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Physicochemical properties of wetland soils developed on basement complex and coastal plain sands in Cross River State, Nigeria

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Abstract

The study was carried out to investigate the physicochemical properties of wetland soils developed on basement complex and coastal plain sand parent materials in Awi and University of Calabar Oceanography farm respectively in Cross River State. Twenty composite soil samples were collected at the depths of 0-20cm and 20-40cm, processed and taken to the laboratory for physicochemical analysis. The study revealed that coastal plain sand soils had texture varying from sandy loam, loamy sand to sandy clay loam while basement complex had sandy loam and loamy sand texture. The soils were acid in reaction with slightly acidic pH in coastal plain sand with values ranging from 5.0-5.3and 4.6-5.2 with mean values of 5.14 and 5.02 and CV values of 2.14 % and 4.96 %in the surface soils and subsurface soils respectively while the basement complex is strongly acid with pH ranging from 4.4 - 5.40 and 4.2-4.9 with mean values of 4.78 and 4.58 and CV of 8.93 and 6.05% in the surface soils and subsurface soils respectively. Organic carbon had mean values of 0.84 % and 0.692 % and CV v of 17.1 % and 23.7 %in the surface and subsurface soils respectively in coastal plain sand. While in the basement complex soil, it had mean values of 1.342 % and 0.886 % and CV of 84.1 % and 75.9 % in the surface soils and subsurface soils respectively. Total N had means of 0.068 % and 0.054 % and CV values of 14.7 % and 30.9 in coastal plain sand, 0.108 % and 0.07 % and CV of 46.29 % and 71.4 % in basement complex for top and sub soils accordingly. Available P and Exchangeable bases were higher in coastal plain sand than in basement complex. ECEC had means of 23.9 and 26.9 c mol/kg, 7.31 and 6.23cmol/kg in surface and subsurface of coastal plain sand and basement complex accordingly. The result of the studies revealed that the fertility indices of wetland soils of the two parent materials were generally low probably due to their acidic nature with majority of the parameters higher in coastal plain sand than in basement complex.

Keywords: Parent materials, acidity, wetland, fertility, texture.

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1.0. Introduction

The nature of parent materials is said to profoundly influence the development and characteristic of soils. For appropriate and sustainable use soil, firsthand information of the soil is necessary. In small region of uniform climate, the nature of parent material is probably more important than any other single factor in determining the characteristics and productivity of soil. Soil characterization provides the information for our understanding of the physical and chemical properties of the soils we depend on to grow crops, sustain forests and grasslands as well as support homes and society structures (Fasina *et al*., 2015).Each soil, based on its characteristics has a predictable response to management or any kind of manipulation (Ogunkunle,2004).Irmak *et al*.,(2007) studied the soils of Arid region of Turkey and observed that different parent materials affect the morphology and chemistry of soils under the same agro ecological conditions.

The knowledge of the parent material of soil is essential for understanding of many important characteristics related to soil nutrient status and knowing their origin, mechanism of weathering and means of transport and deposition are essential to understanding soil genesis (Omeke *et al*., 2014). The soils of Calabar metropolis are derived from coastal plain sand and these soils are strongly weathered, characterized by coarse to fine sand texture, low content of organic carbon, total nitrogen, exchangeable bases and preponderance of low activity clays. The soils are highly leached and are therefore acidic in reaction probably due to high amount of rainfall in the area (Akpan-Idiok, 2012). Soils of Southeastern Nigeria formed on coastal plain sands have low physical and chemical fertility due to dominance of low activity clays and inherent low organic matter content (Obi and Udoh, 2011).

Soils of Akamkpa local government area are derived from basement complex rocks consisting of granite and gneiss. Basement complex parent materials occupied about 50% of Nigeria's surface area (Maniyunda *et al*., 2014). Basement complex rocks are found at Oban known as Oban massif (Aki *et al*., 2014). Despite the abundant literatures on the soils developed on basement complex and coastal plain sands in many parts of Nigeria (Fagbami 1981, Mustapha and Fagam, 2007 and Fasina *et al*., 2007) they have been only few studies on the physicochemical properties of wetland soils developed on basement complex and coastal plain sands in Nigeria. This study therefore seeks to bridge the gap that exists on selected physicochemical properties of wetland soils developed on basement complex and coastal plain sands.

20.. Materials and Methods

2.1. Study area

The study was carried out in Awi, Akamkpa Local Government Area and University of Calabar Oceanography Farm both in Cross River State. Akamkpa Local Government Area lies between latitude $5^0 00^1$ and $5^0 57^1$N and longitude $8^0 06^1$ and $9^0 0^1$ E while University of Calabar Oceanography Farm is located at latitude $4^0 30^1$ and $4^0 40^1$N and longitude $08^1 5^1$ and $8^0 15^1$ E. The area has humid tropical climatic condition with mean annual rainfall of 2500 to 3000mm, mean annual temperature of 26 to 27 ^{0}C with mean relative humidity of 80 to 90% at the peak of the rainy season. The underlying geological materials are basement complex rocksin Awi and Benin formation in the Oceanography Farm, University of Calabar.

2.2. Field work

Twenty composite samples each were obtained at the depths of 0-20cm and 20-40cm from Awi, Akamka and the Oceanography Farm, University of Calabar, well labeled in sampling bags and transported to the Soil Science Laboratory of University of Calabar for physicochemical analysis.

2.3. Laboratory analysis

Soil samples were air-dried, crushed and sieved with 2 mm sieve and analyzed in the laboratory using standard routine methods. Particle size distribution was determined using Bouyoucous hydrometer method as outlined by Juo (1979). Soil pH was determined using the procedure reported by Bamgbose, *et al.,* (2000). Organic carbon was determined by Walkley-Black wet oxidation method described by Srinkanth *et al.,* (2013). Total nitrogen was determined using modified micro-kjeldhal method while available phosphorus was extracted and determined using the method outlined by Udoh *et al*., (2009). Exchangeable bases were determined by leaching the soil samples with 1ml neutral NH_4OAc as the extractant solution. Calcium and Mg were determined by the EDTA complexometric titration method while K and Na were determined by flame photometry (IITA, 1979). Exchangeable acidity was determined by titration method described by Srinkanth *et al.,* (2013). ECEC was obtained by the summation method and base saturation obtained by expressing the exchangeable bases as a percentage of the ECEC.

2.4. Data Analysis

The data obtained were statistically analyzed using descriptive statistical tools for mean, range and coefficient of variability.

3.0 Results And Discussion

3.1. Particle size distribution

The physicochemical properties of wetland soils developed on coastal plain sands in Calabar and basement complex in Awi, Akamkpa LGA both in Cross River State are presented in Tables 1 and 2. Coastal plain sand soils are predominantly sandy with sandy loam, loamy sand and sandy clay loam texture while basement complex soil has loamy sand and sandy loam texture. The sand ranged from67-82 %and 70-80 % with mean values of 77.2 % and 74.4 % and CV values of 8.3 % and 59 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the sand ranged from 67-79 % and 71-79 % with mean values of 73.2 % and 76.2 % and CV of 6.4 % and 4.1% in the surface soils and subsurface soils respectively. The silt ranged from2-15 %and 6-10 % with mean values of 7.6 % and 8.4 % and CV values of 61.4 % and 18.1 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the silt ranged from 15-26 % and 16-22.2 % with mean values of 20.6 % and 18.2 % and CV of 21.5 % and 13.7% in the surface soils and subsurface soils respectively. The clay ranged from10-21 %and 11-21 % with mean values of 13.2 % and 17.2 % and CV values of 34 % and 24.1 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the clay ranged from 4-9 % and 7-5 % with mean values of 8.2 % and 5.6 % and CV of 30.9 % and 15.9 % in the surface soils and subsurface soils respectively. Contrary texture was obtained for soils developed on basement complex in Savanna region of Nigeria by Oyatokun *et al.,* (2017) while coastal plain sand texture similar to that of this study was obtained by Abam and Orji (2019) in Calabar.

3.2 Chemical properties

The chemical properties of the soils studied are also presented in Tables 1 and 2**.** Coastal plain sand soil had slightly higher pH than the basement complex soil with values ranging from 5.0-5.3and 4.6-5.2 with mean values of 5.14 and 5.02 and CV values of 2.14 % and 4.96 %in the surface soils and subsurface soils respectively. While in the basement complex soil, pH ranged from 4.4 - 5.40 and 4.2-4.9 with mean values of 4.78 and 4.58 and CV of 8.93 and 6.05% in the surface soils and subsurface soils respectively. The result is in contrary to the report of Abam and Orji (2019); Afu *et al.,* (2019) who obtained higher pH in basement soils than coastal plain sand soils which are both higher than that of this study. The study revealed that soil developed on basement complex is strongly acid while that developed on coastal plain sand in Calabar is moderately acid in reaction according to Udo *et al.,* (2009). This result is similar to the pH ranges of 4.5 to 5.3 obtained in basement complex soil in Southwestern Nigeria by Fasina *et al.,* (2015) while the result of coastal plain sand soil agrees with pH range of 4.6to 5.5 reported in coastal plain soil in the University of Calabar farm by Okon-Inyang *et al.,* (2010). In coastal plain sand, organic carbon ranged from 0.64-1.03 %and 0.54-0.94 % with mean values of 0.84 % and 0.692 % and CV values of 17.1 % and 23.7 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the organic carbon ranged from 0.11-1.89 % and 0.05-1.83 % with mean values of 1.342 % and 0.886 % and CV of 84.1 % and 75.9 % in the surface soils and subsurface soils respectively. Organic carbon was higher in basement complex soil than in coastal plain sand soil. The organic car-

Table1: Physicochemical properties of soil developed on coastal plain sands in the University of Calabar Oceanography farm.

Location	Depth	Particle Size Dist. Sand	Silt	Clay	TC	pH	OC	TN	Avai. P	Exch. Bases Ca^{2+}	Mg^{2+}	K^+	Na^+	Exch. Acidity Al^{3+}	H^+	ECEC	BS
			(%)				(%)	(%)	(mg/kg)	←		(Cmol/kg)			→		(%)
1	0-20	75	15	10	SL	5.1	0.64	0.05	38.87	4.6	2	0.08	0.07	0.32	0.76	7.83	86.2
2	20-40	73	10	17	SL	5.1	0.66	0.05	12.56	3.6	2.4	0.1	0.08	0.52	0.62	7.32	84.4
3	0-20	67	2	21	SL	5.2	0.78	0.06	10.37	4.2	1	0.09	0.08	0.24	2.32	7.93	67.7
4	20-40	80	9	11	LS	5	0.94	0.08	12.75	4.4	0.8	0.1	0.07	0.4	0.6	6.37	84.3
5	0-20	80	7	13	LS	5.3	0.86	0.07	12.37	6.1	7.8	0.1	0.08	0.12	2.48	16.68	53.7
6	20-40	71	8	21	SL	5.2	0.76	0.06	10.62	8	10	0.11	0.08	0.48	0.64	19.31	94.1
7	0-20	82	7	11	SCL	5	1.03	0.09	13.87	10	12.2	0.1	0.09	0.12	0.28	36.66	27.8
8	20-40	78	6	16	SL	5.2	0.54	0.04	11	22	23.8	0.09	0.07	0.36	0.64	46.96	97.8
9	0-20	82	7	11	LS	5.1	0.89	0.07	16.75	23.8	26.6	0.1	0.08	0.24	0.52	50.74	98.5
10	20-40	70	9	21	SCL	4.6	0.56	0.04	7.75	26	27.9	0.09	0.07	0.4	0.45	54.91	98.4
Surface soil																	
Mean		77.2	7.6	13.2		5.14	0.84	0.068	18.45	9.74	9.92	0.094	0.08	0.21	1.272	23.96	66.78
Minimum		67	2	10		5	0.64	0.05	10.37	4.2	1	0.08	0.07	0.12	0.28	7.83	27.8
Maximum		82	15	21		5.3	1.03	0.09	38.87	23.8	26.6	0.1	0.09	0.32	2.48	50.74	98.5
CV (%)		8.26	61.4	34		2.14	17.1	14.7	63.2	84.1	104.5	9.57	12.5	42.9	82.5	79.4	41.5
Subsurface soil																	
Mean		74.4	8.4	17.2		5.02	0.692	0.054	10.94	12.8	12.98	0.098	0.074	0.43	0.59	26.974	91.8
Minimum		70	6	11		4.6	0.54	0.04	7.75	3.6	0.8	0.09	0.07	0.36	0.45	6.37	84.3
Maximum		80	10	21		5.2	0.94	0.08	12.75	26	27.9	0.11	0.08	0.52	0.64	54.91	98.4
CV (%)		5.9	18.1	24.1		4.96	23.7	30.9	18.4	82	95.1	8.16	13.5	16.3	13.6	83.9	7.62

Table1: Physicochemical properties of soil developed on coastal plain sands in the University of Calabar Oceanography farm.

Location	Depth	Particle Size Dist.			TC	pH	OC	TN	Avai. P	Exch. Bases				Exch. Acidity		ECEC	BS
		Sand	Silt (%)	Clay			(%)	(%)	(mg/kg)	Ca^{2+}	Mg^{2+}	K^+ (Cmol/kg)	Na^+	Al^{3+}	H^+		(%)
1																	
	0-20	75	21	4	LS	5.4	1.76	0.14	7.38	3.4	2	0.09	0.07	0.08	0.12	5.76	96.52
2	20-40	77	18	5	LS	4.4	0.83	0.07	8.13	3.6	1.2	0.08	0.06	0.24	0.56	5.74	86.06
3	0-20	67	26	7	SL	4.4	1.89	0.15	4.75	6.6	1	0.1	0.08	0.4	0.08	8.26	99.03
4	20-40	78	16	6	LS	4.2	0.05	0.01	5.63	4.6	0.2	0.08	0.07	0.24	0.16	7.15	69.23
5	0-20	75	20	5	LS	4.4	1.79	0.14	10.25	5.8	3.6	0.11	0.08	0.32	0.02	9.93	96.57
6	20-40	76	19	5	LS	4.9	0.53	0.04	6.88	4	0.6	0.1	0.07	0.08	0.12	4.97	95.97
7	0-20	79	15	6	LS	5	0.11	0.02	6.5	5	0.6	0.09	0.06	0.12	0.04	5.91	97.29
8	20-40	79	16	5	LS	4.7	1.19	0.09	6.88	4.2	1.8	0.09	0.07	0.16	0.24	6.56	93.9
9	0-20	70	21	9	SL	4.7	1.16	0.09	7.5	5.4	0.4	0.11	0.08	0.32	0.42	6.71	89.26
	20-40	71	22	7	SL	4.7	1.83	0.14	6	4.4	1.4	0.08	0.06	0.32	0.48	6.74	88.13
10																	
Surface soil																	
Mean		73.2	20.6	6.2		4.78	1.342	0.108	7.276	5.24	1.52	0.1	0.074	0.25	0.136	7.314	95.73
Minimum		67	15	4		4.4	0.11	0.02	4.75	3.4	0.4	0.09	0.06	0.08	0.02	5.76	89.26
Maximum		79	26	9		5.4	1.89	0.15	10.25	6.6	3.6	0.11	0.08	0.4	0.42	9.93	99.03
CV (%)		6.4	21.5	30.9		8.93	84.1	46.29	27.3	22.7	86.8	10	13.5	56	117.6	24.2	3.92
Subsurface soil																	
Mean		76.2	18.2	5.6		4.58	0.886	0.07	6.704	4.16	1.04	0.086	0.066	0.21	0.312	6.232	86.66
Minimum		71	16	5		4.2	0.05	0.01	5.63	3.6	0.2	0.08	0.06	0.08	0.12	4.97	69.23
Maximum		79	22	7		4.9	1.83	0.14	8.13	4.6	1.8	0.1	0.07	0.32	0.56	7.15	95.97
CV (%)		4.09	13.7	15.9		6.05	75.9	71.4	14.5	9.13	61.5	11.6	15.2	42.9	64.1	13.9	12.2

bon mean value in coastal plain sands is quite lower than the mean of 1.09% obtained in coastal plain sand soil in Akpabuyo by Akpan-Idiok (2012) but similar to 0.73% obtained by Abam and Orji (2019) in a similar study. The level of organic carbon in basement also agrees with 0.87% obtained by Abam and Orji (2019) in similar soils. Total N in coastal plain sand soil had range of 0.05-0.07 % and 0.04-0.08 % with mean values of 0.068 % and 0.054 % and CV values of 14.7 % and 30.9 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the total nitrogen ranged from 0.02-0.15 % and 0.01-0.14 % with mean values of 0.108 % and 0.07 % and CV of 46.29 % and 71.4% in the surface soils and subsurface soils respectively. The total N values of coastal plain sand are lower than contrary value of 0.19% and 0.125% obtained in a similar soil by Afu *et al.,* (2019) and Ahukaemere *et al*., (2016). Available P was higher and more variable in coastal plain sand and varied from10.37-38.87 mg/kg and 7.75- 12.75 mg/kg with mean values of 18.45 mg/kg and 10.94mg/kg and CV values of 63.2 % and 18.4 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the available phosphorus ranged from 4.75-10.25 mg/kg and 5.63-8.13 mg/kg with mean values of 7.276 mg/kg and 6.704 mg/kg and CV of 27.3% and 14.5% in the surface soils and subsurface soils respectively. These results are in line with the observations made by Omeke *et al.* (2014) in soils of dissimilar lithology in Southeastern Nigeria. Available P was low in basement complex and moderate in coastal plain sand (Landon, 1991)

Exchangeable bases were higher in coastal plain sand than in basement complex. The exchangeable Ca^{2+}ranged from4.2-23.8and 3.6-26cmol/kg with mean values of 9.74 and 12.8 c mol/kg and CV values of 84.1 % and 82 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable Ca^{2+} ranged from 3.4-6.6 and 3.6-4.6 c mol/kg with mean values of 5.24 and4.16cmol/kg and CV of 22.7 % and 9.13% in the surface soils and subsurface soils respectively. The exchangeableMg^{2+}ranged from 1-26.6and 0.8-27.9 c mol/kg with mean values of 9.92 and 12.98 c mol/kg and CV values of 104.5 % and 95.1 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable Mg^{2+} ranged from 0.14-3.6 and 0.2-1.8 c mol/kg with mean values of 1.52 and 1.04cmol/kg and CV of 86.8 % and 61.5% in the surface soils and subsurface soils respectively. The exchangeable K^+ ranged from 0.08-01and 0.09-0.11cmol/kg with mean values of 0.094 and 0.098 cmol/kg and CV values of 9.57 % and 8.10 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable K^+ ranged from 0.09-0.11 and 0.08-0.1 cmol/kg with mean values of 0.1 and 0.086cmol/kg and CV of 10 % and 11.6 % in the surface soils and subsurface soils respectively. The exchangeable Na^+ ranged from0.07-0.09and 0.07-0.08cmol/kg with mean values of 0.08 and 0.074 cmol/kg and CV values of 12.5 % and 13.5 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable Na^+ ranged from 0.06-0.08 and 0.06-0.07 cmol/kg with mean values of 0.074 and 0.066cmol/kg and CV of 13.5 % and 15.2 % in the surface soils and subsurface soils respectively. Calcium and magnesium high in coastal plain sand and low in basement complex while potassium was low in both soils (Landon, 1991) Exchangeable Al^{3+} and H^+ were higher in coastal plain sand soil than in the basement complex soil. The exchangeableAl^{3+} ranged from 0.12-0.32and 0.36-0.52c mol/kg with mean values of 0.21 and 0.43 c mol/kg and CV values of 42.9 % and 16.3 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable Al^{3+} ranged from 0.08-0.4 and 0.08-0.32 c mol/kg with mean values of 0.25 and 0.21cmol/kg and CV of 56 % and 42.9 % in the surface soils and subsurface soils respectively. This probably confirms the acidic nature of coastal plain sand as they are widely reported in literatures as acid sands. The exchangeable H^+ ranged from0.28-2.48and 0.45-0.64cmol/kg with mean values of 1.27 and 0.59 c mol/kg and CV values of 82.5 % and 13.6 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable H^+ ranged from 0.02-0.42 and 0.12-0.56 c mol/kg with mean values of 0.136 and 0.312cmol/kg and CV of 117.6 % and 64.1% in the surface soils and subsurface soils respectively. These observations are in line with those made by Ajiboye *et al*., (2014). Exchangeable acidity was also statistically different in the two soils. ECEC was higher and more variable in coastal plain sand soil and varied from7.83-50.7and 6.37-54.9cmol/kg with mean values of 23.9 and 26.9 c mol/kg and CV values of 79.4 % and 83.9 %in the surface soils and subsurface soils respectively. While in the basement complex soil, the exchangeable ECEC ranged from 5.76-9.93 and 4.97-7.15 c mol/kg with mean values of 7.31 and 6.23cmol/kg and CV of 24.2 % and 13.9% in the surface soils and subsurface soils respectively. Contrary to ECEC, base saturation was higher in basement complex soil and ranged from27.8-98.5and 84.3-98.4cmol/kg with mean values of 66.8 and 91.8 c mol/kg and CV values of 41.5 % and 7.62 %in the surface soils and subsurface soils respectively. While in the basement complex soil, BS ranged from89.3-99.03 and 69.2-95.9 c mol/kg with mean values of 95.7 and 86.7cmol/kg and CV of 3.92 % and 12.2% in the surface soils and subsurface soils respectively. Higher BS values in basement complex soils agrees with the findings of Ajiboye *et al.,* (2008) who stated that soils developed basement complex are more fertile than those of coastal plain sands. BS was statistically different in the two soils. ECEC was high in coastal plain sand and low in basement while in base saturation was high in both soils.

4.0 Conclusion and Recommendations

The results of the study revealed that coastal plain sand soil is moderately acidic while basement complex soil is strongly acidic and that basement complex soil is relatively fertile than it coastal plain sand counterpart. Organic carbon and total N were low in both soils while available P was low in basement complex and moderate in coastal plain sand. Calcium and magnesium high in coastal plain sand and low in basement complex while potassium was low in both soils while exchangeable Al^{3+} and H^+ were higher in coastal plain sand soil than in the basement complex soil. ECEC was higher in coastal plain sand than in basement complex while the opposite is the case for BS. With low fertility as indicated by the results, the soils will require application of NPK fertilizer, organic matter, cultivation of leguminous crops to boost nitrogen level, fallowing for recuperation and reversion of nutrients and liming to raise soils' pH especially in basement complex to between 5.5 and 7.0. However, it is imperative to state that cultivation of basement complex soil will require careful management and higher inputs to enhance sustainable cultivation than it coastal plain sand soil counterpart.

References

Abam, P.O. and Orji, O.A. (2019). Morphological and physico-chemical properties of soils formed from diverse parent materials in Cross River State, Nigeria. IOSR Journal of Applied Geology and Geophysics(IOSR-JAGG). 7(1) PP 1-7.

Afu, S.M., Isong, I.A. and Awaogu, C.E. (2019) Agricultural potentials of flood plain soils with contrasting parent materials in Cross River State, Nigeria. Global Journal of Pure Applied Sciences. Vol. 25, Pp 13-22

Ahukaemere, C.M., Onweremadu, E.U, Ndukwu, B.N. and Nkwopara, U.N. (2016) Properties of soils of contrasting lithosequences in South-Eastern Nigeria. Futo Journal Series.Vol.2(1) Pp 6-9.

Ajiboye, G.A., Ogunwale, J.A.,and James, T.(2008) Characteristics and pedogenesis of soils developed over talc at Odo-Ogbe, Kogi State, Nigeria. American-Eurasian Journal of Agriculture and Environmental Science. Vol.4(4) 1-4.

Ajiboye, G.A., Olaniyan, J.O., Bosioko, C. and Oyetunde, O.O. (2014) Assessment of land use pattern and land forms on selected physic-chemical properties of soils developed on basement complex-sedimentary transitional zone of South Western Nigeria. Nigeria Journal of Soil Science. Vol.24(1) Pp 22-29.

Aki, E.E., Esu, I.E. and Akpan-Idiok, A.U. (2014) Pedological study of soils developed on biotite-hornblende-gneiss in Akamkpa Local Government Area of Cross River State, Nigeria. International Journal of Agricultural Research. Vol. 9 Pp 1-3.

Akpan-Idiok, A.U. (2012) Physico-chemical properties, degradation rate and vulnerability potential of soils formed on coastal plain sands in Southeastern Nigeria. International Journal of Agricultural Research. Vol.7, Pp1-5.

Bamgbose, O., Odukoya, O. and Arowolo, T.O.A. (2000). Earthworm as bio-indicator of metal pollution in dumpsite of Abeokuta city, Nigeria. *International Journal Tropical Biology and Conservation*

Bray R.H. and Kurtz, L.T. (1945) Soil science and conservation (2nd Ed.) New York: Tata McGraw-Hill Publishing Company Ltd.

Fagbemi, A.A. (1981) Soil formation processes in the sub-humid tropic on basement complex. Nigeria Journal of Soil Science. Vol. 12 Pp131-146.

Fasina, A.S., Omolayo, O.S., Faladun, A.A. and Ayayi, O.S. (2007) Granitic derived soils in humid forest of South Western Nigeria: Genesis, classification and sustainable management. American-Eurasian Journal of Agriculture and Environmental Science. Vol. (2), Pp189-195.

IITA (1979) Selected methods for soil and plant analysis. Manual series No 1 IITA, Ibadan. Pp 70.

Irmak, S., Surueu, A.K. and Aydogdu, L.A. (2007) Effect of different parent materials on the mineral characteristics of soils in the Arid Region of Turkey. Parkistan Journal of Sciences. 10(4): 528-536.

Juo, A.S.R. (1979) Selected methods for soil and plant analysis. International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria.

Landon, J.R. (1991). Booker tropical soil manual. A handbook for soil survey and agricultural land evaluation in the tropics and sub-tropics. Longman scientific and technical. England UK.

Maniyunda, L.M., Raji, B.A., Odunze, A.C. and Malgwi, W.B. (2014) Morphological and physical properties of soils on basement complex in North Guinea Savanna of Nigeria. Nigeria Journal of Soil Science. Vol.24(1) Pp 42-43.

Mustapha, S. and Fagam, A.S. (2007). Influence of parent material on the content and distribution of Boron and Zinc in upland soils of Bauchi State, Nigeria. International Journal of Environmental Science and Technology. Vol. 4 (3), Pp 359-362.

Obi,J.C. and Udoh, B.T.(2011). Identification of soil management factors from spatially variable soil properties of coastal plain sands in Southeastern Nigeria. Open Journal of Soil Science. Vol.1 Pp 2-15.

Okon-Inyang, P.B., Okon, A.P. Iren, O.B. and Essien, I.E. (2010) Bucket—drip fertigation effects on vegetable (Cocumber) grown on tropical acid sand sands. Research Journal of Soil and Water Management. Vol.1(2). Pp4-5.

Omeke,J.O., Nkwopara,U.N., Eshett, E.T., Onwudike,S.U.,Uzoho,B.U.,Ihem, E.E., Opara, I.U. and Ndukwu, B.N.(2014). Properties of soils of dissimilar lithology supporting yam-based cropping system in Southern Nigeria. International Journal of Agriculture and Rural Development. Vol.17(3) Pp1-12.

Oyatokun, O.S., Okafor, B.N., Oluwasemire, K.O. and Adeoye, G.O. (2017). Properties of some soils developed from basement complex parent materials in a Savanna Zone of Nigeria and their effect on Soybean (Glycine max) production American-European Journal of Agriculture and Environmental Science. 17(4) 280-283.

Srikanth, P., Sormasekhar, S.A., Kanthi, G.K. and Raghu, B.K. (2013) Analysis of heavy metals by using atomic adsorption spectroscopy from the samples taken around Visakhpatnam. *International Journal of Environmental Ecology, Family and Urban Studies*.3(1):127-132.

Udoh, E.J., Ibia, T.O., Ogunwale J.A., Ano, A.O. and Esu, I.E. (2009). Manual of soil, plant and water analysis.Lagos: Sibon Books Limited. Pp32-183.