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Full Length Research Paper

Levels of essential micronutrients in soils and growing plants around refuse dumpsites in Akure, Nigeria

P. O. Oviasogie[1*], A. A. Oshodi[2] and E. Omoruyi[3]

[1,3]Chemistry Division, Nigerian institute for Oil Palm Research (NIFOR). P.M.B. 1030, Benin City, Nigeria.
[2]Chemistry Department, Federal University of Technology, P.M.B.704, Akure, Nigeria.

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In the present study, the levels of some essential micronutrients (Fe, Mn, Zn and Cu) were determined in the soils and growing plants at the base and 25 m away from refuse dumpsites located in Akure, Ondo state, Nigeria. The soils and plants obtained were processed and analysed for these metals using the Bulk scientific GVP 210 atomic absorption spectrophotometer. The results showed that the levels of Fe in soils at the base of the dumpsites were higher at the various locations investigated, the highest being 745.00 mg/kg at Oja oshodi, while the highest level at 25 m away from the sites was 441.00 mg/kg detected also at Oja Oshodi. This trend was followed by Mn with the highest amount (354.00 mg/kg) determine at the base of the refuse dumpsite at Idanre and Igbatoro roads respectively. Similarly, Zn and Cu had their highest levels (198.00 mg/kg Zn, 29.00 mg/kg Cu) in soils obtained from the base at the Oke-Ijebu and Oja Oshodi dumpsites respectively. The concentration of these metals in the roots tissue indicated that Fe was highest in the roots of *Amaranthus cruentus* (142.50 mg/kg dry matter). The level of Fe obtained was higher than the amount determined in the plants at 25m away from the dumpsites. There were equally various distributions of Mn Zn and Cu in the different tissues of the plants around the dumpsites. These study also revealed that the accumulation or uptake of these micronutrients depended not only on the availability of these metals as enriched at the base of the dumpsites but also on other factors which were not considered in the study.

Key words: Micronutrients, dumpsite, uptake and plant tissue.

INTRODUCTION

The traditional bush fallow system is gradually giving way to intensive land cultivation with the use of improved crop varieties, nitrogen, phosphorus and potassium (NPK) fertilizers. There is equally an attendant demand for soil micronutrients or essential trace elements which incidenttal input through major micronutrient fertilizer application is unable to cope with the plant demands (Heathcoke and Stockinger, 1990). Moreover, the pressure on arable land and loss in soil fertility has directed attention to alternative land use practices and soil enrichment strategies (Bonuma and Progers, 1998). Hence, it is a common phenomenon to find people especially in urban areas using soil from refuse dumpsites for the purpose of vegetable garden farming. Often times these soils are dark brown in color and are perceived to be rich in organic manure and other macro and essential micronutrient elements for plant cultivation. This perception or assumption may be right or wrong depending on the type and composition of the wastes at such dumpsites and their impact on these useful elements in soils.

Furthermore, there are relatively abundant reports on the toxic heavy metal loads in soils of refuse dump facilities (Bozkurt et al. 1999; Mcbride, 2003; Marschner, 1996). These have generated relevant data regarding the amount and distribution of these metals particularly, Pb, Cd, Cr, Co, As, Hg and V in the soils studies. It is very important to emphasize that Fe, Mn, Zn and Cu are essential trace elements in soils needed by plant for various physiological processes and growth. There are comparatively insufficient reports on the levels and perhaps avai-

*Corresponding author. E-mail: philipoviasogie5@yahoo.com.

Table 1. Levels of the micronutrient elements in the soil at the various dumpsites.

Location	Depth (cm)	Distance from base of dump (m)	mg/kg			
			Fe	Mn	Zn	Cu
Igbatoro Road	0-15	0.0	540.00	139.00	38.00	27.00
	15-30	0.0	155.00	8.00	16.00	6.00
	0-15	25.0	252.00	48.00	18.00	6.00
	15-30	25.0	96.00	14.00	9.00	2.00
Idanre road	0-15	0.0	258.00	59.00	89.00	11.00
	15-30	0.0	185.00	37.00	30.00	5.00
	0-15	25.0	220.00	48.00	20.00	7.50
	15-30	25.0	150.00	25.00	14.00	4.00
Oke - Ijebu	0-15	0.0	618.00	118.00	198.00	23.00
	15-30	0.0	204.00	70.00	36.00	8.00
	0-15	25.0	312.00	37.00	49.00	5.00
	15-30	25.0	131.00	21.00	20.00	3.00
Oja Oshodi	0-15	0.0	745.00	354.00	192.00	29.00
	15-30	0.0	427.00	45.00	42.00	7.00
	0-15	25.0	441.00	44.00	38.00	8.00
	15-30	25.0	125.00	20.00	10.00	5.00
Ijapo estate	0-15	0.0	507.00	65.00	27.00	8.00
	15-30	0.0	201.00	37.00	18.00	5.00
	0-15	25.0	327.00	46.00	14.00	4.50
	15-30	25.0	142.00	12.00	10.00	1.50

lability of these nutrients in soil associated with refuse dumpsites. The aim of the present work therefore was to assess the levels of Fe, Mn, Zn and Cu in soils and growing plants obtained at refuse dumpsites in Akure town, south western Nigeria.

MATERIALS AND METHODS

Study area

Five refuse dumpsites located at Igbatoro road, Idanre road, Oke-Ijebu, Oja Oshodi and Ijapo estate currently in use in Akure metropolis were used for this study. The wastes comprise household materials, hospital disposals, metal scraps, polyethylene bags and papers, plant debris and litter amongst other substances.

Sample collection

Soils were collected with the aid of a stainless soil augar at the base (0 m) and 25.0 m away from the various dumpsites. Ten cores were sampled around each point to make a composite sample. The soils were collected at 0 - 15 and 15 - 30 cm depths respecttively and then transferred into well labeled polyethylene bags for storage and analysis. Similarly, major plants seen growing on the refuse dump soils which include *zea mays, sorghum vulgare, amaranthus cruentus, lycopersicum esculentum* and *talinium triangulare* were uprooted, labeled and taken to the laboratory for the analysis of their partitioned tissues (leaf, trunk and root).

Determination of the micronutrient in the soil

In the laboratory, the soils were dried at ambient temperature, crushed in a porcelain mortar and sieved through a 2 mm (10 mesh) stainless sieve. Air dried <2 mm soils were used for the determination of the micronutrients as follows: 1 g soil sample was introduced into digesting tubes following the addition of 40 ml concentrated HNO_3. The samples were placed in the digester for 8 h at 96°C with intermittent stirring (Lisle et al., 1986). Upon complete digestion preceding the observation of white fumes, the samples were allowed to cool, filtered into 100 ml volumetric flasks using Whatman no. 42 filter paper. The samples were made to the 100 ml mark on the volumetric flask using distilled-deionized water. The concentration of Fe, Mn, Cu and Zn in the supernatant solutions was determined using atomic absorption spectrophotometer Buck scientific model GVP 210. All samples were analyzed in duplicates.

Determination of the metals in the plant tissues

The plants were washed thoroughly with distilled-deionized water, dried at ambient temperature, and partitioned into leaf, stem and root tissues. These tissues were further dried in a forced-air Galenkamp oven at 60°C, ground to 20 mesh size using a stainless Wiley Mill and 1 g digested using concentrated nitric and perchloric acids. The cooled samples were diluted to 25 ml and filtered through Whatman no. 42 filter paper. The supernatant was finally made up to 50 ml mark of the volumetric flask and then analyzed for Fe, Mn, Zn and Cu using the Buck scientific model GVP 210 atomic absorption spectrophotometer. All analysis was done in duplicates.

RESULTS AND DISCUSSION

The levels of the micronutrients elements studied in the soil and plant tissues are shown (Tables 1 and 2 respectively). The amount of Fe in the soils at the base (0 m) of

Table 2. Levels of the micronutrient element in the various plant tissues.

Location/Plant	Depth (cm)	Distance from base of dump (m)	mg/kg			
			Fe	Mn	Zn	Cu
Igbatoro road *zea mays*	Leaf	0.0	45.50	4.00	10.70	1.70
	Trunk	0.0	52.40	2.30	12.60	1.20
	Root	0.0	76.10	12.40	11.50	1.80
	Leaf	2.50	33.10	3.50	3.80	0.60
	Trunk	25.0	30.80	3.00	4.90	0.50
	Root	25.0	52.10	6.80	8.40	1.00
Idanre road *Sorghum Vulgare*	Leaf	0.0	32.50	3.20	1.70	0.50
	Trunk	0.0	41.60	2.90	3.70	0.60
	Root	0.0	57.60	3.40	5.20	0.70
	Leaf	25.0	21.20	1.50	1.20	0.70`
	Trunk	25.0	39.50	1.70	2.20	0.50
	Root	25.0	67.00	2.90	3.20	0.80
Oke-Ijebu *Amaranthus cruentus*	Leaf	0.0	63.30	3.20	5.20	1.20
	Trunk	0.0	79.60	4.0	10.20	1.20
	Root	0.0	142.50	5.60	10.20	3.6
	Leaf	25.0	39.23	2.80	4.60	1.40
	Trunk	25.0	42.80	3.70	10.30	0.90
	Root	25.0	87.60	4.00	11.20	1.60
Oja Oshodi *Lycopersicum esculentum*	Leaf	0.0	224.30	30.00	13.00	3.00
	Trunk	0.0	115.00	32.00	16.00	4.60
	Root	0.0	123.00	15.00	6.00	2.50
	Leaf	25.0	87.60	23.00	6.80	2.30
	Trunk	25.0	30.80	4.00	8.20	1.50
	Root	25.0	29.20	3.00	7.10	1.00
Ijapoestate *Talinium triangulare*	Leaf	0.0	96.50	29.90	11.60	1.40
	Trunk	0.0	50.40	8.80	19.80	1.60
	Root	0.0	98.00	6.80	23.00	2.50
	Leaf	25.0	33.00	8.10	15.00	1.40
	Trunk	25.0	36.50	1.30	9.80	1.60
	Root	25.0	42.50	2.40	16.60	2.20

the dumpsite were higher at the various locations investigated (540.00 mg/kg at Igbatoro road, 258.00 mg/kg at Idanre road, 618.00 mg/kg at Oke-ijebu estate). The corresponding levels at 25 m away from the sites were 252.00, 220.00, 312.00, 441.00 and 327.00 mg/kg respectively. It is evident that there was enrichment of the soil by Fe at all the locations. This trend was closely followed by Mn at the various dumpsites. Mn concentration was 139.00 mg/kg at the base of Igbatoro road dumpsite and 48.00 mg/kg at 25 m away. Interestingly, the highest levels of Fe (745.00 mg/kg) and Mn (354.00 mg/kg) occurred at the base of the Oja Oshodi dumpsite. The levels of these micronutrients elements in the soil as obtained in this study are generally lower than the values determined in similar studies at other dumpsites in Nigeria (Eddy et al., 2006; Aluko et al., 2003; Akaeze, 2001). Their results showed that the levels of Fe at the base of the dumpsites ranged between 69140 to 83241 mg/kg and 53012 to 69 014 mg/kg at 10 m away. Furthermore, Eddy et al. (2006) reported concentration of Mn in the range of 19.21 to 485.00 mg/kg at 100 m away from a dumpsite located within Akwa Ibom State, Nigeria. The results for Fe and Mn in the present study are within the permissible levels of these metals in soil (Eddy et al. 2006).

The soils were also enriched with Zn and Cu. These metals had their highest values (198.00 mg/kg Zn, 29.00 mg/kg Cu) at the Oke-Ijebu and Oja Oshodi dumpsites respectively. The natural range for the concentration of Zn and Cu in soils is 10 - 300 mg/kg and 7-80 mg/kg respectively. Although the values for these metals obtained in the present study fall within these range, it is quite evident that the soils at the dumpsites (0 m) were enriched in these metals by the refuse. The order of enrichment being Fe>Mn>Zn>Cu.

The accumulation of these metals in the various plants tissues (Table 2) indicated that the amount of Fe was highest in the roots of *A. cruentus* (142.50 mg/kg) and *L.*

Table3. Typical natural trace element concentrations of plant and plant foodstuffs.

Trace element	Concentration [a] (mg/kg) (dry weight)	
	Plant	Plant foodstuffs [b]
Li	0.5 (<0.01 – 143)	0.3 (0.06 –10)
B	5 (1 – 30)	5 (0.8 –10)
Al	200 (6 –3500)	15 (3 –140)
Ti	2 (0.15 –80)	1 (0.1 –5)
V	0.5 (0 –2 .5)	0.01 (0.001 –0.7)
Cr	0.2 (0.02 –0.2)	0.05 (0.01 –14)
Mn	80 (20 –240)	15 (1.3 –90)
Fe	120 (30 –920)	60 (6 –130)
Co	0.08 (0.03 –0.6)	0.07 (0.008 –0.2)
Ni	1 (0.1 –5)	0.8 (0.06 – 4)
Cu	5 (1 –12)	4 (0.08 –9)
Zn	30 (12 –60)	25 (1.2 – 45)
As	0.15 (0.009 –1.5)	0.08 (0.003 –0.3)
Se	0.06 (0.002 –0.88)	0.03 (0.003 –0.15)
Br	35 (5 –120)	5 (0.2 – 40)
Rb	55 (44 –130)	15 (1 –55)
Sr	220 (6 –1500)	25 (0.06 –150)
Mo	0.3 (0.03 –8)	0.5(0.04-2.5)
Cd	0.1 (0.02 –0.5)	0.08(0.008-0.3)
Sb	0.06 (0.001 –10)	0.01 (0.001-0.25)
I	0.1 (0.03 –12)	0.1 (0.005-12)
Cs	0.1 (0.03 –0.4)	0.007(0.001-0.05)
Hg	0.01 (0.001 –0.04)	0.003 (0.002-0.04)
Pb	1 (0.3 –10)	0.7 (0.05-4)

Source: (Ward, 2000) [a] Mean (range). [b]Lettuce, cabbage, beans, corn, cereals.

esculentum (123.00 Mg/Kg) *T. triangulare* (98.00 mg/kg) *Z. mays* (76.10 mg/kg) and *S. vulgare* (57.00 mg/kg) all at the base of the various dumpsites. These values were all higher than their corresponding values at 25 m away from the dumpsites except for *S. vulgare* at Idanre road. Interestingly, the concentration of Fe obtained in the soil at this location is comparable at both distances. Perhaps, soil conditions such as pH, redox potential and organic matter at the 25 m area favored the uptake of Fe by the root of *sorghum vulgare*. Mn equally exhibited relatively higher bioaccumulated levels in the root tissues of the various plants at the different dumpsites. Higher concentrations of Zn were detected in the leaves and trunk of *Z. mays* (10.70 and 12.60 mg/kg respectively) when compared with the values for Mn (4.00 and 2.00 mg/kg) at the same location and spot. The highest amount of Cu (4.60 mg/kg) was detected in the trunk of *L. esculentum* at Oja Oshodi dumpsite. It is important to emphasize that the amount of these metals in the plant tissues did not reflect there corresponding levels of occurrence in the soil although they occurred more at the base of the dumpsites than at 25 m away. Several reasons may be adduced for these discrepancies. The up-take of metals by plants depend on factors such as, plant species, redox potential, organic matter, plant maturity just to mention a few. Effective correlation between metal uptake by plants and metal availability in soil is difficult because of the contributions and effects of these factors. It is noteworthy to emphasize that the levels of the essential micronutrient element as determined in the various plant tissues in the present study and within typical natural trace elements concentration in plant and plant foodstuffs (Ward, 2000) (Table 3).

Conclusion

The amounts of the micronutrients (Fe, Mn, Zn, and Cu) were found to be higher at the base (0 m) of the refuse dumpsites compared with their corresponding levels in the soils obtained at 25 m away from the dumpsites irrespective of the soil depth. Similarly, there were increased concentrations of these metals in the various tissues of the plants investigated. The amounts in the plants did not however correspond with the order of abundance of these metals in the soil. The study has shown that the refuse at the various dumpsite have contributed to the increased levels of the micronutrients in the soil and that uptake of these nutrients is species dependent. It is important to state that soils obtained from refuse dumpsites should be properly screened or assessed for the presence or otherwise of both essential micronutrient elements and toxic heavy metals before being used for the cultivation of crops.

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