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Full Length Research Paper

Effects of poultry droppings in soil on some heavy metals uptake potential of water leaf (*Talinum triangulare*) and fluted pumpkin (*Teffairia Occidentalis*)

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This research was undertaken to assess the influence of poultry droppings in soil on the heavy metals uptake by fluted pumpkin (*Telfairia occidentalis*) and water leaf (*Talinum triangulare*). Water leaf and fluted pumpkin leaves grown on a soil treated with poultry droppings have been analysed for four (4) heavy metals: Iron (Fe), zinc (Zn), copper (Cu) and lead (Pb) by atomic absorption spectrophotometry (AAS). The result showed that, the concentration of the analysed metals ranged from iron (6.83 to 4.83), zinc (2.81 to 1.68), copper (1.83 to 0.72) and lead (0.23 to 0.20) ppm. The concentrations of all the metals in the leaves of the two plants sampled from the treated soil were generally higher when compared with those from the untreated soil (control). Possible explanation offered for the observed result include the fact that, though the poultry droppings may not contain high amounts of heavy metals, it is assumed that their organic nature could help in chelating and solubilizing the heavy metals in the soil thus making them more bioavailable than is the case with the control. The results of this study showed that, the concentration of all the heavy metals in the two plant leaves from the amended soil fell below toxic levels though they were significantly ($P < 0.05$,) higher than those from the control.

Key words: Heavy metals, poultry droppings, *Telfairia occidentalis*, *Talinum triangulare*.

INTRODUCTION

Increase in population in Nigeria has made shifting cultivation no longer sustainable. Before now, shifting cultivation system was comrnon as an environmentally sound and sustainable practice of rebuilding soil fertility (Ano and Agwu, 2005). Soil is usually degraded due to the constant use and the need to be replenished either by the use of organic matter or fertilizer (Alegria et al., 1991). Chemical fertilizers often produce plants products quickly and in large quantities, but over time, they become less and less effective and eventually leave the land arid with some xenobiotic chemicals; and the soil also depleted of essential nutrients (Ekop and Eddy, 2007). Bray and Kurtz (1945) observed that, the rapid decline of plant nutrients, low organic content and poor physical condition of the soil constitute strong limitations to crop production in areas regarded as the major food belt of Nigeria. Consequently, attention is now shifting towards organic manures as soil amendment for crop production on soils (Ano et al., 2003).

The application of poultry droppings to land is an effective disposal of animal waste. It solves the problem of animal waste disposal and also improves agricultural productivity (Obasi et al., 2008). This is a typical economic sustainable means of changing waste to wealth. Due to the high cost of inorganic fertilizers, small-scale farmers now apply animal manure, sewage sludge and municipal waste to improve soil fertility (Odoemelam and Ajunwa, 2008). The use of agricultural lands for sewage sludge and effluents disposal is being increasingly considered in many countries as a valuable alternative in the management of sewage and effluents and has become attractive, especially in low-organic matter soils (Obasi et al., 2008). It is pertinent to note that, for soil to fulfill its function in agricultural production and as a habitat for numerous beneficial microorganisms, heavy metals accumulation has to be minimized to a level

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Table 1. Mean concentrations of heavy metals in fluted pumpkin and water leaf.

Sample	Treatment group	Element (ppm)			
		Zn	Cu	Pb	Fe
Water leaf	Experimental	2.50 ± 0.30	1.83 ±0.03	0.20 ± 0.01	5.10 ±0.01
	Control	1.60 ± 0.05	0.89 ±0.01	0.21 ± 0.01	4.83 ± 0.02
Percentage change		48.80	105.61	(-4.76)	5.59
Fluted pumpkin :	Experimental	2.81 ± 0.02	0.81 ±0.02	0.20 ± 0.01	6.83 ± 0.03
	Control	2.00 ±0.10	0.72 ± 0.01	0.23 ± 0.02	5.20 ± 0.02
Percentage change		40.50	12.50		31.35

Means of 3 determination ± Sd.

that is not deleterious to the ecosystem. Therefore, long-term accumulation of heavy metals in agricultural soils may cause serious ecological problems if tolerance levels are exceeded (Odoemelam and Ajunwa, 2008). More often, heavy metals input to agricultural soils may come from inorganic fertilizer applications; other sources of heavy metal input to agricultural soils may include atmospheric decomposition, sewage sludge, agro-chemicals, livestock manure, irrigation water, industrial waste and compost (Zhou et al., 2004). Fluted pumpkin and water leaf are highly relish cooked vegetables along side “Afang” (*Gnetum africanum*) in continental cuisine (Ekop, 2007). The 2 perennial leafy vegetables are now grown on commercial scale in Nigeria. They are the most ubiquitous plants in most home stead gardens where poultry droppings is the most outstanding soil addendum for their optimum growth.

This research work is aimed at evaluating the levels of some heavy metals uptake by water leaf *(Talinum triangulare*) and fluted pumpkin (*Telfairia occidentalis*) grown on a poultry droppings amended soil.

MATERIALS AND METHODS

Ten stands each of fluted pumpkin *(T. occidentalis*) and water leaf *(T. triangulare*) were planted on loamy soil amended with poultry droppings and another set of ten grown on a similar soil without any amendment to act as a control experiment. The plants were watered as necessary and allowed to stand for six (6) weeks, when the leaves were matured enough for collection and laboratory analysis.

The leaves of water leaf and fluted pumpkin were randomly collected from a soil treated with poultry droppings. Another set of water leaf and fluted pumpkin leaves were collected from another part of the soil on the same area which was untreated. This served as the control. Samples from the treated and untreated soil were washed and dried to constant weight in an oven set at 50 to 60°C. The samples were then ground into powdery form and then sieved using a 0.1 mm sieve. The samples were transferred into polyethylene bags and stored until analysis. Each sample from the untreated and treated soil was digested using wet acid digestion. Determinations of Zn, Fe, Cu and Pb were carried out in triplicate on representative plant sample using Atomic Absorption Spectrophotometer pye-Unicam 603 models.

RESULTS AND DISCUSSION

The mean concentrations of heavy metals in fluted pumpkin and water leaf as shown in Table 1 revealed that, the concentrations of heavy metals in plants from soil treated with poultry droppings are higher than those from untreated soil. Iron had the highest concentration of 5.10 mg/kg in water leaf from the experimental soil and 6.83 mg/kg in fluted pumpkin from the experimental soil compared to other heavy metals which were present in the leaves of the sample. Zinc which was next in the trend with a concentration of 2.50 mg/kg in water leaf from the experimental soil and 2.81 mg/kg in fluted pumpkin from the experimental soil. Copper was the next abundant and it had a concentration of 1.83 mg/kg in water leaf from the experimental soil and 0.81 mg/kg in fluted pumpkin from the experimental soil. Lead had the lowest concentration of 0.20 mg/kg in the leaves of both samples. The concentration of lead was lower in the leaves from the experimental soil than in the control soil. A careful observation of Table 1 revealed that, the concentration of heavy metal in the leaves sample varied in trend as follows Pb < Cu < Zn < Fe in both water leaf and fluted pumpkin. The trend is similar in the experimental and control soil.

From the result presented in Table 1, there is increase in heavy metal concentrations in plants – water leaf and fluted pumpkin harvested from soil amended with poultry droppings as compared with those from the control soil. This elevated or increased heavy metals in plants from the amended soil could be attributed to the high nutrient content of the poultry feed. This observation stands to confirm earlier ascertion by other investigators (Mbah and Asegbeke, 2006).

It is also presumed that the nutritional status of the soil could enhance heavy metal absorption by the plant perhaps by making the heavy metal more soluble and hence biologically more available. The sandy nature of the soils makes amendment with animal manure suitable because the high permeability of the soil will allow large quantities of leachates to pass through the soil thereby making the crops to absorb nutrients readily (Odoemelam

Table 2. Results of t- test analysis.

Parameter	Calculated students t-test values			
	Zn	Cu	Pb	Fe
Experimental versus control (water leaf)	5.03*	8.14*	0.12 Ns	2.70 Ns
Experimental versus control (fluted pumpkin)	4.05 Ns	9.00*	0.30Ns	12.62*
Experimental (water leaf and fluted pumpkin)	2.40 Ns	7.90*	0Ns	14.98*

$t_{crit.}$, $t_{critical}$ at 95% confidence level (n = 3) is 4.303; * , significant difference between experimental and control ($p< 0.05$); Ns, non significant difference ($p> 0.05$).

and Ajunwa, 2008). The accumulation of these metals in the leaves could be attributed to the acidity of the soil.

Zinc

A careful observation of the first column on Table 1 revealed that, fluted pumpkin leaves contain 2.81 mg/kg and was higher than that of water leaf (2.50 mg/kg). Both values were greater than the result from the control. The percentage change in the zinc content from the experimental and control samples are 48.80% for water leaf and 40.50% for fluted pumpkin. From Table 2, the student's t-test calculated showed that, there was significant difference between water leaf from control and experimental soils. There was no significant difference between the concentration of the metals in fluted pumpkin from experimental and control soils. Also, there was no significant difference between fluted pumpkin and water leaf from experimental soils. The concentration of zinc from the result fell below the range of concentration of zinc in plants (8.00 to 100.0 ppm) according to Hayes (1978), excess of zinc forms an acid in food or drinks due to galvanized container used to store food or drinks especially canned food. This excess of zinc causes vomiting, diarrhea. Normal zinc intake by human is about 30 to 150 for several weeks and its deficiency often manifest as growth retardation, night blindness, dry skin, impaired dark adaptation, mental depression and diarrhea (Alegria et al., 1991). There is evidence that zinc sometimes depresses copper uptake from soils and it is thought that, this is due to a competitive interaction during uptake rather than a soil effect.

Copper

A casual look at the second column on Table 1 showed that, water leaf leaves contain 1.83 mg/kg which is higher than fluted pumpkin (0.81 mg/kg). These values were greater than their controls. The percentage change in copper content between the experimental and control in both samples are 105.61% for water leaf and 12.50% for fluted pumpkin. The concentration of copper is far higher in water leaf than fluted pumpkin. This confirmed the statement "plants vary greatly in the amount of heavy metal they uptake depending on the species, stage of growth and environmental condition" (Alegria et al., 1991). The difference was statistically significant at 95% confidence level using student's t-test analysis. Table 2 showed that, there was significant difference between water leaf from the control and experimental soil, also in fluted pumpkin; from the experimental and control soil. There was also significant difference between fluted pumpkin and water leaf from the experimental soils. From the result, it was evident that, the concentration of copper is below the range of concentration of copper in plants (4.00 to 15.00 ppm) according to Hayes (1978).

Copper is an essential substance to human life, but in high dose, it can cause anemia, liver and kidney damage as well as stomach and intestinal irritation. People with Wilson's disease are at greater risk for health effects from over exposure to copper. Copper normally occurs in drinking water from copper pipes, as well as from additives designed to control algal growth.

Lead

The concentration of lead in column 3 of Table 1 was lower in the experimental than in the control in both water leaf and fluted pumpkin. The percentage difference between water leaf from control and experimental soil was 4.76% and in fluted pumpkin, the difference was 13.04%. From Table 2, student's t-test showed that, there was no significant difference in the concentration of lead between water leaf from experimental and control soil. Also, there was no significant difference between fluted pumpkin from experimental soil and the control soil. The same is true in water leaf and fluted pumpkin (experimental). Although, the concentration of lead from the result of this work was within the range of lead concentration of plants (0.10 to 10.00 ppm) according to Hayes (1978). Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation is the increase in concentration of chemical specie in biological organism overtime, compared to the chemical concentration in the environment. An average daily intake for adults is 1.6 ug from air, 20 ug from drinking water and 28 ug from food (Bioremediation.com, 2008). High

levels of exposure may result in toxic biochemical effects in humans which in turn cause problems in the synthesis of haemoglobin, effects on the kidney, gastrointestinal tract, joints and reproductive system and acute or chronic damage to the nervous system. As the level of lead in the human system increase, hyper-excitability is seen. Confusion, delirium and convulsion may occur in some cases, while in others there is progressive lethargy to a comatose state.

Iron

A careful study of the last column on Table 1 showed that, iron has the highest concentration among other metals which were present in the plant samples. It has a concentration of 5.10 mg/kg in water leaf and 6.83 mg/kg in fluted pumpkin. The percentage change between water leaf experimental and control soil was 5.59% and for fluted pumpkin, it was 31.35%. The difference was statistically significant at 95% confidence level using student t-test analysis as shown in Table 2, which revealed that, there was significant difference between fluted pumpkin experimental and control soil in fluted pumpkin and water leaf experimental. There was no significant difference between water leaf control and experimental soil but the concentration of iron in the plant samples fell below the range of iron concentration in plants l49 ppm according to Hayes (1978).

Acute poisoning causes vomiting, abdominal pain, shock, drowsiness. It also causes liver enlargement and hepatoma. Deficiency of iron decreases work efficiency (Alegria et al., 1991).

Conclusions

From the results obtained in this work, it could be concluded that soils amended with poultry droppings enhanced the uptake of heavy metals (Fe, Zn, Pb and Cu) by water leaf and fluted pumpkin. The uptake by these plants from the experimental soil were significantly ($P < 0.05$; $n = 3$) higher than those from control. Possible explanation offered here include the fact that, though the poultry droppings may not contain high heavy metals, it is assumed that, their organic nature could help in the chelation and solubilization the heavy metals thus making them more bioavailable than in the case of the control.

Application of poultry droppings on agricultural soils may increase the solubility of heavy metal present in the soil thus making them available for uptake by plants. The results of this study showed that the heavy metals determined in fluted pumpkin and water leaf fell below toxic levels; however, constant monitoring of agricultural soil amended with poultry droppings was necessary in other to evaluate the accumulation effect. This constant monitoring was necessary because, heavy metals tend to bioaccumulate overtime and this is dangerous to human health and consumption. Vegetables like fluted pumpkin and water leaf from agricultural soils amended with poultry droppings are suitable for human consumption and does not affect the food chain initially but after sometimes, bioaccumulation which is the increase in the concentration of a chemical in biological organism overtime becomes dangerous.

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