EFFECT OF SOIL SOURCE AND VARIETY ON THE HEAVY METAL CONTENTS OF GUINEA GRASS

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Abstract

The aim of this study was to evaluate the heavy metal content in soils and grasses planted on selected contaminated soils. The study was a 3 x 2 factorial experiment in a completely randomized design comprising of two factors which are: 3 soil sources (i.e., industrial site, dump site and Fadama (a lowland around a river/stream) which was used as the control) and 2 varieties of *Megathyrsus maximus* (var. Local and Ntchisi) replicated four times. Soils were collected from the three sites and planting was done in a greenhouse. Soil samples were collected before and after planting. Samples of the dried grasses were milled and analyzed for heavy metals (Cadmium, Chromium and Lead). The statistical evaluation was done by analysis of variance (ANOVA) and separation was by Tukey HSD on 0.05% probability values using SAS® 9.0 version. The results showed that Cadmium (Cd) accumulation was more in the soil than the plants. *Megathyrsus maximus* Local had higher ($P<0.05$) quantity of Cd in the shoot than Ntchisi variety. Soil sourced from dumpsite and industrial site had increased ($P<0.05$) lead content in the shoot than the root of the grasses. *Megathyrsus maximus* (Local) had higher ($P<0.05$) lead accumulation than the other variety. The study concluded that both varieties of *M. maximus* have phytoextraction and phytostabilization potential and can be used for phytoremediation.

Introduction

Soil is the most important component of the environment, but it is the most undervalued, misused and abused of the earth's resources (Gokulakrishnan and Balamurugan, 2010). Increase in population, industrialization, waste disposal, modern-day agricultural activities and mining have significantly contributed to large contamination of soil over the last centuries (Singh and Jain, 2003). Nearly all human activities generate waste and the ways in which this is handled, stored, collected and disposed of, can pose risks to the environment and to public health (Zhu *et al*., 2008). One of the major industrial activities associated with soil pollution in Nigeria is cement production (Olayinka *et al*., 2016). It spreads contaminant loaded dust across large areas through wind, rain and other dispersal processes. Cement dust contains heavy metals such as chromium, nickel, cobalt, lead, mercury, and organic pollutants which are toxic to surrounding vegetation, human and animal health (Adeyanju and Okeke, 2019). Heavy metals contamination may alter the chemical compositions of plants, thereby affecting the nutritive quality. Metals such as Cadmium, chromium, lead, and mercury had been reported to affect the growth and nutritive quality of maize (Ghani, 2010; Hussain *et al*., 2013). The presence of these metals retards the growth, affected protein content, germination percentage and plant biomass. These contaminants accumulate in the food chain through uptake by the plant which is the primary producer. Plant roots are the primary contact site for heavy metal ions and these metals, after being taken up by the plants, are subsequently transferred to herbivorous animals through feeding (Nica *et al*., 2012). Hence, there is a need to remediate and manage these different contaminated soils safely and economically. This study was carried out to evaluate the effect of soil source on the heavy metal contents of two guinea grass varieties.

Methods and Study Sites

The experiment was carried out at Federal University of Agriculture, Abeokuta, Nigeria. The study was a 3 x 2 factorial experiment in a completely randomized design comprising of two factors which are: 3 soil sources (i.e., industrial site, dump site and Fadama (a lowland around a river/stream) which was used as the control) and 2 different varieties (Guinea grass var. Local and Ntchisi) replicated four times. The areas of soil collections are Ewekoro cement factory (6°54′412″N; 3°12′366″E and 6°54′435″N; 3°12′377″E), dumpsite (7°10′759″N; 3°24′331″E and 7°10′775″N; 3°24′346″E) and Fadama (7°14′082″N; 3°26′106″E and 7°14′104″N; 3°26′117″E). Soil samples were collected from the three sites and planting was done in a greenhouse (7°13′950″N and 3°26′298″E). Samples of the dried grasses were milled and analyzed for heavy metal (Cadmium, Chromium and Lead) by Atomic Absorption Spectrophotometer (AAS) Buck Scientific VGP210 Model. The statistical evaluation was done by analysis of variance (ANOVA) and separation was by Tukey HSD on 0.05% probability values using SAS® 9.0 version.

Results

The main effects of soil source, variety, and harvest age on the heavy metal content of the grasses is as shown in Table 1 and were ($P<0.05$) different. The grasses planted on Fadama soil had more Cadmium content in the root and the grasses planted on industrial soil had the highest values in both the shoot and the soil. Grasses planted on dumpsite soil had the highest chromium and lead content in the root while grasses planted on Fadama soil had highest chromium content in the shoot. In the shoot of the grasses planted on industrial soil, lead content was highest. On the other hand, dumpsite soil had the highest lead content. Ntchisi variety had higher cadmium content in the root. Chromium content was higher in the root of the Local variety. The shoot of Ntchisi variety had higher chromium content whereas lead content was higher in the shoot and root of Local variety while the soil of Ntchisi variety had higher lead content.

Table 1: Main effects of soil source, variety, and harvest age on the heavy metal content (mg/kg) of *M. maximus*

Factors	Root			Shoot		
	Cd	Cr	Pb	Cd	Cr	Pb
	mg/kg					
Soil source						
Dumpsite	0.005^b	0.791^a	0.043^a	0.007^b	0.161^b	0.050^b
Industrial site	0.002^c	0.326^c	0.014^c	0.010^a	0.061^c	0.061^a
Fadama	0.025^a	0.436^b	0.026^b	0.001^c	0.167^a	0.036^c
SEM	0.001	0.015	0.001	0.000	0.006	0.002
Variety						
Local	0.004^b	0.685^a	0.049^a	0.007^a	0.082^b	0.055^a
Ntchisi	0.017^a	0.350^b	0.006^b	0.005^b	0.178^a	0.043^b
SEM	0.001	0.012	0.001	0.000	0.005	0.002

$^{a, b, c,}$: Means with different superscript in each column are significantly ($p<0.05$) different

SEM = Standard Error of Mean

Discussion (Conclusion/implication)

According to Filipović-Trajković *et al*. (2012), accumulation and distribution of heavy metals in the plant depend on the plant species, the levels of the metals in the soil, pH, cation exchange capacity and other factors. Cadmium content being more in the shoot of *M. maximus* Local than Ntchisi shows that cadmium was more concentrated in the shoot of the Local variety than its root biomass. This is in line with the report of Benavides *et al*. (2005) that the grass response to increased Cadmium level varies in terms of the plant variety for transport and cadmium uptake. In the evaluation of the grass ability to take up Chromium from the soil sourced from the three locations in this study, *M. maximus* had more accumulation of Cr in the root than in the shoot. This result is in accordance to Paiva *et al*. (2009) and Sundaramoorthy *et al*. (2010) who reported that chromium accumulation is more in the roots and only a small part is translocated to the shoots. Lopez-Luna *et al*. (2009) also found that roots of wheat, oat, and sorghum had more Cr accumulation than shoots. With respect to variety, Chromium accumulation was more in the root of *M. maximus* Local. The reason for the high accumulation of chromium in the root of the grasses could be because chromium is immobilized in the vacuoles of the root cells. According to Nafiseh *et al*. (2012), chromium accumulation in root is due to binding of chromium on the cell wall of root and retard cell division and cell elongation.

High lead content observed in the shoot than the root of the grasses harvested from soil sourced from both dumpsite and industrial site might be as a result of the high soil pH values for both locations which increased lead uptake by the grass. This is in support with the report of Lee *et al*. (1998) that lead absorption increases with increasing pH value up to 8.5 and in variance with the study of Malkowski *et al*. (2002) who reported higher rate of lead accumulation in the root of *Zea mays*. According to Traunfeld and Clement (2001) the pH of the soil must be adjusted with lime to a level of 6.5 to 7.0 to reduce lead uptake by plants. Meanwhile, the shoot of *M. maximus* Local had more lead accumulation. This might be as a result of the accumulation mechanism utilized by the Local variety. It is observed that lead accumulation was more at the level of the plants shoot of *M. maximus* Local than Ntchisi. This is in line with the findings of Hogban *et al*. (2020).

Conclusion

From the result of this study, it can be concluded that both varieties of *M. maximus* have phytoextraction and phytostabilization potential and can be used for phytoremediation.

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