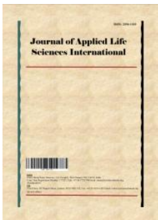

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Comparing Organic Matter Content under Four Different Land Uses in Uloanondugba, Imo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author OUO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EOAD and SAI managed the analyses of the study. Author UA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The variability of organic matter across four contrasting land uses namely oil palm plantation OPPL, sand mining site SM, tenuously cultivated land CCL and primary Forest (PFL) were evaluated in Imo State. Results obtained showed that the percentage of sand decreased down the depths in all the land uses: PFL, CCL, OPPL, SM which were 76.6, 76.1, 77.7 and 70% respectively. The soils ranged from sandy loam to sandy clay loam in texture. The SM had the highest mean bulk density of 1.76 g/cm3 against the lowest mean value of 1.52 g/cm3 in the PFL. Similarly the PFL had the highest mean percentage organic matter of 2.12% as well as the lowest coefficient of variation 7.8% compared to the high coefficient of variations observed in the other land uses. The sand mining had 68% coefficient of variation while the CCL, OPPL had coefficient variations of 58% and 52% respectively indicating high variations .There was little or no variations in the percentage total nitrogen as well as available phosphorus in the PFL compared to the high variation in the other land

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uses. Land uses that depleted the essential nutrients in the soil should be avoided. Mulching and conservation tillage that tends to restore the soils nutrient ability should be adopted and sustained.

Keywords: Organic matter; land uses; coefficient of variations.

1. INTRODUCTION

The soil organic matter represents the organic components of the soil including the remains of plant and animals at various stages of decomposition. It consists of three primary parts including small plant residues and small living organisms, decomposing (active) organic matter, and stable organic matter (humus) [1]. Soil organic matter serves as a reservoir of nutrients to crops, provides soil aggregation, facilitates nutrient exchange and helps to retain moisture. Similarly the soils organic matter helps in reducing surface crusting, increases soils infiltration as well as water retention. It impacts the potential for herbicide carryover for future crops and amount of lime necessary to raise the pH.

So many factors are known affect the organic matter content of the soils and they include but not limited to climate: rainfall, temperature, moisture etc. According to [2] climate and geological history are importance factors that affects soil properties on regional and continental scales. However, land use may be the dominant factors of soil properties under small catchment scale. Land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization, and leaching, etc [3,4]. This ultimately modifies the processes of transport and redistribution of nutrients.

In an Undisturbed land use such as a forest, the type of vegetative cover is a factor influencing the soil organic matter content [3,5].

In Uloanondugba, land is put to many uses driven by the increasing demand for industrialization and development, yet studies are scanty on the effects of land use on soil properties. The dearth of information has not addressed the impacts of continuous cultivation, excavation activities, and dumping of household and municipal wastes on the soil organic matter and productivity.

The decline in productivity in Uloanodugba which is an agrarian community in Imo State Nigeria has been a source of concern for the inhabitants of the area. Huge amounts of money are being spent every farming season on inorganic fertilizer in order to boost the soils fertility for optimum harvest, but such efforts have not yielded the desired result, hence this research whose objective is to determine the variability of the soils organic matter of the area and ascertain some of the important soil quality indices.

2. MATERIALS AND METHODS

2.1 Location

The study was conducted in Uloanondugba in Isu L.G.A of Imo State, Nigeria. Uloanondugba lies on latitude 05º39'52''N and longitude 007º02'52''E. The area is a tropical humid climate area with daily minimum and maximum temperatures of 20ºC and 30ºC respectively. The mean annual temperature of the place ranged from 27 - 28ºC with relative humidity ranging from 75-80% [6]. The vegetation type in the area is tropical rainfall with mean annual rainfall of 2000-2500 mm, [7]. The common land use in the area is arable farmlands planted with maize, cassava and yam. Farming is predominantly at the subsistent level.

Four profile pits were dug in each of the land uses namely primary forest (above 100 years), a continuously cultivated land (20 years), oil palm plantation and sand mining sites. Samples were collected at four different depths in each of the respective profile pits at 0-30, 30-60,60-90 and 90-120 cm depths. Samples collected were prepared using the standard methods.

Particle sizes were determined using the hydrometer method [9]. The bulk density was determined by the core methods as described by Anderson and Ingran [7]; the soil pH was measured in an effort electrically by glass electrode in distilled water using a 1:2:5 [10].

The organic carbon was determined by the Weakley-black method [10], the organic matter was calculated by multiplying the organic carbon values by 1.724 (Van Beinellens correction factor).

Total N was analyzed using the Kjeldahl digestion and distillation method as described by black [9].

2.2 Statistical Analysis

Coefficient of variation CV as used by Wilding [11] was used to estimate the degree of variability existing among soil properties in different land uses studies and comparisons were drawn.

CV (% Coefficient of variation) was determined so that CV =SD\X ×100\1, were SD is the standard deviation and X is the mean. The % CV was ranked as follows: CV<15 % is little variation; CV>15 is moderate variation and CV>35% is high variation.

3. RESULTS AND DISCUSSION

The results of the physical and chemical properties of the studied soils of Uloanondugba was presented in Tables 1 and 2. The four land uses were predominantly sandy loam in texture with the primary forest having a mean percentage sand of 76.6% while the continuously cultivated land had a mean percentage sand of 76.1, the Oil palm plantation had the highest mean percentage of sand (77%), while the sand mining site had the least mean value of 70%. Also the percentage mean silt distributions were 6.05, 6.3, 6.1 and 5.3 for the Primary forest (PF), the Continuously Cultivated Land (CCL), the Oil Palm Plantation (OPPL) and the Sand Mining site (SM) respectively. The mean percentage clay content was highest on the sand mining site with a mean value of 20% compared to the 16%, 17.5%, 16.1% mean clay recorded in the PFL, CCL and OPPL respectively with 9% coefficient of variation of 60%.

There was high variation in the percentage clay (60%) in the sand mining site compared to the moderate variation witnessed in the other 3 land uses. Similarly, the bulk density increased down the profiles in all the land uses studied. Mean bulk density values were 1.52, 1.58, 1.68 and 1.76 for the primary forest PFL, Continuously Cultivated Land CCL, Oil Palm Plantation OPPL and Sand Mining site SM respectively. The high bulk density observed at the Sand mining site was as a result of compaction by heavy machines during excavations. Decrease in organic matter, compaction may have resulted to the increase in the bulk density [12].

Table 1. Mean soil physical properties across the four land uses

Land uses	Depths	% sand	% silt	% clay	Text	BD g/cm3
PFL	0-30	80.1	6.5	13.4	SL	1.43
	30-60	77.5	5.5	17.0	SL	1.50
	60-90	75.1	6.1	18.0	SL	1.54
	90-120	73.8	6.1	20.1	SCL	1.62
	Mean	76.6	6.05	17.1		1.52
	CV	3	7	16		5.2
CCL	0-30	80.1	6.5	13.4	SL	1.50
	30-60	74.4	6.5	17.0	SL	1.55
	60-90	75.8	5.8	18.4	SL	1.59
	90-120	72.1	6.5	21.4	SCL	1.68
	Mean	76.1	6.3	17.5		1.58
	CV	4.3	6.0	19		5.0
OPPL	0-30	82.8	4.5	12.7	LS	1.50
	30-60	77.8	7.5	14.7	SL	1.65
	60-90	76.1	6.5	17.3	SL	1.77
	90-120	74.4	5.8	19.7	SL	1.8
	Mean	77.7	6.1	16.1		1.68
	CV	4.7	20.0	18		8.0
SM	0-30	80.3	6.0	13.0	SL	1.70
	30-60	70.8	4.8	24.3	SCL	1.75
	60-90	68.1	5.1	26.7	SCL	1.79
	90-120	67.8	5.1	27.0	SCL	1.82
	Mean	70.0	5.3	20.0		1.76
	CV	3.7	14	60		3

Pfl =Primary Forest ; Ccl =Continously Cultivated Land; Oppl=Oil Palm Plantation

Table 2. Mean soil chemical properties across the four land uses

Land uses	Depth (cm)	pH	%OC	%OM	%TN	% AV.P
PFL	0-30	6.02	2.5	4.3	0.26	22.1
	30-60	5.4	1.44	2.47	0.15	19.6
	60-90	4.6	0.83	1.39	0.08	13.8
	90-120	4.1	0.20	0.35	0.02	7.7
	Mean	5.03	1.24	2.12	0.13	15.8
	CV	17	7.8	7.8	8.1	34
CCL	0-30	5.84	1.50	2.64	0.11	20.6
	30-60	5.45	1.34	2.32	0.09	19.8
	60-90	4.65	0.56	0.96	0.05	11.0
	90-120	4.71	0.40	0.69	0.01	6.9
	Mean	5.16	0.95	1.65	0.06	14.5
	CV	11	58	58	68	46
OPPL	0-30	6.2	2.08	3.6	0.14	22.8
	30-60	5.8	1.42	2.45	0.12	17.5
	60-90	4.6	0.86	1.48	0.05	13.4
	90-120	4.5	0.62	1.00	0.02	7.7
	Mean	5.2	1.24	2.14	0.82	15.35
	CV	16	52	52	7.0	41
SM	0-30	4.6	1.3	2.25	0.07	13.5
	30-60	4.3	0.81	1.39	0.03	9.8
	60-90	3.6	0.54	0.92	0.01	6.1
	90-120	3.6	0.22	0.28	0.01	14.8
	Mean	4.02	0.71	1.21	0.02	11.0
	CV	13	63	68	94	35

Sm=Sand Mining Site; Om =Organic Matter, Oc =Organic Carbon, Tn= Total Nitrogen, Avp Available Phosphorus; Ccl =Continously Cultivated Land; Oppl=Oil Palm Plantation, Pfl =Primary Forest, Sm Sand Mining Site

3.1 Mean Chemical Properties for All the Four Land Uses

The chemical properties of the soils as shown in Table 2 indicated an irregular distribution of the soil pH. The mean pH ranged from 5.03-4.02. The primary forest had a mean pH of 5.03 as against the 5.1 recorded in the CCL. The OPPL and the OPPL had respective mean values of 5.2 and 4.0, meanwhile the mean percentage organic matter had a definite trend of decreasing down the profiles in the four land uses. The primary forest had a mean value of 2.12%. The percentage coefficient of variation was 80% indicating a high variation down the four depths. The continuously cultivated land, oil palm plantation and the soil mining sites had respective mean percentage organic matter of 1.65, 2.14 and 1.21 respectively. The Continuously Cultivated land had a coefficient variation of 58% while the Oil palm plantation and the Soil mining had respective coefficient of variation of 52%and 68%. According to Obasi et al. [12] ranking, the percentage organic matter was highly variable in the all land uses. Liu et al. [13] had observed similar variations in organic matter in three pedons in Umuagwo, Imo state Nigeria. Effects of different land-use types on soil organic carbon and its prediction in the mountainous areas in the middle reaches of Lancang River has been discussed by Liu et al. (2015). There was also a high variability in the percentage total nitrogen. The percentage total nitrogen was highest in the oil palm plantation with a mean percentage value of 0.82 while the sand mining has a mean value of 0.3%. The primary forest had the least value of 0.13. The available phosphorus had a mean value of 15.1 in the primary forest as well as a mean value of 14.5 in the Continuously Cultivated Land. The Oil Palm Plantation and the Sand mining sites had respective mean values of 15.3 and 11 mg/kg of available Phosphorus. It's coefficient of variation was highest in the Continuously Cultivated land with a percentage value of 46. The primary forest had the lowest Coefficient of variation of available phosphorus with 34%. Human activities frequently cause the degradation of soil environment which leads to reduction in the number of animal and plant communities, where species able to bear stress predominate and rare taxa decrease in abundance or disappear [14,15].

4. CONCLUSION

The soils were dominated by the sand fractions as seen in the result of the laboratory analysis. The bulk density values were high although it falls within the acceptable limit of <1.85 required for root penetration. The soil pH had an irregular distribution and ranged from very strong acids in the lower depths to moderate acids in the superficial 0-30 cm depth. The soils organic matter was moderate in all the land uses except in the 90-120 cm depth were low values were obtained. Low levels of total Nitrogen were observed in all the land uses. Also moderate levels of available phosphorus were seen in all the land uses studied. Generally, there were high variations in the chemical properties except in the primary forest of the soils compared to the physical properties.

Farmers are advised to use organic manure to counteract the deficiency observed in the levels of basic soil nutrients. Organic manure also has the potency of aggregating the mostly sandy textured soils of the area. Soil testing practice to ascertain the nutrient status of the soils should be embraced and sustained, as that will help to reduce the unwholesome application of inorganic fertilizers that has assumed the only remedy to the decline in agricultural productivity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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