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FERTILITY ASSESSMENT OF SOILS UNDER RICE CULTIVATION IN KADAWA, GARUN MALLAM LOCAL GOVERNMENT KANO STATE

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ABSTRACT

This research was conducted in Kadawa, Garun Mallam local government of Kano State with aim of assessing the fertility of soils under rice cultivation in the area. Ten (10) composite samples were randomly collected from the top (0-20cm) in the sites. The samples were analyzed for some soil fertility index parameters using standard routine laboratory tests. In addition, Mean values of soil parameter determined were computed so as to compare the results with the critical limits for interpreting levels of soil fertility. The findings indicated that the soil texture was generally sandy loam with brown colour. The soil was moderately acidic with mean pH values of 6.07 and 5.95 in water and $CaCl_2$ respectively. The electrical conductivity (ECE) ranged from 0.027 to 0.2 dS/m with a mean of 0.097 dS/m. The total nitrogen (TN) ranged from 0.035 to 0.053% with a mean of 0.05%. The organic matter content (OM) ranged from 0.79 to 1.87% with a mean of 2.61%. The Available phosphorus (AP) ranged from 9.63 to 87.50ppm with a mean of 54.87ppm. Furthermore, The Exchangeable K ranged from 0.11 to 0.87Cmol/kg with a mean value of 0.24Cmol/kg and Cation Exchange Capacity (CEC) ranged from 5.0 to 11.0Cmol/kg with a mean of 7.57. it was recommended that organic manure and inorganic fertilizer should be applied to the soils in order to improve nitrogen, phosphorus and potassium levels.

Keywords: Soil, Fertility, Assessment, Rice Cultivation

INTRODUCTION

Hilgard (1914) defined soil as "the more or less loose and friable material in which, by means of their roots, plants may or do find a foothold and nourishment, as well as other conditions of growth."This is one of the many definitions that consider soil primarily as a means of plant production. Soil fertility is defined as the ability of a soil to supply essential elements for plant growth without a toxic concentration of any element (Foth, 1990).

Many factors are responsible for the quality of any given soil and these factors are generally called indicators and they include agro-climatic, hydrogeology and cropping/cultural practices (NAS, 1993). Although, it is difficult to measure (Cannon and Winder, 2004), however it still needs to be evaluated regularly, because nearly all land uses depend on healthy soil functions (USDA, 2002). The necessity for regular investigation of soil in order to evaluate its quality is further heightened because of the simple fact that land use and management can change the capacity of the soil to function (Karlen, 1997; USDA, 2002). There are three basic processes through which soil quality can be degraded namely, physical (erosion); chemical (Salinization, alkalinity, nutrient deficiency and heavy metal contamination) and biological (which borders on loss of organic matter) (NAS,1993)

Rice cultivation is intensively carried out year round in the area therefore there is incessant uptake of nutrients especially those that are essential for the growth of rice. This continuous uptake of these nutrients may cause the soil to be deficient in certain nutrients which in turn render the soil to be infertile. In view of the aforementioned reasons, this research is aimed at

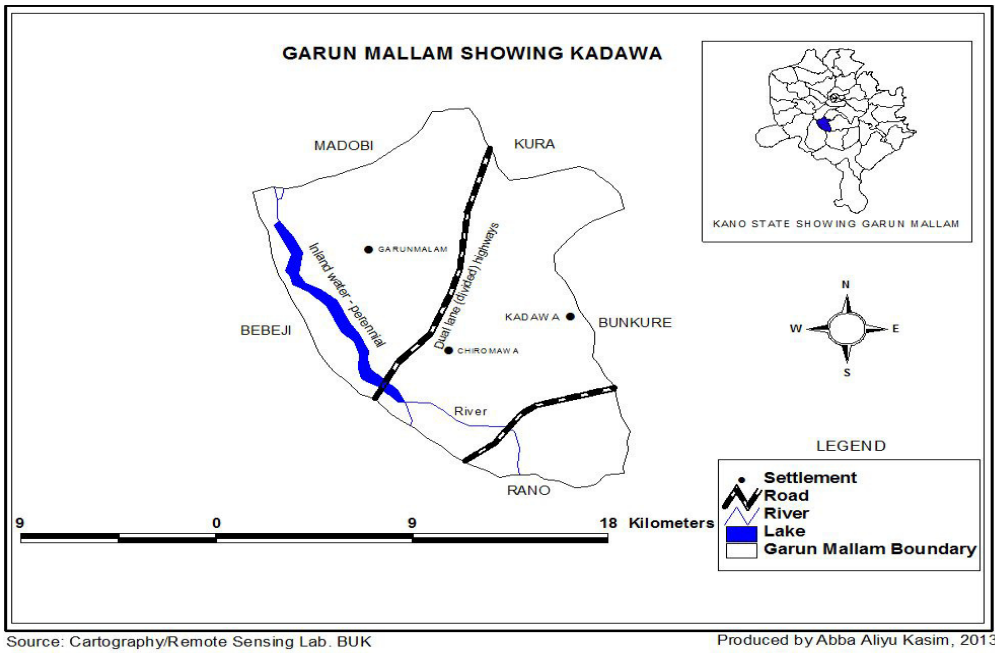
ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

assessing the fertility of soils under rice cultivation in Kadawa in order to boost the production and achieve sustainable and judicious utilization of soils.

MATERIAL AND METHODS

Study Area

The study area is positioned in Garun Malam Local Government area in southern part of Kano State. It is bordered with Kura and Madobi Local Governments to the north; Rano Local Government to the south; Bebeji Local Government to the west and Bunkure Local Government to the east (figure 1). Kadawa is enclosed between latitude 11^0 30"N and longitude 8^0 30"E. The area has been identified as an area where mechanized and intensive irrigation activities are taken place.



Climate

The climate of Kano State (Kadawa inclusive) is the tropical wet and dry type denoted as ***Aw*** by Wladimir Koppen (1936) in his climate classification. The temperature is averagely warm to hot throughout the year at about 25°C+/-7°C (Olofin and Tanko, 2002). The monthly rainfall distribution over the Kano region is characterized by one peak (single maximum) which is usually attained in August (Buba, 2009).

Vegetation

The Sudan savanna can be said to be the natural vegetation of Kano State (the study area inclusive). It is composed of a variety of trees scattered over the expanse of grassland. Distinctive trees that can be found in the area include: acacia albida, parkia clappa toniana, Mangifera indica etc

Soil

The soils of the area have sandy loam textured surface and sandy clay loam textured subsoil (NEDECO, 1976; IAR, 1994). Malgwi (2001) classified the soils of the area as Aquic Natrustalfs and Aquic Haplustalfs using the USDA soil taxonomy and Gleyic Solonetz, Haplic Solonetz and Calcic Luvisols using the FAO classification system.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Geology

The area is predominantly underlain by older granites and younger metasediments of Precambrian to lower palaeozoic age (McCury, 1976).

Sample Collection

The soil samples were collected from different farmlands using random sampling method. Ten (10) soil samples were collected at a depth (0-20cm) using soil auger and trowel.

Laboratory Analyses

Standard laboratory methods were used to determine the physical and chemical properties of the soil samples. Munsell soil colour chart was used for determining colours of the soil samples. Soil texture (particle-size distribution) was determined using (Bouyouscos, 1962) method, popularly known as hydrometer method). Soil pH, both in water and $CaCl_2$ (1:2.5 soil- water ratio), was determined using glass electrode pH meter, EC was determined using conductivity meter at 25^oC in 1:5 soil-water ratio, the reading was multiplied by 6.4 (Landon, 1991) to obtain the ECe. Organic carbon was determined using the Walkley – Black (1965) and the values were multiplied by 1.73 to get organic matter; total N was obtained using the Macro kjeldahl digestion–distillation method (1965) and available P was determined using the Bray-1 method (Bray and Kurtz, 1945). Cation exchange capacity was obtained using 1M ammonium acetate (NH4OAC) saturation method (Page *et al*., 1982). Na and K in the extract was determined using flame photometer.

Statistical Analysis

Descriptive statistics (mean values) of soil parameters were computed and employed to compare the results with the relevant findings. Rating of soil organic matter as low, medium and high was adopted from Adamu (1997). Critical Limits for Interpreting Levels of Soil Fertility, Salinity and Sodicity Analytical Parameters was adopted from Omar (2011).

RESULTS AND DISCUSSION

This section presents the results obtained from various soil analyses (both physical and chemical parameters). The relationship between nutrient uptake of rice and present soil fertility is also discussed. Table 1 presents the mean values of the parameters determined.

Table 1. Mean Values of Soil Parameters Determined in the Study Area

Parameter		*Mean*	*N*
Soil texture	*Clay%*	8.8	10
	Silt%	26	10
	Sand%	83.9	10
Textural class		Sandy loam	10
Soil colour		Brown	10
pH ratio 1:2.50	*H_2O*	6.07	10
	$CaCl_2$	5.95	10
ECE (dsm)		0.097	10
OC%		1.51	10
OM%		2.61	10
TN%		0.05	10
AP (ppm)		54.87	10
K (Cmol/Kg)		0.24	10
CEC (Cmol/Kg)		7.57	10

Source: Laboratory analytical data 2012

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Based on the results of laboratory analyses, the soil parameters determined are painstakingly explained in the following sections.

Soil Colour

The findings of soil colour determination have shown that all the soil samples were generally brown in colour (Table 2). This indicated a high level of organic matter content in the soil samples which in turn indicates the level of fertility. This heralded that the soil is likely to be fertile due to abundance of soil organic matter. According to Foth, 1990, soil colour is an important soil parameter because it is an indirect measure of other important characteristics such as water drainage, aeration, and organic matter content.

Soil Texture

The particle size distribution ranged from 6-18%, 22-32% 54-76% clay, silt and sand respectively, hence sand particles dominated the soils. The average soil texture for the all soil samples was found to be sandy loam (Table 2). This is in accord with what Maduakor (1991) found. He found out that most of the soils of sudano-sahelian zone of Nigeria are sandy to very fine sandy loam (the study area inclusive). The soils had high amount of sand and little amount of silt and clay (Table 2). This is in conformity with what Jibrin e tal. (2008) found. They found out that soils at Kano River Irrigation Project (KRIP) contained high amount of sand with little silt and clay.

Table 2. Soil physical parameters of the individual samples

Sample	*Clay%*	*Silt%*	*Sand%*	*Textural Class*	*Soil Colour*
1	10	30	60	Sandy loam	Brown
2	18	28	54	Sandy loam	Brown
3	10	32	58	Sandy loam	Brown
4	8	22	70	Sandy loam	Brown
5	6	24	70	Sandy loam	Brown
6	10	24	66	Sandy loam	Brown
7	6	22	72	Sandy loam	Brown
8	6	18	76	Sandy loam	Brown
9	6	28	66	Sandy loam	Brown
10	8	32	60	Sandy loam	Brown

Source: Laboratory work, 2012

Table 3 shows the surface texture in some selected areas in sudano-sahelian zone of Nigeria. Generally speaking, the soils under rice cultivation Kadawa were well-drained as they contained high amount of sand with little silt and clay (Table 2)

Table 3. Surface Texture of some soils in Sudano-sahelian zone of Nigeria

Site	*Sand%*	*Silt%*	*Clay%*	*Texture*
Kadawa	85.0	11.0	4.0	Loamy sand
Kano City	87.0	9.0	4.0	Loamy sand
Dambatta	92.0	4.0	4.0	Sand

Source: Maduakor, 1991

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

pH

The result has shown that the pH values in water and in $CaCl_2$ ranged from 5.40-7.10 and 5.20-6.40 respectively (Table 4). The mean pH values in water and $CaCl_2$ were found to be 6.07 and 5.95 respectively (Table 1). This indicated that the soil was moderately acidic. The moderate acidity of the soil might be as a result of the leaching of basic cations or due to incessant uptake by crop. The moderate acidity implied that nutrients are likely to be available for crop uptake. Odunze e tal (2006) asserted that the pH range of 5.5- 6.5 is optimum for the release of plant nutrients.

Table 4. Soil Chemical Parameters of the Individual Samples

Sample	*pH ratio 1:2.50*		*ECE (dsm)*	*OC (%)*	*OM (%)*	*TN (%)*	*AP (ppm)*	*K Cmol/Kg*	*CEC Cmol/Kg*
	H_2O	*$CaCl_2$ 0.01M*							
1	6.70	6.40	0.120	0.79	1.36	0.053	45.50	0.20	9.00
2	5.90	5.40	0.050	0.83	1.43	0.053	9.63	0.87	11.00
3	5.40	4.70	0.035	0.54	0.93	0.035	57.80	0.15	9.40
4	5.40	4.60	0.027	1.08	1.87	0.053	52.50	0.14	7.30
5	5.40	4.70	0.075	0.62	1.07	0.035	66.50	0.11	6.10
6	5.90	5.30	0.090	0.75	1.29	0.053	19.25	0.27	7.30
7	6.20	5.60	0.10	0.81	1.40	0.053	82.30	0.20	6.00
8	7.10	6.20	0.20	0.46	0.79	0.035	70.00	0.14	5.00
9	6.80	6.20	0.20	0.66	1.14	0.035	57.80	0.16	6.20
10	5.90	5.20	0.070	0.81	1.40	0.053	87.50	0.19	8.40

Source: Laboratory work, 2012

ECe (decisiemens per meter/dS/m)

The finding indicated that The EC values ranged from 0.027-0.1dS/m with a mean value of 0.097dS/m (Tables 1 & 4).This signified that the ECe was generally low in all soil samples hence the salinity effect is negligible. According to Forth 1990, salinity effects are mostly negligible within the ECe range of 0-1dS/m. Landon (1991) and Esu (1991) classified soils with ECe of less than 4.0dS/m as non saline. Therefore, the soil of the study area was generally non-saline.

Soil Organic Matter (SOM/%)

The values of organic matter content ranged from 0.79-1.87% (Table 4). The mean soil organic matter of the soil samples was found to be 2.61% (Table 1).According to guidelines for rating soil fertility indicators suggested by ILACO, 1985 and Landon, 1991, the soil had high amount of organic matter content. The high level of soil organic matter in the study area could be attributed to the high return of litter or agricultural residues to the soils.

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Table 5. Critical Limits for Interpreting Levels of Soil Fertility, Salinity and Sodicity Analytical Parameters

Parameter	Low	Medium	High	Units
Ca	< 2	2 – 5	> 5	cmol (+)/kg
Mg	< 0.3	0.30 – 1.0	> 1.0	cmol (+)/kg
K	< 0.15	0.15 – 0.30	> 0.30	cmol (+)/kg
Na	< 0.1	0.1 – 0.30	> 0.30	cmol (+)/kg
CEC	< 6	6 -12	> 12	cmol (+)/kg
BS	< 50	50 – 80	> 80	per cent (%)
Org. C	< 10	10 – 15	> 15	g/kg
Total N	< 0.1	0.1 - 0.2	> 0.2	g/kg
Avail. P	< 10	10 – 20	> 20	mg/kg

Source: Esu (1991)

pH[1]		**Saline soil***		**Sodic soil***	
Ultra acid	< 3.5	ECe	> 4.0 dS/m^2	ECe	< 4.0 dS/m^2
Extremely acid	3.5 – 4.4	ESP	< 15 %	ESP	> 15
Very strongly acid	4.5 – 5.0	pH	< 8.5	pH	> 8.5
Moderately acid	5.5 – 6.0				
Slightly acid	6.1 – 6.5	1= **Source**: Esu (1991) * = **Source**: Landon (1991)			

Adopted from Omar, 2011

Total Nitrogen (TN/%)

The result has shown that the total nitrogen ranged from 0.035-0.053% with a mean of 0.05% (Table 1 & 4). This value fell within the range suggested by ILACO, 1985 and Landon, 1991 as low.

Available Phosphorus (AP/ppm)

Available P ranged from 9.63-82.30ppm (Table 4). 54.87ppm mean value of AP was obtained (Table 1). This heralded a high amount of AP (ILACO, 1985 and Landon, 1991).

Exchangeable potassium (Exch. K/Cmol/kg)

Exchangeable K ranged from 0.11-0.87Cmol/kg with a mean value of 0.24Cmol/kg (Table 1 & 4). This fell within the low range (ILACO, 1985 and Landon 1991).

Cation Exchange Capacity (CEC/Cmol/kg)

The finding has shown that Cation Exchange Capacity (CEC) ranged from 5.0-11.0Cmol/kg (Table 4). The mean CEC was found to be 7.57Cmol/kg (Table 1). This value fell within the medium range suggested by ILACO, 1985 and Landon, 1991.

CONCLUSION

Conclusively, the soil was generally fertile and non-saline. This is because most of the soil fertility parameters determined fell within the acceptable limits. The soils were well-drained and moderately acidic. The moderate acidity inferred that nutrients are likely to be available for crop uptake. Therefore, the aforementioned soil characteristics made the soils fertile and highly recommended for crop production.

RECOMMENDATIONS

Based on the aforementioned findings, the following recommendations are suggested;

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

1. Sufficient amount of inorganic fertilizer and organic manure should be applied so as to improve the levels of nitrogen, phosphorus and potassium in the soil and soil water holding capacity.
2. Low tillage practices should be promoted in order to minimize loss of organic matter.
3. Continuous monitoring of fertility status of the soil for quality evaluation should be carried out regularly.

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Vol. 5 No. 1 January 2014

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