EFFECT OF COMPOSTED AND UNCOMPOSTED ORGANIC AMENDMENTS AND BIOCHAR ON SOIL CHEMICAL PROPERTIES AND LEAD UPTAKE IN TWO MAIZE VARIETIES PLANTED IN Pb CONTAMINATED SOIL

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Abstract

Laboratory and screen-house studies were carried out to investigate the influence of composted manure, chicken manure, biochar, and control on the chemical characteristics and nutrient uptake of maize grown in lead-contaminated soil. The uncontaminated soil with lead was utilized as a control. All treatments were administered at three levels (20, 30, and 40t/ha). The treatments were implemented in a completely randomized design (CRD) with three replications. The maize cultivars employed were DTMA-Y-STR and DTMA-W-STR. The Pb content of DTMA Y STR planted in Pb-contaminated soil supplemented with 40t/ha of compost manure was dramatically reduced to 37300mg/kg, while DTMA W STR was reduced to 15027mg/kg when compared to the previously documented 66377mg/kg. In addition, Pb uptake in DTMA W STR shoots was reduced with Pb-contaminated soil supplemented with composted cow dung at a rate of 20t/ha. The experiment demonstrated that composted organic manure might assist in alleviating metal stress in maize crops growing in lead-contaminated soil, as well as immobilizing lead in the soil.

Keywords: biochar, composted and uncomposted**,** lead, maize, Pb contaminated soil

Introduction

Heavy metals are typically described as elements possessing metallic properties (ductility, conductivity, stability as cations, ligand selectivity, etc.) with an atomic number greater than 20. They are chemical elements whose specific gravity is at least five times that of water. For example, cadmium has a specific gravity of 8.65, iron 7.9, lead 11.34, and mercury 13.5. Approximately 53 of the 90 naturally occurring elements are heavy metals; however, not all of them are agriculturally useful. Heavy metal contaminants in soil are primarily sourced from metal mining and smelting, agricultural and horticultural materials such as fertilizer and pesticide application, sewage sludges, fossil fuel combustion, metallurgical industries, electroplating, chemical and other industrial sources (energy and fuel production), and waste disposal.

As and Cd have contaminated large areas of cultivated land in many countries as a result of agricultural and industrial practices such as pesticide and chemical fertilizer application, Elevated levels of heavy metals in soils may lead to their uptake by plants, which is determined not only by heavy metal concentrations in soils but also by soil pH, organic matter, and clay content, as well as fertilization. Recent research has linked organic matter to reduced heavy metal bioavailability in soils. Some researchers have shown that adding organic matter to contaminated soils reduced heavy metal absorption (Kham et al., 2000). Because transition metal cations prefer to form stable complexes with organic ligands, soil organic matter has piqued the interest of researchers studying heavy metal sorption by soils (Elliott et al., 1996). Waste water irrigation, smelter waste, and metal mining residues (Papazoglou et al., 2005).

Organic substances can create powerful compounds with heavy metals. The content of organic matter influences heavy metal speciation in oil (Lo et al., 1992). Organic matter amendments, such as compost, fertilizers, and garbage, are commonly used to immobilize heavy metals and improve soil quality in polluted soils (Clemente et al., 2005). The influence of organic matter amendments on metal bioavailability, however, is determined by the nature of the organic matter, its microbial degradability, salt content, and effects on soil pH and redox potential, as well as the specific soil type and metals involved (Walker et al. 2003, 2004). The use of organic waste materials, mainly of animal and plant origins are potential source of organic matter and plant nutrients (Adediran *et al*.,2003)

Composting has been a popular method for digesting organic wastes for use as soil conditioners and amendments (Butler et al. 2001). One of the most significant benefits of employing composted manure for agricultural uses is its consistency and maturity. Applying undecomposed wastes or non-stabilized compost to land may lead to immobilization of plant nutrients and phytotoxicity due to insufficient biodegradation of organic matter (Butler et al., 2001). Composting is regarded as a practical and environmentally sound approach to waste management that accelerates the breakdown of organic waste under regulated conditions, lowering its volume (Eneji et al., 2001). The purpose of this study was to see how compost manure, chicken manure, and biochar at various rates affected the soil chemical characteristics and nutrient concentration of two maize cultivars exposed to Pb.

Materials and Methods

Location: The experiment was carried out at Arakeji, Osun State, Nigeria.

The compost used was made from Mexican sunflower (*Tithonia diversifolia)* and poultry manure. The materials were laid out in a ratio of 3:1 of plant materials to poultry manure (on a dry weight basis) after sorting and chopping using the Partially Aerated Composting Technique (PACT-2) proposed by Adediran et al. (2001*).* The heap was left to decompose for a period of three months (September to December). Continuous turning and watering were done fortnightly to quicken the decomposition rate, after which the matured composts were evacuated from the heap, air-dried, shredded, and a sample taken for physico-chemical analysis.

Composted cow dung and poultry manure were laid out in a ratio of 2:1 of cow dung to poultry manure on a dry weight basis using the Partially Aerated Composting Technique (PACT-2) inside a composting bin. The compost mixture was watered moderately and thoroughly mixed to allow for even distribution of moisture. The bin was covered, and turning was done weekly to hasten the decomposition rate. Matured compost was evacuated from the composting bin after a month and was air-dried, ground, sieved, and stored in polythene bags. Composted poultry manure and composted cow dung followed the same composting process. Rice husk biochar was collected from the Crop Physiology Unit of the Department of Crop Protection and Environm The treatments used were control (contaminated soil), control (normal soil), composted poultry manure, composted cow dung, uncomposted poultry manure, uncomposted cow dung, composted cow dung and poultry manure (2:1), and rice husk biochar. The three levels for all treatments are 20, 30, and 40 t/ha in both laboratory and screenhouse studies. The treatments were arranged in a completely randomized design (CRD) and replicated three times.

Contaminated soil (1.5 kilograms) was weighed into different pots, and the pots were labelled according to the treatment. The treatments were applied according to rate by mixing them with soil two weeks before sowing. Two maize (*Zea mays)* varieties were planted. The two varieties used were DTMA-Y-STR and DTMA-W-STR. Three seeds per pot were planted and later thinned to two plants per pot a week after germination. The experiment was terminated at four weeks.

Plant Analysis

Dried plant samples were ground, and the samples were taken for nutrient determination. Total nitrogen was determined by the Kjeldahl method, in which plant material was digested with concentrated sulfuric acid and hydrogen peroxide with selenium as a catalyst. Phosphorus and potassium were determined in plant ash using the Vanado-Molybdenum method. The standard and the sample absorbance values were read off the spectrometer at a 470 nm wavelength setting. Plant tissue was digested with a mixture of nitric acid and hydrochloric acid, and the Pb content was determined by atomic absorption spectroscopy. After planting, a soil sample representative was taken from each treatment for laboratory analysis soil chemical parameters study was determined according to the AOAC (1999) analytical method.

Data Analysis

Data were analyzed using ANOVA of the IBM Procedure of the SPSS package (2010). Means were separated using Least Significant Difference (LSD) at $P<0.05$

Results

The P, K, Ca and Na, as well as OC content of the *Tithonia diversifolia* dry compost were 7.84, 6.80, 0.43, 14.80 and 16.7% respectively. Nitrogen content of the compost was 1.92% meaning that the compost was rich in nutrients. The cow dung and poultry manure were low in total N and P (Table 1).

The chemical and physical properties of the soil used for the experiment showed that the soil used was slightly acidic, and the pH of uncontaminated soil was slightly alkaline Tables 1 and 2). The organic matter (OM), total nitrogen (N) and available phosphorus (P) were adequate for uncontaminated soil but low for contaminated soil. The Pb present in uncontaminated soil was below 50 mg/kg, recommended by Umoru (2014) as the critical level for crop production. The contaminated soil had lead (Pb) concentration far above the critical level and thus might pose a problem to soil fertility.

Table 1: *Chemical properties of Organic amendments used for the experiment*

Parameters	Compost	Cowdung	Poultry Manure
Organic C(g/kg)	16.72	31.63	68.49
Total N(g/kg)	1.92	0.66	1.54
Available P(mg/kg)		0.19	0.45
Exchangeable bases(cmol/kg)			
K	6.80	0.12	2.23
Ca	0.43	0.74	0.77
Mg	30.75	0.16	0.47
Na	14.08	0.06	0.44
Extractable Micronutrient(mg/kg)			
Mn	16.00	167.50	32.50
Fe	9.78	1.95	0.24
Zu	2.05	52.50	57.95
Cu	75.00	14.30	6.95

Table 2: *Chemical properties of the initial soil*

Parameters	uncontaminated soil	Contaminted soil
pH(H_2O)	6.9	5.5
OM	3.50	1.84
Exchange acidity	0.50	1.60
Total N(%)	2.12	0.53
Available P(mg/kg)	18.96	2.61
Exchangeable bases(cmol/kg)		
K	0.40	1.51
Ca	13.92	2.49
Mg	1.24	1.08
Na	0.25	4.26
Extractable Micronutrient(mg/kg)		
Mn	13.00	33.40
Fe	138.00	378.00
Cu	4.95	39.40
Zn	1.64	4.21
Heavy Metal(mg/kg)		
Pb(lead)	38.75	66376.75

Source: Morakinyo et al. (2025)

Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA Y STR Maize variety Shoot planted in Pb Contaminated Soil

The effect of amendments showed that the application of composted poultry manure and cow dung at 40t/ha reduced the uptake of Pb in the shoot of DTMA Y STR during the period of growth, with a concentration of 218.00mg/kg. Also, the application of uncomposted poultry manure at 30t/ha reduced the uptake of Pb in the shoot with a concentration of 280.00mg/kg. (Figure 1)

Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA W STR Maize variety Shoot planted in Pb Contaminated Soil.

From this result, application of composted cow dung at 20t/ha and 30t/ha reduced the uptake of lead in the shoot of DTMA W STR during the period of growth with concentrations of 344.00 and 413.00mg/kg. Also, applying biochar at 20t/ha reduced the uptake of lead in the shoot to a concentration of 417.00mg/kg. Composted poultry manure at 30t/ha and 40t/ha has the highest lead uptake with concentrations of 1281.00 and 1276.00mg/kg, respectively. (Figure 2)

Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA W STR Maize variety Root planted in Pb Contaminated Soil.

Applying uncomposted cow dung at 30t/ha reduced the uptake of lead in the root of DTMA W STR planted on lead-contaminated soil with a concentration of 39673.25mg/kg. There was also a reduction in lead uptake with application of composted poultry manure at 20t/ha and composted poultry manure and cow dung at 40t/ha, giving concentrations of 43028.50mg/kg and 43153.00mg/kg, respectively. (Figure 3)

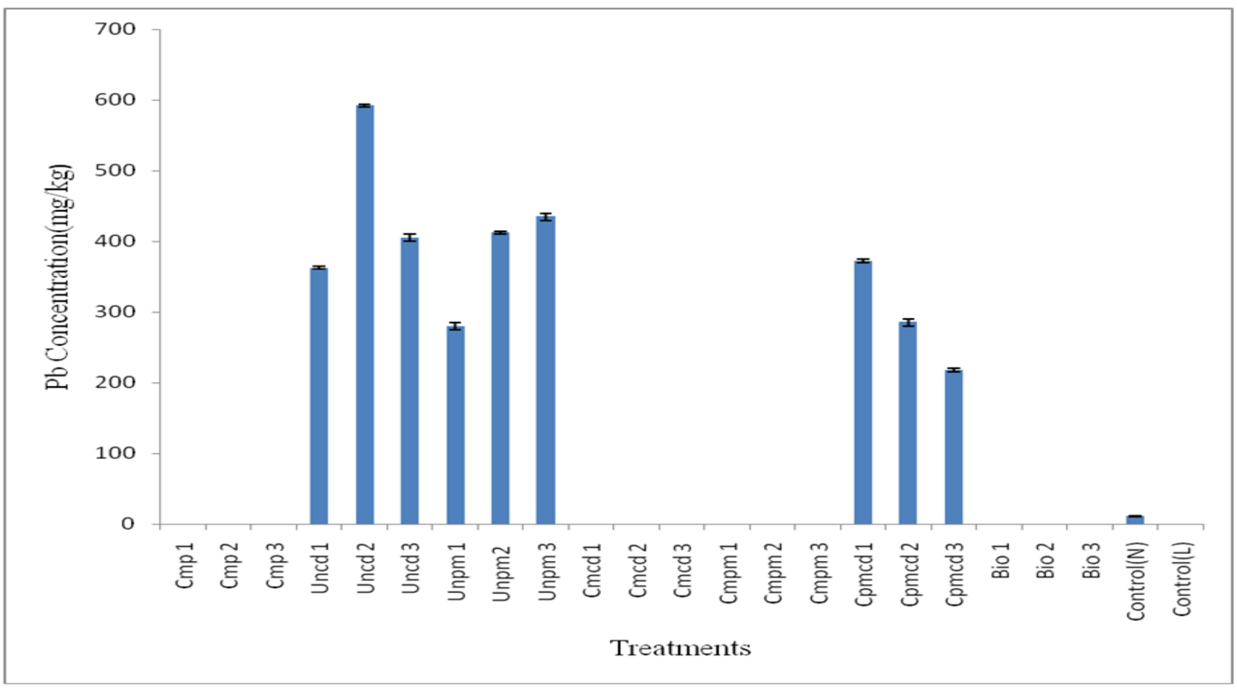

Figure 1: *Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA Y STR Maize variety Shoot planted in Pb Contaminated Soil.*

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha, UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil

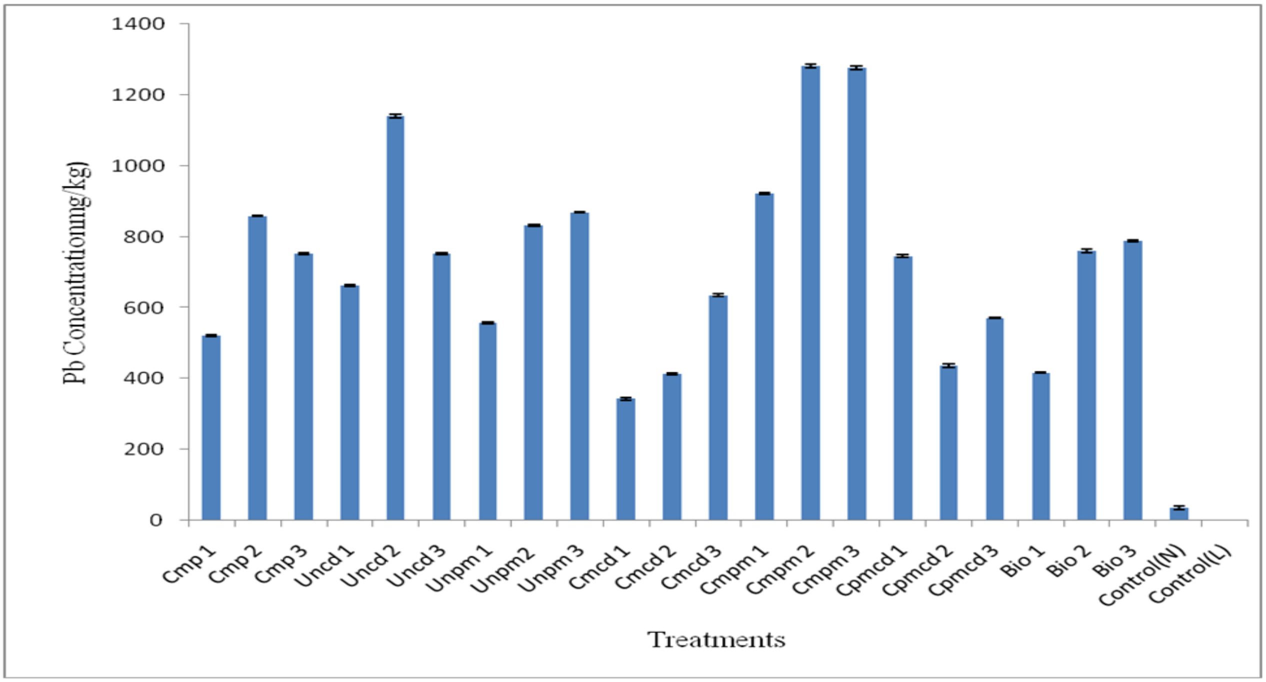

Figure 2: *Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA W STR Maize variety Shoot planted in Pb Contaminated Soil.*

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha, UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).

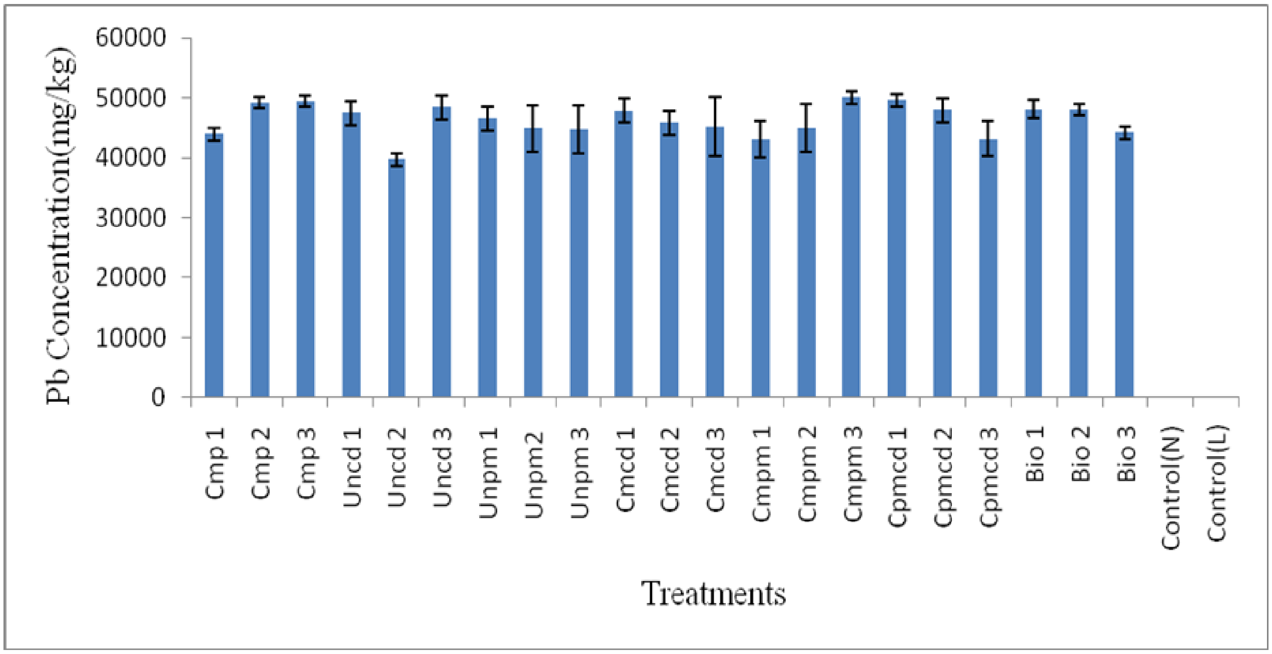

Figure 3: *Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in DTMA W STR Maize variety Root planted in Pb Contaminated Soil.*

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha, UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).

Effect of Composted and Uncomposted Organic Amendments and Biochar on Lead Concentration in Pb Contaminated Soil Planted with DTMA Y STR And DTMA W STR Maize Varieties.

After the experiment on Pb contaminated soil planted with DTMA Y STR maize variety, a reduction in lead concentration was observed in the soil amended with compost at 30t/ha, with lead concentration of 37300mg/kg. Other amendments that reduced lead concentration were compost at 20t/ha and composted poultry manure at 30t/ha, with concentrations of 42450mg/kg and 42950mg/kg. Biochar at 20t/ha and 30t/ha recorded the highest lead concentrations of 66500mg/kg and 66000mg/kg, respectively. (Figure 4)

With Pb contaminated soil planted with DTMA W STR maize variety, it was observed that the reduction in the lead concentration in the soil came from the amendment with composted poultry manure at 40t/ha with lead concentration of 15027mg/kg. Other amendments that reduced lead concentration were compost at 30t/ha and 40t/ha, with concentrations of 16300mg/kg and 16203mg/kg, composted poultry manure and cow dung at 20t/ha, having a lead concentration of 16063mg/kg. Uncomposted cow dung at 30t/ha had the highest lead concentration of 25563mg/kg. Comparing all the treatments with the control(contaminated), there was a significant reduction in the lead concentration of Pb soil treated with organic amendments and biochar. (Figure 5).

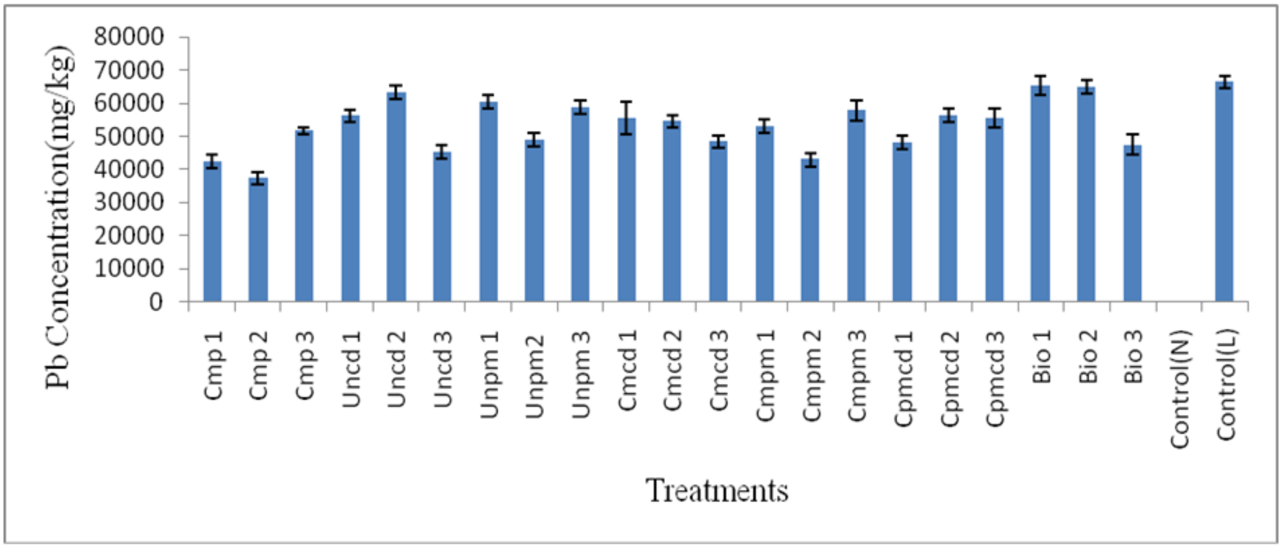

Figure 4: *Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in Pb Contaminated Soil planted with DTMA Y STR variety*

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha, UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).

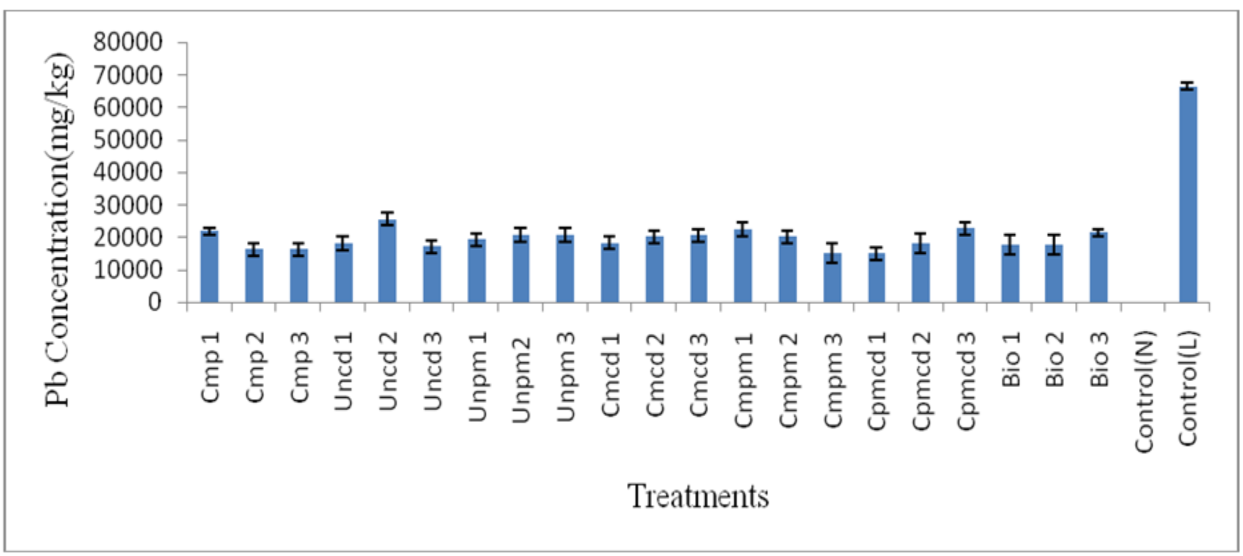

Figure 5: *Effect of Composted and Uncomposted Organic amendments and Biochar on Lead concentration in Pb Contaminated Soil planted with DTMA W STR maize variety*

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha, UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).

Effect of Composted and Uncomposted Organic Amendments and Biochar on Post-Cropping Soil Analysis of Lead Contaminated Soil

After harvesting, it was observed that the Nitrogen content of Pb contaminated soil amended with composted poultry manure and cowdung at 30t/ha and uncomposted poultry manure at 30t/ha increased the N content from 0.53, which was the initial pre-cropping value, to 1.25% and 1.16% respectively. Other organic amendments also increased the nitrogen content of the lead-contaminated soil. In the case of Potassium, it was observed that the treatments did not affect the Potassium concentration of the Pb-contaminated soil. There was a significant reduction in the potassium concentration of Pb-contaminated soil applied with organic amendments. For Phosphorus, application of biochar at 30t/ha and 40t/ha increased the phosphorus content when compared with the control(1.51cmol/kg), with mean values of 1.58cmol/kg and 1.59cmol/kg, respectively. Also, application of uncomposted cow dung at 30t/ha gave a slight increase in phosphorus level with a mean value of 1.52cmol/kg. There was a significant reduction in the Pb-contaminated soil amended with compost at 20t/ha and 30t/ha and uncomposted cow dung at 20t/ha. Although other treatments also reduced phosphorus concentration in the Pb-contaminated soil.

For Sodium concentration in the lead contaminated soil, the value of sodium increased drastically when compared with the pre-cropping value(4.26cmol/kg), except for Pb contaminated soil amended with biochar at 40t/ha, which reduced sodium concentration with a mean value of 2.70cmol/kg. Like Sodium, Magnesium also recorded an increase in its value when compared with the pre-cropping value and control. All the amendments applied to the Pb-contaminated soil increased the magnesium concentration in it. (Table 3).

Table 3: *Effect of Composted and Uncomposted Organic amendments and Biochar on post-cropping soil analysis of Lead Contaminated Soil*

			Exchangeable Bases (cmol/kg)				Extractable Micronutrients (mg/kg)			
Treatments	Total N(%)	Avail P(mg/g)	Ca	Mg	K	Na	Mn	Fe	Cu	Zn
Comp 1	0.34	0.56	0.93	3.95	0.91	5.66	192.75	51500.50	95.25	390.75
Comp 2	0.67	0.57	1.30	3.38	0.89	5.09	153.00	46876.25	65.75	350.50
Comp 3	1.02	0.72	2.04	3.88	1.24	5.84	161.25	47761.75	75.25	374.00
Uncd 1	0.16	0.45	0.82	3.40	0.91	7.88	165.75	44255.75	77.75	350.75
Uncd 2	0.37	0.58	1.17	6.56	1.52	10.24	255.25	79011.75	116.25	539.00
Uncd 3	1.05	0.41	0.97	3.82	1.13	8.32	199.50	53753.50	90.50	434.00
Unpm 1	0.94	0.55	2.29	4.91	1.05	7.26	161.75	52527.00	72.25	425.75
Unpm 2	1.08	0.62	2.51	5.44	1.25	8.19	147.25	49681.25	102.75	422.25
Unpm 3	1.16	0.57	1.92	4.91	1.19	5.68	181.00	54375.00	81.50	425.50
Cmcd 1	0.21	0.53	0.98	5.22	1.00	8.96	184.00	49756.25	81.75	341.25
Cmcd2	0.48	0.57	1.22	4.61	1.42	8.33	168.75	48379.25	75.25	360.50
Cmcd 3	0.69	0.52	0.87	4.48	1.05	8.00	174.50	50256.00	89.50	327.75
Cmpm 1	0.78	0.68	2.31	5.23	1.25	7.78	178.50	47400.00	102.75	324.50
Cmpm 2	1.02	0.67	1.54	6.36	1.42	10.05	208.50	59503.50	104.00	578.50
Cmpm3	1.00	0.52	1.79	4.70	1.01	7.90	241.00	74751.00	114.00	528.25
Cmpm+cd 1	0.97	0.60	1.46	5.03	1.05	9.20	191.25	62802.25	99.75	388.25
Cmpm+cd 2	1.04	0.58	1.19	3.59	0.71	5.16	180.75	57004.25	99.00	388.25
Cmpm+cd 3	1.25	0.77	3.33	6.90	1.52	8.52	174.50	51507.00	83.00	360.50
Bio 1	0.31	0.52	1.42	7.14	1.48	12.77	176.00	76003.75	125.75	564.00
Bio 2	0.29	0.56	1.11	4.83	1.58	8.28	245.50	73634.00	103.75	475.75
Bio 3	0.41	0.40	0.87	3.26	1.59	2.70	171.00	53256.00	61.25	262.75
Control(Nor)	0.70	0.39	1.37	2.26	0.57	0.33	380.75	25131.00	9.25	52.75
Contro(Pb)	0.53	2.61	5.49	2.08	1.15	4.26	33.40	373.00	39.40	4.21
LSD(P<0.05)	0.09	0.13	0.26	1.03	0.27	0.14	16.23	187.6	5.63	1.48

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha UNCD (Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).

Effect of Composted and Uncomposted Organic amendments and Biochar on DTMA W STR nutrient content planted in Pb Contaminated soil

From the result, the nitrogen content increase was found in maize planted on lead contaminated soil amended with composted poultry manure and cowdung at 40t/ha with mean value of 1.85% while maize planted on soil amended with uncomposted cowdung at 20t/ha had the lowest nitrogen content with mean value of 1.03%. There was no significant effect of the amendment of Pb-contaminated soil on the phosphorus content of DTMA W STR. For potassium content, amendment with composted poultry manure at 40t/ha significantly increased the potassium content with a mean value of 206.25cmol/kg, which was the highest. Pb-contaminated soil applied with uncomposted poultry manure at 20t/ha had the lowest potassium content, with a mean value of 80.47.

Apart from uncomposted cowdung at 40t/ha and composted cowdung at 40t/ha, composted cowdung at 30t/ha and compost at 40t/ha were not significantly different, all other organic amendments were significantly different from one another for the potassium content. It was observed that the application of uncomposted poultry manure at 40 t/ha gave the highest calcium content in DTMA W STR planted on Pb-contaminated soil. Appreciable increase was also noticed in calcium content in DTMA W STR planted on Pb contaminated soil amended with uncomposted poultry manure at 30t/ha, composted poultry manure at 20t/ha and 40t/ha. However, DTMA W STR planted on Pb soil amended with biochar at 40t/ha gave the lowest calcium content of 2.78cmol/kg. Pb soil amended with composted poultry manure and cow dung at 20t/ha significantly increased the magnesium content of DTMA W STR.(Table 4).

Table 4: *Effect of Composted and Uncomposted organic amendments and Biochar on DTMA W STR maize variety planted in Pb-contaminated soil*

			Exchangeable Bases(cmol/kg)			
Treatments	Total N(%)	Avail.P(mg/g)	Ca	Mg	K	Na
Comp 20t/ha	1.13	1.72	4.05	16.37	120.84	40.28
Comp 30t/ha	1.34	1.33	5.26	13.25	89.12	18.65
Comp 40t/ha	1.46	1.47	5.14	16.67	148.41	24.19
Uncd 20t/ha	1.03	1.48	4.15	16.51	117.47	39.47
Uncd 30t/ha	1.15	1.48	4.13	17.62	121.49	41.53
Uncd 40t/ha	1.35	1.16	6.95	18.66	113.78	39.41
Unpm 20t/ha	1.13	1.16	4.72	14.42	80.47	12.42
Unpm 30t/ha	1.18	1.14	8.47	18.17	124.05	17.74
Unpm 40t/ha	1.25	1.27	11.90	19.48	127.88	18.92
Cmcd 20t/ha	1.23	1.72	4.14	16.27	104.65	57.88
Cmcd 30t/ha	1.36	1.32	5.91	15.94	147.76	34.89
Cmcd 40t/ha	1.20	1.46	5.01	12.95	114.26	18.53
Cmpm 20t/ha	1.09	1.75	5.15	20.44	154.65	95.15
Cmpm 30t/ha	1.32	2.33	3.76	18.24	132.38	99.18
Cmpm 40t/ha	1.35	2.32	7.15	22.13	206.25	88.86
Cmpmcd 20t/ha	1.43	1.37	7.09	26.51	138.46	123.94
Cmpmcd 30t/ha	1.64	0.99	4.61	17.74	131.74	30.05
Cmpmcd 40t/ha	1.85	2.31	6.07	17.20	142.02	47.13
Biochar20t/ha	1.17	1.45	4.53	13.98	110.26	40.99
Biochar 30t/ha	1.22	2.09	8.94	17.61	131.41	44.92
Biochar 40t/ha	1.54	2.13	2.78	15.31	115.55	120.12
Control(Normal)	1.42	1.38	9.68	19.40	143.59	3.43
Control(Contaminated)	0.00	0.00	0.00	0.00	0.00	0.00
LSD($P<0.05$)	0.86	0.24	1.23	9.32	73.43	1.19

COMP1(Compost at 20t/ha), Comp 2-Compost at 30t/ha,Comp 3- Compost at 40t/ha UNCD(Uncomposted Cowdung)1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, UNPM(Uncomposted Poultry manure)- 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMCD(Composted Cowdung) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CMPM(Composted Poultry manure) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, CPMCD(Composted poultry *manure+cowdung 1- at 20t/ha, 2- at 30t/ha,3- at 40t/ha, Bio(Biochar) 1- at 20t/ha, 2- at 30t/ha, 3- at 40t/ha, Control N(Normal soil), Control L(Lead contaminated soil).*

Discussion

The use of organic amendments as reactive materials may control metal mobilization and aid the reclamation of contaminated soil. They also contain a high proportion of humified organic matter (OM), which can decrease the bioavailability of heavy metals in soil (Pitchel *et al.*, 2008). The organic matter forms strong complexes with heavy metals, which results in their immobilization in the soil. Studies have shown that the application of organic matter (farmyard manure, compost) resulted in a decrease in Cd concentration in some crop plants (corn, wheat, radish) (Tordoff *et al.*, 2000).

From the result, composted poultry manure and cowdung reduced the uptake of lead in shoot in DTMA-Y-STR and composted cowdung at 20t/ha and 30t/ha reduced the uptake of lead in DTMA-W-STR although some other treatments did also and this correlates with the findings of Scialdon *et al.,(*1980), Wong and Lau (1985); Ye *et al*,(1999) who reported that cow waste, poultry manure, compost, sewage sludge and pig manure were found to be effective in reducing lead availability to plant leading to lower uptake of lead. They are commonly used as tailings amendments because the addition of organic matter can significantly improve the physical characteristics and nutrient status of mine soil(Ye *et al.*,1999).

The total extractable Pb in the lead-contaminated soil was reduced in soil with the application of composted poultry manure at 40t/ha, and also compost at 40t/ha in Pb-contaminated soil grown with DTMA-W-STR. The reduction in the total extractable Pb may be due to chelation, complexation and adsorption between metal in soils and organic matter that is contained in the organic amendment and also the dilution effect when they are mixed with soils (Friedland 1989; Lozano-cerezo et al.,1999; Chiu *et al.*, 2006).

Conclusion

Laboratory and screen-house experiments were conducted to determine the effect of composted manure, poultry manure, biochar and control on soil chemical properties and nutrient uptake of maize grown in a soil contaminated with lead. The uncontaminated soil with lead was used as a control. The three levels for all the treatments used were (20, 30 and 40t/ha). The treatments were arranged in a Completely Randomised Design (CRD) with three replications. The two maize varieties used were DTMA -Y -STR and DTMA –W- STR. The Pb concentration of DTMA Y STR planted in Pb-contaminated soil amended with 40t/ha of compost manure was reduced, while DTMA W STR was reduced at 20t/ha. The experiment showed that composted organic manure could help in alleviating metal stress in maize crop grown on lead-contaminated soil and immobilized lead in the soil.

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