Nigerian Journal of Soil Science

journal homepage:www.soilsjournalnigeria.com

CHARACTERIZATION, CLASSIFICATION AND AGRICULTURAL POTENTIAL OF SOME SELECTED SOILS OF KWARA STATE, NIGERIA

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ABSTRACT

The major soils of Kwara State were identified using the FDALR- produced soil map of Nigeria. These soils were mapped. Soil samples were taken from pedogenic horizons and analysed in the laboratory for further characterization and classification. The soils developed on basement complex rocks are gravely while those developed on sandstone are more sandy and free of coarse fragments. The soils are generally very deep (at least 150 cm) with dark colours having values and chromas <4 at the Ap horizons and variable colours at the subsoil. The soils are sandy to loamy in texture. They are moderately acidic to neutral in pH and generally low in exchangeable bases, Ca and Mg dominate the exchangeable sites. They are also low in Fe, Mn and Zn. The soils are classified as typic and plinthic paleustalfs; Typic Kaudiustalfs; Rhodic Tropustalfs and Vertic and Arenic ustropepts of the Soil Survey Staff (1992). They are also classified as Ferric, plinthic, Orthic and Arenic Luvisols; Vertic cambisols and cambic Arenosols of FAO (1988). All the soils are arable with little amendments except pedon III of Ilorin that is plinthic and may require sub soiling or used for dry season farming.

Keywords: *Taxonomic classification, characterization, agricultural potential.*

INTRODUCTION

Little is known about Kwara State Soils. The few literature available cover very small areas while the FDALR (1990) produced soil map of Nigeria was at a reconnaissance level. In the area of detailed characterization and classification of Kwara State soils, a few studies were recorded by Adegbite and Ogunwale (1994), on a sandstone derived terrain and Ogunwale *et al*. (2003), on a basement complex soil and a few others by the National Agricultural land Development Authority, the Agricultural Development Project and River Basin Authority. In a situation where a reasonable percentage of the State's population are crop farmers, and shifting cultivation is becoming a thing of the past, soil information relevant to crop growth and development as could be obtained from detailed soil survey is an essential ingredient towards sustainable crop production. This is because; the farmers will now have a basis of selecting appropriate sites and management practices for their farms. The objectives of this work therefore are:

(1) To make a detailed characterization of some selected soils of Kwara State,

(2) To classify the soils using the criteria of the soil Taxonomy and FAO

Revised Legend of the Soil Map of the world and,

(3) To determine the agricultural potential of the selected soils.

MATERIALS AND METHODS

The sites

Kwara State is located between latitudes 7 and 12^0 N and Longitudes 3 and 7^0 E. It is geographically located at the southern border of the Niger River and in the Southern guinea savanna ecological zone of Nigeria. The three major mapping units identified within Kwara State on the FDALR produced soil map of Nigeria were selected for study. These are mapping unit 15e, 15g and 18g. A contiguous land area not less than 600 ha and completely covered by each of the mapping units was chosen for detailed studies. The three sites are: Ilorin (site I) for mapping unit 15g; and NALDA operational farms Elebu (site III) for mapping unit 18d and NALDA operational farms at Tankpafu (site II) for mapping unit 15e. Sites I and III are developed over basement complex while site II is developed over sandstone parent material.

Field work

The rigid-grid method of soil survey was adopted using transects that are 200 m apart. Observations were made on auger spots located at 200 m interval along each transect. The observation spots were selected in such a way that about 50 m to the edges of the farm and other biased spots such as anthills and burnt spots were avoided. Observations were made at 0-15, 15-30, 45-60 and 60-90cm depths at each point. These were morphologically described following FAO (1977) guideline.

For the distinctly different soils encountered in each site (three each), profile pits were dug on points representative of each of the different soils. The profile pits were described following FAO (1977) guidelines. Soil samples were taken from each pedogenic horizon of these profile pits for laboratory analyses.

Laboratory analyses

The soil samples were air-dried; crushed and sieved through a 2 mm diameter sieve and these were analysed routinely in the laboratory. Particle size distribution was determined by the hydrometer method. Soil pH was determined in 1:1 soil: water suspension using a pH meter. Organic carbon was determined by the chromate wet oxidation method (Jackson, 1958). Exchangeable cations were extracted with neutral normal NH_4OAc solution using soil: extract ratio 1:10. Calcium and magnesium in the extract were determined by the versanate titration method. Potassium and sodium were determined with flame photometry. Total acidity was extracted with molar KCI solution and the extract titrated against 0.1N NaOH. The effective cation exchange capacity (ECEC) was the summation of the basic cations and total acidity (Juo *et al*., 1976). Base saturation was calculated with reference to the NH_4OAc-ECEC.

Available micronutrients (Fe, Mn and Zn) were extracted simultaneously using diethylenetriamine penta acetic acid (DTPA)-Triethanolamine (TEA) mixture, adjusted to a pH of 7.3. The concentrations of the elements in the extract were determined with AAS.

RESULTS AND DISCUSSION

Morphological and Physical properties

Table 1 presents the morphological as well as the physical properties of the pedons. Soil colour was taken at a moist state. The entire Ap or surface horizons are dark coloured as is evident by their colour values and chromas of not higher than 4. This is as a result of organic matter melanization. Colour of the sub-soil is very variable with hues of 2.5YR, 5YR, 7.5YR, 10YR and 10R giving colour ranges including light brownish grey, light brown, Reddish yellow, Brown, Reddish brown, greyish brown, Red, Dark reddish grey, yellowish red, olive and light olive. Chromas and values of the gleyed horizons are generally lower and they are with mottles of hues in the yellow region.

Table 1: Morphological and Physical characteristics of the pedon

Taxonomic Unit	Horizon Designa Tion	Dept (cm)	Colour	Mottles ++++	Texture ++	Consistence ++	Structure *	Boundary **	Drainage **/	Minerals	Concretions	Gravel g/kg	Sand g/kg	Silt g/kg	Clay g/kg
Mapping Unit	15g														
Typic	A1	0-10	5YR3/2	A	LS	m,fr	L,f,cr	dw	IV	a	a	49.5	668.0	230.0	102.0
Paleustalf	A2	10-31	10YR5/6	A	LS	m,fr	L,f,sb	dc	IV	qr(m)	a	0.0	808.0	110.0	82.0
	Btl	31-62	5YR5/6	A	SCI	m,fr	2,m,sab	dc	IV	qr(m)	Fe-Mn	18.0	468.0	250.0	282.0
	Bt2	62-150	2.5YR4/8	C3d2.5Y6/6	SCI	m,fr	3,m,sab	dc	IV	qr(c)	Fe-Mn	4.4	488.0	270.0	242.0
	Bt3	110-150	5YR6/6	C3d2.5Y6/6	SCI	m,fr	1,m,cr		IV	q(f)	Fe-Mn	4.3	448.0	270.0	282.0
Plinthic	Ap	0.30	7.5YR3/4	A	LS	m,fr	1,m,sab	ds	IV	qr(f)	a	30.6	808.0	110.0	.0
Paleustalf	A2	30-40	7.5YR5/4	A	LS	m,fr	1,m,sab	cw	IV	qr(m)	a	35.8	788.0	130.0	82.0
	Bt1	40-110	7.5YR5/4	A	SCI	m,fr	3,m,sab	ds	IV	q(m)	Fe-Mn	240.6	518.0	2000	282.0
	Bt2	110-150	7.5YR5/4	C3d2.5Y5/4	SCI	m,fr	1,m,sab		IV	q(f)	Fe-Mn	231.3	518.0	2200	262.0
Vertic	A1	0-20	5YR3/1	A	SL	m,,fr	1,m,sab	sc	II	a	a	0.0	688.0	200	102.0
Ustropept	Bv1	20-45	5YR4/3	A	SL	m,,fr	1,m,sab	sc	II	a	Fe.Mn	104.0	608.0	300.0	142.0
	Bv2	45-130	5YR6/2	C3d2.5Y5/8	SL	m,fr			I	a	Fe-Mn	106.0	648.0	210.0	142.0
Mapping Unit	15E														
Typic	A1	0-7	7.5YR4/2	A	LS	m.fr	l,f,cr	ds	IV	qr(m)	a	5.2	885.2	60.0	84.8
Kandustalf	A2	7-38	5YR5/8	A	LS	m,fr	l,f,cr	ds	IV	qr(m)	Fe.Mn	406	895.2	20.0	44.8
	Bt	38-140	2.5YR4/8	A	SL	m,fr	2,m,sab		IV	qr(m)	Fe.Mn	5.7	715.2	59.7	224.8
Typic	Ap	0-10	7.5YR4/2	A	LS	m,fr	l,f,cr	sc	IV	a	a	5.0	855.2	60.0	84.0
Paluestalf	Bt	10-38	7.5YR4/8	A	LS	m,fr	l,f,cr	dc	IV	qr(m)	Fe.Mn	21.1	815.2	100.0	84.0
	B2	38-140	2.5YR4/8	A	SCI	m,fr	2,m,sab		IV	qr(m)	Fe.Mn	7.8	495.2	80.0	424.0
Arenic	A1	0-10	7.5YR3/2	A	LS	m.fr	l,f,cr	sc	IV	qr(m)	a	19.0	775.2	140.0	84.8
Ustropept	Bt	10-54	5YR4/257.	A	SL	m.fr	l,f,cr	ds	IV	qr(m)	a	6.5	775.2	120.0	104.8
	B2	54-140	5YR6/4	C3d25Y6/8	LS	m.fr	l,f,cr		IV	qr(m)	a	22.3	875.2	20.0	104.8
Mapping unit	18d														
Xeric	A1	0-30	10R2/2	A	sgSL	m,fr	1,m,sab	sc	IV	qr(m)	Fe-Mn	159.2	640.0	268.0	92.0
Tropustalf	Bt1	30-53	2.5YR3/4	A	sgSL	m,fr	2,c,ab	sc	IV	qr(m)	Fe-Mn	484.3	708.0	100.0	192.0
	Bt2	53-98	2.5YR4/8	A	VgSL	m,fr	2,c,ab		IV	mar	Fe-Mn	487.8	518.0	80.0	214.0
	Ap	0.10	10YR2/1	A	SL	m,fr	2,c,sab	ds	IV	qm(f)	a	98.1	721.7	200.0	78.3
Typic	Bv1	10-40	7.5YR4/2	A	LS	m.fr	1,f,sab	ds	IV	qr(m)	Fe-Mn	502.8	801.7	140.0	58.3
Kandiustalf	Bv2	40-76	7.5YR3/4	A	GSL	m,fr	l,f,sab	ds	IV	qr(c)	Fe-Mn	249.2	861.7	60.0	78.3
	B3	76-150	7.5YR3/4	M3d10YR5/2	SL	m,fr	2,c,sab		IV	qr(c)	a	156.8	681.7	160.0	158.3
	Ap	0.30	7.5YR3/2	A	LS	m,fr	1,m,sab	ds	IV	qr(c)	a	19.0	761.7	180.0	58.3
Typic	B1	30-70	7.5YR4/6	AA	LS	m,fr	1,m,sab	ds	IV	qr((c)	Fe-Mn	141.6	761.7	160.0	78.3
Kandiustalf	B2	70-120	7.5YR4/6		SL	m,fr	2,m,sab		IV	qe©	Fe-Mn	156.1		260.0	138.3

*1=weak ;2= moderate; 3=well developed; c=coarse; m=medium; f=fine; g=granular; cr=crumbs; sab=sub-angular blocky; ab=angular blocky

C=clear; S= smooth; g=gradual; d=diffuse; w=wavy * 1=swamp; II= poorly drained; IV=well drained; ****qr=quartz;; fld=feldspar; a=absent; f=few; c=common; m=many

Mar=Marble + m=moist; w=wet; fr=friable; fi=firm; st=strong; l=loose; ss=slightly sticky ++Ls-loamy sand; SL=sandy loam; SCL= sandy clay loam; g=gravelly; Sg=slightly gravelly; Vg=very gravelly

+++ l=fine; 2=medium;3=coarse;=f=few; d=distinct; a=absent; p=prominent; m=many; c=common

++++ p=present; a =absent; Fe-Mn= Iron- manganese concretion

The soils are generally sand to loam in texture ranging from loamy sand to sandy clay-loam. The argillic (Bt) horizons are finer than other horizons. The sites except Elebu site (site III), which is characterized with outcrop of ironstone boulders, are generally very low in gravel content and the second pedon of Ilorin (site I) has plinthite at 70 cm depth: The gravel particles are mainly hardened Fe-Mn nodules and quartz grains.

All the pedons are well drained except pedon III of site I. The consistence is generally friable while the structure ranges from crumb through sub-angular blocky and a few of the horizons are angular blocky in structure. The crumbs are mainly on the surface while the sub-soil horizons most especially the argillic horizons are mainly sub-angular blocky. This may be due to compaction of sediments under pressure, aided by cementation by clay and sesquioxides that are alluvia.

At site III, laterization, evidenced by abundance of Fe-Mn concretionary nodules may be largely responsible for the very weak structure. The process of laterization has been reported to lead to a massive assemblage of soil material from sesquioxides (Kparmwang *et al.*, 2004). This reduces the rate of infiltration, hence runoff of the excess water may be expected after heavy rains. For sustainable crop production, a good residue management technique that will ensure the soil is under cover is recommended for this soil.

In general, the structures of these soils are weak and this has contributed greatly to their very good drainage conditions except pedon II of site I, which has impervious subsoil. All the soils have a very good workability.

Sand is the dominant fine earth fraction (<2mm) in all the sites (Table 1) being more than 50% of the fine earth fraction in all the pedons except at the sub-soil of site I. Sandy soils are prone to erosion and leaching of nutrients beyond the reach of plant roots. Hence, incorporation of organic fertilizers will improve the structure and aggregate stability of these soils thereby reducing nutrient loss from the root zone. The silt content is generally higher than clay except in some argillic horizons where clay shows marked increases in their contents.

Chemical Properties

Table 2 presents the chemical properties of the soils. The pH measured in soil: water solution ranged from 4.8 to 7.2, indicating a strongly acidic to neutral reaction. The site I pedons however, are the ones with acidity problems in their subsurface horizons while their Ap and surface horizons are only slightly acidic. Since these horizons are also fine-textured, a little lime may be needed to raise the pH for a sustainable agricultural use. The exchangeable acidity ranged between 0.2. to 1.5 cmol/kg soil. Only site II (Tankpafu) soils have some values above unit. Site I (Ilorin) pedons again, are generally higher in exchangeable acidity.

The values of exchangeable Ca, which is the most abundant cation, range from 0.8 to 14.4 cmo1/kg soil. Following Ogunwale (1996)'s ratings, the exchangeable Ca is rated very low (2-5 cmol/kg) both at sites II and III except at pedon III of site III where it is low; and as moderately high (generally 5-10cmol/kg) at site I and pedon I of site III. For sites II and III soils, where Ca is quite low, the use of fertilizer containing Ca would to a large extent remedy the associated slight acidity problem.

Table 2: Chemical characteristics of the pedons

Taxonomic Unit	Horizon Designa Tion	pH in water	O.M. (%)	Total N (%)	Avail p .(ppm)	Exch.Ca (cmol/kg)	Exch. Mg (cmol/kg)	Exch.K (cmol/kg)	Exch. Na (cmol/kg)	Exch. Acid (cmol/kg)	ECEC (cmol/kg)	Base Sat (%)	Extract Fe (ppm)	Extract Mn (ppm)	Extract Zn (ppm)
Mapping Unit	15g														
Typic	A1	6.50	0.29	0.04	18.20	13.20	6.40	0.44	0.20	0.30	20.54	98.50	3.00	9.01	0.32
Paleustalf	A2	6.00	0.15	0.02	12.04	3.20	2.80	0.21	0.11	0.40	6.72	94.00	1.90	2.20	0.25
	Bt1	5.70	0.12	0.02	9.66	9.60	0.80	0.30	0.13	0.50	11.33	95.60	2.40	3.19	0.23
	Bt2	5.40	0.60	0.01	8.68	9.60	1.60	0.28	0.11	0.70	12.29	94.30	2.60	1.54	0.270.2
	Bt3	4.80	0.20	0.00	8.54	10.00	1.60	0.32	0.16	0.80	12.88	94.80	3.60	2.693.8	6
Plinthic	Ap	6.30	0.25	0.04	13.30	1.60	4.40	0.14	0.80	0.40	6.62	93.90	1.40	5	0.29
Paleustalf	A2	6.00	0.19	0.03	9.73	3.20	3.20	0.19	0.11	0.20	6.90	97.10	1.80	2.53	0.25
	Bt1	5.70	0.05	0.010.	9.10	13.20	1.60	0.21	0.12	0.90	16.03	94.30	2.20	1.761.7	0.27
	Bt2	5.00	0.05	01	8.75	14.40	3.20	0.20	0.11	0.50	18.41	97.30	3.00	6	0.25
Vertic	A1	6.10	0.27	0.04	9.87	5.60	2.00	0.81	0.16	0.40	8.34	95.20	16.80	1.76	0.25
Ustropept	Bv1	5.50	0.21	0.03	8.64	8.00	1.20	0.14	0.12	0.50	9.96	94.60	7.40	0.44	0.27
	BV2	5.00	0.15	0.02	8.40	10.00	0.80	0.16	0.12	0.70	11.78	94.10	5.40	4.18	0.28
Mapping	15E														
unit	A1	6.90	2.00	0.53	11.76	2.60	4.40	0.36	0.12	0.38	8.91	95.70	0.43	2.00	2.05
Typic	A2	7.20	1.03	0.76	9.40	2.40	3.80	0.18	0.12	0.20	7.80	97.40	0.49	1.68	1.04
Kandiustalf	Bt	6.00	1.10	0.45	8.54	2.40	3.20	0.95	0.14	1.10	9.04	87.60	1.33	4.41	0.93
Typic	Ap	7.00	1.31	0.22	11.20	2.20	3.60	0.72	0.17	0.34	8.60	86.00	0.31	2.10	1.63
Plaeustalf	Bt	6.90	0.34	039	9.80	1.80	2.40	0.21	0.14	0.28	6.08	95.40	0.110.0	0.53	1.38
	B2	6.30	1.03	0.25	9.10	3.20	5 .430	0.87	0.18	1.50	12.80	88.30	0	2.31	2.08
Arenic	A1	6.70	2.41	0.64	12.18	2.00	3.00	0.31	0.14	0.64	7.31	91.20	0.31	1.69	2.00
Ustropept	Bt	6.50	0.67	0.53	12.60	0.80	1.60	0.28	0.10	1.10	4.78	76.60	0.49	0.95	2.03
	B2	6.80	0.41	0.53	12.74	1.20	2.00	0.21	0.14	0.48	5.25	90.70	0.00	2.31	0.58
Mapping	18d														
unit	A1	6.90	2.13	0.34	10.50	8.00	5.60	0.31	0.06	0.28	14.25	98.00	0.56	0.52	0.40
Xeric	Bt1	9.70	1.58	1.28	2.10	6.80	5.60	0.17	0.05	0.44	13.26	96.60	0.21	0.00	1.21
Trop	Bt2	6.80	1.51	0.91	0.70	12.40	6.40	0.26	0.09	0.32	19.47	98.40	0.42	0.23	1.88
Ustalf	Ap	6.70	1.52	0.20	12.04	2.40	4.40	0.85	0.96	0.26	8.87	97.10	0.60	1.30	2.10
Typic	B1	6.60	0.83	0.69	11.76	2.00	0.80	0.49	0.57	0.32	4.18	92.30	0.23	0.52	1.70
Kandiustalf	B2	6.60	0.34	0.11	11.20	1.60	1.60	0.74	0.57	0.32	4.83	93.40	0.39	0.00	0.28

Values of exchangeable magnesium (Mg) are next in abundance to those of Ca. Its values vary from 0.8 to 6.4 cmol/kg soil and this is in the range of moderate to high Ogunwale (1996). Hence, Mg is not likely to constitute any constraint to agricultural production on these soils. Exchangeable potassium (k) varies from 0.14 to 0.95 cmol/kg soil, in the soils and these fall within the moderate to high values (Ogunwale, 1996). In fact, site II soils are high in k values. In short k is not a constraint in soils of Kwara State. Sodium (Na) values ranged between 0.05 to 1.04 cmol/kg soil. This is in the range of very low to high. Sodicity problem is excluded from the soils of Ilorin and Tankpafu but for pits II and III of Elebu where Na values are greater than unit in some horizons, care must be taken so that this does not increase beyond the present level.

The ECEC values of most of the soils are high. It generally ranged between 4.18, which is moderate (Ogunwale, 1996), to as high as 20.54 cmol/kg. Values of ECEC generally increased with depth and argillic horizons tend to have higher values than the overlying horizons. This may be attributed to the higher clays of the argillic horizons. Going by FPDD, (1989) rating, pedons III of site II and pedon II and III of III cannot sustain intensive agriculture. A high ratio of fallow or grass legumes pasture to crop would be required for their intensive cultivation.

The soils are very high in base saturation. It has values higher than 90 % except in the last horizons of pedons I and II and the second horizon of pedon III of site II. This implies that the exchange complexes of the soils are dominated by basic cations.

The values of organic matter are critically low, the highest being 2.69 %. This may not be unconnected with the traditional bush burning both for games and as a means of land preparation in these areas. Organic manuring as well as a good residue management technique is recommended for the soil.

Total N values are generally lower than unit indicating a serious deficiency problem. FPDD (1989), gave a critical level of 0.2 % for soils of this region. By this standard, Nitrogen levels at site I are generally very low. This may be attributed again, to bush burning as a means of land clearing year after year as well as continuous uptake by plants without a commensurable addition to the soil. Mineral N fertilizer application that involves covering the fertilizer with soil to prevent loss in gaseous form is therefore, mandatory for Ilorin soils for sustainable arable crop production. Available P values ranged from moderate to high. Higher values are obtained at the Ap horizons. This may be attributed to mineralization of crop residues on the soil surfaces. A good residue management technique is also recommended to improve the status of these elements.

Micronutrients

The values of extractable Fe ranged between 0.11 to 16.8ppm. The values are generally very low except for pedon III of site I. Site I soils are generally higher in extractable Fe. The values of both Mn and Zn are also very low ranging from 0.22 to 0.01 ppm and 0.23 to 210 ppm respectively. Generally, all these soils are low in Fe, Mn and Zn. Foliar application of these micronutrients is recommended for intensive agricultural production.

Soil Classification

University of Ilorin site (site I)

(a) Pedon I is located at the peak of a slope; has argillic horizons as evidenced by clay accumulation in the sub-surface horizons; it has high base saturation; it therefore, classifies as Alfisol; it falls within ustic moisture regime, hence classified as ustalf. It has no lithic or paralithic contact within 50 cm; the argillic horizon shows a clay increase of more than 30 % within a vertical distance of 150 cm. It was therefore, classified as typic paleustalf (Soil Survey Staff, 1992) and as Ferric luvisol (FAO, 1988).

(b) Pedon II is located on mid-slope; has similar properties to pedon I; was classified as paelustalf. However, it has more than 5 % plinthite in more than one horizon within 150 cm of the mineral soil surface. It was therefore classified as Plinthic Paleustalf (Soil Survey Staff, 1992) and Plinthic luvisol (FAO, 1988).

(c) Pedon III is a shallow soil located on a minor depression at the middle slope; has faint evidence of argillic horizon as indicated by slight clay increase at the subsoil. It was therefore classified as inceptisol. It falls within iso-temperature regime and consequently classified as tropept; imperfectly drained as evidenced by variegated colour; sandy loam in texture; high base saturation and the pedon is characterized by ustic moisture regime; it was therefore classified as ustropept. It has paralithic contact at 20 cm; cracks that are at least 5 mm wide through a thickness of not less than 30cm. It was therefore, classified as vertic ustropept (Soil Survey Staff, 1992) and as Vertic cambisol (FAO, 1988).

Tankpafu site (site II)

(a) Pedon I had argillic horizon; the eluvia horizons had <15 % clay while the argillic horizons had > 3% more clay than the eluvia horizons, ECEC ranged between 7.8 and 9.0 cmol/kg soil, base saturation > 50%, it classifies as Alfisol. It has ustic moisture regime and colour hue of 5YR and 2.5 YR in the subsoil. The pedons therefore classified as Typic kandiustalf (Soil Survey Staff, 19992) and as Ferric Luvisol (FAO, 1998).

(b) Pedon II also has all the properties of Ustalf. It has ECEC of > 12 cmol/kg clay and the subsurface horizons has a hue of 7.5YR. It therefore, classified as Typic Paluestalf (Soil Survey Staff, 1992) and as Ferric luvisol (FAO, 1988).

(c) Pedon III has no evidence of diagnostic horizons; it has high base saturation and an iso-temperature regime. It therefore qualified as Tropept. It has ustic moisture regime; mottling as from 54cm depth indicative of poor drainage it was therefore classified as Arenic Ustropept (Soil Survey Staff, 1992) and as Cambic Arenosol (FAO, 1988).

Elebu site (site III)

(a) Pedon I had argillic horizon; clay content of eluvia horizon < 15%; the argillic horizon has > 3% higher clay than eluvia horizon and has a high base saturation; it therefore classifies as alfisol. It is in ustic moisture regime and iso-temperature regime zone; it was classified a Tropustalf. Reddish in colour with colour hues of 5YR (dry) or redder. The pedon was therefore, classified a Rhodic Tropustalf (Soil Survey Staff, 1992) and as Orthic Luvisol (FAO<19988).

(b) Pedon II was like pedon I of Tankpafu; it was therefore classified as Typic kandiustalf (Soil Survey Staff, 1992); but as Arenic Luvisol (FAO, 1988).

(c) Pedon III had properties like pedon II, but it is shallower due to the presence of concretions at a depth of 120 cm. However, it still classified as Typic kandiustalf (Soil Survey Staff, 1992) and as Arenic Luvisol (FAO, 1988).

CONCLUSION

The major soils of Kwara State as presented in the FDALR (1990) produced soil map of Nigeria were characterized and classified in this study. The soils developed on sandstone parent materials are generally more sandy and free of coarse fragments. Those developed on basement complex rocks are more gravelly. In fact, Elebu soils are characterized by presence of ironstone boulders on the soil surface. They are also characterized by common iron-manganese concretions. The soils are generally very deep except one of the pedons formed on basement complex where there is plinthite as from a depth of 40 cm from the surface. The soils are moderately acidic to neutral in pH. They are generally very high in exchangeable bases (at least 76 %) but low (<8cmol/kg) in some of the pedons and these will not sustain continuous cropping. The soils are generally low in micronutrients (Fe, Mn and Zn) and will therefore require supplements. The soils were classified at the subgroup level of the soil taxonomy as Typic and Plinthic Paleustalfs, Typic kandiustalfs, Rhodic tropustalfs, and Vertic and Arenic Ustropepts. They were also classified at the lower level of FAO as Ferric, Plinthic, Orthic and Arenic Luvisols, Vertic cambisols and cambic Arenosols.

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