Assessment of Some Plant Species for Possible Heavy Metal Uptake in Some Dump Sites in Ogbomoso Metropolis.

Adelasoye, K. A[1]; Adesina, G.O[1]; Ogundola, A. F[2] and Olayioye, A[1]

[1]Department of Crop and Environmental Protection, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[2]Department of Pure & Applied Biology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

ABSTRACT

Metal concentration (Pb, Cd, Cr, Cu, and Mn) were measured in nine plant species and soil samples from one non-contaminated site and twelve dump sites located in Ogbomoso city, Nigeria. One dominant plant species was collected in paper envelope at each site. Soil samples were also collected in polythene bags with plastic spoon up to 15cm depth at three spots per site, mixed together to prepare a composite sample. The entire soil and plant samples were taken to the laboratory at IAR&T, Moor Plantation, Ibadan for analysis. The plant samples were washed with de-ionised water, dried in the oven at 70^0C to constant weight, and ground with hammer mill incorporated with 2mm sieve.2g were weighed into crucible and ashed at 580^0C. The ash was then washed with digestion solution and made up to volume with de-ionised water. Soil samples were dried, sieved with 2mm sieve and 2g was weighed into digestion tube and digestion procedure followed using 10ml concentrated perchloric acid and nitric acid (1:1). Organic carbon percentages and pH of the soil samples were determined. The absolute metal concentration from the polluted soil ranged from the lowest Cr (990µg/g) to Cu (24,200µg/g) with the trend Cr<Pb<Cd<Mn<Cu. Five plant species, *Tithonia diversifolia, Ageratun conyzoides, Cassia obtusifolia, Triumfetta rhomboids*, and *Sida corymbosa* were found to be good bioindicator of metal pollution and can be suitable for phytoremediation of metal polluted site. The implications of some of these plant species in natural food chain were also discussed.

Corresponding author: amofelade@yahoo.com

INTRODUCTION

Monitoring of pollutants with higher plants presents several advantages as compared to other systems based on animals or microorganisms mainly because of the wider range of situations which can be monitored with these organisms. Contamination of the environment by heavy metals is of major concern because of their toxicity and threat to human life and environment (Purves, 1985). Some studies have revealed that waste dump sites can transfer significant level of toxic metals into the soil environment (Alloway, 1996). In the natural setting, certain plants have been identified which have the potential to uptake heavy metals. At least, 45 families have been identified to have hyperaccmulate plants; some of the families are *Bassicaceae,Fabaceae, Euphorbiaceae. Asteraceae, Lamiaceae,* and *Scrophulariaceae* (Salt et al., 1998; Duschenkov, 2003)

Plants growing on municipal dump sites accumulated higher concentration of the metals than those on rural dump sites. The uptake of metal ion has been shown to be influenced by the metal species and plant part (Juste and Mench 1992). Roechan *et. al*. (2000) reported that Vetiver grass could grow well on soils polluted with lofty concentration of lead (Pb) and Cadmium (Cd). By concentrating the contaminants in its roots, the Vetiver grass reduced the concentration of lead in the soil by 35-42 %. Sun flower, *Helianthus annus* have been proven effective in the remediation of radionuclide and certain other metals. This plant was reported to have reduced uranium concentration from 350parts per billion to 5 ppb, achieving a 95% reduction in 24 hours (Schnoor, 1997).

Ogbomoso metropolis, like many other cities in Nigeria, faces the problems of environmental sanitation such as improper disposal of refuse near collection center. It is a common feature to find huge refuse dump sites within residential areas and along major and minor roads in Nigeria. Many hyper accumulator plants remain to be discovered, and there is the need to know more about their physiology (Raskin et al. ,1994). It is the objective of this study to identify some plant species with potential to accumulate metals in dump sites in Ogbomoso metropolis.

METHODOLOGY

Twelve dumpsites (Laka, Stadium, Winners, Papa Ajisiyan, Oke ado Akintola, Papa Alajiki, Odeloba, Rubbi Petrol Station area, LAUTECH dump sites, Ori oke, Maryland and Adenike area, in Ogbomoso, Oyo state, Nigeria were selected as the sampling sites along with samples collected from Ladoke Akintola University Teaching and research farm(LAUTECH FARM),

Ogbomoso which served as control (uncontaminated) site. Shoot of one dominant plant species was collected in paper envelope at each of the sites and taken to the laboratory.Soil samples were also collected with core sampler at 15cm depth at three spots per dumpsite and six spots from control site, mixed together to prepare a composite sample. The soil samples were kept in polythene bags and taken to the laboratory at Institute of Agricultural Research and Training (IAT&T), Moor Plantation, Ibadan, Nigeria.

The plant samples were washed with de-ionised water and then dried inside oven at 70^0C until it gives constant weight. Dried samples were grounded inside hammer mill incorporated with 2mm sieve. 2g of the grounded samples was weighed into crucible and ashed inside furnace at 580^0C.The ash was then washed into 100ml volumetric flask using wet digestion solution of 10ml concentrated perchloric and nitric acid (1:1) and made up to volume with de-ionised water. Soil samples were sieved with 2mm sieve after drying. 2g was weighed into digestion tube and wet digestion procedure was followed. The digest were then read from atomic absorption spectrophotometer (AAS) using their respective lamp and wavelength. pH and organic carbon percentages of the soil samples were also determined.

RESULTS AND DISCUSSION

The results are presented in Tables 1, 2, 3, and 4. The pH values of contaminated sites ranged from the lowest 6.87 for Rubi dump site to the highest value of 8.15 for the Winners dumpsite (Table 1). The pH value from uncontaminated site (LAUTECH Farm) is6.64 which is normal for ordinary soil as reported by Banjoko and Sobulo (1990) for some Nigerian soils especially forest and savannah soil with a range of 5.70-6.50.Soil pH is most widely accepted as exerting a controlling influence on the availability of micro-nutrients to plant (Sanders, 1982.) Sposito *et al*., (1992) reported that domino and greenfield composted sites have a pH value of 7.8 and 7.1 respectively, showing that waste contaminated soils have relatively high pH values which may affect plant growth.

The organic carbon from the control site is 7.4% while from contaminated sites it varied from the lowest 3.47for Stadium dump site to 12.4% for Oke-Ado Akintola, Ogbomoso, Nigeria.

Table 1: Metal ion concentration in soil from contaminated (waste dumps) and control sites in Ogbomoso city, Nigeria.

SAMPLE SITE	Soil pH	%OC	Pb	Cd	Cr	Cu	Mn
Laka	7.97	10.88	410	460	100	1420	2470
Stadium	7.3	3.47	420	480	80	2600	1300
Winners	8.15	10.6	380	410	60	1200	1550
Papa Ajisiyan	7.04	8.68	360	350	100	2300	2200
Oke Ado Akintola	7.68	12.4	410	510	30	2300	2700
Papa Alajiki	7.34	9.6	440	530	110	2600	1600
Odeloba	7.38	6.27	430	550	100	2400	1300
Rubbi Petrol	6.87	11.4	430	470	100	3200	1400
LAUTECH	7.84	11.75	430	470	110	900	1460
Ori Oke	7.63	11.07	370	400	70	2400	1470
Maryland	7.22	8.95	400	430	50	1400	2400
Adenike	7.31	12.3	420	490	80	1480	2000
Control	6.64	7.40	10	10	nd	140	160

Data are in µg/g dry weight.
Note: nd = not detected.

Table 2: Metal ion concentration in plants from contaminated sites (waste dumps) in Ogbomoso city, Nigeria.

SAMPLE SITE	PLANT SAMPLE	Pb	Cd	Cr	Cu	Mn
Laka	*Senna occidntalis*	180	160	40	750	400
Stadium	*Eupatorium odoratum*	140	210	20	500	400
Winners	*Triumfetta rhomboidea*	160	180	40	1020	450
Papa Ajisiyan	*Sida corymbosa*	180	160	20	680	440
Oke Ado Akintola	*Cassia obtusifolia*	200	160	20	1200	450
Papa Alajiki	*Sida corymbosa*	180	150	80	640	300
Ode loba	*Ageratum conyzoides*	200	240	20	740	420
Rubbi Petrol	*Triumfetta rhomboidea*	180	210	60	510	300
LAUTECH	*Tridax procumbens*	180	160	10	420	260
Ori Oke	*Amaranthus spinosus*	180	140	10	570	430
Maryland	*Tithonia dixersifolia*	220	60	30	600	370
Adenike	*Tithonia dixersifolia*	220	160	20	1060	340

Data are in µg/g dry weight.

Table 3: Metal ion concentration in plants from contaminated sites (waste dumps) in Ogbomoso city, Nigeria expressed as percentage of Mean metal conc. of each metal in the soil.

SAMPLE SITE	PLANT SAMPLE	Pb	Cd	Cr	Cu	Mn
Laka	*Senna occidntalis*	47.34	9.10	48.48	37.2	21.96
Stadium	*Eupatorium odoratum*	36.82	11.95	24.24	24.24	21.96
Winners	*Triumfetta rhomboidea*	42.08	10.20	48.48	50.6	24.71
Papa Ajisiyan	*Sida corymbosa*	47.34	9.10	24.24	33.73	20.2
Oke Ado Akintola	*Cassia obtusifolia*	52.6	9.10	24.24	59.52	24.71
Papa Alajiki	*Sida corymbosa*	47.34	8.54	96.96	31.74	16.47
Ode loba	*Ageratum conyzoides*	52.6	13.66	24.24	36.7	23.06
Rubbi Petrol	*Triumfetta rhomboidea*	47.34	11.95	72.72	28.27	16.47
LAUTECH	*Tridax procumbens*	47.34	9.10	12.12	20.83	14.27
Ori Oke	*Amaranthus spinosus*	47.34	7.97	12.12	28.27	23.61
Maryland	*Tithonia dixersifolia*	57.86	9.10	36.36	29.76	20.31
Adenike	*Tithonia dixersifolia*	57.86	9.10	24.24	52.58	18.67

Data are in µg/g dry weight.

Table 4: Metal ion concentration in plants from uncontaminated site in Ogbomoso city, Nigeria.

SAMPLE SITE	PLANT SAMPLE	Pb	Cd	Cr	Cu	Mn
Laka	*Senna occidentalis*	3.3	3.1	nd	9.3	4.4
Stadium	*Eupatorium odoratum*	4.3	2.1	nd	3.1	6.1
Winners	*Triumfetta rhomboidea*	5.0	7.0	nd	5.1	3.6
Papa Ajisiyan	*Sida corymbosa*	5.1	6.1	nd	9.1	1.5
Oke Ado Akintola	*Cassia obtusifolia*	2.3	4.2	nd	5.0	7.2
Papa Alajiki	*Sida corymbosa*	5.1	6.2	nd	9.1	1.5
Ode loba	*Ageratum conyzoides*	6.2	5.0	nd	4.3	9.0
Rubbi Petrol	*Triumfetta rhomboidea*	5.0	7.0	nd	5.1	3.6
LAUTECH	*Tridax procumbens*	2.2	4.0	nd	4.1	0.8
Ori Oke	*Amaranthus spinosus*	5.2	6.3	nd	9.3	1.5
Maryland	*Tithonia dixersifolia*	7.1	6.0	nd	2.1	1.1
Adenike	*Tithonia dixersifolia*	7.1	6.0	nd	2.1	1.1

Data are in µg/g dry weight.

Note: nd = not detected.

It was reported that a good forest top soil contains between 3-4% organic carbon and that waste contaminated site tend to have relatively higher organic matter than non-contaminated soil. The higher levels in dump sites could be attributed to frequent dumping of waste plant and animal materials which most often contained decomposers.

The concentrations of heavy metals from the control site were very low compared with the waste dump sites and ranged from Pb and Cd (10µg/g) to Mn (160µg/g). Heavy metals are generally abundant in dump sites in Ogbomoso metropolis. The absolute total metal concentration from the polluted soil ranged from the lowest Cr (990µg/g) to Cu (24,200µg/g). The trend in abundance is Cr<Pb<Cd<Mn<Cu. The average metal concentration for each of the metal followed the same sequence. All the dump sites contained high but variable amount of the five heavy metals. Metal ion concentrations in plants from dump sites also vary from plant to plant. Plants vary in the extent to which they absorb each of the metal. *Tithonia diversifolia, Cassia obtusifolia* and *Ageratum conyzoides* accumulated highest amount of lead. *Eupatorium odoratum* contained the lowest percentage of lead (36.82%) (Table 3). *A. conyzoides, Triumfetta rhomboidea* and *E. odoratum* absorbed the highest amount of cadmium. *Sida corymbosa* (96.96%) and *T. rhomboidea* (72.72%) were the best assimilator of chromium. Copper was absorbed to a highest extent by *C. obtusifolia* (59.52%), *T. diversifolia* (52.58%) and *T. rhomboidea* (50.6%). *T. rhomboidea (*24.71%*), C. obtusifolia (*24.71*), A .conyzoides (23.06)* and *Amaranthus spinosus* (23.61), absorbed the highest manganese (compare Roechan et al., 2000) All these plants showed appreciable accumulation of heavy metals from the control site though the amount absorbed were low.

All the sampled plant species served as bioindicator of heavy metals from dump sites. They can be used in phytoremediation and from all indications, some are better than the others in this case. Thus, *T. diversifolia, A. conyzoides, C. obtusifolia, T. rhomboidea,* and *S.corymbosa* were identified in this study as good agent for decontamination of heavy metals polluted sites. Ensley, (2000); Vangronsveld and Cunningham (1998) reported that plants suitable for phytoremediation must possess certain features: tolerance to prevailing contaminant, a high biomass production (fast growth with large biomass), ease of handling and established cultural practices (phenotype suitable for easy harvest, treatment and disposal) and the species should preferably be indigenous to the region.These plants possess virtually all these traits.

T. diversifolia and *A. conyzoides* were used locally as herbs for treating malaria fever and ulcer respectively. *Trdax procumbens* is a well known food for rabbits in many places. Utilizing these plants from the dump sites will

introduce heavy metals into the food chain.

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