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Soil Fertility Status of Jega Fadama Land, Kebbi State University of Science and Technology Teaching and Research Farm

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ABSTRACT

A survey was conducted at the Kebbi State University of Science and Technology Teaching and Research Farm, in Jega fadama land Kebbi State to investigate the soil fertility status of the area. Soil samples were collected from four soil strata. From each strata, two composite samples were obtained and in each composite sample, ten borings were made using systematic random sampling, at the depth of 0-20 cm, giving a total of eight composite soil samples. The soil samples were analysed in the laboratory using standard analytical techniques. Particle size distribution, soil texture, pH, organic carbon, total N, available P, exchangeable basic cations (Ca, Mg, K and Na) and CEC were determined and the data analyzed using descriptive statistics. It was found that sand particles dominated the area with a range of 49.0 - 88.2%,silt 8.1-35.5% and clay 3.7-19.4%, the soil texture was variable: sandy, sandy loam and loam. Soil organic carbon, total N and available P mean values were 3.55 g kg-1, 0.07 g kg-1 and5.86 mg kg-1, respectively. Exchangeable cations, Ca, Mg, K and Na were0.88, 0.45, 1.55 and 1.17 cmol kg-1 respectively. The soil pH was acidic (5.8) and CEC mean value was 4.92cmol (+) kg-1. It was therefore concluded that nitrogen and calcium nutrient elements were low in the area and augmenting with application of appropriate quantities of organic and inorganic fertilizers rich in N and Ca so as to increase its productivity becomes imperative.

INTRODUCTION

Tropical Sub-Saharan Africa was reported to have a total of 200 million hectares of wetlands of which about 30 million hectares (15%) are used for rainfed rice cultivation (Juo and Lowe, 1985). Fadama is the Hausa name for hydromorphic lands in flood plains and low lying areas. It is a seasonally flooded low lying land occurring along water courses, or on valley bottoms and usually have high water table. They can also be regarded as wet soils formed in inland depressions and alluvial flood plains. In the USDA Soil Taxonomy, fadama soils are described as Aquepts, Aqults, Aqualts, Aquentsetc while the FAO/UNESCO classification referred to them as Fluvisols. Fadama lands have been categorised into three as: those without stream channel, stream plain fadama and flood plain fadama (Singh, 1997b; Okusami and Rust, 1992).

Fadama soils are characterized by high moisture content (residual moisture) which prevails in both dry and wet season during dry spell due to high water table, finer texture, higher organic matter and cation exchange capacity and high contents of total N, available P, S and micronutrients than the adjacent uplands (Singh, 1982) Quartz, K- feldspar and mica are the dominant minerals in the sand fraction in the fadama soils, while kaolinite, smectite and illite constitute the major clay minerals. Fadama land has been described as a wetland in dryland, a garden and a little paradise (Scoone, 1987). The land is among the most important ecosystem on earth which conserves and regulate water supply. Fadama lands have been described as kidneys of the landscape functioning as the downstream receivers of water from natural and human source, also supplying water and thus, reducing both flood and drought, cleansing polluted water, protect sholines and recharge underground aquifers(Isirimah, 2002).

Poor physical condition, inadequate rainfall and low fertility are the major factors limiting crop cultivation in uplands in arid and semi-arid regions of the tropics. *Fadama* soils possessed great potential for sustainable cultivation of crop due to their inherently high fertility and assured availability of moisture all year round. Recently, the land has received greater attention and become increasingly important as they have been utilized for cultivation of high value crops such as tomato, sweet pepper, onion, water melon, lettuce amaranthus, guava, sweet orange, rice, wheat and sugarcane thus constituting a major source ofincome to the rural inhabitants. However, only a few works (Singh *et al*., 1996; Singh, 1997 and 1999, Wadata *et al*., 2011 and Musa *et al*., 2014) is available regarding *fadama* lands in Northern part of Nigeria. Development of sound agricultural policy for the development of the land and sustainable agricultural production depend to a large extent on a sound knowledge of their physical and chemical properties. The objectives of this study therefore are to: Determine the current fertility status of the fadama soil in the study area, identify common fertility constraints and proffer suggestion on how to remedy the problems in the study area.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of Kebbi State University of Science and Technology located at Jega town (Lat.12^o 11’, Long. 4^o 16’ E) in the Sudan Savanna zone covering twenty hectares of land. The climate of the area is Dry sub humid. Temperature varies from about 15^{o}C in November through January to about 40^{o}C in March to May and means annual rainfall is in the range of 580mm-700mm (Arnborg, 1988). Relative humidity ranged between 21-47% in the dry season and 51-79% during rainy season. The area supports natural vegetation such as *Ficusspp*, *Balanitesegyptiaca*, *Acacia spp*. Current land use practices include the cultivation of onion, tomato, maize, pepper and garden egg. Geology of the area comprised of Cretaceous and Tertiary sedimentary rocks overlying basement complex (FDALR, 1985).

Sampling Technique

The Farm was divided into four strata North, West, East and South. Two composite soil samples were taken from each stratum and each composite comprised of ten borings collected at one meter interval in each stratum. The samples were taken at the depth of 0-20 cm with the aid of an auger. The samples were taken to the laboratory, air dried and gently crushed. They were then analyzed using standard laboratory techniques.

Soil analytical techniques

Particle size distribution was analyzed using the Hydrometer method. Soil texture was determined with textural triangle. Organic C was determined using Walkley-Black (1934), total N by Micro-Kjeldahl technique and available P using Bray 1 method (Bray and Kurtz, 1945). pH $CaCl_2$ (1:2.5) was determined with glass electrode pH meter (Jackson, 1962), CEC was determined by saturating the soil with excess ammonium acetate solution and washing with excess alcohol. The samples were later distilled and the distillate received over boric acid indicator and titrated against standard HClas outlined by Chapman (1964).Exchangeable bases were extracted with neutral NH_4 Ac solution; Na and K were then read on flame photometer while Ca and Mg determinations were determined by EDTA titration
Data obtained from soil analyses were analysed using descriptive statistics.

RESULTS AND DISCUSSION

Table 1, shows the particle size distribution of the soil at the Teaching and Research Farm of the Kebbi State University of Science and Technology at Jega fadama. Sand particles ranged from 49.0-88.2%, silt, 8.1-35.5%

while clay particles ranged 3.7-19.4%. It is evident that sand particles were dominant in the area, this was immediately followed by silt and clay gave the least proportion of particles. The soil texture ranged from sandy loam in the north, loam in the West and South sections while sand was the dominant texture in the East. The sand and sandy loam texture of the soils implies that they will be well drained and aerated. Due to sandy nature of the soil in the east section of the farm the soil would need some conservation practice to maintain good moisture content. The sandy loam texture in this finding agreed with the report of Singh (1997b)which indicated that sandy loam was the dominant texture in Sokoto River basin area.

Organic Carbon

Results (Table 2) on soil organic carbon values for Jega Fadama land ranged from 0.2-8.4 g kg^{-1} with an overall mean of 3.55 g kg^{-1}. The soils were found to be low organic carbon content based on the organic C value of >1.0% (<10 g kg^{-1}) for low category rating Esu (1991).Low soil organic C in this report is in line with the findings of Singh (1999a) which indicated organic C in the range of0.01-2.3 g kg^{-1} for the fadama soil in Kebbi State. It is also in harmony with the report of Webster and Wilson (1990) which showed low soil organic C (0.12%) for West African hydromorphic soils. In the same vein, Kozah (1997) observed low organic C value for soils of RafinYaki valley in Bedi village of Zuru local government area in Kebbi State. The low soil organic C observed here could be an indication the soil physical and condition such as structure, CEC and pH may be negatively affected.

Table 1: Particle size distribution and soil texture of Jega Fadama land, Teaching and Research Farm of the Kebbi State University of Science and Technology, Aliero

Particle size	Soil strata								Overall mean
	North (1a)	North (1b)	West (2a)	West (2b)	East (3a)	East (3b)	South (4a)	South (4b)	
Sand	68.0	78.4	49.0	54.9	88.2	88.2	49.0	49.0	65.6
Silt	18.5	12.0	27.7	25.7	8.1	8.1	31.6	35.5	20.9
Clay	13.5	9.6	23.3	19.4	3.7	3.7	19.4	15.5	13.5
Texture	Sandy loam	Sandy loam	Loam	Loam	Sand	Sand	Loam	Loam	Sandy loam

Table 2: Organic C, total N and available P contents in Jega fadama land, Teaching and Research Farm of the Kebbi State University of Science and Technology, Aliero

Soil parameter	Soil strata								Overall mean
	North (1a)	North (1b)	West (2a)	West (2b)	East (3a)	East (3b)	South (4a)	South (4b)	
Org. C g kg^{-1}	5.0	2.6	3.4	0.8	5.6	8.4	2.4	0.02	3.55
Total N g kg^{-1}	0.07	0.06	0.07	0.06	0.08	0.07	0.06	0.06	0.07
Avail. P mg kg^{-1}	5.7	5.8	7.3	7.1	6.3	6.0	4.6	4.1	5.9

Total N

Total N content at the Teaching and Research Farm of the University ranged from 0.06-0.08 g kg^{-1} (overall mean 0.07 g kg^{-1}). Based on soil fertility rating scale given by Esu (1991) for Nigerian soils which indicated a value of < 1g kg^{-1} for low total N, the soils in the study area were low in total N content. Low values of total N observed in the study area corroborated the findings of Jones (1973) which indicated low total N values (0.07-0.29 g kg^{-1}) in the well drained top soils in Savannah region of Nigeria. Also, Kozah (1997) reported low values (0.001-0.650 g kg^{-1}) for total N from soils in Rafin Yaki valley in Bedi village of Zuru local government area of Kebbi State. Similarly, Singh (1999a) noted that 12-65% of the Fadama soils in Kebbi State were found to have total N content. He reported that it ranged between 0.1 and 0.2g kg^{-1}. The low total N content in the soils may be attributed to removal of crop residue on farmlands and low application of organic residues for crop cultivation coupled with low vegetative cover for returning organic matter to the soil. There is therefore the urgent need to improve total N in the soil through the addition of organic and inorganic fertilizers.

Available P

Phosphorus content of the soils in the study area is shown in Table 2. Values for available phosphorus ranged between 4.1 and7.3 mg kg^{-1}(overall mean, 3.55 mg kg^{-1}) The values for available P observed in this report is at variance with the findings of Singh and Tsoho (2001) which indicated that available P values ranged from0.01-0.03 mg kg^{-1} and 0.1-0.07 g kg^{-1} for soils around River Rima in Sokoto and around Goronyo Dam, respectively. However they compared well with the findings of Singh (1999b) on available P value of 2.2 g kg^{-1} for the fadama soils of Zamfara State. Available P values in the study area were found to be low considering the values for available P ratings given by Esu (1991) which set P values of less than 10 mg kg^{-1} in the low category rating for available P.

Exchangeable Ca and Mg

Exchangeable Ca values in the location ranged from 0.07-1.10 cmol kg^{-1} with a mean of 0.88 cmol kg^{-1} (Table 3). An average value of 6.6 cmol kg^{-1} for exchangeable Ca was reported on the soils of Kebbi State (Singh, 1999a). Exchangeable Ca values of 0.04-1.84 cmol kg^{-1} were reported by Onyekwere and Ezenwa (2009) for soils in Barikin Sale, in Niger State. This compares favourably well with this findings. The Ca content of the study area is low.Adepetu*et al.* (1979) set Ca value of 2.0 cmol kg in the low limit. Exchangeable Mg values obtained from the study site were in range of 0.35-0.85 cmol kg^{-1} (mean, 0.45 cmol kg^{-1}). The values for exchangeable Mg observed here were moderate based on the ratings of Adepetu *et al*. (1979). The finding is in accord with the report of Adeboye*et al* (2009) on moderate Mg content on the soils of GidanKwano Teaching and Research Farm of the Federal University of Technology, Minna, Niger State.

Exchangeable K and Na.

Exchangeable K content within the fadama soil at the study site ranged between 0.77 and 2.44 cmol kg^{-1} with a mean value of 1.55 cmol kg^{-1}. While exchangeable Na was observed to range from 1.04-1.30 cmol kg^{-1}(Table 3). Singh *et al.* (1996) observed exchangeable K values of0.05-0.22cmol kg^{-1} for KandoliShela valley soils which were lower than the values in this finding. Also Graham and Singh (1997) reported exchangeable K mean value of 0.5 cmol kg^{-1} in Wurno Irrigation Scheme. Onyekwere and Ezenwa reported low values for exchangeable Na for soils in Barikin Sale in Niger state. In a similar way, Sahabi*et al*. (2002) observed exchangeable Na values of 0.39, 0.53 and 0.51 cmol kg^{-1} for the fadama soils of Kalambaina, Illela/More and the Usmanu Danfodiyo University, Sokoto Fadama land respectively.

CEC and pH

The study site gave cation exchange capacity (CEC) values that ranged from 4.48-5.66 cmol (+) kg^{-1} with mean value of 4.92 cmol (+) kg^{-1} (Table 3). The soil pH was found to range between 5.62-5.94. The CEC values reported in this finding were lower than the values of 4-34 cmol (+) kg^{-1} observed for soils in Dange area of Sokoto State (Agbu and Ojanuga, 1989). Also, they were lower than 6.39-14.64 cmol kg^{-1} reported by (Singh, 1997b) for fadama soils in the Sokoto Rima Basin. However, the values were closer to the ones reported for West African soils (Jones and Wild, 1975) which indicated that they ranged from 3-8 cmol (+) kg^{-1}.Soil pH was moderately acidic and agreed with the pH values of 5.1-6.2 and mean value of 5.7 for Sokoto Rima River Basin soils as reported by Yacouba (1996).

Table 3: Exchangeable Basic cationic content, pH and CEC inJega fadama land, Teaching and Research Farm of the Kebbi State University of Science and Technology, Aliero

Soil Parameter	Soil strata								Overall mean
	North (1a)	North (1b)	1West (2a)	West (2b)	East (3a)	East (3b)	South (4a)	South (4b)	
Exch. Ca (cmol kg^{-1})	1.00	0.85	0.90	1.10	0.95	0.70	0.75	0.80	0.88
Exch. Mg (cmol kg^{-1})	0.40	0.40	0.45	0.85	0.35	0.40	0.35	0.40	0.45
Exch. K (cmol kg^{-1})	0.77	0.92	2.44	2.23	1.28	1.08	2.26	1.44	1.55
Exch. Na (cmol kg^{-1})	1.04	1.13	1.30	1.17	1.22	1.09	1.22	1.22	1.55
pH	5.78	5.62	5.86	5.92	5.70	5.78	5.82	5.94	5.80
CECcmol (+) kg^{-1}	4.48	4.52	5.36	5.66	4.70	4.58	5.12	4.94	4.92

CONCLUSION AND RECOMMENDATION

Generally the soils in the fadama were found to below in organic C, total N and exchangeable Ca. Exchangeable Na, Mg and K values were high, while available P, CEC and pH were moderate. Application of organic residues and inorganic nitrogen fertilizer could therefore be recommended for increased agricultural production in the area.

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