Nigerian Journal of Soil Science

Journal homepage:www.soilsjournalnigeria.com

PHYSICAL AND CHEMICAL PROPERTIES OF SOILS IN KOGI STATE, GUINEA SAVANNA OF NIGERIA

S.O. Amhakhian[1] and I.O. Osemwota[2]

[1]*Soil and Environmental Management Department, Kogi State University, Anyigba*

[2]*Soil Science Department, Ambrose Alli University, Ekpoma, Edo State*

ABSTRACT

This experiment was conducted in Kogi State. Twenty composite surface soil samples (0.15cm depth) drawn from two distinct geological formations (Cretaceous sediments and Basement complex) were used for study. These soils were collected from different sites with varying cropping history. Particle size analysis of the soils used indicated a high proportion of sand, the texture of the soils ranged from sand to loamy sand. All the soils used had very low organic matter contents. Available P ranged from 1.57 to 23.52mg/kg with a mean of 7.58mg/kg while organic P content ranged from 18.94 to 171.00mg/kg and from 24.31 to 485.93mg/kg with means of 56.56 and 134.94mg/kg for Cretaceous Sediments and Basement complex soils respectively. Total P content ranged from 28.94 to 320mg/kg with a mean of 188 36mg/kg. Eighty five percent of the soils were deficient in available Bray P1 extractable P based on established critical level of 15mg/kg P for Nigerian soils. Total P and organic P were a bit high in these soils. Residual P was more in abundance of all the inorganic fractions. The levels of micronutrients in most of the soils used were moderately high.

INTRODUCTION

The study area which is Kogi State, lies between latitutde 5^0 15^1 to 7^0 45^1 N and longitude 5^0 45^1 and 8^0 45^1 East of the equator. The mean annual rainfall ranges from 1.560mm at Kabba in West to 1.808mm at Anyigba in the East. The dry season generally extends from November to March. During this period, rainfall drops drastically to less than 12.0 mm in any of the months. The temperature shows some variation throughout the years. Average monthly temperature varies from 17^{o}C to 36.2^{o}C. The state has two main vegetations; the forest savanna mosaic zone and the southern guinea zone. The State has two main geological formations; they are the Basement complex rocks to the west while the other half is on Cretaceous sediments, to the North of the Confluence and east of River Niger. The State is known for cultivation of arable crops such as yam, cassava, maize, groundnut cowpea, but its soils like the most soils in North central agricultural zone of Nigeria have high erodibility, are structurally weak, coarse textured with low organic matter status. Specifically, there is dearth of information on the physical and chemical properties of the soils in different agro-ecological zones of Kogi State, specifically with reference to availability of phosphorus and micro-nutrients, which are known to limit performance of arable crops and are often not supplied by chemical fertilizer. The objective of this work was to evaluate the chemical properties of soils in different locations of Kogi State of Nigeria.

MATERIALS AND METHODS

Twenty surface soil samples (0-15cm) were collected from pre-classified sites (FDALR 1985). A composite surface soil sample constituted ten cores taken randomly from each of the sampling sites with the aid of auger and mized into a bag. Two composite samples were taken from places indicated in Table 1. Samples were air dried, crushed with the aid of wooden roller and sieved through 2mm sieve and stored in plastic container with covers. Particle size was determined by hydrometer method. Soil pH was measured in a soil: water ratio of 1:1 with the aid of glass electrode pH meter, organic matter was determined by wet dichromate acid oxidation method, exchangeable bases (Ca, Mg, K and Na) were extracted with 1N NH_4OAc buffered at pH 7. The Ca and Mg were determined using atomic absorption spectro photometer, K and Na were read on flame photometer, exchange acidity was extracted with 1N KCl (Thomas, 1982) and determined by fitration with 0.05N NaOH using phenolphthalein as indicator. Nitrogen was determined by Macro Kjedahl method, effective cation exchange capacity (ECEC) was calculated by the summation exchangeable bases (Ca, Mg. K and Na) and exchange acidity (Carter, 1993). Percentage base saturation (PBS) was calculated by multiplying total exchangeable bases by 100 and dividing by ECEC. Extractable micronutrients (Mn, Fe, Zn and CU) were determined by double acid method. Dithionate extractable Fe and Al (Free Fe and Al oxides soils) were determined by method of Mehra and Jackson (1960). Total phsphorus was determined by per chloric acid ($HClO_4$) digestion method and organic phosphorus was determined by ignition method. Available P was estimated by Bray P-1 method.

RESULTS AND DISCUSSION

Properties of the Experimental Soils: The physical and chemical properties of the soils used for the experiments are showed in Table 2 while the mean, range and coefficient of variation values of the properties are presented in Table 3. The micronutrients contents are shown in table 4. The texture of the two geological formations:- Basement complex soils and Cretaceous sediments ranged from sand to loamy sand. The clay, silt and sand contents ranged from 19.00 to 154.00g/kg, 30.00 to 145.00g/kg and 741.00 to 941.00g/kg with a mean of 45.00, 68.00 and 835.00g/kg respectively. They also have co-efficient of variations of 64.50g/kg, 46.70g/kg and 5.70g/kg, respectively (Table 3).

Table 1: Land use and Soil classification of sampling and experimental soils

S/N	Sampling locations	Coordinates	Land use	Soil taxonomy (USDA)
1	Anyigba	7°30’N/7°09’E	Oil palm, cassava, mango, maize, yams and cashew	Typic Tropustult
2	Abejukolo	7°40’N/7°16’E	Shrub, melon, oranges and groundnut	Typic Hyplustult
3	Ajaka	7°09’N/6°49’E	Bambara nut, tomatoes and yam	Arenic paleustult
4	Ikanekpo	7°22’N/7°36’E	Oil palm, yam and cassava	Psammentic Haplustalf
5	Umomi	7°19’N/7°00’E	Cashew, oranges, cassava and oil palm	Rhodic Eutrustox
6	Ochaja	7°25’N/7°14’E	Cashew, oranges, mango, coffee and cassava	Typic Tropustult
7	Idah	7°06’N/6°43’E	Pepper, cassava, yam and rice	Typic Tropaqualf
8	Odenyi	7°47’N/7°02’E	Sugarcane, cassava and mango	Typic Hapludult
9	Okpo	7°12’N/7°31’E	Cassava, oil palm and yam	Arenic Paleustult
10	Kontokarfi	8°05’N/6°48’E	Cashew, cassava and mango	Typic Hapludult
11	Ofunene	7°27’N/6°40’E	Grasses, cassava and yam	Aquic Kandiustalf
12	Obehira	7°30’N/6°11’E	Yam, cassava and melon	Typic Haplustalf
13	Ihima	7°36’N/6°12’E	Tomatoes, maize and oranges	Typic Paleustalf
14	Ishanlu	8°16’N/5°48’E	Cassava, maize and oranges	Aquic Tropopsamment
15	Ayetoro-gbede	7°58’N/5°59’E	Iroko tree, yams, and maize	Kandic Ustropept
16	Mopa-Moro	8°05’N/5°54’E	Fallow land consisting mainly of grasses	Typic Haplaquept
17	Ganaja	7°46’N/6°44’E	Cassava, maize and cashew	Rhodic Ustropept
18	Ofere	7°25’N/5°46’E	Yam, cassava, maize and iroko trees	Typic Plinthustalf
19	Eni	7°26’N/6°10’E	Cassava, yam and oranges	Typic Haplaquepts
20	Ehika	7°40’N/6°25’E	Cassava and maize	Typic Haplustalf

Source: *1: Kogi State Agricultural Development Project Zonal Office Anyigba 2: College of Agriculture, Kabba, Kogi State.*

The pH of the soils ranged from slightly alkaline (7.32) to strongly acidic (5.01) in reaction with a mean of 5.9 and coefficient of variation (CV) of 11.35%. Konto karfi location recorded the lowest pH (5.01) while Eni (Ogori Mangogo) the highest pH (7.32). The pH was positively and significantly correlated with Ca (r = 0.65**), ECEC (r = 0.584*) and Mn (r = 0.510*). It was negatively and significantly correlated with Bo (r = 0.567*).

The pH of most agriculture soils in the tropics has been reported to range from 5.0 to 6.8 (Udo and Dambo, 1979). Organic matter content ranged from 3.3g/kg to 31.7g/kg with a mean of 13.8g/kg and coefficient of variation of 51.77%. These values of organic matter are low when compared to values reported by Enwezor *et al.* (1990). The critical level of organic matter for optimum crop production was given as 30g/kg (Agboola and Corey, 1972). The low value of organic matter coupled with the sandy texture of the soil would encourage a rapid leaching of cations into the subsoil from the surface soils. The soils were therefore, low in ECEC and tended to be low in available P and total nitrogen. This is in agreement with earlier evaluation of Balasubramanian *et al*. (1984). Organic matter was positively and significantly correlted with Ca, Bo, extractable Mn and Cu with (r) values of 0.644**, 0.681** 0.581** and 0.578* respectively. It was also negatively and significantly correlated with Mg and extractable Mn with (r) values of -0.644* and -0.404* respectively (Table 5). Total nitrogen content of both soils (Basement complex soil and Cretaceous sediments) was low. Total nitrogen content was below the critical level of 1.50g/kg for optimum maize production in Nigeria (Agboola and Corey, 1972). The total nitrogen content ranged from 0.01 to 1.20g/kg with a mean of 0.06g/kg and co-efficient of variation of 383.67% (Table 3). The soils are deficient in total nitrogen. It has been documented that temperature and moisture have profound efforts on nitrogen availability through their effect on nitrogen mineralization, transformation and movement (Adepetu and Corey, 1985). Total nitrogen content of the soil, was positively and significantly correlated with ECEC, Mn and Fe with r values of 0.410*, 0.416* and 0.525* respectively. It was negatively and significantly correlated with Ca (r = -0.554*). Exchangeable calcium ranged from 1.92 to 19.34 cmol/kg with a mean of 6.39 cmol/kg and a coefficient of variation of 70.52%. Exchangebale calcium was the principal saturating cation being the mostly abundant exchange cation in these soils and occupied an averagely of 75% of the exchange site. The critical level of exchangeable Ca was given as 2.6 cmol/kg (Agboola and Corey, 1972). Based on this level, 20% of the soils are deficient in exchangeable Ca. Exchangeable Ca was positively and significantly correlated with ECEC, Al_2O_3. Zn and Mn contents with r values of 0.836**, 0.475*, 0.585* and 0.508* respectively. It was also negatively and significatly correlated with Al_2O_3 content with (r) values of -0.475* (Table 5).

Exchangeable sodium content of the soils ranged from 0.48 to 0.94 cmol/kg with a mean of 0.81 cmol/kg and co-efficient of variation of 14.04% (Table 3). Exchangeable Na was positively and significantly correlated with copper contents with ‘r’ value 0.578*. It was also negatively and significantly correlated with Mo content with ‘r’ values of -0.495* (table 3). Exchangeable magnesium content of the soils ranged from 0.32 to 5.44 cmol/kg with a mean of 2.03 cmol/kg and coefficient of variation of 71.77% (Table 3). Exchangeable Mg was positively and significantly correlated with ECEC, Zn. Zn, Mn and Cu with ‘r’ values of 0.449*, 0.553*, 0.451* and 0.460*, respectively (Table 5). Exchangeable potassium content of the soils ranged from 0.05 – 0.84 with a mean of 0.34 cmol/kg (Table 2). It had a coefficient of variation of

90.35%. Exchangeable K was positively and significantly correlated with ECEC and Zn with ‘r’ values of 0.499* and 0.716** respectively. It was also negatively and significantly correlated with Bo, and Fe with ‘r’ values of -0.642** and -0.479** respectively. The critical level of exchangeable K for most crops was given as 0.20 cmol/kg. Based on the value, 60% of the soils were deficient in exchangeable K. The exchangeable bases in order to abundance in the soils studied were of the order Ca > Mg > Na > K. The soil exchange acidity comprises of exchangeable H^+ and exchangeable Al^{3+}, exchangeable H^+ ranged from 0.20 to 0.80 cmol/kg with a mean of 0.41 cmol/kg and coefficient of variation of 48.07% (Table 3). Exchangeable H^+ was positively and significantly correlated with Mn (r = 0.485*). It was negatively and significantly correlated with Zn and Cu contents (r = -0.557* and -0.630* respectively. Exchangeable Al^{3+} values ranged from 0.10 to 0.90 cmol/kg with a mean of 0.45 cmol/kg. Effective cation exchange capacity (ECEC) ranged from 4.56 to 27.57 cmol/kg with a mean of 12.85 cmol/kg and a coefficient of variation of 58.28% (Table 3).

Table 2: Physico-Chemical Properties of soils used for study

Fe_{203}	%	%	%	Textural	pH(H_2O)	g/kg	g/kg	Mg/kg								Al$_{203}$	
Location				Class							← Cmol/kg			→	← Kg		→
	Clay	Silt	Sand			OM	N		Ca	Mg	Na	K	H^+	Al	ECEC		
Anyigba	3.40	6.50	90.10	Sand	5.88	17.20	6.20	5.51	4.08	2.00	2.84	0.35	0.20	0.20	7.63	45.50	6.50
Abejukolo	4.40	4.50	90.10	Sand	5.45	13.20	5.60	0.54	2.72	0.56	0.84	0.84	0.50	0.50	5.99	34.00	2.50
Ajaka	4.40	3.50	92.10	Sand	4.63	4.90	2.00	1.28	1.92	1.20	0.66	0.08	0.30	0.40	4.56	25.60	1.50
Ikanekpo	3.40	4.00	92.10	Sand	6.00	5.50	2.00	0.54	4.16	1.84	0.78	0.05	0.60	0.20	7.66	36.70	7.50
Umomi	2.40	3.50	94.10	Sand	5.35	3.30	1.00	0.55	2.72	1.52	0.84	0.15	0.20	0.60	5.54	31.00	6.00
Ochaja	3.40	3.00	93.66	Sand	6.42	7.10	2.20	7.73	2.40	1.08	0.72	0.11	0.60	0.10	4.88	43.50	2.65
Idah	15.40	10.50	74.10	Sandy Loam	5.34	2.50	6.60	24.50	6.96	3.44	0.91	0.54	0.50	0.30	12.65	52.00	26.50
Odenyi	5.40	14.50	80.10	Loamy Sandy	6. 30	12.20	5.20	12.8	5.66	1.60	0.84	0.17	0.20	0.50	8.92	23.70	11.00
Okpo	4.40	6.50	89.10	Loam Sand	6.62	15.00	66.60	0.92	5.04	1.76	0.97	0.19	0.60	0.40	9.96	34.50	16.50
Kotokarfi	3.50	4.40	92.10	Sand	5.01	6.10	3.00	1.32	2.72	0.56	0.84	0.84	0.50	0.80	6.27	46.60	18.00
Ofunene	9.40	5.00	85.60	Loamy Sand	5.60	11.80	6.00	0.54	10.16	3.52	0.66	0.13	0.30	0.20	14.98	32.50	5.50
Obehira	2.40	6.50	91.10	Sand	6.90	6.70	4.00	0.54	2.96	2.24	0.84	0.19	0.70	0.70	7.64	49.00	4.10
Ihima	3.40	84.50	48.10	Loamy Sand	5.40	11.70	5.00	0.54	13.81	4.96	0.97	0.14	0.30	0.90	21.11	45.00	3.20
Ishanlu	3.40	5.50	91.10	Sand	5.60	13.20	6.00	10.95	5.04	2.24	0.48	0.17	0.20	0.50	8.63	21.20	2.50
Ayetorogbede	3.90	9.00	87.10	Loamy Sand	5.50	2.60	5.00	1.60	3.60	0.64	0.84	0.45	0.46	0.50	6.44	37.00	14.50
Mopa-Moro	6.90	10.00	83.10	Sandy loam	5.99	12.20	6.00	0.54	5.28	2.08	0.84	0.33	0.80	0.30	9.64	16.00	7.50
Ganaja	3.90	6.00	90.10	Sand	6.69	18.80	6.00	7.07	8.64	0.32	0.78	0.30	0.70	0.20	7.14	74.50	23.20
Ofere	5.90	10.00	84.10	Loamy Sand	5.89	14.50	1.00	10.31	10.40	3.30	0.84	0.18	2.20	0.20	15.19	18.50	21.50
Eni	1.90	12.00	86.10	Loamy Sand	7.32	18.20	1.30	11.21	19.38	5.40	0.91	1.14	0.30	0.40	27.57	24.00	17.90
Ehika	3.10	6.80	90.10	Sand	6.25	31.70	6.90	11.95	8.64	0.32	0.77	0.20	0.20	0.60	7.39	37.50	21.30

Table 3: Correlation coefficient matrix of the relationships among soil variables

	Clay	%silt	%sand	pH	Om	N	pH	Ca	Mg	Na	K	H	Al	ECEC	Al_2O_3	Fe_2O_3	Mo	Bo	Zn	Mn	Fe	
%Clay		0.25	-0.118	0.246	0.200	0.023	0.510*	0.050	0.234	0.065	0.030	0.097	0.329	0.118	0.152	0.322	-0.209	0.109	0.109	0.152	0.959***	-0.359
%Silt			-0.007	0.269	0.397	0.041	0.433	0.209	0.159	0.201	0.200	0.180	0.179	0.637**	0.224	0.230	-0.517*	-0.224	0.224	0.632***	0.220	0.123
%sand				0.001	0.383	0.044	0.588*	-0.522	0.201	0.378	0.149	0.054	0.080	-0.490	0.057	-0.334	0.476*	0.040	-0.039	0.479**	0.078	0.135
P%om					0.283	0.260	0.117	0.650**	0.178	0.238	0.108	0.279	0.230	0.584*	-0.088	0.039	-0.004	.0567*	0.298	0.510*	0.078	0.017
N						0.076	0.532	0.644**	0.644*	0.151	0.231	0.175	0.082	0.227	-0.328	0.394	-0.404*	0.681**	-0.066	0.581**	-0.019	0.578*
P							-0.161	0.554*	-0.036	0.338	0.097	0.211	0.226	0.410*	-0.025	0.525*	0.416*	0.332	0.076	0.416**	0.525*	-0.190
Ca								0.303	0.215	0.021	0.271	0.235	0.234	0.064	0.226	-0.124	0.045	0.080	0.495**	-0.508	0.525*	-0.315
Mg									0.363	0.274	0.307	0.278	0.014	0.836**	0.475*	0.241	-0.508*	-0.330	0.585*	0.508*	0.025	0.253
Na										0.266	0.149	0.253	0.026	0.449*	-0.041	0.686	-0.230	-0.050	0.553*	0.451*	0.246	0.460*
K											0.344	0.213	0.252	0.361	0.258	-0.094	-0.495*	-0.139	0.203	0.031	0.006	0.578*
H												0.077	0.299	0.499*	0.078	0.479*	-0.157	0.642*	0.716***	0.221	0.159	0.078
Al													0.170	-0.243	0.740	-0.073	0.087	0.174	-0.557*	0.485*	0.475*	0.630*
ECEC														0.132	0.227	-0.350	0.179	-0.089	0.233	0.154	0.118	0.193
Al_2O_3															0.155	0.169	-0.315	-0.241	0.667*	0.475*	0.057	0.499*
Fe_2O_3																-0.224	0.206	0.303	-0.080	0.554**	0.156	-0.339
Exch.																	0.989***	0.118	0.096	-0.376	-0.024	-0.054
Mo																		0.149	-0.001	0.131	-0.251	-0.079
Exch.																						
Bo																			-0.385*	0.174	0.089	-0.198
Exch.																						
Zn																						
Exch.																				0.321	0.479**	0.509*
Mn																						
Exch.																						
Fe																					0.321*	-0.078
Exch																						
Ca																						
																						0.301

*, ** and *** Significant at 5%, 1% and 0.1% level of probability.

The ECEC was positively and significantly correlated with extractable Zn, Mn and Cu (r = 0.667**, 0.475* and 0.499* respectively). However, ECEC had a non significant negative correlation with Mo and Bo (r = 0.315 and -0.241 respectively) Available phosphorus content ranged from 1.57 to 23.52 mg/kg with an average of 7.58 mg/kg. Based on the critical level of 15 mg/kg, 85 percent of the soils were deficient in avaialable P. Available P had a very low coefficient of variability of 7.15%. Available phosphorus was generally low, thus indicating the poor phosphorus fertility of the guinea savanna soils. Apart from soils of Ganaja, Eni (Ogori-Mangogo), Abejukolo and Idah all other soils were generally below the critical level of 15mg/kg established for Nigerian Soils. Effective cation exchange capacity and pH were positively and significantly corrected with available P with 'r' values of 0.551* and 0.452*, respectively (Table 3). Organic phosphorus varied within each geological formation and between the geological formations based on their parent materials. The mean values of organic phosporus forms were least in soils formed on Cretaceous sediments when compared to that of the Basement complex. The content of organic P of Cretaceous sediments ranged from 18.94 to 171.00 mg/kg P with a mean of 56.56 mg/kg P while that of the Basement complex soils ranged between 24.31 to 485.93 mg/kg P with a mean of 134.94 mg/kg P. Organic P consituted between 87 to 93% of the total phosphorus, the least content was obtained in Ikanekpo (18.94 mg/kg P) while the highest organic P in soils formed on the Basement complex was obtained from Eni (485.50 mg/kg P). Total phosphorus contents of the soils were generally low indicating the poor phosporus fertility of the soils. Generally, total P content ranged from 87.52 to 595.79 mg/kg P with a mean of 258.79 mg/kg P. The low phosphorus content of some tropical soils has been attributed to low apatite content of the soil forming minerals. Parent rocks of the soils studied consisted mainly of schists, granites, granite gneisis and sandstones, all of which have low apatite inclusive parent material may also offer an explanation for the observed differences in total P values between the soils. Variation in total P in respect to parent material has been demonstrated by Rhodes (1977); Matured soils possess low P values. The low P content of these savanna soils, in addition to the low apatite content, may be due to their maturity. Extractable Zn, Mn, Fe, Cu, Bo and Mo ranged from 1.93 to 19.03, 6.69 to 26.95, 6.54 to 19.65, 1.91 to 3.98, 0.67 to 8.57 and 10.13 to 43.60 mg/kh with a means of 5.07, 16.02, 14.28, 2.71, 4.50 and 24.41mg/kg respectively (Table 4). They had coefficient of variation of 72.00%, 39.73%, 25.08%, 21.03%, 48.08% and 86.23%, respectively. In terms of micronutrients abundance in the soils, they were in the following order: Mo > Mn > Fe > Zn > Bo > Cu. Copper was sufficient in the soils when compared to the critical level of 2 – 3mg/kg with the exception of Ehika soils (Typic haplustalf) which was lower than 2.00mg/kg. With a critical level of 5.0mg/kg for extractable Fe, the soils are said to be adequate since all the soils used for the studies were above critical level of 5.00mg/kg; except Ayetorogbede (Kandic ustropept) in the basement complex soil, the soils were sufficient in available Zn (Table 4). The contents of free Fe_2O_3 and Al_2O_3 ranged from 0.25 to 2.65%, 1.600 to 5.20% with a means of 1.17 and 3.33%, respectively, (Table 2).

Table 4: Extractable micronutrient contents of soils studied

S/N	Location	Mo	Bo	Zn	Cu	Mn	Fe
		→			Mg/kg	←	
1.		27.86	8.06	2.30	20.52	17.71	2.40
2.		35.94	2.69	7.27	8.31	17.17	2.49
3.		43.60	3.02	4.44	6.82	17.05	3.27
4.		29.62	7.69	3.60	6.69	13.95	3.24
5.		120.10	3.70	6.01	12.01	15.07	3.28
6.		112.34	3.53	2.87	8.70	12.78	2.18
7.		25.96	6.55	4.86	20.00	12.76	2.16
8.		19.96	4.37	4.02	23.44	10.28	2.03
9.		40.66	7.36	3.71	26.95	6.54	2.29
10.		36.36	4.03	7.27	8.31	17.17	2.55
11.		26.98	3.51	5.12	14.14	16.08	2.20
12.		18.03	5.04	6.01	12.01	15.07	3.28
13.		18.48	4.37	5.96	13.34	15.71	3.18
14.		10.13	8.57	5.23	20.65	7.97	2.99
15.		12.19	3.03	1.93	18.12	18.59	3.09
16.		12.72	4.70	3.29	16.62	19.65	3.27
17.		15.98	4.37	3.34	19.48	18.15	2.18
18.		16.43	0.67	2.87	20.97	12.19	3.22
19.		28.25	1.68	19.03	25.50	21.19	3.98
20.		36.65	2.89	2.34	16.48	17.51	1.19

Table 5: Mean, range values and coefficient of variability of the physical and chemical properties of soil studies.

Properties	**Range (%)**	**Mean (%)**	**CV (%)**
pH (H_2O)	5.01 – 7.32	5.91	11.35
Organic matter (g/kg)	03.3 – 31.7	13.8	51.77
Total N (g/kg)	0.01 -1.20	00.6	383.67
P (mg/kg)	0.54 – 24.80	5.95	116.42
Ca (cmol/kg)	1.92 – 19.34	6.39	70.52
Mg (cmol/kg)	0.32 – 5.44	2.03	71.77
Na (cmol/kg)	0.48 - 0.94	0.81	14.04
K (cmol/kg)	0.05 – 0.84	0.34	90.35
H (cmol/kg)	0.20 – 0.80	0.41	48.07
Al^{3+} (cmol/kg)	0.10 – 0.90	0.45	51.71
ECEC (cmol/kg)	4.56- 27.57	12.85	58.28
Fe_2O_3 (%)	0.25 – 2.65	1.17	64.54
Al_2O_3 (%)	1.60 – 5.20	3.33	31.59
Clay (g/kg)	19.00 – 154.00	45.50	64.51
Silt (g/kg)	30.00 – 145.00	68.90	46.70
Sand (g/kg)	741.00 – 941.00	835.10	5.70

CONCLUSION

Particle size analysis of the soils used indicated a high proportion of sand, the texture of the soils ranged from sand to loamy sand. Since these soils were coarse grained in nature, they may likely have low water and nutrient retention capacities. All the soils used had very low organic matter contents. The low organic matter content might be due to rapid mineralization of organic matter. Soils with less than 2% organic matters are erodible. The low level of organic matter contents may be probably responsible for the low ECEC and nitrogen content of these soils. The levels of micronutrients in most of the soils used were moderately high. Organic matter was positively and significantly correlated with Bo, extractable Mn and Cu with "r" values of 0.681**, 0.578* respectively. Total P content of the soils on average basis appeared to be higher than what was reported for some native ranged land soils of Northern Nigeria.

REFERENCES

Adepetu, J.A. and Corey, R.B. (1985). Changes in N and P availability fraction in Iwo soil from Nigeria, under intensive cultivation. *Plant and Soil.* 46: 309-316 Fertilize.

Agboola, A.A. and Corey, R.B. (1972). Soil test calibration for N.P.K. for maize in the soils derived from metamorphic and igneous rocks of Western State of Nigeria. *Journal of West Africa Science Association, 19(2):* 93-100. Resources 6: (1) 65.

Balasubramanian, V., Nanadi, L.A. and Mokwunye, A.U. (1984). Fertilizing Sole crop maize for high yields. *Samaru Miscellaneous paper*. 76, 14.

Cater, M.R. (1993). *Soil Sampling and Methods of Analysis*. Lewis Publishers. London. Page 23.

Enwezor, W.O., Ohira, A.C., Opuwaribo, E.E. and Udo, E.J. (1990). A review of fertilizer use on crops in southeastern zones of Nigeria. *In literature review on soil fertility investigation in Nigeria*: pp 49-100.

FDALR (1985). Soil Map of Nigeria Federal Department of Agriculture Land Resources.

Gee, G.W. and Bauder, J.W. (1986). In: *Particle Size Analysis Part 1. Physical and Microbiological methods* Second edition. Agronomy. Series No 9. Soil Science Society of America. America Society of Agronomy. Madison, Wiscoson, U.S.A.

Mehra, J. and Jackson, M.L. (1960). Iron oxide removal from soils and clay by a Dithioriate citrate system. Buffered with sodium carbonate. *Clay Mineral*. 7: 317-327.

Rhodes, ER. (1977). Phosphorus in Serra Leone soils. *Trop. Agric*. (Trinidad). 54: 77-85.

Thomas, G.W. (1982). Exchangeable cation. In: A. L. Page, R.H. Moller and D.R. Keeney (eds) *Method of Soil Analysis* part 2 Second Edition. *America Society of Agronomy, Madison* pp. 157-164.

Udo, E.J. and Dambo, V.I. 1979. Phosphorus status of the Nigeria coastal plan sands. *Journal of Agricultrual Science,* (Cambridge) 93: 281-289.