Uptake of Phosphate and Heavy Metals by Sorghum in Automobile Waste affected Typic HaplustuLt in South east Nigeria.

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Abstract: This study investigated the phosphate (P_{04}^{-}) and heavy metal (Cu, Zn, Fe, Pb and Cd) uptake by sorghum in a typic haplustult affected by automobile waste. Results of the study showed that automobile waste enriched the soil with heavy metals above maximum acceptable limits. Similarly, higher levels of P_{04}^{-} and heavy metals were observed in the roots and shoots of sorghum in automobile waste soil relative to the control. However, observed levels of heavy metals in the test crop were within normal range in plants for automobile and control soils. Automobile waste soils in the area are safe for agricultural activities.
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1. Introduction

Soil is naturally a source of heavy metals (Alloway, 1995) and a recipient of heavy metals due to anthropogenic activities (Javier and Rafeal, 2005; Alloway, 1995). In Nigeria automobile servicing and maintenance centres popularly known as "mechanic village" are located in many cities. Wastes that are normally generated in the course of auto-repair and servicing are disposed indiscriminately into the environment. These wastes according to Dominguez – Rosado and Pitchel (2004) include used engine oil which deteriorate the nearby lands and have grave consequences on the system (Nwoko *et al*., 2007).

In a study on the physicochemical characterization of farmland affected by automobile waste in relation to heavy metals, Mbah and Ezeaku (2010)reported decreased ca, k, mg. CEC and increased levels of Zn, Pb, Cd, and Cu (above critical limits) in automobile waste affected farmland relative to the control.In another study on variation of heavy metal contents on roadside soils along a major expressway in south east Nigeria, Mbah and Anikwe (2010) observed increased levels of Cu, Zn, Pb, Fe and Cd in soil nearer the road and this according to Maynard and Turer, (2003) is due to emissions from exhaust of automobile engines and contacts between metallic objects of machines. Mbah *et al*, (2006) and Faghenro (2000) observed accumulation to toxic levels of such metals as pb, zn, cu, cd and cr in crops grown in organic waste amended soils in Nigeria.
Scarcity of land and the need to provide food to the increasing population has led to increased cultivation of lands including automobile waste affected farmlands in major cities in Nigeria. Research on the benefits and dangers associated with cropping in automobile waste affected farmland is scarce in the area. This study examined the uptake of phosphate and heavy metals (cu, zn, pb, zn, and cd) by sorghum in an ultisol affected by automobile waste in Abakaliki Southeast Nigeria.

2. Materials and Methods

2.1 **Study area:**

This study was carrid out in 2009 at Abakaliki south east Nigeria.Abakaliki is located in Ebonyi State in the southern part of Nigeria. Abakaliki is the capital city of Ebonyi State and lies between latitude $06^{o}04^{1}$N and longitude $08^{o}65^{1}$E in the derived savannah zone of the southern-agroecological zone of Nigeria. Soils of the area are products from successive deposit from Asu River of crutaceous age belonging to the order ultisol and classified as Typic Haplustult, (FDALR, 1985). The area experiences bimodal pattern of rainfall i.e. April-July and September – early November with short spell in August – normally called "august break". The area has an average annual rainfall range of 1700 – 2000mm and mean annual temperature ranging from $27^{o}C$ – $31^{o}C$. Farming is a major economic activity even in urban areas where patches of subsistence farms are found.

2.3 Field Studies;

Field sampling was conducted using a free survey technique involving target sampling of soils from two sites viz automobile waste affected farmland (automobiles soil) and non-automobile waste affected farmland (control). On each area soil samples were collected at the surface (0-20cm). Similarly, twelve sorghum plants were uprooted from automobile waste affected soil and twelve from a nearby farmland which served as the control. The roots of the plants were cut of from the shoots. The soil and plant materials (roots and shoots) materials were air dried and analysed for phosphate and heavy metale (cu, zn, pb, cd and fe).

2.4 Analysis

Phosphates was determined by phenol sulphuric acid and ascorbic acid molybednum blue methods, respectively,Total Iron(Fe), copper(Cu), lead(pb), zinc(Zn) and cadmium(cd) were measured by Sp 1900 pye Unican Recording flame atomic absorption spectrophotometer at their respective wavelengths after wet digestion with a mixture of HCL and $HN0_3$.

2.5 Data Analysis:

Linear regression analysis was performed on soil data and heavy metal using SAS computer software (SAS, Institute 2001).

1. Results and Discussions

Results from the Study showed that the phosphate (P_{04}-) level in automobile was 22% higher than that of the control. (Tables 1 and 2). The tables also showed higher P_{04}- uptake by sorghum shoots compared to the roots in both soils. Similarly, higher P_{04}- uptake was observed in shoots and roots of sorghum in automobile waste soil compared to the control.

Heavy metals ranged between 0.09 ± 0.001 (fe) , 38.2 ± 0.04 (pb), 0.09 ± 0.001(fe), 2 ± 0.2 (cd), 2 ± 0.2 (cu) and 0.08 ± 0.01 (fe) , 1.32 ± 0.01 (pb), 0.22 ± 0.01(zn), 0.02 ± 0 (cd), 0.06 ± 0.001 (cu) in automobile waste and control soils, respectively (Tables 1 and 2). Higher levels of heavy metals were observed in the shoots and roots of sorghum in automobile waste soil relative to the control. Lead (pb), zn, cu, fe and cd shoot content in automobile soil were 33%, 16459%, 9%, 16867% and 131900%, respectively higher than observed values in the control. The order of root heavy metal content was pb > zn > cd > fe > cu for automobile waste soil and pb > zn > fe > cd = cu for the control.

Table I: **Soil content and uptake of heavy metal by sorghum in automobile waste soil ($mgkg^{-1}$)**

	Soil depth (cm)	Plant	
Heavy metal	0-20	shoot	root
Fe	0.09 ± 0.001	0.509	0.291
Zn	2.04 ± 0.01	1.324	1.702
Pb	30.2 ± 0.04	12.27	18.34
Cd	2.0 ± 0.2	1.32	1.02
Fu	2.0 ± 0.2	0.012	0.007
$P0_4^{-}$	0.026	0.007	0.005

Table 2: **Soil content and uptake of heavy metal by sorghum in control soil.**

	Soil depth (cm)	Plant	
Heavy Metal	0-20	shoot	root
Fe	0.008 ± 0.01	0.003	0.003
Zn	2.22 ± 0.01	1.008	1.006
Pb	1.32 ± 0.01	9.21	9.70
Cd	0.02 ± 0	0.001	0.001
Cu	0.06 ± 0.001	0.011	0.001
$P0_4^{-}$	0.008	0.007	0.002

Table 3: Maximum permissible levels/normal concentration of heavy metals in soil and plants. ($mgkg^{-1}$)

Heavy metal	Soil	Plant
Fe	< 5.4[a]	-
Cu	< 0.2[a]	5-20[x]
Zn	2[a]	1-40[x]
P	5[a]	0.2-20[x]
Cd	0.81	0.1-2.4[x]

a=maximum permissible level according to FAO (1976) and WHO (2003) x= normal range according to Brown 1979.

The soil of the study area had low levels of phosphate (Po_4-) which was also reflected in its uptake by the roots and shoots of the test crop-sorghum. The high levels of heavy metals obtained in automobile waste soil could be attributed to the disposal of bye-products from auto-repairs and servicing. Apart from soil enrichment with heavy metals, Atuanya (1987) and Nwoko *et al*., (2007) observed that contamination of the environment with such wastes has grave consequences on the system. Okpokwasili and Odukuma (1990) and Odu (1978) observed that such consequences include degradation of agricultural soils, surface and groundwater contamination, toxicity to biodata, poor soil aeration, impairment of water drainage and introduction of plant-growth inhibiting chemicals. According to Vousta *et al*., (1996) trace element uptake by roots depends on both soil and plant factor (e.g. source and chemical form of elements in soil, pH, organic matter plant species, plant age etc) interactions between elements occurring at the root surface and within the plant can affect uptake, as well as translocation and toxicity. High levels of heavy metal observed in the roots and shoots of sorghum in automobile waste soil could be attributed to soil enrichment of these metals by automobile wastes. Mbah et al., (2006) reported that the uptake of metals and subsequent accumulation in crops could cause serious health hazards when they are transferred to the food chain. Though soil heavy metal enrichment by automobile wastes exceeded maximum acceptable limit in the soil, their uptake by shoots and roots of sorghum were with normal or acceptable limits, thus making automobile waste affected soil safe for agricultural activities or crop production in the study area.

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