chemicals of analytical grade purity and distilled water were used. All glassware and plastic containers were washed with detergents.

2.3 Soil Sampling and Pre-Treatment

The soil sample was collected from IITA farm, Wasai using the method recommended by (Petersen, 1994). 100m² of the land was divided into ten equal sized grid cells of 10m². A steel augur was used to dig the soil to a depth of 25cm. Samples collected from all cells were thoroughly air dried, mixed and stored in large plastic bags. For the purpose of preliminary studies, 1kg of the air-dried sol was taken. After removing the debris, the soil was ground in a wooden mortar and sieved through a 2mm mesh. It was then stored in a labeled plastic container.

2.4 Preliminary Soil Analysis

Preliminary soil analyses were carried out by standard methods; the pH and conductivity meters were used to measure the pH and electrical conductivity, respectively, in the soil suspension (1:2.5 w/v dilutions) (IITA, 1982). Organic carbon was determined by Walkley and Black method (Nelson and Sommers, 1996). The hydrometer method was used for the determination of particle size distribution (Gee and Or, 2002). Total nitrogen was determined using the Kjeldahl method (Bradstreet, 1954) and available phosphorus by Bray 1 extraction method (Bray and Kurtz, 1945),

exchangeable cation by extraction with 1 N NH4OAc solution (Page *et al.*, 1982), exchangeable acidity by leaching the soil sample with 1 N KCl solution (Agbenin, 1995), total metal concentration by tri-acid digestion (Stober *et al.*, 1976) and effective cation exchange capacity by summation method.

2.5 Soil Treatments and Planting of Cowpea Seeds

Four replicates each of 0, 1000 to 5,000mg of lead nitrate were applied alone or in combination with 0, 5000, 10000 and 20000mg of human faeces separately to 3kg soil and mixed thoroughly in plastic pots perforated at the base (Wong and Lau, 1985). The soil samples were watered with tap water for two days. Two cowpea seeds per pot were planted. Watering was continued until the plants were harvested.

2.6 Extraction of Water Soluble and Exchangeable Lead

The water soluble lead was extracted from a mixture of 10g of pre-treated soil and 100cm³ of deionized water in a 120cm³ of plastic bottle. The exchangeable fraction was extracted by adding 100cm³ of 1M ammonium oxalate to the residue of the water soluble fraction (Stober *et al*, 1976).

2.7Atomic Absorption Spectrometric Analysis

The soil extracts were analyzed for lead at 283.5nm using flame atomic absorption Spectrophotometry. Blank determinations were made prior to sample analysis. Concentrations of Pb⁺² in soil extracts were obtained in quadruplicates from calibration curves and expressed as mg/kg. (IITA, 1979).

2.8 Statistical Analysis

The data were analyzed in triplets and expressed as mean and standard deviation. The mean of all treatments was subjected to a One-way analysis of variance (ANOVA) using IBM SPSS

Statistics 23 software and mean differences were performed using the Tukey test. All graphs were plotted using Microsoft Excel 2013.

3. Results and Discussion

3.1 Results of Routine Analyses

Table 1: Soil Fertility Parameters

Parameter	Result	RVAS
Texture: Sand (%)	73.8 ± 1.15	
Silt (%)	12.0 ± 0.00	
Clay (%)	14.2 ± 1.15	
Textural class	Sandy loam	Sandy loam
рН	7.08 ± 0.05	6.00–7.80
Organic carbon (%)	0.671 ± 0.09	0.5–0.7
Total nitrogen (%)	0.02 ± 0.00	0.05–0.30

Carbon-nitrogen ratio	34.762 ± 0.04	2.3–10		
Total organic matter (%)	1.16 ± 0.12	0.9 –1.2		
Cation exchange capacity(cmol/kg soil)	3.44 ± 0.10	2.00-30.00		
Exchangeable cations (c mol/kg soil)				
Na	0.15 ± 0.00	0.3 – 2.0		
К	0.86 ± 0.01	0.2 – 1.2		
Mg	0.11 ± 0.01	0.5 – 8.0		
Ca	1.92 ± 0.01	2.0 - 15.0		
Exchangeable sodium percentage (%)	4.37 ± 0.11	<15		
Electrical conductivity (mS/cm)	0.02 ± 0.01	<4.00		
Water soluble phosphate (mg/kg)	2.60 ± 1.00	<10		
NAC Deserves and advelues for agricultural soil (London, 1001)				

RVAS: Recommended values for agricultural soil (Landon, 1991)

The fertility parameters; pH, total organic matter, cation exchange capacity, exchangeable potassium and calcium, exchangeable sodium percentage, electrical conductivity and water soluble phosphate of the IITA farm soil were within the range of recommended values for agricultural soils (Landon, 1991). However, the total nitrogen, exchangeable sodium and magnesium were below the recommended values. So, the soil could be used for agricultural purposes.

Table 2:	Table 2: Properties of Cow Dung and Human Faeces								
S/N	Parameter	Co	ow Dung	1	Human Faeces				
		Results <u>Tekwa</u> et al, 2010		Results	Cheung and Wong, 1981				
1	pН	7.45±0.01	6.76-7.44	7.15±0.01	4.50 - 7.18				
2	Organic carbon (%)	179.35±4.12	0.76-1.71	132.16±5.36	20.49-179.72				
3	Total nitrogen (%)	2.136±0.06	0.02-0.23	1.873±0.03	0.588-2.524				
4	Carbon-nitrogen ratio	83.97±2.13	NA	70.56±3.27	34.85-71.20				
5	Total organic matter (%)	309.20±3.45	1.31-2.95	227.84±6.61	35.32-309.84				
6	Cation exchange capacity(cmol/kg soil)	12.58±0.05	7.64–10.27	10.92±0.12	NA				
7	Exchangeable cations (cmol/kg soil)								
	Na	4.07±0.05	0.08-0.41	2.20±0.07	NA				
	к	4.57±0.04	0.17-1.42	4.03±0.01	NA				
	Mg	0.19±0.01	2.70-4.65	0.18±0.01	NA				
	Ca	3.24±0.01	1.47-2.97	2.35±0.01	NA				
8	Exchanggeable sodium percentage (%)	32.35±0.05	NA	20.15±0.09	NA				
9	Electrical conductivity (mS/cm)	8.81±0.01	38-127.47	4.43±0.01	NA				
10	Water soluble phosphate (ugg ⁻¹)	165.77+1.00	NA	144,94+3,32	28.33-344.20				

Differences in values obtained in this work compared to reported values for cow dung by Tekwa et al, (2010) and for human faeces by Cheung and Wong, (1981) could be attributed to environmental factors, age, eating habit and health status.

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.Table 3: Heavy Metal Concentrations (mg/kg) in Soil							
Metal	WSF	EF	Total	Alloway (1990)	Landon (1991)	Wild (1996)	
Chromium	18.33 ±10.00	23.33 ± 3.85	375.00 ± 16.67	5 –1500	5 –1500	NA	
Manganese	1.26 ± 0.25	2.19 ± 0.25	11.94 ± 1.08	NA	20 –	NA	
					10,000		
Iron	6.00 ± 2.31	9.00 ± 2.00	60.00 ± 16.33	2 – 100	NA	NA	
Cobalt	0.87 ± 0.16	0.48 ± 0.18	18.25 ± 0.92	NA	0.05 – 65	NA	
Nickel	1.15 ± 0.59	1.72 ± 0.44	13.76 ± 1.87	2 - 1000	2 – 750	75	
Copper	6.62 ± 1.23	6.62 ± 1.47	15.93 ± 6.17	2 – 250	2 – 250	140	
Zinc	18.18 ± 10.50	29.55 ± 8.70	113.64 ± 26.24	10 - 300	1 - 900	300	
Cadmium	0.11 ± 0.02	0.44 ± 0.36	1.09 ± 0.26	0.01 - 2.4	0.01 – 2.4	3	
Lead	3.31 ± 074	6.99 ± 1.41	49.63 ± 3.68	2 - 300	2 - 300	300	

There was no heavy metal contamination, since the concentrations of all metals were either less or within the range of standard values.

	Table 4.: Heavy Metal Concentrations of Cow Dung and Human Faeces (mg/kg)									
			Cowdung			Human Faeces			HMIOM	
S/N	Metal	WSF	EF	Total	WSF	EF	Total	heung & Won 1981	EPA, 1993	
1	Chromium	20.00±0.00	15.00±6.38	615.00±57.45	23.33±3.85	13.33±0.00	450.00±24.49	NA	NA	
2	Manganese	1.53±0.25	1.13±0.13	8.36±0.97	2.52±0.46	1.46±0.46	11.94±2.58	5.75 –390.0	NA	
3	Iron	9.35±2.70	13.35.191	82.23±5.81	7.51±1.68	9.81±4.61	73.61±7.28	NA	NA	
4	Cobalt	0.95±0.00	0.40±0.16	2.14±0.82	0.63±0.26	0.87±0.16	1.79±0.71	NA	3–100	
5	Nickel	1.26±0.44	0.92±0.37	27.87±1.18	1.03±0.44	0.80±0.44	23.22±1.98	NA	17.5–250	
6	Copper	8.09±2.17	1.96±0.00	19.85±5.70	5.39±0.57	7.60±0.49	17.48±2.55	14.5–105.0	NA	
7	Zinc	1.97±0.25	9.50±0.42	46.18±1.13	4.91±0.90	10.26±0.91	48.14±1.13	7.5–372.5	100–450	
8	Cadmium	0.53±0.15	0.93±0.21	5.08±1.61	0.23±0.01	0.38±0.16	3.56±2.50	NA	4–83	
9	Lead	5.51±1.41	8.09±1.90	61.21±3.31	4.78±.1.41	10.29±1.21	54.60±3.31	8.3 –33.2	2.5–340	

NA Means Not Available.

ABBREVIATIONS

WSF: Water Soluble Fraction

EF: Exchangeable Fraction HMIOM: Heavy Metals in Organic Manures

The properties of cow dung, human <u>faeces</u> and soil used in this study are shown in **Tables 1 – 4**. Cow dung and human <u>faeces</u> had higher pH, total nitrogen, cation exchange capacity, exchangeable bases and electrical conductivity than the soil sample. The total organic matter, exchangeable sodium percentage and water soluble phosphate of cow dung and human <u>faeces</u> were extremely high when compared with that of the soil.

3.2 Lead in Soil

No soil samples have been found to be free of lead (de Treville, 1964). Many studies have reported decreases in soil lead levels with distance from the highway, depths and changes in traffic volume. Lead from automobile exhaust occurs primarily in the form of halide salts, but if phosphorus is included in the fuel, the lead may be in the form of a phosphate-halide compound (Warren and Delavault, 1962; Cannon and Bowles, 1962). Lead halides are relatively soluble compounds and may be carried downward into the soil for short distances. With time, these compounds are converted to less soluble forms such as lead phosphate. Lead can also react with sulfate and carbonate anions (Singer and Hanson, 1969).There is evidence that organic chelates form compounds which may make lead more mobile in the soil but less available to plants. Chelation by soil organic matter will make lead less mobile and cause accumulation in the surface horizon (Zimdahl and Arvik, 1972). Metal contamination of soil is due to mining, manufacturing and use of synthetic products (e.g. pesticides, paints, batteries, industrial waste and industrial or domestic sludge) which is a serious environmental problem. Hence, determining chemical forms of metals in soils is important to evaluate their mobility or bioavailability (Shuman, 1991)

3.2.1 Metal Speciation in Soil

Metals in soil may be found in one or more of the following forms: (a) dissolved (in soil solution),(b) exchangeable (in organic and inorganic components), (c) as structural components of the lattices of soil minerals, (d) as insoluble precipitates with other soil components. Typically, metals of anthropogenic inputs tend to reside in the first two fractions and metals found in the residual fraction (RF) are of natural occurrence in the parent rock (Kabala and Singh, 2001). The first two forms are available to the plants, while the other two are potentially

available in the longer term. Understanding the mechanisms by which a heavy metal element changes from one form to another, and the speed at which it does so, is imperfect but improving. In general, the concentration of an element in the soil solution is dependent on the equilibrium

between the soil solution and solid phase, with pH playing the decisive role (Lindsay, 1979). The ability of the soil to immobilize metals increases with rising pH and peaks under mildly alkaline conditions. Metal mobility is related to its immobilization in the solid phase. Apart from pH, other soil properties, such as electrical conductivity (EC), organic matter content, quantity

and type of clay minerals, the content of the oxides of iron (Fe), aluminum (Al), and manganese (Mn), and the redox potential determine ability of the soil to retain and immobilize metals.

When this ability is exceeded, the quantities of heavy metals available to plants increase, resulting in the appearance of toxicity phenomena (Ma and Rao, 1997; Arowolo et al., 2000; Ramos et al., 1994; Dudka et al., 1995; Kabala and Singh, 2001; Chlopecka et al., 1996).

3.2.2 Effects of Organic Amendments on	Concentrations of Pb ⁺²	in Soil Fractions
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LNT	SA	WSLBP -HF	WSLBP -CD	WSLAH –HF	WSLAH -CD
0	0	3.31±0.74	3.31±0.74	2.94±1.70	2.94±1.70
0	5000	2.57±1.47	1.84±0.74	1.96±0.00	1.47±0.00
0	10000	2.21±1.90	1.47±0.00	1.10±0.74	1.10±0.74
0	20000	1.84±0.74	1.10±1.20	0.86±1.41	0.74±0.85
1000	0	3.68±0.85	3.68±0.85	3.31±2.21	3.31±2.21
1000	5000	2.94±0.74	2.21±0.85	1.84±0.74	1.84±0.74
1000	10000	2.48±0.85	1.47±1.70	1.47±1.20	1.10±1.41
1000	20000	2.21±2.55	1.10±0.74	1.10±1.70	0.37±0.74
5000	0	7.72±0.74	7.72±0.74	5.88±2.08	5.88±2.08
5000	5000	6.25±0.74	5.58±0.74	4.65±0.00	2.94±1.20
5000	10000	5.42±0.74	4.72±1.90	3.57±1.47	2.57±1.41
5000	20000	4.12±2.21	3.86±1.20	3.26±1.20	2.21±1.90

Table 5: Concentrations of Pb⁺² in Water Soluble Fractions of Soil

LNT: mg of lead nitrate in 3kg of soil SA: mg of cow dung or human faeces in 3kg of soil WSLBP –HF: mg/kg of water soluble lead before planting in presence of human faeces WSLAH –HF: mg/kg of water soluble lead after harvest in presence of human faeces WSLBP –CD: mg/kg of water soluble lead before planting in presence of cow dung WSLAH –CD: mg/kg of water soluble lead after harvest in presence of cow dung



The water soluble Pb⁺² before planting and after harvest decreased highly significantly (Pr < 0.01) with increasing weight of cow dung or human faeces. For example, addition of 0 – 20000mg human faeces to soils amended with 0, 1000 and 5000mg lead nitrate solublized 3.31 to1.84, 3.68 to 2.21, and 7.72 to 4.12 mg/kg respectively. The corresponding values of water soluble lead after harvest were 2.94 to 0.86, 3.3 to 1.10 and 5.88 to 3.26 mg/kg. Similar observations were made when 0 – 20000mg cow dung was applied to soils amended with 0, 1000 and 5000mg lead nitrate. The water soluble lead before planting decreased from 3.31 to 1.10, 3.68 to 0.10 and 7.72 to 3.86mg/kg respectively. The corresponding changes in water soluble lead after harvest were 2.94 to 0.74, 3.31 to 0.37 and 5.88 to 2.21mg/kg respectively. This result is in consonance with the report of Matten and Hammond (1966) who found that only an insignificant amount of 2.5 ppm lead was available for uptake by bromegrass grown in a contaminated sandy loam soil containing 680 ppm lead.

LNT	SA	ELBP -HF	ELBP -CD	ELAH –HF	ELAH –CD
0	0	6.99±1.41	6.99±1.41	6.25±1.41	6.25±1.41
0	5000	6.25±0.74	5.88±0.00	5.14±0.85	5.51±0.74
0	10000	5.14±2.08	4.19±0.00	4.86±1.41	4.04±1.41
0	20000	4.39±2.21	3.68±0.74	3.92±0.74	3.68±1.47
1000	0	11.95±5.51	11.95±5.51	10.48±5.32	10.48±5.32
1000	5000	10.11±5.32	10.56±0.85	9.92±0.74	8.82±1.20

Table 6: Concentrations of Pb ⁺²	in Exchangeable Fractions of Soil
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1000	10000	9.65±0.74	9.09±0.85	8.56±0.85	7.72±1.41
1000	20000	8.82±1.20	6.99±0.74	7.19±1.70	6.35±1.20
5000	0	44.12±12.01	44.12±12.01	40.44±7.35	40.44±7.35
5000	5000	41.54±24.29	37.25±23.52	37.81±23.52	34.93±11.03
5000	10000	36.49±7.04	35.17±24.46	33.56±16.30	33.09±18.50
5000	20000	34.48±8.49	33.46±20.44	31.30±18.50	31.25±9.25

LNT: mg of lead nitrate in 3kg of soil SA: mg of cow dung or human faeces in 3kg of soil ELBP –HF: mg/kg of exchangeable lead before planting in presence of human faeces ELAH –HF: mg/kg of exchangeable lead after harvest in presence of human faeces ELBP –CD: mg/kg of exchangeable lead before planting in presence of cow dung ELAH –CD: mg/kg of exchangeable lead after harvest in presence of cow dung



Although there was a strong decreasing trend with increasing weight of cow dung or human faeces, no significant differences in exchangeable lead before planting (Pr = 0.14 > 0.05) and after harvest (Pr = 0.22 > 0.05) were observed. Addition of 0 – 20000mg human faeces to 0, 1000 and 5000mg lead nitrate decreased the exchangeable lead before planting from 6.99 to 4.39, 11.95 to 8.82 and 44.12 to 34.48mg/kg respectively. The corresponding decreases in exchangeable lead after harvest were 6.25 to 3.92, 10.48 to 7.19 and 40.44 to 31.30mg/kg respectively.

Similar observations were made with cow dung. Addition of 0 - 20000mg cow dung to 0, 1000 and 5000mg lead nitrate decreased the exchangeable lead before planting of 6.99 to 3.68, 11.95 to 6.99

and 44.12 to 33.46µgg⁻¹ respectively. The corresponding decreases of exchangeable lead after harvest were 6.25 to 3.68, 10.48 to 6.35 and 40.44 to 31.25µgg⁻¹ respectively.

The insignificant concentrations of Pb⁺² in the water soluble and exchangeable soil fractions in this study are in the agreement with the reports of Wright et al. (1955), Schnitzer and Hoffman (1967), Zimdahl and Skogerboe (1977) and Stevenson (1979) who attributed the immobilization of Pb⁺² in contaminated soil to its association with organic matter in various organic amendments added to soil. Concentrations of lead in various soil fractions decreased in the order exchangeable lead before planting > exchangeable lead after harvest > water soluble lead before planting > water soluble after harvest. The mean concentrations of Pb⁺² in water soluble fractions before planting and after harvest in presence of cow dung and human faeces were 3.17 and 2.21, 3.73 and 2.66mg/kg respectively. The corresponding mean concentrations of Pb⁺² in the exchangeable fractions were 16.05 and 17.44, 16.62 and 18.33mg/kg respectively. These are below the recommended values of the World Health Organization (40 -250mg/kg) and Food and Agricultural Organization (36 – 250mg/kg) for water soluble and exchangeable Pb⁺² in soil.

4. Conclusion

Cow dung and human faeces have been found to significantly decrease the concentrations of Pb^{+2} in lead contaminated soil. The beneficial effects of soil organic matter in reducing extractable Pb^{+2} provides a basis for adopting management practices to lessen the potential hazard of Pb – contaminated soil.

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Authors' Contributions

Dagari M.S.: Conceptualization, design, undertaking the research work, write-up and data analysis **Jimoh W.L.O.:** Supervision of the research work; Editing of the write-up

References

- Abubakar U. Adamu T. Manga S.B. (2004). Control of *Meloidogyne incognital* (kofoid and white), chitwood (root–knot nematode) of *Lycopersicon esculentus* (Tomato) Using Cow s and Urine, *African Journal of Biotechnology*, 3(6), 375 – 381
- Andersson, R. M, Mercer, J.G, Wilson, R.A, and Carter, N.P. (1982). Transmission of Schistosoma Mansoni from man to Snail, Experimental Studies of Miracidal Survival and Infectivity Influence to Larval Age, Water Temperature, Host Size and Age, *Parasitology*, 85, 339 – 360

Agbenin J (1995). Laboratory Manual for Soil and Plant Analysis (Selected Methods and Data Analysis). Faculty of Agriculture/ Institute of Agricultural Research, ABU Zaria, 7–71

- Alloway, B. J. (1990). *Heavy Metals in Soil*, 5th edn, Blackie Academic and Professionals, Glasgow, Scotland, 69 75.
- Arowolo, A.; Bamgbose, O.; Odukoya, O. (2000). The Chemical Forms of Lead in Roadside Dust of Metropolitan Lagos, Nigeria. *Global J. Pure Appl. Sci.*, *6*, 483–487.

Bloomfield, C., Kelso, W. I. and Pruden, G.: 1976, J. Soil Sci., 27, 16.

Bradstreet RB (1954). Kjeldahl Method for Organic Nitrogen, Anal Chem., 26(1):185–187

- Bray RH, Kurtz L (1945) Determination of Total, Organic, and Available Forms of Phosphorus in Soils, *Soil Sci*,59(1):39–46
- Cannon, H. L. and Bowles, J. M. (1962).Contamination of Vegetables by Tetraethyl Lead, *Science*, 137, 765

Cheng, B. T. and Quellette, G. J.: 1971, Plant and Soi1, 34, 165.

- Cheung Y. H, Wong M. H. (1981): Properties of Animal Manures and Sewage Sludges and their Utilisation for Algal Growth, *Agricultural Waste*, 81, 109-122.
- Chlopecka, A.; Bacon, R.; Wilson, J.; Kay, J. (1996).Forms of Cadmium, Lead and Zinc in Contaminated Soils from Southern West Poland *.J. Env. Qual.*, *25*, 69–79.

Davies, E. B.: 1956, Soil Sci., 81, 209

Dudka, M.; Piotrowaska, A.; Chlopecka, A.; Laptek, J. (1995). Trace Element Contamination of Soil and Crop Plants by Mining and Melting Industry in Southwest Poland. *Geochem. Explore*, 52, 237- 250

De Treville, R. T. P. (1964). Natural Occurrence of Lead, Arch. Environ. Health, 8, 212,

Elliott, L. F. and Blaylock, J. W (1975). Soil Sci., 120, 205.

- EPA (Environmental Protection Agency) (1993): *Standards for the Use or Disposal of Sewage Sludge,* Final Rules, No 257(58) New York, USA, 33 – 38.
- Ghanem, I., EI-Gabaly, M. M., Hassan, M. N., and Tadros, V.: 1971, *Plant and Soil*, 34, 653.
- Gee GW, Or D (2002). Particle-size Analysis, Methods Soil Anal Part 4, (598):255–293

Hassel, J. J.: 1974, Communications in Soil Sci. and Plant Analysis, 5, 499.

Hodgson, J. F. (1963). Advan. Agron. 15, 119.

- Hornby, A. S. (2006). <u>Advanced Learner's Dictionary of English</u>, 7th edn., Oxford University Press, London, 340.
- IITA (1982). Automated and Semi-automated Methods for Soil and Plant Analysis, International Institute of Tropical Agriculture, Ibadan
- IITA (International Institute of Tropical Agriculture) (1979). *Laboratory Manual on Basic Soil and Plant Analyses,* 3rd edn., Longman London, UK, 9 – 67.

Kabala, C.; Singh, R. (2001). Fractionation and Mobility of Copper, Lead and Zinc in Soil Profile in the Vicinity of a Copper Smelter, *J. Quals.*, *30*, 485–492.

Karamanos, R. E., Bettany, J. R. and Stewart, J. W. B.: 1976, *Can. J. Soil Sci.*, 56, 485.

- Landon, J. R. (1991). Booker Tropical Soil Manual (A Handbook for Soil Survey and Agricultural Land Evaluation in the Tropics and Sub-tropics), 1st edn., Longman Scientific and Technical, New York, USA, 108 – 154.
- Linden, B. (1997): Human Urine as a Nitrogen Fertilizer Applied During Crop Growth to Winter wheat and Oats in Organic Farming, Crops and Soils, *Report 1, Department of Agricultural Research, Skara University, Sweden,* 6 – 9.
- Lundblad K., Swanberg O. and Ekman P. (1969). Plant and Soil, 1, 277
- MacLean A.J., Halstead R.L. & Finn B. J. (1969). Extractability of Added Lead in Soils and its Concentration in Plants, *Can. J. Soil Sci.*, 49, 327 34
- Ma, Q.; Rao N. (1997). Chemical Fractionation of Calcium, Copper, Nickel and Zinc in Contaminated Soils, J. Env. Qual., 26, 259–264.
- Malkki, S. (1999). The Current Situation and the Legislation Concerning the Use of Municipal Organic Waste in Finland, *Proceedings of NJF Agricultural Seminar, No.292 (November 23–25, 1998), Research Centre, Jokioinen, Finland. DIAS Report No. 13, II*:73–79.
- Matten G. C. and Hammond P. B. (1966). Lead Uptake by Bromegrass from Contaminated Soils, *Agron. J.*, 58, 553 554
- Nelson DW, Sommers LE (1996). *Total Carbon, Organic Carbon, and Organic Matter*, Methods of Soil Anal., Part3 Chem. Methods, 9:961–1010

- Page AL, Miller RH, Keeney DR (1982). *Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties,* Agronomy, No. 9. Soil Science Society of America, Madison, WI, p 1159
- Petersen, R. G. (1994). Agricultural Field Experiments, Design and Analysis, 8th edn., Marcel Dakker Press, New York, USA, Pp 87 – 91
- Rajagopal, C. K., Moosa Sheriff, M., Selvakumari, G., Madappan, K. and Devarajan, R. (1974). J. Indian Soc. Soil Sci. 22, 347.
- Ramos, L.; Hernandez, M.; Gonzales, J. (1994).Sequential Fractionation of Copper, Lead, Cadmium and Zinc in Soils from Donena National Park. J. Environ. Qual., 23, 50–57
- Singer, M. J. and Hanson, L. (1969). Lead Accumulation in Soils near Highways in the Twin Cities Metropolitan Area, *Soil Sci.Soc. Am. Proc*, 33, 152
- Stevenson, F. J. (1979). Lead Organic Matter Interactions in a Mollisol, *Soil Boil, Biochem.*,11: 493–9.
- Schnitzer M. and Hoffman I. (1967). Thermogravimetric Analysis of the Salts and Metal Complexes of a Soil Fulvic Acid, *Geochim. Cosmochim. Acta*, 31, 7 15
- Stober, R. C. Sheely, G. C. and Rolle, G. (1976). Water Pollution Control, *Fed.*, 48: 2165–75.
- Shuman, Z. N (1975). Soil Sci. Am. Proc., 39,454.
- Tekwa, I. J. Olawoye, H. U. and Yakubu H. (2010). Comparative Effects of Separate Incorporation of Cow Dung and Rice-Husk Materials on Nutrient Status of Some Lithosols, Int. J. Agric. Biol., 12: 857 – 860.
- Ugland, T. N. (1999): The Current Situation Concerning the Use of Municipal Organic Waste in Norway, Proceedings of NJF Agricultural Seminar, No. 292 (November 23–25, 1998), Research Centre, Jokioinen, Finland. DIAS Report No. 13, II: 23–27.
- Walkley, A. and Black, I. A. (1934). An Examination of the Degtijareff Method for Determining Soil Organic Matter and Proposed Modification of the Chromic acid Titration Method, *Soil Sci*, 37: 29–38.
- Warren, H. V. and Delavault, R. E. (1962). Lead in Some Food Crops and Trees, J. Sci. Food Agric, 13, 96

- Wild, A. (1996). *Soils and Environment: An Introduction*, 4th edn., Cambridge University Press, London, 93 98.
- Wong, M. H. and Lau W.M. (1985). The Effects of Applications of Phosphate, Lime, EDTA, Refuse Compost and Pig Manure on Pb Contents of crops, *Agricultural Wastes*, 12: 61 – 75.
- Wright J. R., Levic R. and Atkinson H. J. (1955). Trace Element Distribution in Virgin Profiles, Representing Four Great Soil Groups, *Soil Sci. Soc. Amer. Proc.*, 19, 340 - 344
- Zimdahl, R. L. and Arvik, J. H. (1972). Lead in soils and plants, in *Proc. Conf. on Environ. Chem., Human and Animal Health,* Savage, E. P., Ed., Colorado State University, Ft. Collins,
- Zimdahl, R.L and Skogerboe, R.K (1977): Behaviour of Lead in Soil, *Environ Sci. and Technol.*, 11: 1202 7.