ASSESSMENT OF THE FERTILITY STATUS OF SOILS USED FOR CASSAVA PRODUCTION IN MBAISE, IMO STATE

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Abstract
The fertility status of soils used for cassava production in Mbaise, Imo State were assessed. Composite samples were collected from four different sites at 0-15cm and 15-30cm depth and analyzed in the laboratory. Data generated were statistically analyzed using the co-efficient of variation and standard deviation methods. Results showed that the soils varied from sandy loam to sandy clay loam and strongly acidic (average pH 5.29). They were low in organic matter (OM) (0.48-1.41%), total nitrogen (N) (0.19%-0.22%), exchangeable potassium (0.24-0.16 cmol/kg). Available phosphorus (p) (4.32-3.49mg/kg) calcium (Ca) 2.2-2.0cmolkg), magnesium (Mg) (1.15-1.45 cmol/kg), sodium (Na) (0.10-0.11cmol/kg) and base saturation (83.7-76.2). The result indicates that the fertility status of the study area is low, and requires intensive fertility restoration for soil health improvement. To boast for high crop yields, and productivity of cassava in the study area, application of lime, use of organic and inorganic mineral fertilizers are recommended.

Keywords: Soils, fertility status, soil productivity, crop yields, Mbaise

INTRODUCTION

Cassava (*Manihot esculenta Grants*) is grown throughout Sub-Saharan Africa and it is second to maize as human staple, accounting for more than 200 calories per day per person (IITA, 1998). About 160 million people, or 40% of the Nigerian population, consume cassava as a staple food (Nweke, 1994*)* Cassava plays such a crucial role because of it's efficient production of food energy, year-round availability, tolerance to stress and suitability for present farming systems Nweke (2002). In recent time, there have been decrease in the production of cassava that can be traced to the poor nutrient status of the soil, lack of soil information for effective soil management, excessive rainfall, crop removal, rapid mineralization of soil organic matter and excessive cultivation of land due to increase in human population (IITA, 1995).

Also, the low natural fertility status of some soils have been attributed to multiple nutrient deficiencies, due to low mineral reserve and high leaching intensity (*Chude et al*., 2003). Soil fertility is the inherent ability of soil to supply nutrients for plant growth and development in adequate and required proportion without any detrimental or toxic effect (Ufot et al., 2003). Igbokwe (1982) had identified soil properties such as pH, cation exchange capacity (CEC) and percentage base saturation (BS) as important indices in the determination of the degree of soil fertility. Consequently, cassava has a much lower critical level for available phosphorus than less mycorrhizal dependent crops like maize and beans and is able to grow relatively well on soils with a weak capacity to supply phosphorus Howeler (2002) it is well adapted to acidic soils due to its tolerance to low pH and exchangeable aluminum Howeler (2002), while it can tolerate more water stress than many other crops with high water use efficiency El-Sharkawy (2004). However, studies on fertility status of soils used for cassava production in Ahiazu Mbaise, Imo state have been relatively scarce. Thus, this study was conducted to assess the fertility status of soils used for cassava production in Ahiazu Mbaise and to generate suitable recommendation for improved soil and crop production capacity of the soils.

MATERIALS AND METHOD

Study Area

The study was conducted in Mbaise, Imo State lying between latitudes 5^{o}20'N and 6^{o}55'N and longitudes 6^{o}35'E and 7^{o}08'E. The area is underlain by coastal plain sands, and is generally low-lying and dominated by low lands. The climate is humid tropical with rainy season of about 9 months and 3 dry months mean annual rainfall is about 2,500mm, 27^{0}C temperature and relative humidity of 85%. It has a typical rainforest vegetation with plants arranged in tiers. Oil palm tree (*Elias guineensis*) as one of the dominant plant species. Agriculture is a major socio-economic activity in the area.

Sample sites: Four locations were chosen for the study. They include umuagbarue, umuagwu, umuezuo and Umugwa. At each study site, an area measuring 10x20 m was mapped out and composite soil samples collected randomly from soil depths of 0-15 cm and 15-30 cm, respectively. A total of eight (8) composite samples were collected for the study. The soil samples were air dried and sieved with 2 mm.

Laboratory analysis

Particle size distribution was determined by hydrometer method [Gee and Or., 2002). Bulk density was determined by oven-drying the samples to constant weight at 105°C and bulk density computed as described by Klute (1996). The soil pH was determined in both distilled water and O.IN KCL solution (Mclean, 1982). The soil organic carbon was measured by digestion method (Nelson and Sommers, 1982). While, the soil organic matter content was obtained by multiplying organic carbon values by 1.724. Total nitrogen was determined in accordance with Bremner and Mulvaney, (1982). The extractable phosphorus was determined by Bray II method as described by Olsen and Sommers (1982). The exchangeable cations were obtained by the method described by Thomas (1982). Potassium and sodium ions were determined using the flame photometer method while magnesium and calcium ions were determined using the atomic absorption spectrophotometer (AAS) method.

Statistical analysis: Data collected were analyzed using simple descriptive statistics such as arithmetic means, standard deviation (SD) and coefficient of variation (CV).

Results and Discussion

Results of soil physical properties at 0-15cm and 15-30 cm depths are shown in Table 1. Particle size distribution was dominated by the sand fractions in all the study areas. Texture of the surface soils was generally loamy sand, while that of subsurface was sandy clay loam. The observed high percentage of sand could be attributed to the geology of the area. The geology of the area is coastal plain sands, which are characterized by sandy soils over a wide expanse of land (Akamigbo and Asadu, 1983). However, silt fractions ranged from 6.00-8.00% with a mean of 7.00 in surface soil and 4.00% with a mean value of 4.00% in subsurface soil and 29.60%-13.60% clay fractions at surface soil (0-15 cm), 29.60% -21.60% at subsurface (15-30cm) with a mean of 26.1%. Highest clay fraction of 29.60% was observed in the subsurface and lowest clay contents of 13.60% in the surface soil. This finding agreed with the report of Akamigbo and Ukaegbu (2003) that clay contents in the subsoil are higher than in the topsoil. Bulk density decreased from 1.84-1.92g/cm-^{3} at umuagbara and 1.76-1.74g/cm-^{3} at Okirika-ama 1.72-1.69g/cm-^{3} at umugwa and 1.71-1.64g/cm-^{3} at umuezuo. These results may be due to tillage practices that took place in the surface soil of the study areas in the past.

The chemical properties of the soils of the study areas are presented in Table 2. Soil pH values ranged from 4.86% -5.56 with an average of 5.29 at 0-15cm depth while at 15-30 cm depths pH ranged from 5.17-5.44 with an average of 5.29. The result of the pH indicates that the soil are strongly to moderately acidic. According to the rating of soils of south eastern Nigeria. Organic matter contents ranged from 0.84 (very low to 1.93 percent) (low,), with an average of 1.41 (very low). In the surface 0.32 (very low) to (0.73 (very low) with an average of 0.48 (very low) in subsurface soil. This can be attributed to the generally low nutrient content of the parent rocks (shale) and to the strongly acidic chemical condition of the soils as well as to high rainfall and temperature (FDALR, 1985). The percentage total nitrogen of 0-15cm depth in all sites was found to range of 0.01-0.60% with a mean of 0.19% while that of 15-30 cm depth in all sites had a ranged of 0,01% -0.05% with a mean of 0.22 respectively. *Ufot et al*., (2001) reported total nitrogen range of 0.05-0.11% and attributed the low total nitrogen level to rapid microbial activities, leaching of nitrates and crop removal. *Onyekwere et al.* (2003) pointed out that low total nitrogen level of soils must be a reflection of the organic carbon content in the soil as observed in the present study. However, the total nitrogen of all sites are generally low compared to the rating of soils of southeastern Nigeria. Potassium had a range of 0.13 -0.19 cmolkg^{-1} with an average value of 0.165 cmolkg^{-1} on surface soil of the sites while subsurface had a range of 0.23-0.12 cmolkg^{-1} and average value of 0.24. Available phosphorus was low, it decreased from surface to subsurface soil with a range of 3.22-1.84mgkg^{-1} at umuagbara and 6.32-1.64mgkg^{-1} at Okirika-ama, increased from 2.49-3.52mgkg^{-1} at umugwa, 4.06-6.96mgkg^{-1} at umuezuo the decreasing phosphorus level with increasing depth may be due to crop removal and leaching of soil phosphorus through intense rainfall. In the surface soil, exchangeable ca and mg were in the range of 1.60 -2.80 cmolkg^{-1} and 0.80-1 .80cmolkg^{-1} while the subsurfacel depth, Ca, mg were in the range of 2.00-2.60cmolkg^{-1}, the exchangeable sodium content was low in both the surface and subsurface soil with a range of 0.18 - 0.23 cmolkg^{-1}. However, on comparative basis the high level of exchangeable Ca, Mg over exchangeable K and Na agreed with the findings of Pitty (2014), who stated that Ca and Mg are predominant cations in soils as a result of their strong adsorption and rapid release into the soil system through soil mineral weathering.

The effective cation exchange capacity in the surface soil ranged from 3.77-5.49 cmolkg^{-1} and 4.03-5.58 cmolkg^{-1} in the subsurface with mean ECEC of 4.69 cmolkg^{-1} and 4.48 cmolkg^{-1} and standard deviation of 0.77 and 0.88, respectively. The base saturation level of the surface soils ranged from 79.3-81.4% with a mean value of 83.07 and standard deviation of 3.46 and in the sub-surface soils base saturation values ranged from 65.2-83.1% with a mean value of 76.22. Thus, the base saturation was high implying saturation of the soil exchange complex with bases. In the contrary, the low cation values recorded in these soils might be as a result of rapid crop uptake of the cations or possible losses through leaching due to excessive rainfall, characteristic of the area.

Table 1: Soil Physical Properties of the study area

Sampling Site	Sand (%)	Silt (%)	Clay (%)	Textural Class	Bulk Density g/cm^{-3}
		0-15cm depth			
Umuagbara	80.40	6.00	13.60	S.L	1.84
Okirika-ama	74.40	8.00	19.60	S.L	1.76
Umugwa	76.40	8.00	15.60	S.L	1.72
Umuezuo	64.40	6.00	29.60	SCL	1.71
Mean	73.90	7.00	19.60		1.76
LSD	6.18	1.15	7.11		0.06
CV (%)	9.2	16.48	36.30		3.36
		(15-20 cm) depth			
Umuagbara	74.40	4.00	21.60	SCL	1.92
Okirika-ama	66.40	4.00	29.60	SCL	1.74
Umugwa	66.40	4.00	29.60	SCL	1.69
Umuezuo	72.40	4.00	23.60	SCL	1.64
Mean	69.9	4.00	26.1		1.75
LSD	4.12	0.00	4.12		0.13
CV (%)	5.89	0.00	15.60		6.98

Table 2: Soil Chemical Properties of the study area

Study Area	pH (H2O)	OM %	T.N (%)	P (mg/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	ECEC cmol/kg	TEA cmol/kg	BS (%)
0-15cm depth											
Umuagbara	5.12	1.37	0.60	3.22	0.16	1.60	1.20	0.11	3.77	0.70	81.4
Okirika-ama	5.63	1.93	0.09	6.32	0.19	2.40	1.60	0.17	5.16	0.80	84.4
Umugwa	4.86	1.51	0.07	2.49	0.18	2.00	1.20	0.07	4.35	0.90	79.2
Umuezuo	5.56	0.84	0.01	4.06	0.13	2.80	1.80	0.06	5.49	0.70	87.2
Mean	5.29	1.41	0.19	4.32	0.16	2.2	1.45	0.102	4.69	0.77	83.75
STD	0.366	0.44	0.34	1.67	0.026	0.5	0.3	0.049	0.77	0.89	3.46
CV	6.92	31.2	179	38.6	15.75	22.72	20.68	48.0	16.41	1.16	4.2
(15-30cm) depth											
Umuagbara	5.33	0.32	0.01	1.84	0.21	2.00	1.20	0.13	4.74	1.20	74.6
Okirika-ama	5.17	0.34	0.01	1.64	0.12	1.80	1.00	0.05	3.57	0.60	83.1
Umugwa	5.23	0.55	0.02	3.52	0.40	1.60	0.80	0.09	4.03	1.40	65.2
Umuezuo	5.44	0.73	0.05	6.96	0.23	2.60	1.60	0.15	5.58	1.00	82.0
Mean	5.29	0.48	0.22	3.49	0.24	2.00	1.15	0.11	4.48	1.05	76.22
STD	0.188	0.09	0.81	2.46	0.532	0.43	0.34	0.04	0.88	0.34	8.26
CV	2.23	18.75	3.60	70.54	22.7	21.6	29.56	38.09	19.7	32.38	10.9

Conclusion and Recommendations

This study evaluated soil fertility status of soils under cassava production. The fertility indices evaluated include, organic matter content, soil pH, total nitrogen, effective cation exchange capacity, basic cations, and Base saturation. All these fertility indices were found to be entirely low as values where compared with known fertility standards. Therefore, conservation agriculture is strongly recommended which must involve effective integrated nutrient management such as organic farming, agroforestry, alley cropping including application of organic manure, mineral fertilizers and liming. These measures are deemed to be adequate to sustain the fertility status of these soils for both cassava and other field crop production.

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