CHARACTERISTICS AND MANAGEMENT OF SOILS OF AKAMKPA AREA, CROSS RIVER STATE NIGERIA FOR INCREASED COCOYAM YIELDS

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ABSTRACT

Cocoyam is an important food security crop in Nigeria. It occupies a prominent position in the diets and farming systems in the Niger Delta region, especially Cross-River, Akwa Ibom and Rivers States. A Study was carried out to evaluate the character rustics of the soils of Akamkpa local Government Area (LGA) in Cross River State Nigeria for sustainable Cocoyam production. Free survey method was applied in a reconnaissance soil survey to collect soil samples at 0-30cm depth. 300 soil samples were collected and analyzed. Results showed that the soils are predominantly sandy loam and sandy clay loam. The soils were strongly acidic with pH (H_{20}) range of 4.7 to 5.5, the organic carbon content ranged from 0.98 to 2:03% and total N ranged from 0.06 to 0.17% available P was low (6.5 to 13.(mgkg^{-1}).The exchangeable bases were low while the base saturation ranged from 42 to 87%. Integrated use of rice mill waste and inorganic fertilizer at a rate of 10-30tha^{-1} and 600kg ha^{-1} of NPK 15: 15 is recommended to ameliorate the soils to sustain good yield

KEY WORDS: Management, soils, cocoyam and yields

INTRODUCTION

Cocoyam is an important food security crop in Nigeria and variously grown by resource farmers, mostly women who intercrop them with yam maize, plantain, banana vegetables and rice (lkwelle *et al* 2003.) it occupies a prominent position in the diets and farming systems in Rivers, Akwa Ibom and Cross Rivers State, Nigeria is the largest producer of Cocoyam in the world with an annual average figure of 5,068,00 metric tonnes and this accounts for about 37% of total world output of Cocoyam (FAO 2007).

Nutritionally Cocoyam is a superior crop, and research has shown that the protein content of cocoyam is comparatively higher than those of other root crops. It also has a higher score for dry matter content and total essential amino acids than other staple foods (Akomas *et al* 1987). The starch granule of cocoyam is comparatively small and very digestible and are therefore acclaimed to be good carbohydrate source for persons with gastro intestinal disorders and perhaps diabetics (Eleje 1987). Apart from its potential of being nutritive, cocoyam is one of the cheapest and most handy carbohydrates that serve as a base for infant food (Ubalua and Chukwu 2008)

The cultivation of this crop is seldom practiced now and not much research attention is given to it, thus it can be included among the neglected crops. The problem of its neglect stem to yield. This low yield can be attributed to poor soil fertility management because soil is a vital natural resource in which many agricultural activities take place, thus must be managed to guarantee high productivity and sustained. It is noted that there is a long decline in the inherent ability of the soil to grow crops without reliance on input from outside the system.

To this end for Cocoyam farmers in Akamkpa area Cross River State Nigeria to record an increase from the present Cocoyam yields, there is a need to study the various soil nutrient indices and suggest ways of raising them to an appropriate standard needed by cocoyam to yield very well. Therefore the objective of this work was to study the characteristics of soils of Akamkpa area, Cross River State Nigeria and give possible management measures that will enable cocoyam farmers in the area to have an increase in the yield of the crop.

MATERIALS AND METHODS

Soil Location

Soil sample sites were located in Akamkpa local Government Area of Cross River state Nigeria. The approximate Co-ordinate of the area lies between longitudes $8^0 30^1$and 8^0 35^1 East and latitude $5^0 30^1$ and $5^0 32^1$ North. The mean annual rainfall of the area ranges from 3,500 to 4000mm and the mean annul temperature is between 26 to 27^{0c} and mean annual relative humidity of 80-90%. The geologic materials of the area is predominantly Basement complex rocks while the parent materials are Acid crystalline Rocks

Sampling Scheme

After a reconnaissance survey of the area, ten major cocoyam growing communities were identified. They included Akamkpa, Awi, Etekumi, Eyeneje, Usan, Oban, Obung, Okomita, old Netim and Uyanga. A free survey method was applied in a reconnaissance soil survey to collect soil samples at 0-30cm depth. A total of 300 composite soil samples were collected. The samples were preserved in polythene bags and were transported to the laboratory. Thereafter the Soil samples were air dried and screened through a 2mm-sieve prior to laboratory analysis and samples were crushed to pass through a 0.5mm sieve for total nitrogen and organic carbon

Analytical Methods

Soil pH(H_{20}) was determined in 1:2 Soil/water suspension using a glass electrode, particles size distribution was determined by hydrometer method(Bouyocous 1951), bulk density was determined using black (1963) method, organic carbon was determined by the walkley and black method as described by Nelson and summer (1982). Total N was determined by macrokjeldah method as described by Brenner and Muluaney (1982), Available P was determined by Bray P-1method as described by Bray and Kurtz (1945). Exchangeable bases were extracted with neutral ammonium acetate solution, Ca and Mg in the extracts were determined by the EDTA titration method (Black *et al* 1975) and K and N by flame photometry. Exchangeable acidity was determined by IN KCL extraction method (Mclean 1963).Effective Cation Exchange capacity was calculated as the summation of exchangeable bases and exchangeable acidity and % BS was Calculated as exchangeable bases divided by Effective Cation Exchange capacity.

Statistical Analysis

Data collected from the study were analysed statistically using range, mean, standard deviation and coefficient of variation

RESULT AND DISCUSSION

Physical Characteristics

Bulk Density

The result of the bulk density shown in Table 1 ranged from 1.20-1.46 $gcn^{-3}$with a mean value of 1.35gcm^{-3} and a coefficient of variation of 26.7%. Eyeneje had the height bulk density with a value of 1.49 gcm^{-3} while the least bulk density value of 1.20$gcm^{-3}$was obtained from soils of Uyanga. The result of this study indicated that all the soils studied in the area had no problem of excessive high bulk density. Bulk density less than 1.8gcm^{-3} do not impede root penetration. According to National Soil Science Center (NSSCS)(1995) soils with bulk density values of 1.6-1.8gcm^{-3} indicates that aeration and water movement will be too low for optimum root growth

Table 1: Physical Properties of soils of Akamkpa Area

S/N	Location	Bulk density (gcm^{-3})	Particle Size (%)			Texture Class
			Sand (%)	Silt (%)	Clay (%)	
1	Akamkpa	1.38	78.2	8.4	31.4	SCL
2	Awi	1.29	79.0	6.0	14.5	SL
3	Etekumi	1.46	78.4	6.0	18.8	SL
4	Eyeneje	1.49	83.0	11.8	5.2	LS
5	Nsan	1.32	82.2	12.4	5.4	LS
6	Oban	1.43	85.1	11.2	3.7	LS
7	Obung	1.30	85.0	6.5	8.5	LS
8	Okomita	1.28	79.2	6.0	11.8	SL
9	Old-Netion	1.36	80.0	6.3	13.7	SL
10	Uyanga	1.20	73.0	5.0	2.2	SCL

SCL = Sandy clay Loam
SL = Sandy Loam
LS = Loamy Sand

Particle Size Distribution

The result of the particle size as shown in Table 2 shows that the textural classification of the soils ranged from sandy clay loam to sandy loam, with both sandy clay loam and sandy loam occupying sixty percent of the entire soils studied while loam sand occupied the remaining forty percent. In terms of soil separates sandy was generally the highest while silt was the lowest. Generally the textural classification of these soil studied agrees with optimum criterion of light medium loams, sandy soils (IITA 1990) required for unhindered anchorage and bulking of root and tubers and for easy harvest. This gives the indication that these soils are ideal for cocoyam production.

Table 2: Primary nutrient properties of Soils of Akamkpa Area

S/N	Location	Total N (%)	Avail p (mg/kg^{-1})	Exch K $cmol(+)kg^{-1}$
1	Akamkpa	0.10	5.87	0.07
2	Awi	1.70	12.6	0.08
3	Etekumi	0.11	13.0	0.05
4	Eyeneje	0.16	6.11	0.12
5	Nsan	0.10	6.80	0.19
6	Oban	0.09	6.50	0.15
7	Obung	0.06	8.0	0.10
8	Okomita	0.06	8.5	0.09
9	Old-Netim	0.16	13.0	0.08
10	Uyanga	0.08	8.6	0.04

Table 3: Selected Chemical properties of soils of Akamkpa Area

S/N	Location	$pH(H_{20})$	OC%	Exchangeable ECEC Ca	Mg	Na		E.A	BS (%)
						cmol(+)kg^{-1}			
1	Akamkpa	4.7	1.28	0.8	0.5	0.04	1.5	3.41	42
2	Awi	5.3	2.02	3.0	1.54	0.05	0.76	5.43	86
3	Etekumi	5.2	2.08	2.7	1.4	0.02	0.92	5.01	82
4	Eyeneje	4.8	1.70	0.9	0.5	0.05	1.60	3.17	49
5	Nsan	4.7	1.30	1.25	1.2	0.10	1.70	4.45	61
6	Oban	4.6	1.16	1.0	0.9	0.07	1.50	3.62	59
7	Obung	5.5	1.50	2.0	0.7	0.05	2.60	5.45	52
8	Okomita	5.5	1.48	1.8	0.55	0.03	2.20	3.38	61
9	Old-Netim	5.4	2.03	3.2	1.62	0.77	0.77	5.70	87
10	Uyanga	4.8	0.98	0.6	0.5	2.5	2.5	3.44	42

Table 4: Range, Mean (X), standard deviation (SD) and Coefficient of variation(CV) for the physical properties of soils of Akamkpa Area.

Variable	Range	Mean(**X**)	SD	CV (%)
Bulk density(cm^{-3})	1.20-1.49	1.35	0.36	26.7
Clay (%)	2.2-31.4	11.59	8.35	72.0
Silt (%)	5.8-12.4	8.10	2.53	31.2
Sand (%)	73.0-85.1	80.31	3.47	4.3

Primary Nutrient Properties

N, P and k are primary nutrients most commonly demanded by roots and tuber crops most especially cocoyam as well as other crops in plant nutrition. This explains why most compound fertilizers and fertilizer requirement for this crop (Cocoyam)are bases on N, P and K (Chukwu 2007) the results of these nutrients are shown in Table 2 while their range mean and coefficient of variation are shown in Table 5

Table: 5 Range, Mean(X), Standard deviation (SD) and coefficient of variation (CV) for primary nutrient properties of soils of Akamkpa Area

Variable	Range	Mean(**X**)	SD	CV(%)
Total N %	0.06-0.17	0.11	0.21	19.1
Avail ($mgkg^{-1}$)	6.50-13.0	8.90	3.11	34.9
Exchange K cmol(+)kg^{-1}	0.04-019	0.17	0.002	0.12

Total N and Available P

The result obtained shows that total N of the studied soils ranged from 0.06-0.17% with a mean value of 0.11% having a coefficient of variation of 19.1% this result indicates that apart from soils of Awi and Eyeneje and old Netim which exceeded the critical level of 0.15% required for sustainable cocoyam production. The remaining 70% of the studied soils were deficient in total N. Variable response to applied nitrogen was thus expected in these soils. The low status of nitrogen may be explained by poor status of organic matter or by the relatively low nature concentration of nitrogen in most tropical soils.

Available phosphorus values ranged from 6.50-13 mgkg^{-1} with a mean value of 8.90mgkg^{-1} and coefficient of variation of 34.1%. with as much 40% of the soil studied have values lower than the critical limit of 8.0mgkg^{-1}Bray 1-p established for crops in south eastern Nigeria (FPDD 1989) and 100% having value which fell below the critical level of 15mgkg^{-1} Bray 1 extractable P recommended by Thomas and Peaslee (1973) and cited by Amalu (1997). The studied soils were low to severely deficient (Awi) in phosphorus. Highly weathered tropical soils of South Eastern Nigeria are known to suffer from multiple nutrient deficiencies particularly those involving phosphorus. This has been attributed to the strong fixation of the added P by the hydrous Fe and Al oxides in these soils and the low availability of relative phosphorus (Ibia and Udo 1993)

Exchangeable Potassium

Exchangeable potassium were low ranging from 0.04-0.19 cmol (+)kg^{-1} with a mean value of 0.17 cmol(+)kg^{-1} and coefficient of variation of 0.12%. 80% of the studied soils had potassium level which were below the critical values of 0.13cmol(+)kg suggested by Amalu (1997), while 100% had levels which were as well below the critical limit of 2.0cmol(+)kg^{-1}recommended for soils of south-eastern Nigeria (FDPP 1989). These suggest that all the soils will show substantial responses to applied potassium.

According to Chukwu (1997) the area is subjected to annual and seasonal bush burning which occurs about November through February. Burning deprives the soil of natural organic matter input from vegetative and exposes the soils to erosive impact of heavy annual precipitation (1,500.00- >2,000.00mm) in the area. This aggravates leaching due to the coarse nature of the soils. There is high demographic pressure in the area necessitating unavoidable pressure on the land in quest for food and money with a consequential reduction in fallow periods. These factors explain the multi- nutrient deficiencies of the primary nutrients observed.

Selected Soil Chemical Properties.

The results of selected chemical properties of the soils studied are shown in Table 3 while the range, mean, coefficient of variation are shown in Table 6

Table 6: Range, Mean(X), Standard deviation (SD) and coefficient of variation for selected chemical properties of soils of Akamkpa Area

Variable	Range	Mean(**X**)	SD	CV(%)
pH (H_{20})	4.7-5.5	5.05	0.35	6.93
OC (%)	0.98-2.03	1.63	0.40	24.5
Exch Ca(cmol(+)kg^{-1})	0.6-3.2	2.56	1.23	48.0
Exch Mg(cmol(+)kg^{-1})	0.5-1.54	2.24	1.49	66.5
Exch Na(cmol(+)kg^{-1})	0.02-010	0.04	0.004	1.00
EA(cmol(+)kg^{-1})	0.76-2.6	1.61	0.94	58.4
ECEC(cmol(+)kg^{-1})	317-5.70	4.38	0.31	7.1
%BS	42-87	62.1	18.58	29.9

Soil Reaction

The soils were moderately to strongly acid in reaction with a soil pH range of 4.7 to 5.5 and mean value of 5.05, having a coefficient of variation of 6.93%.Reduction of acidity with locally available liming materials and increasing the base status with organic manure and fertilization provide good ameliorative options.

Organic Carbon

Organic carbon varied between 0.98and 2.03% with an average of 1.63% and coefficient of variation of 24.5% the organic carbon content in the soil ranged from very low to low with only 30% that is soils of Awi, Elekumi and old Netim being moderate having values above 2% regarded as critical level of organic carbon content in the soils. Maintenance of a satisfactory organic matter status is essential to the product of most of the nitrogen and half of the phosphorus taken up by unfertilized crops (Von Uxekull 1986)

Exchangeable Calcium, Magnesium and Sodium

Exchangeable calcium content of soils were very low with a range of 0.6-3.2 cmol(+)kg^{-1} and mean of value of 2.56cmol(+)kg^{-1} having coefficient of variation of 48%. The values were far below the critical value of 5.0cmol(+)kg^{-1}recommeded for such tropical soils by Amalu (1997) and lower than 4 cmol(+)kg^{-1} regarded as lower limit for fertile soils (FAO 1976) cited by Onyekwere et al (2001)

Exchangeable Magnesium contents in the soils studied varied from 05-1.54^{-1}cmol(+)kg^{-1} with a mean value of 2.24 cmol (+)kg^{-1} and coefficient of variation of 66.5%. The soils are endowed with good level of magnesium deposit regarding that 0.5cmol (+)kg^{-1}is the critical value needed by soils (Onyekwere *et al* 2003).30% of the studied soils fell within that range while 70% exceeded the range.

The values of exchangeable sodium content in the soils ranged from 0.02-10cmol(+)kg^{-1} with an average value of 0.04 cmol (+)kg^{-1} and coefficient of variation of 1%.this implies that these soils will show considerable responses to sodium application this is because, the values were below 0.2cmol(+)kg^{-1} regarded as the critical value need by the soils (Amalu 1997).

Effective Cation Exchange Capacity (ECEC)

ECEC of the studied soils ranged from 3.17-5.70cmol (+) kg^{-1}with a mean value of 4.38cmol (+) kg^{-1} and coefficient of variation of 7.1%. These results indicates that the Effective Cation Exchange capacity of the soils are low. The low ECEC and nutrient reserves have been attributed to the fact that soils of south eastern Nigeria are strongly weathered, have little or no content of Weatherable rocks in the sand and silt fractious and have predominantly kaolimite in their clay fractions (FPDD 1989)

CONCLUSION AND RECOMMENDATION

The soils of Akamkpa **a**rea studied have light textured soils with good bulk densities for agronomic practices. The soils reaction is strongly acidic with low primary nutrient (NPK) reserves low exchange bases and effective cation exchange opacity.

To obtain higher yields of cocoyam in the soils there should be some remedial measures which include lining at the rate of 0.5 to 10t/ha^{-1} to increase the pH level to near neutral and provide adequate levels of N, P and K, and integrated use of rice mill waste and inorganic fertilizer at a rate of 10-30t/ha^{-1} and 600kg ha^{-1} NPK 15:15:15. All these remedial measures will sustain good yields.

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