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Assessment of Lead Concentration in *Pennisetum purpureum* Growing Along Akure – Ilesha Express Road Ondo State, Nigeria

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***Abstract* - The assessment of the level of lead in a grass *pennisetum purpureum* growing along Akure-ilesha expressway in Nigeria was carried out using atomic absorption Spectrophotometry (AAS). The concentration of lead in soil and plant on both sides of the road ranged as follows: 5.50-6.o4 and 20.69-32.50, 1.40-8.83 and 7.23-9.37 root, 0.64-4.32 and 1.22-5.02 stem and 0.13-0.95 and 0.09-0.33 in the leaves respectively. The magnification coefficient (MC) ranged between 0.11-0.92 and 0.23-0.35. The concentration of the metal in the plant is in the series root>stem>leaf. The level of the metal in the soil and plant at both sides of the highway was higher than the control ($p<0.05$). The level of the metal in the soil and plant may be attributed to the pollution emanating from vehicular emissions as the expressway experiences a high vehicular traffic all the time. Continuous discharge of gaseous emission from vehicles that use leaded petrol may lead to higher level of this metal in the soil and in the tissues of *pennisetum purpureum* and other plants growing along the expressway over time. This can result to pollution of the soil and plants growing along the expressway, which are ready source of food for the cattle that feeds on them and other organism in the food chain.**

Keywords: Expressway, Lead, pennisetum purpureum. Akure, Ilesha, express road, Lead (Pb), Vehicular Emissions, Heavy Metal Contamination, Soil Pollution, Bioaccumulation, Atomic Absorption Spectrophotometry (AAS, Environmental Monitoring.

I. INTRODUCTION

Heavy metal pollution of the environment even at low levels, and their resulting long-term cumulative health effects are among the leading health concerns all over the world. For example bioaccumulation of Pb in human body interferes with the functioning of mitochondria, thereby impairing respiration, and also causes constipation, swelling of the brain paralysis and eventual death (Cheng, 1992). Besides natural weathering processes of geological materials and soils, the main sources of lead pollution are exhaust fumes of automobiles, chimneys of factories using lead, effluents from the storage battery, industry, mining and smelting of iron ores, metal plating and finishing operations, fertilizers, pesticides and additives in pigment and gasoline. (Borgmann, 1983, Asamit, 1994, Dean, *et al.*, 1972 and Field and Lager, 1975). In urban areas automobile exhaust contributes substantially to theatmospheric pollution and lead compounds are the major pollutants emitted by automobiles (Shea, 1996, Asamit, 1994, Dean et al., 1972**).** In effect plants growing on highways are usually exposed to more lead then other localities. The interest in this study however lies in the likely high level of lead in plants growing along the expressway and potential danger to organisms that depend directly on the plant for food as well as to humans that eat the meet from the herbivores. Particularly to the cattle that are brought by herdsmen to feed on the plant collected along the highway. In Nigeria, it has been predicted that at least 15,00kg of Pb is emitted into the environment through burning (Agbo, 1997). Hence automobile exhausts were believed to account for 80% of the air pollution. Lead content in Nigeria's super grade gasoline is about 600-800mg/L **(**Osinbanjo and Ajayi, 1989 and Shy, 1990).Which is much higher than permissible levels in some pollution conscious countries. Lead is also available to plants form soil and aerosol sources. Plant roots have an ability to take up significant quantities of lead whilst simultaneously greatly restricting its translocation to above ground parts (Lane and Martins, 1977). The importance of this plant as a fodder not only for feeding of cattle, but other domestic ruminants further prompts the interest in wanting to know the level of this metal in the plant tissue and in the soil where they grow. Moreover, leaded petrol is still in use in Nigeria and a good number of commercial vehicles that ply the roads are not road worthy with high volume of exhaust released into the environment. Atmospheric deposition of lead has been reported as a major contributor to a like sediment burden (Outridge *et al.*, 2002). The presence of lead and other heavy metals has been reported in soils and plants including leafy vegetables in Nigeria **(**Akinola and Ekiyoyo, 2006, Adeyeye, 2005 and Osibanjoand Ajayi, 1980). The aim of this study was to determine the lead content of organs in *pennisetumpurpureum* which naturally grow along the roadside.

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II. MATERIALS AND METHODS

Study area, sampling and sample preparation

The study area is along both sides of the Akure – Ilesha Expressway. It covers between FUTA northgate to IKeji-Arakeji. This is a major road that connects Akure, the state capital to other parts of the country. Systematic sampling was used for soil and plant samples. Two soil samples and two plants were collected from the edge at an equidistant position of 5 kilometer apart from both sides fo the expressway. The soil samples were cored out to a depth of 15cm with hand trowel while the plant samples were carefully uprooted with cutlass and digger to ensure that the roots and other plant parts were not damaged. Soil and plant samples were collected 300metre away formthe edge of the road to serve as control. All samples were put in properly labelled polythene bags and transported to the laboratory for analysis. Each plant sample was separated into root, stem and leaf. Each part was then cut into 1cm segments which were oven dried at 70^{o}C, milled and pass through a 2mm sieve mesh. 0.5 of each powdered segments was dissolved in 5ml 2MHNO_3 in a beaker for digestion. The mixture were heated using hot plate until it was reduced to about 5ml, allowed to cool and filtered using what man paper and made up to a volume of 25ml with distilled water.

Each soil sample was air-dried and grinded. The grinded sample was sieved using 2mm sieve and oven dried at 100^{o}C to a constant weigh. 1g of the dried sample was digested with nitric acid in volume ratio of 4:1 in a beaker. The digest was heated with on a hot plate until the digest volume was reduced to 5ml. the digest was filtered after shaking using whatman paper and the filtrate was made up to 25ml with distilled water (Akinola, 2007).

Analytical method

The concentration of lead present in the digestate in both soil and plant samples was determined by atomic absorption spectrometer perkin Elmer model 200. The results for AAS were converted to actual concentration of metal in the samples using the equation.

Concentration µg/g = concentration reading

$$\frac{\text{XExtract volume}}{\text{Sample weight}}$$

Determination of soil pH

The PH was measured using a soil sample added to distilled water in a ratio 1:2 (soil: Water) on a volume basis using a glass pH electrode, SETRA PHS 25, earlier calibrated.

Magnification coefficient

The magnification coefficient which is the concentration of heavy metals in the plant roots in relation to the concentration in the soil sample was calculated using the method described by (Akinola, 2007).

III. RESULTS AND DISCUSSION

Table 1: Concentration of lead (Pb) (µg/g) in the soil of the expressway

	PH	Akure – Ilesha	PH	Ilesha – Akure
Control (300ma away)	4.45	2.50	4.45	3.50
FUTA North Gate	5.55	28.5	5.56	32.5
Ilara Junction	5.87	9.5	5.76	25.0
IgbaraOke	5.86	35.5	5.86	28.5
Owena	6.04	12.5	6.05	20.69
Ikeji – arakeji	5.96	10.5	6.00	25.50

Table 2: Concentration of lead (Pb) (µg/g) in the root of *pennisetum purpureum* on the expressway

Location	Akure - Ilesha	Ilesha - Akure
Control (300m)	1.51	0.87
FUTA North Gate	7.39	7.36
Ilara Junction	8.73	8.41
IgbaraOke	8.83	9.37
Owena	1.40	7.23
Ikeji-Arakeji	7.20	7.27

The concentration of Pb in the soil at the different sampling positions is shown in Table 1. The concentration of Pb ranged between 9.5 – 35.5µg/g. The soil is not polluted with lead since the concentrations recorded are all below the recommended upper limit of 250µg/g in soil (DOE/NWC, 1981, John, *et al.*, 1982). Low concentration of lead, chromium and cadmium has been reported in soils in Nigeria (Akinola and Ekiyoyo, 2006). Furthermore, more of the lead in the soil must have been absorbed by plants since it has been reported that indeed the absorption of lead can increase with increasing pH between 3-8.5 (Lee, *et al.*, 1988) and lead is also easily absorbed and accumulated in different plant parts (Sharma and Dubey, 2005). The pH of the soil is between 6.7 and 7.9. (Table 1). However, the concentration of lead in the soil at the roadside was significantly higher then the control ($P<0.05$). This confirms that the plants at the edge of the expressway are exposed to

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Table 3: The concentration of lead (Pb)(µg/g) in the stem of plant on the expressway

Location	Akure - Ilesha	Ilesha - Akure
Control (300m)	0.73	0.33
FUTA North Gate	1.03	1.08
Ilara Junction	1.10	1.09
IgbaraOke	1.38	1.22
Owena	0.64	5.02
Ikeji-Arakeji	4.32	4.30

Table 4: The concentration of lead (Pb) (µg/g) in the leaf of plant on the expressway

Location	Akure - Ilesha	Ilesha - Akure
Control (300m)	0.16	0.10
FUTA North Gate	0.63	0.36
Ilara Junction	0.70	0.09
IgbaraOke	0.53	0.33
Owena	0.13	0.27
Ikeji-Arakeji	0.95	0.10

Higher concentration of lead form vehicular movement on daily basis since it is the major road that connects Akure, the state capital to all other parts of the country. So continual consumption of the plant growing at the road side could result in the accumulation of lead in the body of the herbivores and humans that feed on such herbivores. Accumulation of lead in edible aquatic plants (Kumar, *et al;* 2002) in soil and vegetation (fatoki, 2003) and in animals (Salanki, *et al;* 2003) and in animals (Salanki, *et al.,* 2003, Wilkinson, *et al;* 2003, Metcheval *et al;* 2003) has been reported. The results of such accumulation of the metal in the body of animals including humans is multidimensional as it can affect the entire organs which could lead to several deficits in the organism (Morley *et al;* 2003). Generally the root of the plant contained higher concentration of lead than stem and leaves (Tables 2, 3 and 4) as has been reported by (zaranyika and Ndapwadza, 1995), (Yang *et al.,* 2003) in their previous studies on some plants. The root is the primary site for absorption of water and minerals including heavy metals (Richards, 1969). The root will thus contain more heavy metals than the stem and leaf that act as a source of storage organ in this case (Tables 3 and 4). Lead has also been found at lower concentration in foliage of barley (Parry, 200) and Talinumtrianqulare (Akinola and Ekiyoyo, 2006). Table 5 shows the relationship of the concentration of lead in the root with the concentration in the soil. The concentration of the metal in the root of the plant was much lower than the concentration in the soil with a resultant low magnification coefficient. This result does not follow the trend of plant roots having higher concentration of heavy metal than the soil as reported by (Gosh and Singh, 2005. (Chandra and Kulshreshtha, 2004) in their recent studies showed that, the availability of lead depends highly on soil conditions lead binds to organic material in the soil. Soil particle size and cation exchange capacity as well as plant factors such as root surface area, root exudates, mychorrhization and rate of transpiration affect the availability and uptake of lead (Davies, 1995). Furthermore, (Baylock, *et al.,* 1997) reported that in soil with pH between 5.5 and 7.5, lead solubility is controlled by phosphate or carbonate precipitates and very little lead is available to plants even if they have the genetic capacity to accumulate it. The pH of the soil in this study is between 5.55 – 6.04 (Table 1). Lead is classified as a weak Lewis acid, which implies a strong covalent character to many of the ionic bonds it forms in soil and plants. Lead present in soil is nearly always tightly bound to organic or colloidal material or in a precipitated form, all of this serve to reduce the uptake of lead by plant roots (Sharma and Dubey, 2005). In general, dicotyledons have been reported to accumulate significantly higher amounts of lead in the roots then monocotyledons (Huang and Cunningham, 1996). In this case, the plant studied is a monocotyledon.

Table 5: Comparison of the amount (µg/g) of lead in the root and the soil showing the magnification co-efficient (MC)

Location	Akure - Ilesha		Ilesha - Akure
Control	Soil	2.50	3.50
	Root	1.51	0.87
	MC	0.60	0.25
FUTA North Gate	Soil	28.5	32.5
	Root	7.39	7.36
	MC	0.92	0.23
Ilara Junction	Soil	9.5	25.0
	Root	8.73	8.41
	MC	0.92	0.34
Igbara Oke	Soil	35.5	28.5
	Root	8.83	9.37
	MC	0.25	0.33
Owena	Soil	12.5	20.69
	Root	1.40	7.23
	MC	0.11	0.35
Ikeji-Arakeji	Soil	10.5	25.50
	Root	7.20	7.27
	MC	0.69	0.29

IV. CONCLUSION

The result of this study generally revealed the presence of lead in the soil and plants of the expressway. The level of the heavy metal at the moment is not high enough to call for intervention by government agencies. However, possible accumulation in the soil and plants growing along the edge of the highway could occur as a result of continual usage of the

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road by vehicles driven with leaded petrol. This can also lead to accumulation of the metal in the tissues of organisms that feed on the plant and other plants growing along the highway. This can be transferred to other consumers in the food chem. Indeed pollution of the soil and plants growing along the expressway cannot be ruled out as the time goes on.

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