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SOIL CHEMICAL QUALITY ASSESSMENT OF SOME LAND USES IN IMO STATE, NIGERIA

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ABSTRACT: *This study was conducted in Imo State, Nigeria to assess the Chemical quantities of some land using soil management assessment framework (SMSF) techniques. Three land uses namely; the grass land, continuously croppedand forest land. Soil profile representations were established in each of the physiographic units and soil samples collected from the pedogenetic horizons for the analysis of some chemical properties. The chemical properties investigated were the soil pH.organiccarbon, total nitrogen, available phosphorus, the exchangeable cations of calcium, magnesium, potassium and sodium, cation exchange capacity and electrical conductivity. Analytical values obtained using the SMAF were combined into quantitative index based on the critical value of the soil properties. The results of this study showed that the grass land, continuously cropped and forest land were moderately acidic with mean pH values 5.43, 5.38, and 5.65. The organic matter contents were low in grass land and continuously cropped with mean values of 0.43 and 0.41 but moderate in the forest land with mean value of 0.82. Total K, available P and exchangeable K were low in grassland and continuously cropped with mean value of 0.96gkg^{-1}, 0.85gkg^{-1} for N, 12.20mgkg-^{1}, and 12.14mgkg^{-1} for P in grass land and continuously cropped respectively. The forest land had high sodium content with mean value of 0.74 and high electrical conductivity with a mean 4.91 dsm^{-1}. The results revealed high chemical quality of forest land and low to moderate qualities of the grass land and continuously cropped.*

KEY WORDS: assessment, land use, soil chemical quality, Imo State.

INTRODUCTION

The management of soil quality depends largely on understanding the reaction of the soil to use dynamics as it has implications for land productivity. There are many causes for spatial differences in soil properties, which include type of vegetation, cultivation history (farm practice). According to Obalum*et al.* (2013) few works are available on the variability of tropical soils among tropical researchers, especially those in West Africa. The differences in field management, land use conversion, which involves change in biomass production and nutrient cycling, have influence on soil properties (Chen, 2003). Change in land use from agriculture to forest brought the development of a large tree biomass and increased the availability of plant nutrient (Liu *et al.* 2010). This type of conversion increased soil organic carbon, microbial biomass and potential nitrogen mineralization rate and reduced the soil bulk density (Folorunso*et al.,* 1988; Nelson and Sommers, 2008). Land use induced changes in nutrient availability and may influence secondary succession and biomass production, reduce crop production and environmental quality (Nwachukwu*et al*., 2020). The changes directly affect some physical chemical and biological properties, such as water retention availability, nutrient cycling, plant root growth and soil conservation (FAO, 1983). These soils are also known to possess unique morphological characteristics that are strongly influenced by temporary or permanent water saturation and adopted vegetations. This study therefore is to assess the soil chemical quality of some land uses in Imo State.

MATERIALS AND METHODS

Study Area

The study was carried out in Ohaji/Egbema area of Imo State which lies between latitudes 05^0 21^1 and 05^0 42^1N and longitudes 07^0 48^1 and 06^0 53^1 E. The region consists of tropical rainforest zone with average annual rainfall distribution of 2,250-2800mm. The annual temperature ranges 26-30^0C with annual relative humidity range of 85-90% (NMA, 2011).
Human activities such as continuous cropping, grazing and bush burning has transformed the natural forest of the area into secondary and grassland soils, but there are some scattered distributions of forest lands in the area. The identified land uses were grass land, continuously cropped land and forest land.

Field Study

Three mapping units were chosen to represent soils that occurred under grass land, continuously cropped land and forest land. In each of the mapping units, representative profile pits were dug up to 90cm delineated and soil samples collected from each of the pedogenetic horizons.

Fig 1: Soil Samples Collected from the Study Area

Laboratory Analysis

Routine laboratory analyses were conducted after collection of samples. Soil pH was determined by electrometric method as described by IITA (2010). The walkley and black methods as described by Nelson and Sommers (2008) were used in the analysis of organic carbon. Total nitrogen was analysized using the procedures as described by Adepetu (2010). The Bray 1 method as described by IITA (2010) was used for extractable phosphorus, exchangeable based were determined from the soil samples through normal ammonium acetate solution (IITA, 2010). The EDTA titration method was used to determine calcium (Ca) and magnesium (mg), while flame photometer was used in the determination of sodium (Na) and potassium (K). The cation exchangeable capacity (CEC) was determined by ammonium acetate saturation method (IITA 2010). The electrical conductivity (EC) was determined by measuring the electrical resistance between parallel electrodes immersed in the soil samples using electrical conductivity meter.

Soil Chemical Quality Assessment

Soil chemical quality assessment was determined by using the soil management framework (SMAF) technique as described by Andrews *et al.,* (2008). The technique was based on the guidelines that soil quality can only be assessed by a combination of different properties of the soil thus; no single indicator can represent the condition of the soil. The laboratory analysis results were combined into a quantitative index using the soil management assessment framework (SMAF). The combination was based on the critical values of the indicators and soil function (Andrew *et al.,* 2008). The soil chemical quality indicators such as soil pH, organic carbon, total nitrogen, available phosphorous, exchangeable bases (Ca, Mg, K and Na), CEC and EC were given relative weights and the entire weights added up to 100%. Standard scoring functions as described by Wymore (2007) was used to combine the different indicators in order to convert numerical or subjective ratings to unit less values on a scale of 0-1. The scoring was assigned according to the critical values of the indicators while weights were done according to the level of importance of the indicator to crop production. Following the scoring of the indicator, the values obtained were multiplied by the appropriate weights and a matrix was produced as below.

$$Q = \sum_{i}^{n} IW$$

Where

Q = Soil chemical quality for crop production
I = Indicator
W = Relative weight
n = nth indicator

Therefore, soil chemical indicators with their relative weight assigned were as follows; soil pH (0.10), organic matter (0.20), exchangeable cations like Ca (0.10). Mg (0.10), K (0.10), Na (0.00), CEC (0.00) and EC (0.00).

Statistical Analysis

The chemical properties of each pedon were analyzed using mean and coefficient of variation. The means were separated using least significant difference (LSD) Test at 0.05 level of significant.

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RESULTS AND DISCUSSIONS

The results of some chemical properties of the soils were shown in Table 1 which represented the grass land, continuously cropped and forest land soils. The soils across the pedons were generally acidic. The grass land and continuously cropped were slightly acidic. The forest land was medium acidic with a mean pH value of 5.65. Available phosphorus was high in grass land and continuously cropped with mean values of 12.20mgkg^{-1} and 12, 4mgkg^{-1} (Table 1). Organic matter and total nitrogen decreased down the profile in all land uses and were low being less than critical limits of <1% for 0M and <0.9g/kg for N as described by Tabi*et al.* (2012). In this study, grass land soils organic matter decreased from 0.64 to 0.25, continuous cropped land from 0.55 to 0.21 while in forest land from 0.96 to 0.66%. The organic matter were low in three land studied,but continuously cropped soils were the lowest.

Erosion, leaching, and increased intensive agriculture in the area may have depleted the nutrient reserve of the soils. The available phosphorus distributions were very high at the surface horizons and decrease down the profile in all soils studied. The chemical indicator used with the assigned relative weight is shown in this investigation. The soil pH is a critical factor in crop production as it affects the mobility of many pollutants in the soil by way of influencing the rate of their biochemical breakdown, solubility and absorption to soil colloids (Yelson and Sommers 2008). The results showed moderate acid condition in the continuously cropped soils and medium acid in grass land and forest land respectively. The implications of these are that, the nutrient availability of the soils may be affected. High pH in relation to the forest land soils could cause the released of some toxic amounts of aluminum into the soils (Brady and Weil, 2007 and Acquah, 2009). This suggests that these soils were low in nutrient elements composition especially the continuously cropped soils and needs to constantly be supplemented to support productivity.

Low values of exchangeable sodium and electrical conductivity (EC) associated with the three land use soil are major soil chemical potentials of the soils as most tolerable tropical plants can be cultivated in them.

Table 1:
SOME CHEMICAL PROPERTIES OF LAND USE SOILS

Soil depth (CM)	Soil pH	Om	N (gkg^{-1})	P ($mgkg^{-1}$)	Ca	Mg	K (Cmol kg^{-1}	Na	CEC	EC dsm^{-1}
Grass land										
0-15	5.64	0.64	0.84	12.74	2.07	0.84	0.18	0.24	6.57	0.93
15-30	5.52	0.49	0.80	12.64	2.06	0.70	0.18	0.24	6.34	0.62
30-60	5.43	0.35	0.76	12.20	2.05	0.65	0.17	0.13	6.32	0-52
60-90	5.13	0.25	0.40	11.23	2.04	0.55	0.16	0.12	5.64	0.42
Mean	5.43	0.43	0.70	12.20	2.06	0.69	0.17	0.18	6.22	0.50
CV%	12.86	10.18	22.30	23.18	10.84	44.77	14.12	23.45	15.15	3.64
Continuous cropped land										
0-15	5.62	0.55	0.88	12.21	1.67	1.07	0.17	0.24	6.89	0.48
15-30	5.53	0.48	0.84	12.20	1.52	1.04	0.16	0.20	6.75	0.47
30-60	5.22	0.38	0.84	12.08	1.45	0.76	0.14	0.16	6.70	0.44
60-90	5.14	0.21	0.83	12.05	1.43	0.74	0.11	0.15	5.45	0.44
Mean	5.38	0.41	0.85	12.14	1.52	0.90	0.13	0.19	6.45	0.46
CV%	13.08	10.64	20.20	20.57	13.03	16.34	19.86	20.54	7.62	13.78
Forest land										
0-15	5.83	0.96	0.98	12.74	4.73	2.10	0.17	0.86	12.32	5.62
15-30	5.64	0.88	0.98	12.68	4.72	2.07	0.15	0.75	12.09	5.03
30-60	5.61	0.76	0.93	12.66	4.72	2.07	0.14	0.70	11.84	4.60
60-90	5.52	0.66	0.89	12.64	4.65	2.04	0.11	0.65	11.25	4.40
Mean	5.65	0.82	0.96	12.68	4.71	2.07	0.14	0.74	11.88	4.91
CV%	12.12	10.81	11.14	25.28	21.01	10.68	19.0	11.77	3.16	16.50

CEC = Cation exchange capacity, EC = Electrical Conductivity, OM = Organic matter

CONCLUSION

The investigated soils were sandy with highest occurring at the grass lands. The chemical quality assessment of the soils using the soil management framework (SMAF) showed that the grass land and continuously cropped soils were low to moderate in nutrient reserves and slightly to medium acidic.

The forest land soils have good chemical qualities in terms of organic matter; total nitrogen and some high electrical conductivity are among chemical properties. However, the use of both organic and inorganic fertilizers and efficient liming are some of the measures that can improve the efficient use of the soils for crop production.

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