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THE SOILS OF SOIL SCIENCE DEPARTMENTAL FARMS AND THEIR MANAGEMENT AT JOSEPH SAAWUAN TARKA UNIVERSITY, MAKURDI

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ABSTRACT

A detailed study was carried out on Department of soil science farm soils {Latitudes 7°47'4''N and Longitudes 8° 37'20E'' and Latitude 7°47'20''N and Longitude 8° 37'28''E} behind the university clinic to characterize, classify the soils and proffer their management practices. Three profile pits were dug and morphological described with respect to FAO guidelines while samples collected from genetic horizons were analyzed using standard laboratory procedures and classified according to USDA/WRB; Climatic data were collected from NIMET station domiciled in Soil Science Department of the University. The soils slope 0-3%, well to imperfectly drained and <130cm deep. Soil surfaces were dark reddish grey (2.5 YR4/3) to reddish brown (2.5YR4/4) with grayish (10YR5/1) subsusurfaces mottled reddish yellow (7.5YR6/6) to red (10YR5/8); textures from sandy loam to clay, structure from weak fine crumbs to strong sub angular blocky.Dominant Sand particlesfrom 38.24% to 85.52%, silt 5.28% to 11.36% and clay 7.20% to 52.40%. Slightly acidic (pH 6.10-6.79.) with bulk densities (1.19 to 1.36gcm^3). the soils' nutrients levels were generally very low too low to sustain agricultural productivity: OC (0.24-0.29%), TN (0.061-0.071%), Available P (4.52-6.44mgl^{-1}), Ca (3.10-2.3), Mg (2.1-1.60), K (0.26-0.36), and Na (0.21-0.29cmolkg^{-1}); CEC (7.10-10.1 cmolkg^{-1}) base saturation (49.00-71.52%) while temperatures were very high (33°C). They were classified as Kanhaplic Rhodustalfs (Kandic Luvisols. Rhodic, Arenic) and Typic Paleustalf ClayiecLuvisols, Glayeic, Kandic). Farm management practices such as organic matter incorporation and mineral fertilizer application are recommended while bush burning should be discouraged to improve the soils fertility level. Plants or crops adaptability is recommended to remedy temperatures limitation cases. Slight acidification may be needed for acid loving crops for optimal yields.

Keywords: *Soil Characterization, Management, Agricultural Productivity, Fertilizer Application, Crops Adaptability*

INTRODUCTION

Characterization is key to soil productivity and determines options for soil management (Abagyeh*et al.,* 2017) Classifications systematically arrange soils into groups or categories base on distinguishing characteristics as well as criteria that dictate choices in use. Such system fosters global communication about soils, soil scientists and people saddled with land management and conservation of soil resources. The management option that will guarantee high soil productivity principally depends on the nature and properties of that soil. In agricultural land use unlike other uses, is discriminatory. It is a fact that not all soils can be used for agricultural purpose and not all crops can be successfully grown on a particular soil type. It is often that a soil type suitable for a particular crop may not be suitable for another crop because crops differ in their requirements. These requirements must be understood within the context of limitations imposed by land and other features which do not form part of the soil but may have a significant influence on use that can be made of the land (FAO, 1976).Inadequate information on the status of agricultural lands can lead to misuse, mismanagement which will eventually manifest in the form of land degradation. This study was therefore set out to characterize the soils thus, determine their suitability for agricultural cultivation and therefore proffer possible soil management practices that will enhance soil productivity and ensure food security.

MATERIALS AND METHOD

Location: The study area lies directly behind the University Clinic; *{Latitudes 7°47'4''N and Longitudes 8° 37'20E'' and Latitude 7°47'20''N and Longitude 8° 37'28''E}*and covered 30,000m^2 (3ha). Profiles' location and height above sealevel were takenby use of Global Positioning System (GPS) Mobile App – Altimeter and slope (Compass Clinometer). The site was subjected to detailed soil survey through conventional grid method.

Soil Sampling: Two profile pits were sunkto 2.0m depth or impenetrable layer or whichever is shallower and morphologically characterized using the pattern outlined in the soil survey manual (Soil Survey Staff, 2010; Gutherie and Witty, 1982). Soil samples collected from genetic horizonswere package in properly labeled sample bags and taken to the Advanced Soil Science Laboratory for the physical and chemical analysis. Samples were air dried and made to pass through a 2mm sieve,then subjected to laboratory analysis using the Manual of Selected Methods of Plants and Soil Analysis, IITA (1994).

Data Collection: Climatic data were obtained from Nigerian Metrological Station (NIMET) located in the Department of Soil Science of the University.

RESULTS AND DISCUSSION

Tables 1 and 2 presentsoil morphological/physical and chemical characteristics of pedons in the study area.

Physical Properties: The low-lying soils with a slope at 0-3%, profiles depthswere deep (130cm), well to imperfectly drained with mottled horizons in all profiles. Soil colour varied from very dark reddish grey (2.5YR 4/3) or reddish brown (2.5 YR 3/1) to reddish yellow (5YR6/8) surfaces and greiyish (10YR5/1) subssurfaces(imprints of gleization) withthe reddish yellow (7.5 YR 6/6) to red (10 YR 5/8)mottles attributedto imperfect drainage conditions due oxidation-reduction cycles (redoxmorphism).as groundwater table fluctuates (Abagyeh*et al.,*2017). Underlying the sandy loam are sandy clay loam/ clay textures with weak fine crumbs to moderately to strongsub angular blocky structures making the sites suitable for all agriculture practices. Occurrences of higher clay contents in the subsurface horizons of profiles may be attributed to elluviation from epipedons and it illuvation in the subsoils; indicating that the soils were well developed.Silt content shows uniform distribution pattern in all profiles.Higher sand percentages were observed in the epipedons of all profiles. The finer particles (silt and clay) were iluviated into the lower horizons at the detriment of the sand fraction hence sandy loam surfaces. Abagyeh*et al.* (2019) observed that parent material's grain sizes are the main determinant of the soil texture. Bulk densities were moderate (1.21–1.42gcm^{-3}); indicating no serious compaction that will undermine agricultural productivity.

Chemical Properties: Soil reaction was slightly acidic to moderately acidic (pH 6.1- 6.79) these values are within the pH requirement for most available nutrients up take by arable crops (Brady and Weil, 1999). The higher OC in the surface (0.34%) than subsurfaces (0.20%) may be attributed to addition of farmyard manures and plant residues to the surface horizons (Abagyeh*et al.,* 2016) but too low to sustain agricultural cultivation.Nitrogen values follow the trend in OC(0.018% to 0.069%) in all soils. Total nitrogen is mobile in soils as a result, its losses through various mechanism like NH_3 volatilization, succeeding denitrification, chemical and microbial fixation, and leaching and runoff which results in residual/available nitrogen becoming poor in soils (Abagyeh,*et al.,* 2019). TheLow values of phosphorus,4.00-6.44mgl^{-1}(too low for optimal crop yield) were due to low cation exchange capacity (CEC) and clay content in conformity with Abagyeh*et al,* (2016) on Lower Benue River Basin soils. Exchangeable bases occurred in the order of Ca>Mg>K>Na on the exchange complex and were rated medium to very low in all the profiles. This may be attributed to the nature of the underlying materials, intensity of weathering, leaching, low activity clay content, very low organic matter content and the lateral translocation of bases according to Kang (1993). It was clear that Mg was present in lower amount than Ca^{2+} because of its higher mobility. These conform to the findings of Abagyeh*et al.* (2016). Higher CEC values (8.12 – 8.66cmolkg^{-1}) were found mostly in horizons with higher clay contents but not high enough for productive agriculture. Similar trends were observed in some Nigerian Southern Guinea Savanna soils (Anande*et al.,* 2019).

Soil Classifiction:

USDA Classification: Pedons 1, 11 and 11 possessed argillic horizons with base saturations at more than 50 % (NH_4OAc at pH 8.0) and are keyed into Alfisols(soil order level). They were placed into suborder Ustalfs due to their ustic soils moisture regime. At great group level, the epipedon of pedon 1 was dark reddish brown (2.5YR3/4) with reddish yellow (7.5YR6/6) subsurface while pedon 11 has reddish brown (2.5YR4/4) surfacess and red (10YR5/8) subsurface; thus the soils were placed into Rhodustalfs. The soils'

CEC (6.42-8.62cmolkg^{-1}) due to low clay content (16.20-25.20%) qualified them into the Kanhaplic Rhodustalfs at subgroup level. Pedon 111 high clay content (52%) qualified it into Paleustalf at Great group and Typic Paleustalf at subgroup level.

WRB: Soil units 1, 11 were classified as Kandic Luvisols, Eutric; ArenicLuvisols, KandicRhodic based on the soils low CEC, high sand contents, base saturation and red coloration and Clayeicluvisol, Gleiyeic, Kandic for pedon 111 due to its high clay content

Conclusion: the soil limitation can be remedied through:
Mineral fertilizers application especiallyNPK will improve nutrients status of N, P and K
Organic matter incorporation will boost general soil fertility and improve soil textural/structural stability.
Crops that can tolerate climatic conditions prevalent in this environment are recommended.

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Table 1: Morphological/Physical Characteristics of Soil Science Departmental Farm Soils at JOSTUM

Pedons		Colour		Texture	Structure	Consistency				Inclusion		PPSD		
Horizon	**Depth**	**Matrix**	**Mottle**	**Class**	**-**	**Wet**	**Moist**	**Dry**	**Root**	**GC**	**BD**	**Sand**	**Silt**	**Clay**
	Cm			**class**	**-**	**-**	**-**	**-**	**-**		**gcm³**	**%**		
KanhaplicRhodustalfs (*KandicLuvisols. Rhodic*) {Latitude 7 47'19"N, Longitude 8 37'24"; 94-103mamsl}														
Ap	0 – 30	2.5YR4/3	-	SL	1FCR	SSSP	VF	S	FCFM	0.18	1.21	81.52	7.28	11.20
A	30 – 51	10YR5/8	-	SL	2MG	SP	VF	S	FF	0.25	1.19	73.52	7.28	19.20
Bt1	51 – 80	10YR6/6	7.5YR2/1	SCL	3SBK	SP	F	H	FF	0.29	1.24	57.58	7.22	35.20
Bt2	80 – 130	7.5YR6/6	2.5YR2/1	SCL	3SBK	VSVP	FI	H	-	0.21	1.26	57.58	7.22	35.20
Mean				**SCL**						**0.23**	**1.23**	**74.55**	**7..25**	**25.20**
KanhaplicRhodustalfs (*KandicLuvisols. Rhodic*). {Latitude 7 47'20", Longitude 8 37'28"; 94-103mamsl}														
Ap	0 – 31	2,5YR4/4	-	SL	1FCR	NSNP	FR	S	FF	0.21	1.24	85.52	7.28	7.20
A	301 – 71	5YR6/8	5YR2/1 10YR3/6	SL	2MCR	SSSP	F	L	FF	0.25	1.23	79.52	7.28	13.20
AB	71 – 91	2.5YR7/4	5YR2/1	SL	3FCR	SP	FI	H	-	0.37	1.42	83.52	5.28	11.20
Bt	91 – 130	10YR5/8	10R5/8	SCL	3SBK	VSVP	VFI	VH	-	0.26	1.36	59.52	7.28	33.20
Mean				**SL**						**0.27**	**1.28**	**77.02**	**7.03**	**16.20**
***TypicPaleustalf (*ClayiecLuvisols. Rhodic, Kandic*).* {Latitudes 7°47'4''N; Longitude 8°37'20''E; 89-109mamsl}*														
Ap	0-18	7,5YR/4		SL	1MCR	NSNP	FR	S	CF-M	0.20	1.31	82.24	7.36	10.40
A	18-30	5YR6/8	10YR5/3	SL	2MCR	SSSP	F	H	FF	0.21	1.32	78.24	11.36	10.40
AB	30-87	2.5YR4/1	10YR4/6	SCL	3CSBK	SP	FI	H	-	0.28	1.39	68.24	9.36	22.40
Bt	87-151	10YR5/8	7.5YR3/6	C	3CSBK	VSVP	VFI	VH	-	**0.22**	1.34	38.24	9.36	52.40
Mean				**SCL**						**0.23**	**1.34**	**66.74**	**9.36**	**2 3.90**

Legend: PPSD = Percentage Particle Size Distribution, **GC = Gravel Content;** SL = Sandy Loam, SCL = Sandy Clay Loam, C = Clay; WFCR = Weak Fine Crumbs, 3FC = Strong Fine Crumb, 3MG = Strong Medium Granular, 3SBK = Strong Crumb – Sub Angular Blocky, 2MC = Moderate Medium Crumb; FR = Friable, FM = Few Medium, H = Hard,, NSNP = Non Sticky Non Plastic, SSSP = Slightly Sticky Slightly Plastic, SP = Sticky Plastic, VSVP = Very Sticky Very Plastic; Fi = Firm, FR = Friable, H = Hard, L = Loose, VF = Very Firm, VH = Very Hard, S = Soft; FF = Few Fine, FC = Few Coarse, CC = Common Coarse.

Table 2: Soil Chemical Properties of Soil Science Departmental Farm, JOSTUM

Horizon		**pH**	**OC**	**OM**	**TN**	**Ap**	**Ca**	**Mg**	**K**	**Na**	**TEB**	**BS**	**CEC**	**EA**	**ECEC**
Des	**Depth**	**H_2O**													
	cm		**%**			**mgl^{-1}**	**$cmolkg^{-1}$**					**%**	**$cmolkg^{-1}$**		
KanhaplicRhodustalfs (*KandicLuvisols. Rhodic*) {Latitude 7°47'19''N, Longitude 8°37'24''; 94-103mamsl}															
Ap	0 – 30	6.79	0.24	0.41	0.069	6.31	3.10	1.90	0.36	0.29	5.65	71.52	7.25	1.02	6.67
A	30– 51	6.46	0.26	0.45	0.064	6.26	2.70	2.10	0.32	0.26	5.38	65.61	7.20	1.06	6.44
Bt	51 – 80	6.36	0.26	0.45	0.061	5.40	2.30	1.80	0.28	0.24	4.62	53.72	8.62	1.12	5.74
Bt_2	80 – 130	6.18	0.24	0.41	0.062	4.52	2.40	1.60	0.26	0.20	4.46	49.00	8.50	1.10	5.56
Mean		**6.45**	**0.25**	**0.43**	**0.068**	**5.62**	2.63	1.85	**0.31**	**0.25**	**5..03**	**59.96**	**7.89**	**1.08**	6.10
KanhaplicRhodustalfs (*KandicLuvisols. Rhodic*). {Latitude 7°47'20'', Longitude 8° 37'28''; 94-103mamsl}															
Ap	0 – 31	6.14	0.29	0.52	0.071	6.44	2.78	1.99	0.35	0.28	5.40	65.06	7.15	1.03	6.43
A	31– 71	6.10	0.28	0.48	0.068	6.33	2.80	1.89	0.31	0.25	5.25	55.85	8.31	1.05	6.30
AB	71– 91	6.17	0.26	0.45	0.063	5.29	2.69	2.05	0.30	0.23	5.27	62.00	6.42	1.01	6.28
Bt	91– 130	6.14	0.29	0.52	0.064	5.22	2.62	2.00	0.28	0.21	5.11	50.59	8.12	1.08	6.19
Mean		**6.14**	**0.28**	**0.49**	**0.067**	**5.82**	2.72	1.98	**0.31**	**0.24**	**5.26**	**58.38**	**7.50**	**1.06**	**6.30**
***TypicHaplustalf(*ClayiecLuvisols. Rhodic, Kandic*).* *{Latitudes 7°47'4''N; Longitude 8°37'20''E; 89-109mamsl}*															
Ap	0-18	6.63	0.34	0.59	0.034	6.23	3.03	2.49	0.27	0.22	6.01	84.41	7.14	1.13	6.63
A	18-30	6.52	0.32	0.55	0.027	5.31	3.10	2.39	0.21	0.16	5.86	91.14	7.66	1.00	6.52
AB	30-87	6.53	0.24	0.41	0.018	4.56	2.54	2.09	0.17	0.14	5.o1	88.53	7.93	1.06	6.53
Bt	87-151	6.45	0.20	0.34	0.010	4.00	2.29	1.94	0.13	0.10	4.46	85.01	8.66	1.04	6.45

Mean	**6.53**	**0,27**	**0.47**	**0.022**	**5.03**	**2.74**	**2.23**	**0.20**	**0.16**	**5.34**	**87.27**	**7.85**	**1.06**	**6.53**

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