CHARATERSTICS AND MANAGEMENT OF FADAMA SOILS OF BARIKIN SALE NIGER STATE, NIGERIA GROWN TO RICE

[1]ONYEKWERE I. N.,[2]IWO, G.A.. [3]EZE, P.C., [1] KORIEOCHA, D.S. AND [1]NWOKOCHA, C.C.

1. Soil Science Division National Root Crops Research Institute Umudike, Abia State, Nigeria.
2. Email: onyeinnoma@yahoo.com

2. Dept. of Crop Science, Faculty of Agriculture, University of Calabar.
3. Soil Science Department Federal University of Technology Minna, Niger State Nigeria

ABSTRACT

A study was conducted to assess the characteristics of fadama Soils of Barikin Sale area of Niger State grown to rice, with a view of evaluating their fertility status and to identify some nutrient management measures for sustainable rice production in the study area. Soil samples at two depths (0- 15 cm and 15 - 30 cm) were collected from nine locations in the area and analyzed. Result showed that the soils were light textured, ranging from loamy sand to sandy clay loam, the bulk density of the soils were non compacted. The soils were moderately acidic, low in organic carbon, total nitrogen, available phosphorus, exchangeable calcium, exchangeable magnesium, exchangeable sodium, available iron and moderate in exchangeable potassium. Some nutrient management measures for these soils for sustainable rice production such as use of green manure, application of rock phosphate, rice straw mulching/incorporation and planting of promiscuous soybean variety were recommended for sustainable rice production in the area.

Key words: Characteristic, Management and Fadama soils.

INTRODUCTION

Sub Sahara Africa region is characterized by chronic food deficit (World Bank, 1984), caused by fast population growth rate and slowest pace of food production (FAO, 1981). The slow pace of production is attributable to many factors among which are vagaries of weather, notably unavailability and uneven monthly distribution of rain fall (Farmer and Wigley, 1985). Unfavourable soil conditions such as low effective cation exchange capacity, low P and K reserves, rapidly declining organic matter and proneness to compaction (Lal 1980).
To satisfy the food demand and ensure the food security of the area, Pendleton and Lawson (1989) suggested that agricultural production needs to be increased by 2.3 percent annually over the next decades in other to even maintain the currently sub-standard nutritional level. This means that there is a great need for larger agricultural expansion and intensification of crop production particularly rice for food security as agricultural land is declining due to urbanization and other uses.

Rice is one food crop that has solved or is nearly solving the food problems of many densely populated countries like India, China, Japan, Taiwan and South Korea. Nigeria as one of the most densely populated black nations in the world with serious food security problems that have gulped its hard earned foreign earnings through food importation can borrow a leave from these nations by establishing the rice culture.

It has then been observed that one of the limiting factors militating against sustainable utilization of agricultural land in Nigeria for rice production is declining soil fertility. A yield increase of 33 percent was achieved in rice production when NPK application was increased from 15:15:15 to 90:30:30: kg ha^{-1} (Palada *et al.,* 1988) in Bida, central Nigeria.

Farmers are often advised to use chemical fertilizer for improving the fertility of the soils, this is however unavailable to resource poor fanners. An affordable low input and sustainable technologically stable and sound fertility maintenance need to be adopted by farmers for increased rice production, to achieve the food security need of the country.

It is therefore necessary to determine the status of soil nutrients as the major contributor to food security. The study reported here evaluated the characteristics of the nutrients in soils of Barikin Sale area of Niger State, Nigeria grown to rice and highlighted possible integrated nutrient management measures for sustainable rice production.

MATERIALS AND METHODS

Soil sample sites were located in Barikin Sale area of Niger State in Southern guinea Savannah ecology of Nigeria. The approximate co-ordinate of the area lies between longitudes 9° 30^1 to 9° 40^1 N and latitudes 6° 30^1 to 6° 40^1E situated at elevation 258.50m above sea level. The mean annual rainfall of the area is 1338 mm, with a mean relative humidity of about 65%. The mean annual temperature of the area is about 27 $.20^c$ (Okoye et aI 1985).The geology consist mainly of Basement complex

After a reconnaissance survey to get familiarized with Barikin sale and identify the major rice growing communities in the area; A total of nine communities namely Tunga Kama, Sauke, Bangwa, Mapi kafunstale, Sapitya, Gidan Tukura, Manhapi and Gidan Dogo were identified, soil samples were collected from each of the nine identified locations at depths of 0-15 and 15-30 cm respectively. A total of eighteen (18) composite samples were made. The samples were preserved in polythene bags and were transported to the laboratory. Thereafter the soil samples were air dried and screened through a 2 mm - sieve prior to laboratory analysis and samples were further crushed to pass through a 0.5 mm sieve for total nitrogen and organic carbon.

Soil pH (H_20) was determined in 1:2 water suspension using a glass electrode, bulk density was determined using Black (1963) method, Organic carbon was determined by 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 and Kurtz (19945). 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 Na by flame photometry. Particle size distribution was determined by hydrometer method. Bouyocous, 1951). Exchangeable acidity was extracted with 1NKCL and estimated in the extract by titration method (Mclean 1965) Effective cation exchangeable capacity was calculated as the summation of exchangeable bases and exchangeable acidity. Available iron was determined by using Tamm's reagent (acidified ammonium oxalate pH3.0) and extraction procedure described by Mekeague and Day (1966) method. SAR was calculated as exchangeable sodium divide by ½ the square root of calcium plus Magnesium. Re salts/data were analyzed

Statistical Analysis

The statistical tools adopted in the analysis of the obtained data were coefficient of variability, range and means

RESULTS AND DISCUSSION

Physial properties of the soil

Some of the physical properties of the soils studied are given in Table 1 while the range, mean, standard deviation and coefficient of variation and given in Table 2. The texture of the soils ranged from sandy to sandy clay loam. The bulk density ranged from 1.36 - 1.72 g/cm^3 which is good for agronomic practice, the result is similar to that of Essoka and Esu (2001).

Table 1: Selected Physical Properties of Fadama Soil of Barkin Sale Area Grown to Rice

S/no	Location	Horizon	Depth (cm)	Bulk Density (g/cm^3)	Particle size (%)			Textural Class
					SAND	SILT	CLAY	
1	Tunga kama	A	0-15	1.37	88.70	6.20	5.10	S
		B	15-30	1.42	85.80	8.00	6.20	S
2	Sauke	A	0-15	1.36	79.20	8.40	12.40	SL
		B	15-30	1.46	79.20	8.40	12.40	SL
3	Bangwa	A	0-15	1.37	75.00	13.30	11.70	SL
		B	15-30	1.45	78.90	8.40	12.70	SL
4	Mapi	A	0-15	1.47	82.00	10.40	7.60	LS
		B	15-30	1.62	85.70	10.10	4.20	S
5	Kafunstale	A	0-15	1.52	79.80	8.20	12.00	SL
		B	15-30	1.66	86.50	10.60	2.90	S
6	Sapitya	A	0-15	1.39	80.80	13.30	9.90	SL
		B	15-30	1.56	86.40	8 .00	5.60	LS
7	Gidan Tukura	A	0-15	1.55	84.00	4.00	12.40	SL
		B	15-30	1.73	95.00	3.00	2.00	S
8	Manhapi	A	0-15	1.43	66.50	15.00	23.50	SCL
		B	15-30	1.44	78.90	10.40	22.00	SL
9	Gidan Dogo	A	0-15	1.45	92.00	4.00	8.00	S
		B	15-30	1.46	89.20	2.00	10.80	S

Table 2: Rage Mean (X), Standard Deviation (Sd) And Coefficient of Variation (CV) For Selected Physical Properties of Fadama Soil of Barking Sale Grown To Rice

Variable	Range	Mean X	SD	CV%
Bulk Density(g/cm^3)	1.36-1.72	1.43	0.22	15.38
Clay (%)	4.20-23.50	10.07	5.81	57.70
Silt (%)	2.00-15.00	8.43	3.61	42.82
Sand (%)	66.50-95.00	82.98	6.65	8.01

Chemical proper of the soils

The result of some chemical properties of the soils studied are shown in Table 3, while the range mean, standard deviation and coefficient of variation are shown in Table 4.

The soil reaction was moderately acidic with a pH range of 5.1 – 6.3 and a mean value of 5.8. The moderately acidic nature of these soils could be attributed to moderate rainfall and low cropping intensity in the area (Beets 1990). The organic carbon content of the soils was low varied from 0.29 – 0.88%, with a mean value of 0.6%. The low organic carbon content of the soils could be attributed to the low natural organic matter returns and other human factors such as burning and removal of crop residue (Ahmed 1995). This could be further attributed to rapid mineralization of the organic matter by micro organism which is active throughout the year as a result of relative high temperature and low amount of clay fraction of the soil (Raji *et al*, 2004).

Total nitrogen content of the soils was low ranging from 0.03 – 0.08% with a mean value of 0.05%. The low amount of total Nitrogen in the soils is a reflection of the organic carbon content in the soils (Onyekwere *et al.*, 2009), since inorganic N is accounting for only a small portion of total N in Savanna soils (Almu and Audu 2001). The C/N ratio of the soils ranged from 9-13 with a mean value of 11.6. This showed that the soils have good C/N ratio index. C/N ratio below 13 is regarded as the critical value for good quality C/N ratio (Windmeijer *et al* 1994).

The available P determined by Bray P – I content of the soils was the low being 4-11 mgkg^{-1} with a mean value of 6.2mgkg^{-1}. The low available P content of these soils is attributed to the generally low total P in savanna soils and the interaction of P and soil constituents (Manu et al., 1995) and due to low phosphate potentials of the parent rock (Raiji *et al*, 2001). Calcium content of the soils was low having a range of 0.4 – 1.76 cmol(+)kg^{-1} with a mean value of 1.21 cmol(+)kg^{-1} which is below 4.0cmol (+)kg^{-1} regarded as lower limit for fertile soils (Onyekwere *et al.*, 2009).

Magnesium status of these soils was low and ranged from 0.38-1.08 cmol (+) kg^{1} with mean value of 0.70cmol (+) kg^{1}. The low value of exchangeable Ca and Mg in the soils could be due to low CEC values of soils resulting from low content of clay and organic carbon (Beet 1990). Exchangeable Potassium value of these soils was moderate, ranging from 0.14 – 0.29 cmol (+) kg^{1} with a mean value 0.21cmol (+) kg^{-1}. This is slightly above 0.20 cmol (+) kg^{-1} regarded as the critical limit of exchangeable K in the soils (Kyuma et al, 1986) and (Onyekwere et al., 2001). Sodium content of the soils was low ranging from 0.16 – 0.32cmol (+)kg^{-1} with a mean value of 0.22 cmol(+)kg^{-1}. The high calcium and magnesium content over K and Na in these soils agrees with the findings of pity (1980) who stated that calcium and magnesium are the most predominant cations in the soil because of their strong adsorption and rapid release into the soil through mineral weathering. The CEC values of these soils were low ranging from 3.99 – 7.57 cmol (+) kg-^{1} with a mean value of 5.38 cmol (+) kg^{-1}. The low cation exchange capacity of these soils indicates the influence of texture and the nature of parent materials. The CEC of soils formed in fine materials appear higher than those of coarse materials. This agrees with earlier studies on similar parent materials in Cross River (Eshett, 1985). Generally the low CEC values of these soils may indicate the dominance of Kaolinite in the fine earth fraction (Ojanuga and Awujoola 1981). Available iron content of the soils is low and varied from 2.6-4.18 mgkg^{-1} with an average value of 3.0mgkg^{-1}. This gives the indication that iron toxicity may not be a problem to rice production in these soils. Fe_2+ activity of 50 – 100 mgkg-^{1} is considered as the range in which rice starts to show iron toxicity symptoms especially in soils with low fertility status (Mansvoort et al 1984).

Nutrient Management

The analytical result of the soils studied revealed that the organic carbon, total nitrogen and available P were low while exchangeable K was moderate. According to IVC-NCU (2000), the Nutrients limiting the yield of rice production are principally nitrogen (N), phosphorous (P) and to a small extent potassium. NPK fertilization in these soils will show a substantial increase in yield to rice farmers but owing to its unavailability and high cost, the resource poor farmers in the study area are advised to integrate NPK fertilizer with an affordable low input technology

1) *Use of green manure*

Planting of multi-purpose trees in the farms so that these trees could be pruned down three to four times a year and then incorporated into the soils. This will increase organic cabon base of the soils Studies at the National Cereals Research Institute Badeggi Niger State showed substantial increase in grain yield of rice upon incorporation of green manure (sesbania rostrata) grown in-situ with or without organic fertilizer. It is therefore recommended for farmers in this area for an enhanced Rice production

2) *Application of rock phosphate*

Farmers in this area are advised to apply rock phosphate as fertilizer in their rice farms. This will improve the available P content of the soils. A study by (Onyekwere *et al*. 2001) reported that rock phosphate is known to persist in some soils for at least 40 years and therefore, the residual effect of rock phosphate is of considerate practical interest in this area.

3) *Rice straw and mill wastes incorporation*

Presently, rice straw and mill wastes constitute environmental pollutants in this area. Analysis of this agro-wastes indicated that it contains 1.85% N, 39% P, 4.30% K, 30% Ca and 0.09% Mg (Ano 1996). Use of these wastes as soil amendment will not only help in solving the disposal problem of these wastes but will also help in improving the low total N, available P and exchangeable K content of the soils.

Table 3: Selected chemical properties of Fadama Soils of Barking Sale Area Grown to Rice

Location	HORIZON	DEPTH(CM)	pH (H_20)	OC (%)	TOTAL N (%)	C/NRATIO	BRAY P-1 (m gk g^{-1}	EXCHANGEABLE CATIONS CEC cmol(+)kg^{-1}							Avail Fe (mgkg^{-1})
								Ca	Mg	K	Na	E A	CEC	ECEC	
Tungan	A	0-15	6.1	0.88	0.08	11	5	0.40	0.90	0.17	0.21	0.50	1.68	3.99	2.18
Kaura	B	15.30	5.8	0.49	0.04	12	6	0.96	0.87	0.16	0.24	0.82	2.23	5.27	3.09
Sauke	A	0.15	6.3	0.33	0.03	11	6	0.68	0.80	0.19	0.22	065	1.89	4.25	2.54
	B	15-30	5.9	0.64	0.05	13	5	0.86	0.98	0.14	0.22	0.42	2.2	4.02	2.62
Bangwa	A	0-15	5.8	0.88	0.07	13	6	1.29	1.08	0.16	0.28	0.65	2.81	6.35	3.48
	B	15-30	5.8	0.76	0.07	11	6	1.29	0.95	0.23	0.25	0.63	2.72	6.26	3.35
Mapi	A	0-15	5.5	0.78	0.06	13	6	0.97	0.71	0.24	0.23	0.71	2.15	5.35	2.86
	B	15-30	5.1	0.69	0.06	11	6	1.21	0.96	0.28	0.22	0.65	2.67	5.91	3.32
Kafuns	A	0-15	5.5	0.59	0.05	12	6	0.96	0.71	0.28	0.23	0.53	2.18	5.02	2.71
Tale	B	15-30	5.9	0.66	0.05	13	6	1.84	0.98	0.29	0.32	0.75	3.43	7.57	4.18
Sapitya	A	0-15	5.8	0.55	0.05	11	11	1.76	0.78	0.21	0.22	0.39	2.97	6.02	3.36
	B	15-30	5.4	0.78	0.08	13	5	0.96	0.72	0.2	0.16	0.56	2.04	5.57	2.6
Gidan	A	0-15	6.2	0.88	0.07	13	4	1.24	0.38	0.22	0.18	0.66	2.02	6.02	2.68
Tukura	B	15-30	6.2	0.52	0.06	10	6	1.76	0.66	0.23	0.21	0.54	2.86	4.37	3.4
Manhapi	A	0-15	5.8	0.36	0.04	9	11	1.40	0.75	0.18	0.19	0.71	2.52	4.73	3.23
	B	15-30	5.8	0.29	0.03	10	6	1.34	0.55	0.24	0.2	0.52	2.33	4.37	2.95
Gidan	A	0-15	5.5	0.37	0.03	12	5	1.32	0.96	0.2	0.19	0.80	2.66	5.76	3.46
Dogo	B	15-30	5.4	0.04	0.04	11	6	1.60	0.46	0.21	0.2	0.68	2.47	5.86	3.15

4) *Planting of promiscuous soybean variety*

The residual effect of promiscuous soybean increases soil nitrogen content, as well as increasing the value of soil available P through symbiotic association with mycorrhizas (Onyekwere et al 2001). Promiscuous soybean variety can as well be planted in these soils prior to the cultivation of rice.

The above integrated nutrient management practices can improve the fertility status of these soils and make them suitable for increased rice production and sustainable food security.

Table 4: Ranges Mean (X), Standard Deviation (SD) AND Coefficient of Variation (CV %) For Selected Chemical Properties of Fadama Soils of Barking Sale Grown to Rice.

Variable	Range	Mean X	SD	CV%
pH(H20)	5.1-6.3	5.8	0.320	5.51
OC(%)	0.29-0.88	O.61	0.20	33.33
Total N(%)	0.03-0.08	0.05	0.20	40
C/N Ratio	9-13.00	11.61	1.24	10.68
Bray p-1(gkg $^{-!}$)	4-11.00	6.22	1.83	29.42
Ca (cmol (+)kg ^{L})	0.4-1.79	1.16	0.44	37.93
Mg (cmol(+)kg $^{-1}$)	0.38-1.38	0.79	0.79	24.05
K (Cmol(+)kg $^{-1}$)	0.14-0.29	0.22	0.06	27.27
Na (cmol(+)kg $^{-1}$)	0.16-0.32	O.22	0.04	18.18
Avail Fe (mgkg $^{-!}$)	2.6-4.18	3.06	0.47	15.36

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