CHANGES IN SOIL PHYSICAL PROPERTIES OF SUMMITS OF THREE TOPOSEQUENCES IN OHAFIA AREA OF SOUTHEASTERN NIGERIA.

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ABSTRACT
Soils vary in time and space. The study investigated variations in some soil physical properties of summits of three toposequences in Amaekpu Ohafia in Abia State Southeastern Nigeria. A transect was used to align soil profiles in all the summits studied. Adjusted soil profiles were dug, described and sampled using some FAO guidelines. Data collected were subjected to Analysis of Variance (ANOVA) and Coefficient of Variation (CV). There were differences in macromorphological properties such as colour, texture, structure and drainage. Summit of Northeast (NE) lying slope had mean value of 770g/1kg sand, 34g/1kg silt, 176g/kg clay, 1.41mg/m^3 bulk density and 46.78% total porosity while that of Northwest (NW) lying slope had 794/kg sand, 32g/kg silt, 174g/kg clay, 1.36mg/m^3 bulk density and 48.48% total porosity. Soils of southwest (SW) lying slope recorded 794/kg sand, 36g/kg silt, 170g/kg clay, 1.38mg/m^3 bulk density and 47.90% total porosity.
Keywords: Orientation, pedon, physical properties, toposequence.

Introduction

Soil physical properties vary in time, space and with depth. These variations occur with differences in slope properties. Onweremadu (2009) reported marked differences in soil morphology due to topography.

Differences in soils along a slope can be attributed to a combination of microclimate, pedogenesis, slope orientations and geological processes (Hoosebeck et. Al., 2000), including very short distance variation in soil properties (Cassel, 1983). Processes influenced by the above factors lead to morphological changes in colour and horizonation (Hall, 1983). According to Igwe (2000), land use differences on soils of varying topographic positions contribute to changes as experienced among them, and this can lead to varying rates of degradation on such soils.

Babalola (20007) reported differences in type and intensity of pedogenic processes resulting to changes in soil texture , and nutrient values (Ogban et. Al., 1999). Slope orientations contribute greatly to differences in properties of soils along the slope and within topounits. Esu (2005) stated that north-facing slopes in northern hemisphere are perpendicular to the sunrise than their south-facing counterparts resulting varying effects on soils. Onweremadu (2007) reported marked differences on some soil physical properties such as temperature and drainage while Brady and Weil (2007) observed changes on soil structure, soil density, water movement, pattern of pores, heat transfer, aeration and porosity.

Given that soil physical properties are parameters that govern movement, transfer of matter and energy as well as having pronounced influence on agricultural, architectural and engineering projects, it becomes necessary to investigate the variations that occur in physical properties of soils of similar topographic unit (summit) in sloping locations of Ohafia area in Abia State, Southeastern Nigeria. The major objective of the study was to investigate differences in some soil physical properties of three summit soils of varying orientations in three toposequences in Ohafia Abia State, Nigeria. Specific objective aimed at establishing the degree of variation among soils studied.

Materials and Method

Study Area: The study was conducted at Amaekpu Ohafia in Abia State Southeastern Nigeria, lying between latitudes 5^{o}30' and 5^{o}50'N, and longitudes 7^{o}10' and 7^{o}50'E. The elevation is below 200m, and soils are derived from lower coal measures (Mamu formation) (Orajaka, 1975). Ohafia is located within the humid tropics with an annual rainfall of about 2200mm and annual temperatures ranging from 27 to 31^{o}C. Rainfall pattern is bimodal and is characterized by 9 rainy and 3 dry months.

The vegetation of the study area is the rainforest characterized by multiple plant species but dominated by oil palms (*Elaeis guinenesis*. Smallscale farming, hunting, trading and cottage industrial activities constitute the socio-economy of inhabitants.

Site characteristics: Three summits of the toposequences were chosen for the study. They include the NE-lying summit with 11% slope, NW-lying slope with 10% slope and the SW-lying slope with 12% slope.

All the summits harbor secondary forests with the Southwest (SW) lying summit indicating greater population of plant species while that of the Northeast (NE) lying slope having few plant types and having more grasses.

Prefield Studies: A reconnaissance visit was conducted to familiarize with the sites. Necessary materials for the field study were assembled including Munsell Colour Chart and handheld Global Positioning System (GPS) receiver (Garmin Ltd., Kansas, USA).

Field Studies: Free survey technique was used in the study. An adjusted profile was dug, described and sampled from each summit soil colour was determined in situ under moist status using Munsell Colour Chart. Each soil profile was georeferenced using handheld Global Positioning System Reciever. Core samples were collected from designated horizons for bulk density determinations.

Laboratory Analyses: Particle size analysis was determined by hydrometer method (Gee and Or, 2002) while textural classes were obtained using textural triangle. Bulk density was measured using core method according to the procedure of Grossman and Reinsch (2002). Total porosity was calculated using a relationship between bulk density and particle density as follows:

TP = $(1 - {}^{BD}/_{PD})$ 100… (Foth, 1984).

Where TP = total porosity

BD = bulk density

PD = particle density

Data Analysis: Generated data were subjected to descriptive statistical tools of mean, standard and deviation and coefficient of variation.

Results and Discussion

Morphological properties of soils are shown on Table 1. Soils are borwn to reddish brown irrespective of slope orientation. Colour changes are attributable to varying degree of influences from organic matter, iron, type and oxidation. Surface soils were indicating sub regular blocky with varying strengths of aggregate possibly showing losses of surfaces soils and weakening influences of erosive forces at that height in the area. Friable consistence deominated the epipedons while firmer consistence was reported at the deepest endopedons. Soils were excessively drained to well-drained suggesting possibility of heightening runoff and leaching losses.

Table 1: Morphological properties of soils of the summit

Depth (cm)	Colour (moist)	Structure	Consistence (moist)	Drainage
	Toposequence 1 (5% slope) NE			
0 – 15	Brown 10YR $^5/_3$	3msbk	Friable	ED
15-30	Strong brown 7.5YR $^4/_6$	3msbk	Firm	WD
30-45	Reddish Brown 5YR $^4/_4$	3msbk	Firm	WD
45-60	Red 2.5YR $^5/_8$	3msbk	Firm	WD
> 60	Red 2.5YR $^6/_6$	3msbk	Firm	WD
	Toposequence 2 (7% Slope) NW			
0 – 15	Brown 10YR $^4/_5$	2msbk	Friable	ED
15-30	Reddish brown 5YR $^5/_3$	2msbk	Friable	WD
30-45	Reddish brown 2.5YR $^5/_4$	2msbk	Friable	WD
45-60	Red 2.5YR $^3/_6$	3msbk	Firm	WD
> 60	Red 2.5YR $^5/_8$	3msbk	Firm	WD
	Toposequence 3 (8% slope) SW			
0 – 15	Reddish brown 5YR $^5/_3$	2msbk	Very friable	WD
15-30	Weak red 2.5YR $^5/_3$	2msbk	Friable	WD
30-45	Red 2.5YR $^5/_8$	2msbk	Friable	WD
45-60	Red 2.5YR $^4/_6$	3msbk	Firm	WD
> 60	Red 2.5YR $^4/_8$	2msbk	Firm	WD

Structure: *M = medium, sbk = subangular blocky, 1 = weak, 2 = moderate drainage, Wd = well drained, PD = Poorly Drained, ED = Excessively drained.*

Physical properties of soils of the three summits are presented in Table 2. Sand sized soil particles dominated other fractions, and ranged from 730 to 880g/kg (NE- lying summit), 750 to 850g/kg (NW – lying summit soils) and 750 to 860g/kg (SW-lying summit soils). Next in abundance was day sized particles with mean values of 176g/kg (NE-lying summit soil), 174g/kg (NW-lying summit soil) and

170g/kg (SW-lying summit soil) and 170g/kg (SW-lying summit soil) while silt-sized particles ranged from 20 to 50g/kg (NE-lying summit soil).

Table 2: Physical Properties of soils

Depth Cm	Sand g/kg	Silt g/kg	Clay g/kg	Silt clay	TC	BD mg/m^3	TP %
	Toposequence 1 (6% Slope) NE 5°38'.984"				**7°49'.747"**		
0 – 15	880	30	90	0.33	LS	1.32	50.2
15 – 30	750	50	100	0.50	SL	1.35	49.0
30 – 45	750	40	210	0.19	SL	1.41	46.8
45 – 60	740	30	230	0.13	SL	1.45	45.3
> 60	730	20	250	0.08	SL	1.52	42.6
Mean	**770**	**34**	**176**	**0.246**		**1.41**	**46.78**
STDV	**62.04**	**11.4**	**75.36**	**0.18**		**0.08**	**3.01**
	Toposequence 2 (7% Slope) NW 2.5°42'.039"				**7°45'.970"**		
0 – 15	850	50	100	0.5	LS	1.29	51.3
15 – 30	800	40	160	0.25	SL	1.3	50.9
30 – 45	790	30	180	0.16	SL	1.36	48.6
45 – 60	750	20	230	0.09	SL	1.39	47.5
> 60	780	20	200	0.10	SL	1.48	44.1
Mean	**794**	**32**	**174**	**0.22**		**1.364**	**48.48**
STDV	**36.48**	**13.03**	**38.78**	**0.17**		**0.07**	**2.91**
	Toposequence 2 (7% Slope) NW 2.5°42'.039"				**7°45'.970"**		
0 – 15	860	40	100	0.40	LS	1.28	51.7
15 – 30	830	40	130	0.30	SL	1.31	50.5
30 – 45	770	30	200	0.15	SL	1.37	48.3
45 – 60	750	20	230	0.09	SL	1.45	45.3
> 60	760	50	190	0.26	SL	1.49	43.7
Mean	**794**	**36**	**170**	**0.24**		**1.38**	**47.9**
STDV	**48.27**	**11.4**	**53.38**	**0.13**		**0.09**	**3.38**

STDV = Standard deviation, NE = Northeast Orientation, NW = Northwest orientation, SW = southwest orientation TC = Textural Class, BD = Bulk Density, TP = Total porosity, LS = Loamy Sandy, SL = Sandy Loam

Table 3: Variation among soil physical properties of the three summit soils

Property	Sand	Silt	Clay	SCR	BD	TP
CV%	1.80	5.90	1.80	5.80	1.70	1.80
Ranking	LV	LV	LV	LV	LV	LV

Generally, all soil physical properties – the summit soils indicated low variability

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