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SPATIAL VARIABILITY IN THE PHYSICO-CHEMICAL PROPERTIES OF SOME SOILS IN MUTUM BIYU, GASSOL LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA

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ABSTRACT

An assessment was conducted on the spatial variability in the physico-chemical properties in soils of Mutum Biyu, Gassol Local Government Area of Taraba State. Four soil profile pits were randomly sunk within the study area, following standard procedure. Soil samples were then collected from identified genetic horizon in each of the dug soil profile, carefully stored, processed and analyzed in the laboratory using standard procedures. The results revealed that soils of the study area were found to be deep to very deep in depth, while surface and subsurface soils were predominantly dark red and dusky red in colour. Soil texture was predominantly found to be loamy sand, while mean bulk density and total porosity values ranges from 1.53 to 1.58 g/cm^3 and 35.25 to 37.5%, respectively. The soil pH was moderately acidic in nature (pH range 6.40 to 6.43) across the pedon. The organic carbon, total nitrogen and available phosphorus were generally low. Similarly the exchangeable bases were generally rated low with the exception of magnesium which was observed to be medium in content (0.97 to 1.13cmol/kg). Soil variability was observed to be low to moderate for most soil properties across depths. This is an indication that soil depth rarely influenced the content and distribution of both physical and chemical properties in the study area. In order to improve upon the fertility

statue of soils of the study area, it is therefore recommended that, the incorporation of crop residue, addition of organic manures and provision of adequate drainage will improve the physical and chemical properties of the soils, which will in turn enhance sustainable crop production.

Key words: Spatial, Variability, Exchangeable bases, Organic matter, Soil pH

INTRODUCTION

In the past, agricultural system in Nigeria relied mainly on shifting cultivation to maintain the fertility of the soil through organic and plant nutrient build up during fallow periods. But the ever increasing population pressure on land and the rate at which prime agricultural land are lost to other non agricultural uses with the resultant decline in output per hectare of food crops due to continuous cropping, necessitated that every hectare of land should be used in accordance with its capacity and limitations. The degree of land degradation (chemical, physical and biological) is very high and is on the increase (Ayoub, 1994), hence the amount of good agricultural land is dwindling with time.

Generally variations in soil properties have been found to have significantly influenced soil management and crop production (Fashina, 2003). Soil variability has been seen as a world-wide problem. It does not only cause within field crop growth variability which reduces farmer's yields, but also complicate the interpretation of agronomic experiment (Brouwer, *et al*., 1993).

In Nigeria today there is a gradual drift from traditional to a more scientific agriculture, consequent upon this, the increasing unit cost of fertilizer and the fragility of soils in Nigeria, amongst others, the evaluation of the fertility statue of soils becomes necessary. Such evaluations will ensure prudent and sustainable fertilizer application and utilization. This approach is useful now as efficient fertilizer use, based on recommendations from soil testing that recognizes inherent variability in soil properties is the tool for achieving Nigeria's scientific agricultural rejuvenation (Mustapha, 2007). The recommendation will differ from the blanket rates made over large geographical area which farmers are been encouraged to adopt (Ayodele and Omotoso, 2008). Recent studies have shown the inappropriateness of these blanket recommendations being wasteful thus causing environmental pollution by, among others, irrational overuse of chemicals such as chemical fertilizers (Sokouti and Mahdian, 2011)

In the light of this, the paper is aimed at assessing the fertility indices of soils in Mutum Biyu, Gassol LGA of, Taraba state, and suggests management practices for optimum and sustainable cropping systems.

MATERIALS AND METHODS

The study area

The study was conducted at The field experiment was conducted at Mutum Biyu, Gasol Local Government area of Taraba State (tutare farm). The study area is located within latitude 70 12/N to 90 00/N of the equator; and longitude 100 00/ E to 120 00/ E of the meridian. It has a land mass of about 50,000m2 and lies within the guinea savanna ecological zone of Nigeria. The temperature ranges between 22^0c to 35^0c. The soil is dominantly of ferruginous tropical type that lies on sandy parent materials. Rainfall is the most variable element of the tropical climate most of its characteristics such as amount, quantity and intensity vary widely in time and space. The movement of inter-tropical discontinuity associated zones of rainfall during the course of the year is the major factor controlling rainfall in the state. The annual rainfall ranges from 750mm to 1100mm. The geological succession of the area is underlain by the upper cretaceous rocks of marine sediments. The sediments are predominantly argillaceous and consist of alternating shale and limestone with sandy mudstones, siltstones and sandstones respectively and inclusion which are either decreasing or increasing with depths or are uniformly distributed.

Soil sampling and handling

A total of sixteen samples were collected from identified genetic horizon. The collected Soil samples were then properly labeled in polythene bags and taken to the laboratory for analysis. In the laboratory, each sample was separately air dried ground and passed through a 2mm sieve for laboratory analysis as described by Agbenin (1995), unless otherwise indicated. Particle size analysis was determined using the Bouyouces hydrometer method, after dispersing the soil samples with 5% Sodium hexametaphosphate. Soil pH was determined in 1:1 water ratio using a glass electrode pH metre. Determination of Organic carbon, and Total nitrogen were done by the wet oxidation method and regular micro-kjeldal method respectively. Available phosphorus was determined using the Bray 1 method, cation exchange capacity and exchangeable bases were determined using ammonium saturation method.

Data analysis

The variability of soil properties across the studied pedons was determined using the coefficient of variation (CV). The coefficient of variation was ranked according to the procedure of Wilding *et al. (*1985) where CV <15 % = low variation, CV ≥15 % ≤35 % = moderate variation, CV >35 % = high variation. The statistical analyses were done using GENSTAT statistical software version 8.1

RESULTS AND DISCUSSION

Morphological Properties

The morphological properties of soil derived from the study area are presented in Table 1. Soil depths in the studied area reach a maximum of 150cm, and were generally rated as very deep (Malgwi, 2007). Zata *et al.* (2013), reported deep to very deep soil depth in their various studies. The depth of all the soil profiles will permit effective crop roots proliferation and elongation. Similarly, the results also showed that all the horizons observed have colours which varied from 2.5YR 3/6 (Dark red), 10R 3/6 (Dark red), 2.5 YR 3/2 (Dusky red), 2.5YR 5/2 (very dark red) in pedon 1, 2.5 YR 4/3 (Weak red), 10R ¾ (very dusky red), 2.5 YR 2.5/3 (Dark reddish brown), 7.5 YR ¾ (Dark brown, 2.5 YR 3/2 (Dusky red) in pedon 2, 2.5 YR 3/6 (Dark red), 2.5 YR 2.5/2 (Very dark red), 2.5YR 2.5/3 (Dark reddish brown),7.5YR ¾ (Dark brown in pedon 3 and 2.5YR 3/6 (Dark red, 2.5YR 3/2 (Dusky red), 10R 3/6 (Dark red), 2.5YR 2.5/2 (Very dark red) in pedon

4. The difference in coloration could be associated with drainage condition. Osujieke *et al.* (2017) earlier reported that parent materials and environmental factors might have contributed to the soil colour variation across horizons and pedons. However, the predominantly dark colour in the surface horizon may be attributed to organic matter deposit. Soil texture was observed to be predominantly loamy sand across the studied pedons (Table 1). The structures of the pedons were crumb at the surface horizon of pedons 1 and 2 and sub-angular blocky at the sub-surface horizons across all the profile, while soil consistency (moist) were observed to be dominantly found to be Friable (Table 1). The surface horizons showed the presence of common but few roots, while the subsurface horizons were found to include few but fine roots across the studied profiles, this root variation is associated with the depth differences in the horizons, plant species and shallow rooting system of the plants found in the studied sites. The studied pedons were generally found to be well drained

Table 1. Soil Morphological Properties of The studied site

Horizon	Depth (Cm)	Colour (moist)	TC	Structure	Consistency (Moist)	Inclusions	Drainage
Pedon 1							
A	0 - 25	2.5YR 3/6 (Dark red)	LS	Crumb	Friable	cfr	Well-drained
AB	25 -60	10R 3/6 (Dark red)	LS	SBK	Firm	ffr	Well-drained
Bt1	60 – 115	2.5YR 3/2 (Dusky red)	LS	SBK	Firm	ffr	Well-drained
Bt2	115 - 150	2.5YR 5/2(very dark red)	LS	SBK	Firm	ffr	Well-drained
Pedon 2							
A	0 – 30	2.5 YR 4/3 (Weak red)	LS	Crumb	Firm	cfr	Well-drained
AB	30 – 65	10R ¾(very dusky red)	LS	SBK	Firm	ffr	Well-drained
Bt1	65 – 120	2.5 YR 2.5/3 (Dark reddish brown)	LS	SBK	Firm	ffr	Well-drained
Bt2	120 - 150	7.5 YR ¾ (Dark brown)	LS	SBK	Firm	ffr	Well-drained
Pedon 3							
A	0 – 25	2.5 YR 3/6 (Dark red),	LS	SBK	Firm	cfr	Well-drained
A B	25 – 70	2.5 YR 2.5/2 (Very dark red)	LS	SBK	Firm	ffr	Well-drained
BA	70 – 125	2.5YR 2.5/3 (Dark reddish brown),	SL	SBK	Firm	ffr	Well-drained

Bt	125 - 150	2.5YR 2.5/3 (Dark reddish brown),	SL	SBK	Firm	ffr	Well-drained
Pedon 4							
A	0 – 35	2.5YR 3/6(Dark red)	LS	SBK	Firm	cfr	Well-drained
AB	35 – 80	2.5YR 3/2 (Dusky red)	SL	SBK	Firm	ffr	Well-drained
Bt1	80 – 115	10R 3/6 (Dark red),	SL	SBK	Firm	ffr	Well-drained
Bt2	115 - 150	2.5YR 2.5/2 (Very dark red	SL	SBK	Firm	ffr	Well-drained

TC = Textural Class, LS = Loamy Sand, SL = Sandy loam, SBK sub angular blocky, f f r = few fine roots

Soil Physical Properties

The sand fraction was predominant over other soil separates and recorded means of 82.01 %, 81.68 %, 76.18 % and 81.68 % for pedons 1, 2, 3 and 4, respectively (Table 2). The sandiness of the soil could be associated with the parent material known as sandstone from which the soil was formed. This agreed with the works of Osujieke *et al.,* (2017) that parent material influences soil texture. However, the coefficient of variation across pedons recorded low variation ≥2.42 % ≤5.22 % which is an indication of homogeneity of soils of the study area. However, Osujieke *et al.,* (2017) reported low variation in sand content at the Black swamp, while characterizing and classifying soils of two toposequences formed over different parent materials in Imo State, Nigeria. The silt content was generally found to be low, with mean values of 7.0 %, 7.5 %, 9.08 %, and 7.5% for pedons 1, 2, 3 and 4, respectively. The low silt content could be attributed to the nature of the parent material (Brady and Weil, 2013). However, Silt was observed to be predominantly moderately variable (MV) across the study area (Table 2). This could be associated with weathering of silt into finer particles. Salem, *et al.,* (2020a) also reported moderate variability in silt content while undertaking a study in spatial variability in the fertility and salinity/ sodicity status of fadama soils of Baure, Yamaltu Deba Local Government Area, Gombe state, Nigeria. The mean clay fraction ranged from 10.82 to 14.82% across the studied pedons. Similarly, there was an observed increase in clay content with an increase in soil depth which forms an argillic horizon among the pedons (Table 2). However, Brady and Weil (2013) stated that this higher clay content observed in the subsurface horizons in the pedons could be a result of illuviation and faunal activities taking place in the area. The result for coefficient of variation reported a predominantly moderate variation (≥16.51 % ≤17.70 %)(Table

2). This level of variation across the studied pedons could be attributed to the rate of fine particle deposition as well as illuviation and possibly erosion. Osujieke *et al*. (2017) and Salem, *et al*. (2020) also reported low and moderate variation in clay content respectively, in their studies. Silt/clay ratio is an important criterion used in the evaluation of clay migration, stage of weathering and age of parent material and soils (Young, 1980). Young (1980), further stated that old parent materials usually have a silt/clay ratio below 0.15 while silt clay ratio above 0.15 is indicative of young parent materials. The results of this study show that all the soils have a silt/clay ratio above 0.15 (Table 2) indicating that the soils are relatively young with a high degree of weathering potential. Silt/clay ratios are relatively higher in the surface horizons and decrease with increase in soil profile depth. The decrease in silt/clay ratio with profile depth is an indication that subsoil horizons are more weathered than surface horizons. Hence, soils with low silt clay ratio are more weathered as stated by Landon, (1991). The coefficient of variation recorded low to moderate variation across the study area (Table 2). The mean bulk density values ranges from 1.53 to 1.58 g/cm^3 across the study area (Table 2). There was also an observed decrease in bulk density with profile depth in most profile (Table 2). The mean bulk density values obtained in this study fall within the range that is expected of tropical soils (Landon, 1991). Hence, bulk density will not impede root penetration and tillage practices within the soil group, as lower bulk density promotes root penetration when compared to higher bulk density values. Furthermore, Brady and Weil (2002) and Odunze (2006), opined that soils with higher bulk density promote soil resistance to root penetration, poor aeration, slow movement of nutrients and water, and build up of toxic gases and root exudates. The bulk density values recorded across the studied area showed low variation (≥1.45 % ≤2.15 %) (Table 2) in the pedons which could be attributed to the similarity in climatic condition and homogeneity of the pedons. This result is in line with the findings of Chris-Emenyonu (2014) who reported low variation at the foot slope while working on the soils of Awo-omamma in Imo state, Nigeria. Similarly, Pantami, (2017) reported low variability for bulk density. On the contrary, Salem *et al.* (2020b) reported moderate variability while characterizing and classifying Soils of the University Farm, Federal University of Kashere, Gombe State Nigeria. The mean particle density values were generally found to be 2.44 g/cm^3 across the pedons (Table 2). Similarly, Particle density values increased with soil depth among the pedons (Table 2). This is in line with the findings of Brady and Weil (2002), who reported that particle density values increase with soil depth. This range of values is rated low as per Malgwi (2007) rating scale. The coefficient of variation across the mapping units for particle density recorded low variation (≥0.23 % ≤2.44 %) (Table 2). This result agrees with the findings of Pantami, (2017) who investigated Profile Spatial Variability of Physico-chemical Properties of Waste Water Irrigated soils in Peri-Urban Kano, Nigeria. The mean total porosity values obtained in this study range from 35.25 to 37.5% (Table 2). The recorded range of total porosity values across the locations are regarded as low (Malgwi, 2007). Zata, *et al.* (2020) also reported low total porosity in their study. However, Ayolagha and Opene (2012) reported high soil porosity while undertaking their studies on soils in Niger Delta, Bayelsa State, Nigeria. Pantami, (2017) reported soil porosity values of <50%, and attributed it to clogging of pore spaces by transported finer materials from the upstream. Akpan-Idiok *et al*. (2012) and Esu, (2010) reported that soils with 45 to 50% total porosity are porous, well granulated and may have good moisture retention for crop plants. Total porosity values across the study area indicated low variation (Table 2). This report agrees with the findings of Chris-Emenyonu (2014) who reported low variation in total porosity at the foot slope when working on the soils of Awo-omamma in Imo State, Nigeria. However, on the contrary Imadojemu *et al.* (2017) recorded moderate variation in total porosity at the foot slope soils.

Table 2: soil physical properties of the studied site

Horizon	Depth (cm)	Sand	Silt	Clay	SCR	BD	PD	TP
		→	%	←		gcm3		%
Pedon 1								
A	0 - 25	84.68	6.0	9.32	0.64	1.61	2.45	34.0
A B	25 - 60	82.68	6.0	11.32	0.53	1.57	2.44	36.0
Bt1	60 - 115	80.68	8.0	11.32	0.71	1.57	2.45	34.0
Bt2	115 - 150	80.0	8.0	12.0	0.73	1.57	2.44	37.0
Mean		82.01	7.0	10.99	0.65	1.58	2.44	35.25
CV		1.80	1	10.83	14.47	1.45	0.23	4.26
Ranking		**LV**	**L V**	**L V**	**L V**	**L V**	**L V**	**LV**
Pedon 2								
A	0 - 30	84.68	6.0	9.32	0.64	1.61	2.45	34.0

AB	30 65	80.68	8.0	11.32	0.71	1.57	2.44	36.0
Bt1	65 - 120	84.68	6.0	9.32	0.64	1.61	2.45	34.0
Bt2	120 150	76.68	10.0	13.32	0.75	1.54	2.44	37.0
Mean		81.68	7.5	10.82	0.64	1.58	2.44	35.25
CV		4.69	25.53	17.70	14.03	2.15	0.23	4.26
Ranking		**LV**	**MV**	**MV**	**LV**	**LV**	**LV**	**LV**
Pedon 3								
A	0 - 25	80.68	8.0	11.32	0.71	1.57	2.44	36.0
AB	25 - 70	76.68	8.0	15.2	0.52	1.52	2.44	38.0
BA	70 - 125	72.68	12.0	15.32	0.78	1.51	2.44	38.0
Bt	125 - 150	74.68	8.0	17.32	0.70	1.52	2.44	38.0
Mean		76.18	9.08	14.82	0.68	1.53	2.44	37.5
CV		5.22	24.74	16.51	20.08	2.09	0.00	3.09
Ranking		**LV**	**MV**	**MV**	**MV**	**LV**	**LV**	**LV**
Pedon 4								
A	0 - 35	84.68	6.0	9.32	0.71	1.61	2.44	34.0
AB	35 - 80	80.68	8.0	11.32	0.64	1.61	2.44	34.0
Bt1	80 - 115	84.68	6.0	9.32	0.64	1.54	2.45	36.0
Bt2	115 - 150	76.68	10.0	13.32	0.75	1.57	2.45	37.0
Mean		81.68	7.5	10.82	0.64	1.58	2.44	35.25
CV		4.69	25.53	17.70	14.03	2.15	0.23	4.26
Ranking		**LV**	**MV**	**MV**	**LV**	**LV**	**LV**	**LV**

SCR= Silt Clay Ratio, BD= Bulk density, PD= Particle density,, CV=coefficient of Variation,

< 15= Low variability,(LV), >15 <35 = moderate variability (MV), > 35= High variability (HV)

Soil chemical Properties of the studied site

The result of the soil chemical properties was stated in Table 3. The mean pH (H2O) values of the studied pedons ranges from 6.40 to 6.43 and were rated moderately acidic as per Malgwi (2007) rating scale. Brady and Weil (2013), attributed the soil pH of the study area to the nature of the parent material, climate of the region, organic matter and topography. According to Halving *et al*. (2005), a pH range of 5.5 to 6.5 is the preferred range for most crops to thrive. The coefficient of variability in soil pH across the studied soils showed low variation (Table 3). Similarly, Salem *et al*. (2020b) reported low variability in soil pH in soils of the Teaching and Research farm of the Federal University of Kashere, Gombe State. pH is a "master variable" and regulates almost all biological and chemical reactions in soils (Brady and Weil, 2002). The electrical conductivity of a soil solution is a good indicator of the degree of salinity of the soil (Brady and Weil, 2013). The mean EC values across the study area ranged from 0.04 to 0.06 dS/m (Table 3). The electrical conductivity range of values of the studied soils was found to be below the critical limits of 4dS/m to be defined a saline soil (FAO, 1993). This implies that salinization is not a significant pedogenic process in the soil and the soil does not contain a concentration of soluble salt that may hamper the growth of plant. The coefficient of variation across the different pedons recorded a Moderate variability (MV) (Table 3). This finding contradicts the work of Ogban *et al.* (2012) who reported high variation in electrical conductivity content in their study. The mean Organic carbon values across the pedons ranged from 0.20 % to 0.43 % and were rated low according to the ratings of Landon (1991) (Table 3). The general low level of OC in these soils could be attributed to low organic matter returns and other human factors such as crop residues removal, burning and mineralization. Similarly, there was an observed decrease in organic carbon content with increasing soil depth among the four pedons. This is because the surface horizon is the site where all forms of biochemical processes take place. The surface horizon has more population of micro faunas and floras as a result of organic matter decomposition. Organic carbon had moderate variability (≥20.47 % ≤34.25 %) in pedons 2 and 3 while it had high variability (43.90 %) in pedon 1 and 4 (Table 3), this could be attributed to litter fall and increase in soil biodiversity, or cultural practices by the farmers that encourages erosion and deposition, or reflects a combination of soil physical properties, biomass inputs as well as decomposition rates which are functions of climatic conditions. The mean content of available phosphorus ranged from 15.17 to 19.12 mg/kg (Table 3), among pedons and is generally indicative of low to high soil content, according to the ratings of Landon (1991). The low to high content of AP across the pedons could be attributed to its low content in the parent materials and its propensity to sorption on mineral surface (Adisa *et al*., 2016), or to fixation, as a result of acidic condition of the soils (Brady and Weil, 2002). However, there was an observed high variability (HV) in available P across the four pedons (Table 3). This can be attributed to the eroded particles in runoff water, biomass removed through harvests and fixation. On the contrary, Salem *et al*. (2020a) reported moderate variations in available P contents in soils, which are related to the the degree of P-fixation. Also, Brady and Weil (2013), reported that acid soils have a high capacity of fixing soil P due to the formation of the insoluble Al-P complex. The mean exchangeable bases showed that calcium (Ca) and magnesium (Mg) are the predominant basic cations in the studied soils (Table 3). The mean Ca content ranged from 1.88 to 2.18cmol/kg (Table 3). This range of values is termed low as per Landon (1991) rating scale. The low Ca content in this study could be attributed to the nature of the parent material, or leaching or even both (Brady and Weil, 2013) and or anthropogenic activities such as tillage, use of acidic fertilizer. The coefficient of variation of soil Ca content across the pedons showed mostly a Moderate variability (MV) (Table 3). This result is contrary to the findings of Pantami (2017) who reported low variability in Ca content while working on waste water irrigated soils in Peri-Urban Kano, Nigeria. The result for mean Mg content ranged from 0.97 to 1.13cmol/kg (Table 3). This range of Mg values is termed as medium (Landon, 1991). This medium Mg content obtained in this study could be attributed to the calcareous nature of the parent material (Babablola *et al*., 2011). Magnesium values across the pedons showed moderate variation (MV) (Table 3). This finding is contrary to an earlier report by Ogban *et al*., (2012) who reported high variation in magnesium content while working on Inland Swampland soils in Akwa Ibon State, South-South Nigeria. However, the mean K content ranged from 0.03 to 0.05cmol/kg (Table 3) and was rated low as per Landon, (1991) rating scale. This low content of K in the studied soils could be attributed to leaching and uptake by plants. Nevertheless, across the pedons, potassium showed mostly high variation

(HV) (Table 3). This result disagree with the findings of Salem *et al.* (2020b) who recorded low coefficient of variation while working on soils of Teaching and Research farm of the Federal University of Kashere, Gombe State, Nigeria. Similarly, the mean Na content ranged from 0.005 – 0.008cmol/kg across the four pedons (Table 3). Landon, (1991) rated this range of mean Na values as low. Malgwi (2001) and Babalola *et al.* (2011) attributed the content of Na in this study to the nature of the parent material. However, the subsoil recorded an apparent increase in Na value with depth (Table 3), and this could be attributed to leaching of basic cation down the profile (Brady and Weil (2013).

Table 3: Soil Chemical Properties of the Studied Site.

Horizon	Depth (cm)	pH	EC	OC	Av. P	Ca	Mg	K	Na
Pedon1									
A	0 – 25	6.42	0.05	0.49	52.5	2.40	1.0	0.092	0.0043
AB	25 – 60	6.50	0.04	0.34	13.5	2.00	1.2	0.062	0.0070
Bt1	60 – 115	6.37	0.05	0.25	7.0	1.80	0.7	0.025	0.0048
Bt2	115 – 150	6.46	0.08	0.17	3.5	1.70	1.0	0.024	0.0043
Mean		6.43	0.05	0.31	19.12	1.97	0.97	0.05	0.005
CV		0.86	27.2	43.90	118.34	15.67	21.14	64.42	25.26
Ranking		LV	MV	HV	HV	MV	MV	HV	MV
Pedon2									
A	0 – 30	6.27	0.05	0.25	24.5	2.15	1.3	0.043	0.0056
AB	30 65	6.51	0.06	0.17	14.0	2.00	1.0	0.041	0.0061
Bt1	65 – 120	6.45	0.06	0.19	7.0	1.50	1.1	0.028	0.0052
Bt2	120 150	6.45	0.09	0.17	7.0	1.50	1.1	0.028	0.0052
Mean		6.41	0.06	0.20	15.17	1.88	1.13	0.03	0.006
CV		1.94	23.07	20.47	58.08	18.07	13.4	21.81	8.01
Ranking		LV	MV	MV	HV	MV	LV	MV	LV

Pedon3									
A	0 – 25	6.40	0.06	0.60	28 . 0	2. 3 0	1.3	0.084	0.0088
AB	25 - 70	6.40	0.04	0.35	14 . 0	2.15	1.0	0.046	0.0078
BA	70 – 125	6.41	0.05	0.34	14 . 0	2.10	0.85	0.046	0.0061
Bt	125 – 150	6.41	0.04	0.34	14 . 0	2.10	0.85	0.031	0.0061
Mean		6.40	0.04	0.43	18.67	2.18	1.05	0.05	0.008
CV		0.09	17.4	34.25	43.30	4.76	21.88	50.91	18.04
Ranking		LV	MV	MV	H V	L V	M V	H V	MV
Pedon4									
A	0 – 35	6.42	0.05	0.49	52.5	2.40	1.0	0.092	0.0043
AB	35 – 80	6.37	0.05	0.34	13.5	2.00	1.2	0.062	0.0070
Bt1	80 – 115	6.50	0.05	0.25	7.0	1.80	0.7	0.025	0.0048
Bt2	115 – 150	6.46	0.07	0.17	3.5	1.70	1.0	0.024	0.0043
Mean		6.43	0.05	0.31	19.12	1.97	0.97	0.05	0.005
CV		0.86	15.7	43.90	118.34	15.67	21.14	64.42	25.26
Ranking		LV	MV	HV	H V	M V	M V	H V	M V

CONCLUSIONS AND RECOMMENDATIONS

The study area was generally observed to be low to medium in fertility status. The results for coefficient of variation for the studied soils showed that soil depth slightly and moderately influenced the distribution of Sand, bulk density, particle density, total porosity, silt clay ratio and pH and silt, clay, EC, Ca, Mg and Na, respectively, while OC was both moderately and highly variable across depth depending on the pedon. However, AP and K were found to be highly influenced by soil depths. The low fertility status of the soils of the study area can be brought to better use for agriculture by increasing the organic matter level through incorporation of organic residues such as plant residues, farmyard manure, household refuse and mulching. These practices will improve soil fertility, soil structure, porosity and aeration. Intercropping with leguminous crop should also be practice to replenish the soils with nitrogen and phosphorus across all the soil mapping units. For sustainable crop production, there is need for guided inorganic fertilizer use.

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