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MACRO AND MICRO NUTRIENTS STATUS OF SELECTED SOILS BASED ON LAND USE IN SOUTHWEST, NIGERIA

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ABSTRACT

In Africa, production of food per capita had suffered a decline in the past decade despite the enormous increase in population. To sustain the growing dependence on agricultural production the use of fertilizers became paramount and more fertilizers are now applied than before. Ironically, agricultural production problem persisted. This could be attributed to improper use of fertilizers due to lack of proper methods of soil analysis that should give a true picture of the soil status. This study therefore assessed the macro and micronutrient status of selected soil in Ibadan (South western, Nigeria) based on four different land uses Twenty-four (24) bulk surface soil samples (0 -2 0 cm depth) were collected from the four different land use types within the University of Ibadan Campus. Particle size analysis, soil pH, total N, available P, organic C, CEC, exchangeable K, Ca and Mg, Mn, Fe, Cu and Zn were determined. Available phosphorus was extracted with Bray P-1 method. . Total nitrogen was determined using macro Kjeldahl digestion. Exchangeable Bases (Mg^{2+}, Na^{+}, K^{+}, and Ca^{2+}) were extracted using NH_4OAc. Ca^{2+} and Mg^{2+} were determined using Atomic Absorption Spectrophotometer, while K^{+} and Na^{+} were determined by flame photometer. Micronutrients (Cu, Zn, Mn and Fe) were extracted using 0.1N HCl.

The results indicated that the soils ranged from near neutral to slightly alkaline. Soil samples were predominantly sandy. All the soils were very high in Organic matter content. The values for cultivated soil indicated that Total nitrogen was low for cultivated soils (1.05 ± 0.15 g/kg) while that of fallow and forest (1.69 ± 0.11 g/kg) and (1.74 ± 0.09 g/kg) soil were moderate and high in dumpsite soils (5.47 ± 0.22 g/kg). Available phosphorus in the soils ranged from moderate to extremely high with a mean of 8.87 ± 0.40 mg/kg for cultivated land use and 10.95 ± 0.66 mg/kg and 55.49 ± 1.12 mg/kg for forest and dumpsite soils respectively. Exchangeable K+, Ca^{2+}, Mg^{2+} were above the critical values in the studied soils and followed the order Cultivated > fallow > forest > dumpsite. Micronutrients in the soil were observed to follow this order: Mn > Fe > Ni > Zn >Cu with cultivated, having the lowest concentration and dumpsite soils having the highest concentrations of micronutrient. Available manganese and zinc were above the critical levels of 5.0 and 1.0 mg/kg for Mn and Zn respectively. Organic carbon, Zn, NH_4OAc, CH_3COOH, HCl and EDTA had significant ($P \leq 0.05$) positive correlation with pH (r =0.91***, 0.95***, 0.83**.0.96***, 0.76 ***and 0.83*** respectively). Mn also correlated positively with Cu (r=0.79***) but negatively with Zn (r=-0.84***) at $P \leq 0.05$ and the other extractants. Zinc correlated significantly with all the extractants positively. All the extractants correlated positively with each other significantly at ($P \leq 0.05$). The low Nitrogen content in the cultivated soils can be boosted by the addition of N-based fertilizers.

Keywords: Macro nutrients. Micronutrients, land use and available phosphorus

INTRODUCTION

Nutrient elements are vital to crop production. They are also known as essential nutrients. Essential plant nutrients deficiency disrupts plant's growth and reproduction. Deficiency can be prevented or corrected only by supplying the element. Nutrient is directly involved in the nutrition of the plant. They are either required in large quantities (Macronutrient) or small quantities (Micro nutrients.). Macronutrients are further divided into two classes: primary and secondary. The three primary macronutrients are nitrogen (N), phosphorus (P), and potassium (K); all are required in relatively large quantities by plants. The secondary macronutrients are Calcium (Ca), magnesium (Mg) and sulphur are required in lesser quantities relative to the primary macronutrients. Micronutrients that are required by plants in smaller quantities includes: zinc, (Zn), iron (Fe), copper (Cu), boron (B), molybdenum (Mo) and chlorine (Cl). Nickel (Ni) known as a non-essential micronutrient before now is considered an essential nutrient element for plant growth and development (Epstein and Bloom, 2005; Liu, 2001). Brown *et al.* (1987, 1987b; 1990) discovered and established this fact based on criteria for essential elements for plant growth. This was validated by Wood *et al.* (2004) that pecan could not complete its life cycle without Nickel (Ni). Nickel (Ni) is one of the micronutrients which is required by plants only in small proportion or quantities. Nickel is unique among plant nutrient because of its functions in plant growth and development. It is a key component of selected enzymes involved in Nitrogen metabolism and biological N fixation (Liu *et al.*, 2001). West Africa soil, in particular Nigeria soils are characterized with coarse texture, low activity clays and harsh climatic condition which often result in leaching, erosion and low organic status of the soils (Oladipo *et al.*, 2012). Soil chemical fertility particularly lack of nutrient input is a major factor in soil degradation (Hartemink, 2010). Due to inherent low fertility status, tropical soils often have negative soil nutrient imbalances (Smallings, 1995). In order to boost and sustain crop production, soil management practices that will enhance continuous nutrient in soil for plant uptake must be considered. The general practice for peasant farmers was to add manure, inorganic fertilizers and fallowing. However the correlation between plant yield and nutrients availability is paramount in determining the effectiveness of the soil to support healthy and less cost expensive crop production. While sufficient information about the nutrient status of the soil must be available for adequate utilization for agricultural purposes including fertilizer application for soils deficient in nutrients of interest. This study therefore determines the nutrient status of soil under different land use and guide farmers in fertilizers application for deficient nutrient elements.

MATERIALS AND METHODS

Soil Sample Collection And Preparation

Twenty-four (24) bulk surface soils (0 - 20 cm) were collected in four different locations as shown in figure 1, within the University of Ibadan Campus. Soil samples were randomly collected from the various land use types. These are: Parry road to represent cultivated land (CU) and fallowed land (FA) with the coordinates of 7^0 27'10''N, 3^0 53'20''E; new postgraduate hall road to represent the dumpsite (DS) with coordinates of 7^0 43'94''N, 3^0 89'48 E and Abadina to represent secondary forest (FO) with coor-

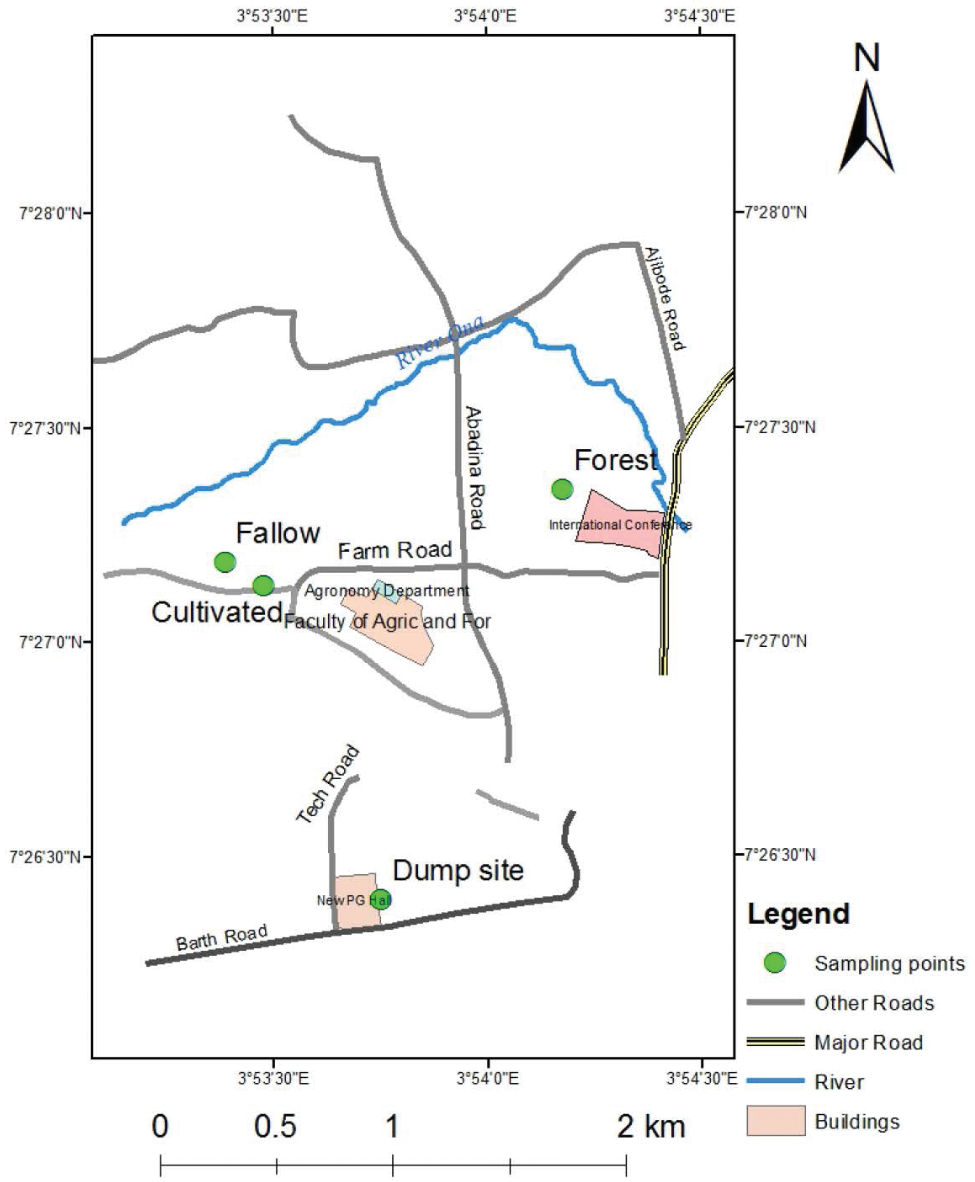

Figure 1: Map showing the sampling locations for the four land use types

dinates of 7027'80''N, 3053'58''E. The soils samples collected from each location were bulk together to form a composite sample.

Laboratory Methods

In the laboratory, the bulk composite soil samples were air-dried, crushed and passed through a 2 mm sieve, bagged, re-labeled and stored. Soil chemical properties were determined as follows; Soil pH was determined in water suspension using a soil-water ratio of 1:2 using glass electrode pH meter (Udo and Ogunwale, 1978). Organic carbon by Walkley and Black method as modified by Nelson and Sommers (1996) were used. Organic matter was calculated by multiplying percentage organic carbon by a correction factor of 1.72. Total nitrogen was determined using macro Kjeldahl digestion and distillation method. Exchangeable Acidity (EA) was extracted using 1M KCl methods and extracted with 0.01N NaOH, Exchangeable Bases (Mg^{2+}, Na^{+}, $K^{+,}$ and Ca^{2+}) were extracted using NH_4OAc. Ca^{2+} and

Mg^{2+} were determined using Atomic Absorption Spectrophotometer, while K^+ and Na^+ were determined by flame photometer (Thomas, 1982). Available phosphorus was extracted with Bray P-1 method of Bray and Kurtz (1945). Micronutrients (Cu, Zn, Mn and Fe) were extracted using 0.1N HCl and read with Atomic Absorption Spectrophotometer. Particle size distribution was determined using the hydrometer method by Gee and Or, 2002.

Determination of Available Nickel

Four extractants were selected and used for laboratory soil test of available nickel (Ni^{2+}). These include; 1N HCl, 1N NH_4OAc, 0.5N CH_3COOH, 0.05N EDTA.

Extraction of available nickel with the different extracting solutions was carried out as described by Mishra and Kar (1974).

Statistical Analysis

Means and standard deviation were used. Also, simple correlation coefficients were used to show the relationship between plant uptake and soil test values obtained with four different extractants for available nickel (Ni^{2+}), to know which of the extractant was best for these soils.

RESULTS AND DISCUSSION

Results of the laboratory analysis of soil samples for chemical properties and particle size distribution of the soil studied are presented in Table 1.

Particle size distribution

Sand fraction in location Cultivated soil (CU) ranged from 880.0 g/kg – 900.0 g/kg with a mean value of 890.0 ± 6.23 g/kg. The silt content ranged from 50.0 – 60.0 g/kg with mean of 58.0 ± 3.72 g/kg, while the clay has values ranging from 48.0 – 60.0 g/kg with mean of 52.0 ± 4.34 g/kg. The distribution pattern in location Fallow soil (FA), Forest soil (FO) and Dumpsite soil (DS) slightly varies from location CU, except that the clay content was a little lower in location FA. Based on the USDA textural class, these values resulted in sandy texture soil.

Soil reaction and Exchanged Acidity

The results indicated that the soils ranged from near neutral to slightly alkaline. In location CU, the pH ranged from 6.8 – 6.9 with mean of 6.9 ± 0.05. The pattern was almost the same for locations FA and FO, but location DS being a dump site had a pH range of 7.6 – 7.7 with a mean of 7.7 ± 0.05. This implies that the soil pH of locations CU, FA and FO were near neutral, while that of location DS was slightly alkaline. The soil pH of this range 6.5 – 7.7 is said to be appropriate for crop production (David *et al.*, 2011 and Donald, 2013).

The soil Exchangeable Acidity (EA) was low. The values ranged from 0.15 – 0.15 with a mean of 0.15 ± 0 cmol/kg for locations CU and FA, while values ranged 0.15 – 0.20 with mean values of 0.17 ± 0.24 cmol/kg and 0.18 ± 0.02 cmol/kg for locations FO and DS respectively.

Organic carbon, Total Nitrogen and Available phosphorus

The organic carbon content in the soil ranged from 22.96 – 24.22 with a mean of 23.51 ± 0.47 g/kg, 24.99 – 26.94 with a mean of 25.97 ± 0.63 g/kg, 26.59 – 30.05 with a mean value of 54.90 ± 0.84 g/kg for locations CU, FA, FO and DS respectively. These values translated to organic matter content of 39.49 – 41.66, 42.98 – 46.34, 45.73 – 51.69 and 91.93 – 96.18 with mean values of 40.47 ± 0.79 g/kg, 44.66 ± 1.09 g/kg, 48.82 ± 2.31 g/kg and 94.42 ± 1.45 for locations

Table 1: Mean values, standard deviation and ranges of chemical properties and particle size of soil for the four locations studied

								Exchangeable Bases				Particle size			Texture
Location	Calculated	pH	Total N	Org.C	Org. M	Avail. P	Ex. Acidity	Ca	Mg	K	Na	Sand	Silt	Clay	
				g/kg		mg/kg		Cmol/kg					g/kg		
CU	Range	6.8-6.9	0.78-1.23	22.96-24.22	39.49-41.66	8.80-9.24	0.15-0.15	2.42-2.69	0.23-0.26	0.15-0.16	0.22-0.22	880.0-900.0	50.0-60.0	48.0-60.0	
	Mean±SD	6.9±0.05	1.05±0.15	23.51±0.47	40.47±0.79	8.87±0.40	0.15±0	2.57±0.11	0.25±0.01	0.16±0.01	0.22±0	890.0±6.23	58.0±3.72	52.0±4.34	S
FA	Range	6.8-6.9	1.57-1.82	24.99-26.94	42.98-46.34	7.58-8.93	0.15-0.15	4.05-4.22	0.37-0.68	0.25-0.39	0.22-0.22	890.0-950.0	20.0-70.0	30.0-48.0	
	Mean±SD	6.8±0.04	1.69±0.11	25.97±0.63	44.66±1.09	8.27±0.49	0.15±0	4.15±0.06	0.55±0.13	0.32±0.05	0.22±0	929.0±18.75	30.0±18.26	41.0±8.06	S
FO	Range	6.5-6.7	1.62-1.89	26.59-30.05	45.73-51.69	10.06-11.98	0.15-0.20	2.79-2.83	0.36-0.45	0.13-0.20	0.22-0.22	890.0-952.0	0-70.0	40.0-50.0	
	Mean±SD	6.6±0.07	1.74±0.09	28.39±1.34	48.82±2.31	10.95±0.66	0.17±0.24	2.81±0.02	0.41±0.04	0.17±0.03	0.22±0	926.0±23.79	27.0±25.60	47.0±3.22	S
DS	Range	7.6-7.7	5.09-5.70	53.45-55.92	91.93-96.18	53.23-56.76	0.15-0.20	22.75-24.78	1.41-1.65	1.92-2.37	0.30-0.30	890.0-932.0	20.0-70.0	40.0-50.0	
	Mean±SD	7.7±0.05	5.47±0.22	54.90±0.84	94.42±1.45	55.49±1.12	0.18±0.02	23.65±0.77	1.56±0.09	2.08±0.15	0.30±0	915.0±17.98	38.0±19.51	47.0±3.39	S

CU – cultivated, FA-Fallow, FO- Forest soil, DS- Dumpsite soil,

SD – standard deviation, S – Sand

CU, FA, FO and DS respectively. All the soils had over 20 g/kg of organic matter content in the soil surface which suggested very high in organic matter content (FFD, 2012).

Total Nitrogen values ranged from 0.78 – 1.23, 1.57 – 1.82, 1.62 – 1.89 and 5.09 – 5.70 with mean values of 1.05 ± 0.15 g/kg, 1.69 ± 0.11g/kg, 1.74 ± 0.09 g/kg and 5.47 ± 0.22 g/kg for locations CU, FA, FO and DS respectively. The values for location CU indicated that total nitrogen was low and this is expected as this particular location was under cultivation. The crops planted must have exhausted the Nitrogen in the soil. Again, the soil texture of this location could have contributed to the loss of nitrogen via leaching. The values for locations FA and FO showed that Total Nitrogen was moderate in these locations. While values for location DS revealed that Total nitrogen was extremely high (FFD, 2012). This once again proves that soils of the Tropics vary highly in Total Nitrogen, the variation could be due to low or high plant residues incorporation, intensive cultivation of a particular land and depletion due to the fact that nitrate are readily leached from the soil. Although, this may not solve the problem of leaching, it is advisable to always apply nitrogenous fertilizer in split so that part of it will take care of the vegetative growth while the other will take care of the reproductive phase (Idem and Showemimo, 2004). Also, in the Tropics there is a strong advocacy for application of organo-mineral fertilizer. This will not only provide the required nitrogen but also reduces leaching because it is a slow released fertilizer.

Available phosphorus in the soils ranged from moderate to extremely high. The values ranged from 8.80 – 9.24 with a mean of 8.87 ± 0.40 mg/kg for location CU, values of location FA were not different from location CU. However, available phosphorus values ranged from 10.06 – 11.98 and 53.23 – 56.76 with mean values of 10.95 ± 0.66 mg/kg and 55.49 ± 1.12 mg/kg for locations FO and DS respectively. The values indicated that the available phosphorus was moderate in location FO and extremely high in location DS. According to critical range of 7 – 20 mg/kg and critical value of 15 mg/kg (Bray P-1) (Adeoye, 1986), locations CU – FO will require phosphorus fertilizer application to raise up the phosphorus level of the soils. The high soil pH range in location DS (table 1), suggests why available phosphorus is very high because it is not being fixed in the soil. David *et al* (2011) and Donald (2013) reported that Nickel availability in soil will enhance phosphorus availability.

Exchangeable Bases (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}).

The soil exchangeable Ca^{2+} ranged from 2.42 – 2.69, 4.05 – 4.22, 2.79 – 2.33 and 22.75 – 24.78 with mean values of 2.57 ± 0.11cmol/kg, 4.15 ± 0.06 cmol/kg, 2.81 ± 0.02 cmol/kg and 23.65 ± 0.77 cmol/kg for locations CU, FA, FO and DS respectively. Exchangeable Mg^{2+} ranged from 0.23 – 0.26, 0.37 – 0.68, 0.36 – 0.45 and 1.41 – 1.65 with mean values of 0.25 ± 0.01 cmol/kg, 0.55 ± 0.13 cmol/kg, 0.41 ± 0.04 cmol/kg and 1.56 ± 0.09 cmol/kg for locations CU, FA, FO and DS respectively. Exchangeable K+ ranged from 0.15 – 0.16, 0.25 – 0.39, 0.13 – 0.20 and 1.92 – 2.37 with mean values of 0.16 ± 0.01 cmol/kg, 0.32 ± 0.05 cmol/kg, 0.17 ± 0.03 cmol/kg and 2.08 ± 0.15 cmol/kg for locations CU, FA, FO and DS respectively. Exchangeable Na^{+} values ranged from 0.22 – 0.22 with a mean of 0.22 ± 0 cmol/kg for locations CU-FO. While values for location DS, ranged from 0.30 – 0.30 with a mean of 0.30 ± 0 cmol/kg. The values for exchangeable calcium indicated that Ca^{2+} was

Table 2: Mean values, standard deviation and ranges of micronutrients status for the four sites studied

Location	Calculated	Mn	Fe	Cu	Zn
			mg/kg		
CU	Range	84.80-118	68.51-79.60	0.38-1.13	2.21-3.33
	Mean±SD	105.05±12.24	75.04±5.15	0.98±0.29	2.67±0.51
FA	Range	114.00-133.00	58.23-69.80	1.05-1.15	4.26-6.45
	mean±SD	121.32±7.02	65.67±5.03	1.09±0.03	5.67±0.96
FO	Range	78.99-81.40	150.00-184.00	0.46-0.50	4.25-4.99
	Mean±SD	80.28±0.83	170.18±12.31	0.49±0.01	4.69±0.23
DS	Range	42.50-45.25	1.69-2.90	0.12-0.37	83.50-85.14
	Mean±SD	44.53±1.01	2.28±0.50	0.27±0.10	84.34±0.59

low in location CU-FO, while it was very high in location DS (FFD, 2012). The values of Mg^{2+} showed that Mg^{2+} was very low in location CU, while location FA and FO indicated a low concentration. However, exchangeable magnesium was moderate in location DS. Exchangeable potassium values indicated that locations CU and FO were very low in K^{+}, moderate in location FA. While, locations DS values showed that exchangeable potassium was very high. The low K^{+} in soil indicates the need for potassium fertilizer. The soil Na^{+} content for locations CU - FO were low while moderate for location DS. The low values indicated that the soils have good aggregate stability with good pores distribution. The basic cations decreased in the order Ca> Mg > K > Na in locations FA and DS which was in conformity with Oputa and Udo (1980) findings. While, the order did not follow for locations CU and FO.

Micronutrients contents in the soils studied

Available Mn. Fe, Cu and Zn are presented in Table 2. Available Mn ranged from 84.80 – 118.0, 114.0 – 133.0, 78.99 – 81.40 and 42.50 – 45.25 with mean values of 105.05 ± 12.24 mg/kg, 121.32 ± 7.02 mg/kg, 80.28 ± 0.83 mg/kg and 44.53 ± 1.01 mg/kg for location CU, FA, FO and DS respectively. Manganese content was the highest among the micronutrients studied in location CU - FO, but was low in location DS. Iron was the second highest after manganese and ranged from 68.51 – 79.60, 58 23 – 69.80, 150.0 – 184.0 and 1.69 – 2.90 with mean values of 75.04 ± 5.15 mg/kg, 65.67 ± 5.03 mg/kg, 170.18 ± 12.31 mg/kg and 2.28 ± 0.50 mg/kg for locations CU, FA, FO and DS respectively. Available Fe was highest at location FO and very low in location DS. Copper had the least concentration with values ranging from 0.38 – 1.13, 1.05 – 1.15, 0.46 – 0.50 and 0.12 – 0.37 with mean values of 0.98 ± 0.29 mg/kg, 1.09 ± 0.03 mg/kg, 0.49 ± 0.01 mg/kg and 0.27 ± 0.10 mg/kg for locations CU, FA, FO and DS respectively. Available copper was below the critical level in location 4, while locations CU-FO were above the critical level of 0.3 mg/kg Cu (Rhue and Kidder, 1983). The available zinc was somewhat higher than that obtained for Cu in locations CU – FO. However, the values revealed that Zn was the highest in location DS. The values ranged from 2.21 – 3.33, 4.26 – 6.45, 4.25 – 4.99 and 83.50 – 85.14 with mean values of 2.67 ± 0.51mg/kg, 5.67 ± 0.96 mg/kg, 4.69 ± 0.23 mg/kg and 84.34 ± 0.59 mg/kg for locations CU, FA, FO and DS respectively. Available manganese and zinc were above the critical levels of 5.0 and 1.0 mg/kg for Mn and Zn respectively, (Rhue and Kidder, 1983). In locations CU, FA, FO and DS values of iron and zinc showed that both micronutrients were above the critical level in locations CU –FO, but were below the critical levels of 2.5 mg/kg for Fe and 0.3 mg/kg for Cu (Viets and Lindsay, 1973; Rhue and Kidder, 1983).

The low available Fe and Cu obtained in location DS, suggests from (Table 2) that both micronutrients are probably fixed by high organic matter (carbon), high soil pH and possibly high available phosphorus obtained in this location (Petruzzelli and Buidi, 1976; Stevenson and Ardakani, 1972).

Data from the four locations studied were pulled together and correlation coefficient was calculated for soil characteristics and the result of this analysis is presented in Table 3.

Soil pH correlated significantly with organic carbon (0.907***), Zn (0.951***), NH_4OAc (0.827***), CH_3COOH (0.958***), HCl (0.762***) and EDTA (0.829***). While correlating negatively with Mn (-0.677***), Fe (-0.868***) and Cu (-0.488*) at $P \leq 0.05$ and $P = 0.001$. Organic carbon correlated positively with Zn (0.991***), NH_4OAc (0.584*), CH_3COOH (0.850***), HCl (0.816***), EDTA (0.898***) and negatively with Mn (-0.868***), Fe (-0.639***) and Cu (-0.665***) at $P \leq 0.05$ and $P = 0.001$. Sand correlated negatively with silt (-0.962***) and NH_4OAc (-0.473) at ($P = 0.001$ and $P \leq 0.05$). This implies that the more the coarse fraction, the less the silt fraction in the particle size distribution. Silt correlated positively only with NH_4OAc (0.416*) at $P \leq 0.05$. Manganese correlated positively with Cu (0.785***) but negatively with Zn (-0.836***), NH_4OAc (-0.398*), CH_3COOH (-0.600***), HCl (-0.568***) and EDTA (-.0.839***) at $P \leq 0.05$ and $P = 0.001$. Iron correlated significantly but negatively with all the nickel extractants NH_4OAc (-0.867***), CH_3COOH (-0.899***), HCl (-0.677***) and EDTA (-0.601***). Copper had significant negative correlation with Zn (-0.628***) and EDTA (-602**). Zinc correlated significantly with all the extractants positively. All the extractants correlated positively with each other significantly at ($P = 0.001$, $P \leq 0.01$ and $P \leq 0.05$). The positive correlation means that increase in one soil characteristics increases the other, while negative correlation implies that increase in one soil property decreases the other and vice visa.

Nickel contents in the soils studied

Available nickel extracted with four different extractant is presented in Table 4. Available nickel extracted with 1N NH_4OAC ranged from 26.55 – 29.77, 19.79 – 22.32, 14.48 – 17.22 and 30.31 – 33.90 with mean values of 28.55 ± 1.10 mg/kg, 20.79 ± 0.90 mg/kg, 15.62 ± 1.00 mg/kg and 32.10 ± 1.23 mg/kg for locations CU, FA, FO and DS respectively. The nickel contents extracted using acetic acid (0.5N CH_3COOH) was the least among the four extractants used

Table 3: Correlation coefficients calculated for chemical properties and particle size distribution of soil for the four locations

	pH	OC	OM	Sand	Silt	Clay	Mn	Fe	Cu	Zn	NH4OAc	CH3COOH	HCl	EDTA
pH	1													
OC	0.907****	1												
OM	0.907****	1.000****	1											
Sand	-0.105	0.077	0.076	1										
Silt	0.086	-0.083	-0.083	-0.962****	1									
Clay	0.087	0.005	0.005	-0.347	0.077	1								
Mn	-0.677****	-0.868****	-0.868****	-0.021	0.065	-0.148	1							
Fe	-0.868****	-0.639****	-0.639****	0.185	-0.201	0.014	0.292	1						
Cu	-0.488*	-0.665****	-0.666****	0.049	0.025	-0.265	0.785****	0.103	1					
Zn	0.951****	0.991****	0.991****	0.007	-0.017	0.032	-0.836****	-0.72	-0.628****	1				
NH4OAc	0.827****	0.584*	0.585****	-0.473*	0.416*	0.297	-0.398*	-0.867****	-0.285	0.675****	1			
CH3COOH	0.958****	0.850****	0.850****	-0.117	0.119	0.02	-0.600****	-0.899****	-0.388	0.898****	0.829****	1		
HCL	0.762****	0.816****	0.816****	0.255	-0.188	-0.284	-0.568****	-0.677****	-0.27	0.821****	0.419*	0.757****	1	
EDTA	0.829****	0.898****	0.898****	0.05	-0.092	0.133	-0.839****	-0.601****	-0.602**	0.902****	0.583**	0.749****	0.756**	1

* Correlation is significant at P ≤ 0.05

** Correlation is significant at P ≤ 0.01

*** Correlation is significant at P ≤ 0.001

Table 4: Available nickel determined by four different extractants for the soils studied

Location	Calculated	1N NH_4OAc	0.5N CH_3COOH	1N HCl	EDTA
			mg/kg		
CU		29.61	20.54	23.97	36.86
		28.92	21.95	25.45	29.98
		26.55	21.25	29.62	37.32
		29.77	19.69	27.23	35
		27.81	20.81	29.93	37.4
		28.65	19.99	24.57	36.56
	Mean±SD	28.55±1.10	20.71±0.75	26.79±2.34	35.52±2.60
FA		22.32	19.17	31.48	36.66
		21.4	21	34.06	33.82
		20.11	20.05	30.67	35.68
		21.13	21.2	33.57	35.97
		19.79	19.75	31.79	34.91
		20	20.36	33.41	35.53
	Mean±SD	20.79±0.90	20.25±0.69	32.49±1.24	35.43±0.88
FO		15.24	16.68	28.84	36.53
		15.08	16.1	26.92	36.06
		17.22	15.55	29.04	34.98
		14.48	14.28	27.56	37.33
		16.77	14.32	29.78	36.75
		14.96	16.79	28.47	35.44
	Mean±SD	15.62±1.00	15.62±1.20	28.44±0.95	36.18±0.79
DS		31.67	26.54	39.84	45.81
		30.31	31.25	35.88	40.99
		33.9	28.54	36.4	42.91
		32.2	32.95	38.73	44.09
		31.19	32.18	38.22	43.5
		33.38	30.26	36.05	45.51
	Mean±SD	32.10±1.23	30.28±2.18	37.52±1.49	43.80±1.62

with values ranging from 19.69 – 21.95, 19.17 – 21.20, 14.28 – 16.79 and 26.54 – 32.95 with mean values of 20.71 ± 0.75 mg/kg, 20.25 ± 0.69 mg/kg, 15.62 ± 1.02 mg/kg and 30.28 ± 2.18 mg/kg for locations CU, FA, FO and DS respectively. Nickel extracted by 1N HCl ranged from 23.97 – 29.93, 30.67 – 34.06, 26.92 – 29.78 and 35.88 – 39.84 with mean values of 26.79 ± 2.34 mg/kg, 32.49 ± 1.24 mg/kg, 28.44 ± 0.95 mg/kg and 37.52 ± 1.49 mg/kg for locations CU, FA, FO and DS respectively. However, EDTA extractant had the highest extractable nickel in all the four locations with values ranging from 29.98 – 37.40, 33.82 – 36.66, 34.98 – 37.33 and 40.99 – 45.81 with mean values of 35.53 ± 2.60 mg/kg, 35.43 ± 0.88 mg/kg, 36.18 ± 0.79 mg/kg and 43.80 ± 1.62 mg/kg for CU, FA, FO and DS respectively.

The highest value of available nickel was recorded with the EDTA extractant. This is expected because EDTA is known to be a chelating agent and probably extracting not from the same pool that the plants are taking. EDTA had been reported to extract more metals than any other extracting agent by Wuana *et al., (*2010). The maximum available nickel was observed in location DS (dump site); this may be due to the fact that organic matter of this particular location is extremely high. Shi *et al.* (2012) have reported that Ni adsorption on soil organic matter (SOM) was dominant in the short term and the slow transfer of adsorbed Ni to Ni- layered double hydroxide (Ni-LDH) phases with longer reaction times. High Ni level in dumpsite could be attributed to the accumulation of industrial and municipal wastes which are major sources of Heavy metals in polluted soils. This same assertion was reported by (European Environmental Agency, 2004; Birmingham & McLaughlin, 2006; Jin *et al.,* 2009) that the release of high quantities of Ni into the environment, could be attributed to industrial sources, activities in mines or smelters, production of alloys use of fertilizers and pesticides and dumping of wastes materials.

Correlation coefficient was calculated for the four nickel extractants and the result is presented in Table 5. NH_4OAc correlated positively with CH_3COOH (0.829***), HCl (0.419*), EDTA (0.582**). CH_3COOH correlated positively with HCl (0.757***), EDTA (0.748***). All the extractants correlated positively with each other significantly at ($P = 0.001$, $P \leq 0.01$ and $P \leq 0.05$). The result indicates that all four extractants are extracting nickel from the same pool at different levels.

CONCLUSION

This study investigated the status of both macro and micronutrient element in soil based on four different land use. The soils belong to the sandy loam textural class according to USDA classification and ranged from neutral to slightly alkaline. Soil organic matter was high in all the soil samples as they had over 20 g/kg of Organic matter content. Cultivated soil was low in Nitrogen while fallow, forest and dumpsite soils had moderate to high nitrogen content. Available phosphorus in the soils were moderate in cultivated soil while they were moderate to extremely high in forest and dumpsite soils respectively.

Exchangeable K^+ ranged from 0.16 ± 0.01 cmol/kg, 0.32 ± 0.05 cmol/kg, 0.17 ± 0.03 cmol/kg and 2.08 ± 0.15 cmol/kg while soil exchangeable Ca^{2+} ranged from 2. 2.57 ± 0.11 cmol/kg, 4.15 ± 0.06 cmol/kg, 2.81 ± 0.02 cmol/kg and 23.65 ± 0.77, exchangeable Mg^{2+} ranged from 0.25 ± 0.01 cmol/kg, 0.55 ± 0.13 cmol/kg, 0.41 ± 0.04 cmol/kg and 1.56 ± 0.09 cmol/kg,

Table 5: Correlation coefficients calculated for the four extractants

	NH_4OAc	CH_3COOH	HCL	EDTA
NH4OAc	1.000			
CH3COOH	0.829***	1.000		
HCL	0.419*	0.757***	1.000	
EDTA	0.582**	0.748***	0.756***	1.000

* Correlation is significant at P ≤ 0.05

** Correlation is significant at P ≤ 0.01

*** Correlation is significant at P ≤ 0.001

available Mn ranged from 105.05 ± 12.24 mg/kg, 121.32 ± 7.02 mg/kg, 80.28 ± 0.83 mg/kg and 44.53 ± 1.01 mg/kg for soils of cultivated, fallow, forest and dumpsite land uses respectively.

Manganese content was the highest among the micronutrients studied and ranged 75.04 ± 5.15 mg/kg, 65.67 ± 5.03 mg/kg, 170.18 ± 12.31 mg/kg and 2.28 ± 0.50 mg/kg for cultivated, fallow, forest and dumpsite soils respectively. The highest value of available nickel was recorded with the EDTA extractant. The maximum available nickel was observed in location DS (dump site);

Soil pH correlated significantly with organic carbon (0.91***), Zn (0.95***), NH_4OAc (0.83***), CH_3COOH (0.96***), HCl (0.76***) and EDTA (0.83***). ***). While correlating negatively with Mn (-0.68***), Fe (-0.87***) and Cu (-0.49*) at $P \leq 0.05$ and $P = 0.001$. Manganese correlated positively with Cu (0.79***) but negatively with Zn (-0.84***), NH_4OAc (-0.39*), CH_3COOH (-0.60***), HCl (-0.57***) and EDTA (-.0.84***) at $P \leq 0.05$ and $P = 0.001$. Iron correlated significantly but negatively with all the nickel extractants NH_4OAc (-0.87***), CH_3COOH (-0.89***), HCl (-0.68***) and EDTA (-0.60***). Copper had significant negative correlation with Zn (-0.63***) and EDTA (-60**). Zinc correlated significantly with all the extractants positively. All the extractants correlated positively with each other significantly at ($P = 0.001$, $P \leq 0.01$ and $P \leq 0.05$).

Therefore all the soil used in this experiment have medium to high content of macro and micronutrient except the cultivated land. This could be attributed to the fact that the macro and micro nutrient elements in these soils have been used by crop harvested in this land over time.

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