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SOIL CLASSIFICATION AND IDENTIFICATION OF DIAGNOSTIC (B) HORIZON OF SOME SOILS IN TEACHING AND RESEARCH FARM OF THE POLYTECHNIC BALI, TARABA STATE, NIGERIA

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ABSTRACT

This study was conducted to characterized and identify soils of Teaching and research farm of the Polytechnic Bali, based on Diagnostic B horizon which are essential in the study of soil. Reconnaissance field survey using transect walk was done on the 50 hectares of land in the study area were geo-reference with the aid of GPS, (3) profile pit were excavated. Soil samples were collected for laboratory analysis from various horizon identified. The results

INTRODUCTION

Soil, a heterogeneous and dynamic natural body is made up of organic matter, inorganic materials (soil colloids) living organisms, air and water. The sustainability of any Agricultural system depends on the type, nature and quality of the soils. (Jangir et al,.2020). Soil a product of its developmental factors including Climate, vegetation/organic material, parent materials, relief and time with different type of soils exhibiting diverse behaviours as a result of differences in micro – morphological, physical, chemical and mineralogical properties. These variations were as a results of soil forming processes and factors operating on the parent material under different climatic, topography, and biological condition over a long period of time. (Magaji et al, .2020, Soil survey staff, 1993) Majority of land in Taraba, Northeaster Nigeria are being used without any form of evaluation and the ones that are evaluated, sometimes not utilized. When land resources match the requirement for the intended uses, the risks in crop failure is reduce drastically, thereby predicting the potential of the soil. (Peter & umweni, 2021). The data obtained as a result of soil survey of an area concerning Agricultural production, Engineering, Urban development, pollution control through the description of soils, provide an insight to the capabilities and constrain of soil. (Peter et al, .2022), (peter & Aaron, .2019). Land is measured in hectares, each of these should be used in

obtained shows that soil textural classes consisted of Loam. Sandy loam, Loamy sand, and Sandy clay loam, Soil pH values were strongly acidic pH 4.9 (HCl) to slightly acidic pH 6.3 (H2O), the Exchangeable Cations Calcium, Potassium and Magnesium were medium to high ranging from 3.85 cmol/kg to 0.21 cmol/kg for Ca and K while Mg was high 1.84 cmol/kg. Cation Exchange Capacity (CEC) were medium to high ranging from 15.38 cmol/kg to 19.64 cmol/kg, the percentage base saturation 59.59 % to 51.6% of the soil is fertile. The available phosphorus is medium ranging from 7 mg/kg to 14 mg/kg, level of organic carbon were medium to high ranging from 0.5% to 0.7 % and the total Nitrogen was rated low 0.12 % to 0.13 %. The soils are classified in the order of Ultisols, sub –order of Udalfs with Udic moisture regime, great group and sub – great group of Hapludalfs and Typic Hapludalfs respectively by the USDA Classification System and according to WRB, the soil is classified as Euric Cambisols, Calcic Luxisols and Argic Lixisols for having Cambic and Argic horizon.

Keywords: Classification, Luxisols, Argic Horizon, Udic, Typic Hapludalfs

accordance with its suitability, capability and limitation by carrying out a land suitability evaluation through detail soil survey and the interpretation of such data is managed. (Peter & Ogbogun, 2022). Identifying limiting factors, qualities of soil in an area, soil classification and characterization evaluation assessment processes are needful key to inform farmers on appropriate management practices of land for optimum productivity (peter & ogbogun, 2022). Soil characterization and classification gives adequate, proper information on soils/land performances on crop productivity and sustainability. Hence the classification of soils is done usually in accordance to the soil properties described in each diagnostic horizons and identifiable properties that are measured in the field (peter et al. 2022).

Proper soil assessment/investigation needs to be carried out using the appropriate procedures for soil characterization and classification at both local, regional and international level peter et al, 2022). Soil characterization provides information for understanding the physical, chemical, biological and morphological properties of the soils for crop productivity, sustainability of forest, grasslands and support homes and society structures (sharu et al,. 2013). Soil classification on the other hand provides an informed knowledge, facilitates the transfer of experience and technology from one place to another and helps to compare different soil properties. (sharu et al. 2013, eswaram, 1977). Scientist from other places could make use of data gotten from classification and characterization of soil which helps in their system of classification or taxonomy of soil and a basis for more detailed evaluations of soil as well as gathered information concerning nutrient, physical or other limitation needed to produce a capability class .(sharu et al,. 2013). Therefore, the study of soil characterization is a major step taking to understand the soil, classifying it and having the information concerning the environment (Esu, 2005, Sharu et al, 2013).

Topography controls the formation and development of soils which also influences the chemical and physical properties and the pattern of soil distribution on the landscape. (kalivas et al,.2002, Esu et al, 2008). The impact of rainfalls is great where the landscape is sloppy with regard to erosion and depositions. Soils on the hill slopes are different from those at the valley in terms of moisture distribution, soil depth, cation distribution and organic matter content. (Lawal et al,.2013). In accordance to their research, Umoh et al, (2015) came up with their findings that the difference in quality and form of sesquoxides was influenced by geomorphic position and soil profile at higher slopes were dominated by crystalline forms of Iron (Fe) and Aluminium (Al) oxide while at the valley bottom, the soils are dominated by amorphous form of Fe and Al. The importance of soil classification is the determination of the best possible use and management of soil. (okunsebor and umweni,.2021, osujike et al,. 2018). Soil characterization and classification provides a powerful resources for the benefit of mankind in terms of food security and environmental sustainability (sharu et al, .2013). federal polytechnic Bali is an academic institution with the responsibility of providing adequate information that will salvage Agricultural sector especially now that attention has being geared towards precision Agriculture in order to meet up with food demand of the rising population of Nigeria. Therefore, the aim of this study was designed to determine the morphological, physical and chemical properties of the soil, and classify the soils using USDA Soil Taxonomy and correlated with World Reference Base Legend Soil Classification System.

MATERIALS AND METHODS

Site Location

The study was carried out on the students Teaching and Research Farm of the Department of Agricultural Technology, Federal Polytechnic Bali, Taraba State, Nigeria. The study area is between Latitude 7^{o} 12'N to 9^{o} 00N of the equator and Longitude 10^{o} 00E to 12^{o} 00E of the meridian, it has a land mass of 10000 km2 and lies within the Guinea savannah ecological zone of Nigeria. This area has been under intensive production before the establishment of the polytechnic in 2008 up to date. The annual rainfall ranges from 750mm to 1100mm with the temperature ranges between $22^{o}C$ – $35^{o}C$.

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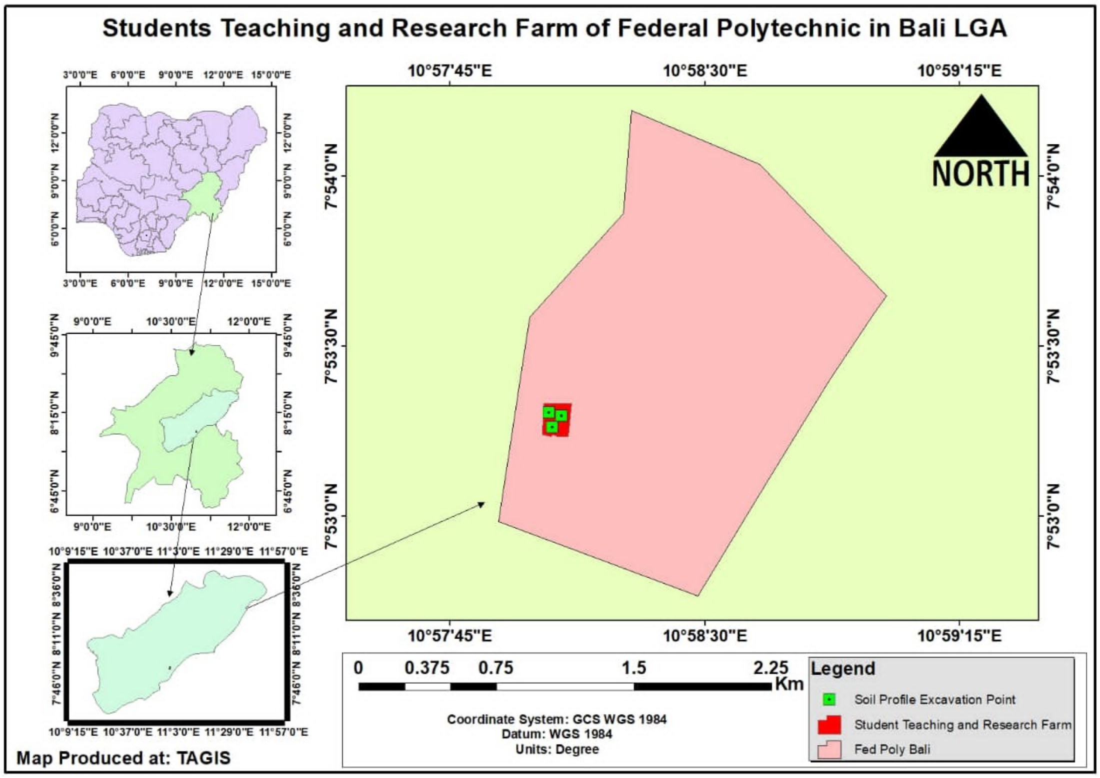

Fig 1: The arc- GIS Map of federal polytechnic Bali and points where the profile pits were excavated (TAGIS 2024)

Field Study

The 50 hectares of land in the study area were geo reference by international coordinates with the aid of Global Positioning system (GPSMAP 78 Sc) Garmin Model. Soil profile pit were excavated on each of the three locations to describe the characteristic of soil. Munsell colour charts was used to determine the colour of the soil. Munsell Colour (2019) The Research farm covering the 50 hectares of land in the study area were assessed with the aid of detailed soil survey procedures, it was geo-referenced and digitized using ARC map software to form the proposed shape field of the study location.

The digitalized map was gridded with rigid method (100 x 100 m^2) (1 ha) per sampling point. 28 auger soils samples points were established and soil samples were collected at the depth of 0-25, 25- 50, 50-75 cm, and 75 cm – 100 cm. The morphological description of the soil was done in the field including soil colour, texture (by hand feeling), structure, drainage, presence of mottle, concretion/ induration. Soil with the same morphological properties were assembled to form mapping units. Grouping base on similarities, three mapping units were identify and delineated. Soil profiles pit were dug in each of the mapping unit with (2 m x 2 m x 2 m) and were described from the bottom to the top of the profile (peter & Agbogun, 2022).

Laboratory Analysis

Soil samples were air-dried and crushed with pestle and mortar, fine earth separate was obtained by passing the soil samples through a 2 mm sieve which was transported for analysis at the Federal University of Technology Akure, Ondo state, Nigeria for the determination of chemical and physical properties following the standard procedures. Particle size distribution analysis was done using the Hydrometer Method of (Wang *et al*, .2022). The bulk density was determine using the clod method of Liu *et al. (2020)*. The (PH) soil reaction determination was carried out using 1: 1 water ration in glass electrode PH meter (Zhou *et al*, 2022) .soil organic carbon was determine using the method of He et al.(2022). The total Nitrogen was calculated by the use of macro kjeldhal digestion method (Hicks et al, 2022), the method describe by Lin et al,.2022, was used to determine the available phosphorus while the exchangeable cations ($Ca2+$,$Mg2+$, $K+$ and $Na+$) were determined using the Ammonium acetate saturation method by Zhao et el,.(2020). The effective Cation Exchange Capacity (ECEC) was calculated by adding total exchangeable Bases and total exchangeable acidity, and % Base Saturation was calculated by expressing the total exchangeable bases as a function as a function of cation exchange capacity while the percentage base saturation of the soil was calculated by the use of the below formula: BS (%) = Echangeable bases / Cation Exchange Capacity x 100.

RESULTS AND DISCUSSION

Morphological Properties of Soils

Table: 1 Morphological properties of soils in the study area

Pedon	soil depth	colour	texture	structure	consistency	Roots
FPB I	0 -14	10YR3/4	SL	1sbk	friable	Abundant root
	14 -28	10YR5/6	LS	2sbk	friable	less root
	28 -49 1	0YR6/8	SCL	3sbk	friable	no root
	49 -67	10YR6/4	SCL	2abk	friable	no root
	67 -104	10YR5/2	SCL	2abk	friable	no root
	104 -200	7.5YR5/8	SL	sbk	friable	no root
FPB II	0 -19	10YR4/4	SL	1fsbk	friable	Abundant roots
	19 -28	10YR5/6	SL	2fbk	friable	Abundant root
	28 -49	10YR3/2	L	1abk	very friable	no root
	49 -67	10YR5/2	SCL	2fbk	friable	on root
	67 -104	10YR5/3	SCL	2abk	friable	no root
	104 -200	7.5YR4/6	SCL	2abk	friable	no root
FPB III	0 -18	10YR5/6 LS	1abk	friable		Abundant root

18 -28	10YR4/3	SL	1sbk	friable	Abundant root
28 -49	10YR6/4	SL	1sbk	friable	less root
49 -67	10YR4/4	SCL	2abk	friable	no root
67 -104	7.5YR4/8	CL	2fsbk	no friable no root	
104 -200	7.5YR4/6	SCL	2fsbk	friable	no root

Remarks: sl = sandy loam, scl = sandy clay loam, ls = loamy sand, l = loamy, s = sandy, 2fsbk =fine sub angular blocky, sbk = sub angular blocky, csbk = coarse sub angular blocky, fbk = fine blocky, 1 = weak, 2 = moderate, 3 = strong
FPB I, FPB II and FPB III = Federal Polytechnic Bali.

Morphological and Physical Properties of the Soil

The results on the morphological properties of the soil in the study area are indicated in table 1. The locations were partitioned into lower, middle and upper slope positions which are designated as FPB I, FPB II and FPB III respectively. It was observed that the depths of soil in both pedons were 200 cm deep. The surface of pedons FPBI are characterized by a very dark greyish brown (10YR3/4) colour and change at the subsurface with reddish brown (10YR6/4, yellowish red (10YR5/2) to light grey 7.5YR5/8 in the subsurface horizons. The soils were well drained which account for the observable changes in colours of soils in the study area which is in line with the summary of Dumba and Peter (2020) and Peter and Umwani (2020b). The dark greyish brown colouration in most of the horizons was as a result of the presence of organic matter as the most influential colouring agent in the surface soil. (Peter et al., 2022). This also collaborate with the findings of Peter and Umweni (2020), Peter et al., 2021) Peter et al., 2022). Who reported that dark soils colouration was as result of the presence of organic matter and the degree of pedogenic activities (illuviation and eluviation in the soil is considered factor in the colouration matrix of each soil pedons. Texturally, the soils were Sandy loam in the surface changing to Sandy clay loam at the subsurface horizons. Table 1. The structure of the soils were weak sub angular blocky in the surface and change to moderate angular blocky in the sub surface horizons. The consistence of the soil was friable, sticky and plastic when wet at the depth of 67 – 104 and 104 – 200 cm with abundance of roots at the surface region of the soil.
In pedon FPBII, the colour of the soil at the surface horizon was strong brown (10YR4/4), changing to yellowish red (7.5YR4/6) at the subsurface. The soils were well drained with deep rooting zone, has sub angular blocky structure at the surface and change to moderate angular blocky structure at the subsurface. The textures varies from sandy loam, loamy sand at the surface to sandy clay loam at the subsurface soils. The soils in FPBIII, are characterized by light brown colour (10YR5/6) at the surface horizons and changed to greyish brown (7.5YR4/6) at the depth of 67 – 104).

Physical Properties of Soils in the Study Area

Table 2 show the physical characteristics of soils in the study area. It indicate that soils across the pedon are well drained as shown in their coloured. Sand fractions decreased from 74 g/kg to 45.7 g/kg with the mean of 58.54 g/kg down the profile depth in pedon

FPBI. There was a reduction in sand fraction in pedon FPBII from 49.5 g/kg to 42.5 g/kg with the mean value of 43.8 g/kg. The sand fraction in FPBIII also decreases from 52.5 g/kg to 47.7 g/kg with mean value of 48.98 g/kg. The reduction in sand fraction down the profile with an increase at the surface horizons as indicated in table 2. The increase in sand fraction at the top soil horizons could be attributed to parent material rich in quartz mineral, the dominant component in granite (Lawal,.et al 2013), and partly due to geological process involving sorting of materials by biological activities, clay migration through eluviation and illuviation, or surface erosion by run off. (Malgwi et al, .2012). The silt content of the soils was observed to slightly increase with soil depth in almost all the profiles except pedon FPBII that had the highest amount of silt with the average value of 27.9 g/kg. Which may be due to depositional effect of the seasonal stream and also could be as a result of the influence of harmattan dust in contributing silt to soils as reported by Morbeg and Esu (1991) and (kparmwang (1995). Clay fraction was next to sand in dominance. Clay was higher in the subsurface than in the surface horizons. There was an irregular distribution of clay in the subsoil of the three pedons, characteristic of cambic horizon. The increase in clay fraction down the soil profile in all the pedons could be due to the eluviation- illuviation processes and also as a result of the geologic materials from which the soils were formed. This also correspond to the results of peter et al. (2021). The bulk density of the soil in the study range from 1.12 – 1.63 g/cm2 in pedon FPBI, 1.31 g/cm2 – 1.79 g/cm2 in FPBII and 1.21 – 1.61 g/cn2 in FPBIII table 2. The soil bulk density of the studied area was between medium and high which was above the critical limits for roots restriction as reported by key soil Taxonomy, Soil Survey Staff (2020). The increase may be as a result of the agricultural activities of farm operations carried out by farm implements such as mouldboard tractors and harrows over the time.

Table: 2. Physical properties of soils in the study area

Horizon	Depth (cm)	Sand (g/kg)	silt (g/kg)	clay (g/kg)	TC	Drainage	BD (g/cm^3)
AP	0 -14	74	10	16	SL	well drain	1.21
AB	14 -28	74	9	17	LS	well drain	1.12
Bt1	28 -49	73	10	17	SCL	well drain	1.52
Bt2	49 -67	49.5	23.4	27.1	SCL	well drain	1.61
Bw1	67 -104	50.5	23.4	26.1	SCL	well drain	1.61
Bw2	104 -200	45.7	26.4	27.9	SCL	well drain	1.63
	Mean	**58.54**	**18.44**	**23.02**			
AP	0 -19	49.5	24.5	26	SL	well drain	1.31
AB	19 -28	40.3	25.2	34.5	SL	well drain	1.31

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Bt1	28 -49	41.8	32.5	25.7	L	well drain	1.61
Bt2	49 -67	42.9	29.5	27.6	SCL	well drain	1.64
Bw1	67 -104	42.5	29	28.5	SCL	well drain	1.79
Bw2	104 -200	45.7	26.4	27.9	SCL	well drain	1.73
	Mean	**43.8**	**27.9**	**28.4**			
AP1	0 -18	52.5	26.4	21.1	LS	well drain	1.21
AP2	18 -28	49.5	24.4	26.1	SL	well drain	1.21
AB	28 -49	48.5	23.9	27.6	SL	well drain	1.42
Bt1	49 -67	47.9	22.6	29.5	SCL	well drain	1.41
Bt2	67 -104	49.8	25.5	29.7	CL	well drain	1.52
Bw1	104 -200	47.7	23.3	29	SCL	well drain	1.61
	Mean	**48.98**	**23.9**	**27.2**			

Table 3. Chemical properties of soil the studied area

Horizon	pedon	Depth (cm)	soil pH H2O	KCl	OC %	TN %	Av.P mgkg-1
AP		0 -14	6.2	4.9	1.4	0.1	10.5
AB		14 -28	5.3	5.1	0.8	0.2	9.7
Bt1		28 -49	5.8	4.7	0.8	0.1	13.1
Bt2	FPBI	49 -67	6.1	4.8	0.2	0.1	7.5
Bw1		67 -104	6.0	5.2	0.3	0.1	7.0
	Average		**5.9**	**4.9**	**0.7**	**0.12**	**10**
AP		0 -14	6.1	5.0	1.1	0.2	10.2
AB		14 -28	5.2	4.6	0.9	0.2	10.2
Bt1		28 -49	5.8	4.7	0.7	0.1	12.8
Bt2	FPBII	49 -67	5.9	5.2	0.4	0.1	7.0
Bw1		67 -104	6.3	4.8	0.1	0.1	6.8
Bw2		104 -140	5.5	4.9	0.1	0.1	6.9
	Average		**5.8**	**4.9**	**0.6**	**0.13**	**9.0**
AP		0 -17	5.9	5.1	1.0	0.1	11.5
AB		17 -28	6.0	4.8	0.9	0.1	14.8
Bt1		28 -54	6.2	5.1	0.5	0.2	13.5
Bt2	FPBIII	54 -67	5.8	4.7	0.3	0.1	7.3
Bw1		67 -120	5.8	4.9	0.2	0.1	7.1

Bw2	120 -190	6.2	4.8	0.2	0.1	7.2
	Average	**6.2**	**4.9**	**0.5**	**0.1**	**10.2**

Table 4: Exchangeable Acidity, Exchangeable Bases, Cation Exchange Capacity and Base Saturation of soils in the studied area.

Depth (cm)	Horizon	Exchangeable Acidity Ca	Exchangeable cmol(+) kg^{-1} Mg	K		TEB	PBS %	CEC	
0 – 14	AP	0.52	3.78	1.75	0.15	6.05		12.15	54.65
14 -28	AB	0.35	4.99	1.20	0.17	6.28		9.30	76.82
28 -49	Bt1	0.49	3.38	2.85	0.21	5.80		10.59	72.71
49 -67	Bt2	0.76	3.25	1.63	0.23	5.76		28.10	73.81
67 -104	Bw1	1.05	3.85	1.77	0.27	6.25		16.75	18.76
	Mean	**0.63**	**3.85**	**1.84**	**0.21**	**6.03**		**15.38**	**59.35**
0 – 14	AP 0.57	3.72	1.73	0.17	6.02	12.13		50.62	
14 -28	AB	0.34	4.90	1.22	0.19	6.23		9.32	76.85
28 -49	Bt1	0.44	3.34	2.83	0.24	5.85		10.51	72.71
49 -67	Bt2	0.72	3.21	1.61	0.22	5.73		28.10	70.83
67 -104	Bw1	1.01	3.82	1.74	0.21	6.21		16.74	18.71
104 -200	Bw2	1.12	3.73	1.65	0.24	6.32		13.34	19.87
	Mean	**0.71**	**3.79**	**1.80**	**0.21**	**6.06**		**15.02**	**51.60**
0 – 17	AP	0.52	3.75	1.75	0.15	6.01		11.15	52.65
17 -28	AB	0.35	4.34	1.20	0.17	6.18		10.30	74.82
28 -54	Bt1	0.49	3.28	2.85	0.21	5.60		12.59	69.71
54 -67	Bt2	0.76	3.25	1.63	0.23	5.36		28.10	70.81
67 -120	Bw1	0.67	3.32	1.58	0.24	5.47		28.14	77.76
120 -190	Bw2	0.62	3.23	1.43	0.34	5.28		27.54	73.65
	Mean	**0.57**	**3.53**	**1.74**	**0.22**	**5.65**		**19.64**	**69.90**

Chemical Properties of Soil

The data for the chemical properties of soils in the study locations are represented in table 3 and 4. Strongly acidic pH 4.9 in (KCl) was observed in all the pedons FPBI, FPBII and FPBIII respectively. The soil reaction (pH) in water ranges from moderately to slightly acidic when compared to the rating by chude et al., (2011). Pedon FPBI and FPBII had soil pH (H2O) ranges from 5.3 to 6.2 and 5.3 to 6.3 indication of moderate to slight acidic nature of the soils which are in line with the assertion of Awanish et al,. 2014. This is also in confirmative to the study by Danladi et al, .2019 that the soil in Bali is strongly acidic in

(KCl). The acidic nature of the soils in the study area could be as a result of parent material, extensive weathering and leaching of the soil. According to Brady and Weil (2010) a pH range of 5.5 to 7.0 is the preferred range for the overall satisfactory availability of plant nutrients in the soils. The exchangeable acidity is less indicating that the acidity cannot be a threat to the soils studied. Soils of the studied locations had average organic Carbon of 0.7 %, 0.6 % and 0.5 % respectively in the pedons as shown in table 3. This shows that the level of organic carbon of the soils studied was medium to high which was in agreement with the finding of Danladi et al,.2019. The level of organic Carbon observed at the surface of all the pedons ranges from 1.1 % to 1.4 % compare to the subsurface 0.2 % to 0.5 %. These could be as a result of deposition of organic materials on the soil surface leading to an increase in the level of organic carbon at the surface of soil horizons. The total Nitrogen values ranged from 0.1 % – 0.2 % (0.12 % average) in pedon FPBI and FPBIII while 0.1 % to 0.2 % (average 0.13 %) is the value of TN in pedon FPBII. The values were rated very low when compared to the available standard as reported by peter and Aaron (2019). Similar result of low values of Nitrogen was reported by danladi et al (2019) in Bali, Nigeria. The values of total Nitrogen in the soils changes irregularly with the depth, which may be as a result of the influence of continuous farming practices in the area occasioned by the removal of crop residues and burning of the organic matter.

The available phosphorus values in the study area range from 7 mg/kg – 13.1mg/kg (average 10 mg/kg) in FPBI, 7 mg/kg to 12.8 mg/kg (average 9.0 mg/kg) in FPBII and 7.1 mg/kg to 14.8 mg/kg (average 10.2 mg/kg) in FPBIII table 3. It was observed that the level of available P in the soils studied were in medium condition when compare to the rating by Esu (1991) which are within the minimum critical level required for the optimum productivity of crops as recorded by petel et al (2021).

Calcium and Magnesium are the principal basic cations in the soils studied. Calcium (Ca) and Potassium (K) were rated medium in all the pedons with their average values 3.85 cmol/kg and 0.21 cmol/kg, 3.79 cmol/kg and 0.21 cmol/kg, 3.53 cmol/kg and 0.22 cmol/kg respectively, while the average value of Magnesium (Mg) are 1.84 cmol/k, 1.80 cmol/kg and 1.74 cmol/kg for both pedon FPBI, FPBII and FPBIII respectively. The medium to high level of exchangeable base (Ca, K and Mg) could be attributed to the pedogenic processes occurring in the soil and the continuous cropping system, leaching and origin og parent materials from where the soils are formed. (Peter and Umweni 2020, peter et al, 2021). The cation Exchange Capacity (CEC) of the soils were medium to high as indicated in appendix 1 by Esu (1991) rating of < 6 is low, 6 – 12 is medium and > 12 is high. The higher average of CEC 15.38, 15.02 and 19.64 cmol/kg of FPBI, FPBII and FPBII in table 4 was as a result of the medium to high exchangeable bases and the mineralogical composition of the parent materials. The variation in the value of CEC as observed in all the pedons may also be attributed to the variability in the mineralogy of the parent materials.

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Soils in the study locations has the average base saturation value of 59.35 %, 51.60 % and 69.90 % as shown in table 4 above. According to FAO (1999), soils with base saturation of > 50 % are regarded as fertile soils while those with the value less than (< 50 %) are considered as not fertile. Therefore, soils of the studied area are regarded as fertile soils.

Soil Classification

The soils were categorized base on the latest laid down criteria in Key to Soil Taxonomy USDA/ Soil Survey Staff (2020); Sinae et al.(2021) and World Reference Base for Soil Resources (peter,2018). Soil Classification was done at order, suborder, Great group and Subgroup level using some of the following characteristics of soil including Morphological, Physical and Chemical properties of the soils studied. Most surface pedons of FPBI, FPBII and FPBIII in the study area were thin 14 cm to 19 cm having a colour value 3 to 6 with chroma 3 – 5, organic carbon ranged from 0.9 to 1.4 with the percentage base saturation in NH4OAC varied from 59.35 % to 69.90 % table 4. With all these properties in place therefore, the epipedons were regarded as an Ochric epipedon for FPBI and FPBII with Umbric horizon in FPBIII. According to WRB, when the organic carbon is (> 0.6 %) with the chroma of 3 and a value of 2 – 3, base saturation of more than (>50 %). Hence, the soil profile in the study area are considered having Mollic Epipedons and FPBIII with less organic carbon (< 0.6 %), the value 3 with the 28 cm thickness is placed as an Umbric surface horizon

In FPBI, the subsurface horizon was underlying a coarse textured surface horizon (Sandy Loam), without lithic, paralithic, desic orpeytroferric contact within the 60 cm mineral surface of the soil. The average CEC of the horizon was 15.38 cmol/kg of soil which is (< 16 cmol/kg). Organic carbon decreased irregularly within the profile and the ratio of clay B/A was 1.16 as such, the characteristic identified, has qualified the subsurface horizon to be classified as Kandic horizon. The presence of kandic horizon, the total base saturation of 54.7% (> 35%), and the overlying epipedon of Sandy loam, an increase in clay content along the profile, the soil is placed into the order of ultisols. The FPBI pedon falls within the suborder Udelts for possessing udic moisture regime, hence the soil is placed in the great – group Kandiudults. In the subgroup, the soil is within the Arenic Kandiudults and Haplic Acrisols for having a texture class sandy loam, loamy sand, and sandy clay loam layer extending from the mineral soil surface to the top of kandic horizon at the depth of 49 – 104 cm by both USDA and FAO Classification System.

The subsurface horizon of pedon FPB II and FPB III profiles contains a higher percentage of phyllosicate clay than the overlying soil materials that are evidence of clay illuviation the horizons are form below the surface of the soil that contains the textural class of sandy clay loam which qualifies the subsurface horizon to be Argillic horizon. The average percent base saturation of 51.6 % and 69.9 %

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(> 35 %), the present of argillic horizon and the overlying epipedon of sandy clay loam with an increase in clay content within the profile, the soils are classified in the order of ultisols. Both FPB II and III has a sub- order of Udalfs for having Udic moisture regime. Therefore, the soils are placed as hapludalfs in the Great – group while in the sub –group level, the soils are classifies as typic Hapludalfs by USDA classification and Abruptic Lixisols by FAO system.

The soil pedon FPBI are classified as Cambisols at the Reference Soil Groups (RSGs) because of the presence of Cambic Horizon overlaid by Sandy loam. At the subsurface level, pedon FPBI is classified as Dystric/ Euric Cambisols for having sandy clay loam textural class. FPBII is classified as Luvisols for having an argic horizon within one hundred and fifty centimetre of the soil surface containing textural class of clayed loam. At the lower level, pedon FPBII is classified as calcic Luvisols for possessing the morphological properties of loamy sand. The FPB III profile is qualified to be placed Lixisols for having argic horizon by (RSGs) at the surface of the soil overlaid by sandy loam. At the lower level, it falls within the Argic Lixisols for possessing a subsurface horizon with a distinct higher clay content than the overlying horizon.

Conclusion

Soils of the teaching and research farm of the polytechnic Bali has been under intensive production of crops as a result of rising number of student population, pressure worldwide on urbanization of land resources, the need to increase crop cultivation to make supply food available for the teaming population is mandatory. To do this, it has become necessary to obtain detailed, reliable data on the type of soils in the study area and their sustainability. The characterization and morphological properties of the horizons were observed in the soil including soil texture, certain thickness of the horizon, nature of the soil separate, organic carbon content, cation exchange capacity (CEC), the buck density and percent base saturation. The result indicate that the soils is qualified to be classified as Umbric and Kandic horizons, Ochric and mollic epipedon based on USDA criteria system of classification while the World Reference Base for soil resource (WRB), the soil is placed as Luvisols, Lixisol and Cambisols which are sustained for reasonable Agricultural productivity

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Appendix I

CRITICAL LIMIT FOR INTERPRETING FERTILITY LEVELS OF ANALYTICAL PARAMETERS FOR NIGERIA SOILS

Parameters	Low	medium	High
Ca2 (cmol kg-1	< 2	2 – 5	> 5
Mg2+ (cmol kg-1	< 0.3	0.3 – 1	> 1
K+ (cmol kg-1	< 0.15	0.15 – 0.3	> 0.3
Na+ (cmol kg-1	< 0.1	0.1 – 0.3	> 0.3
CEC (cmol kg-1	< 6	6 – 12	> 12
Org C (g kg-1)	< 10	10 – 15	> 15
Avail. P (mg kg-1)	< 10	10 – 20	> 20
B.S (%)	< 50	50 – 80	> 80

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