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Evaluation of Fertility Status of Soils of Yagba West Local Government Area of Kogi State

Amhakhian Sunday Okhonfoh*, Oyelude Ifelola, AINA Oluseyi Abel

Department of Soil and Environmental Management, Faculty of Agriculture, Kogi State University, Anyigba, Nigeria

Abstract

The study was conducted to evaluate the current soil fertility status of different farmlands in Yagba West Local Government area of Kogi state. A total of 24 samples were taken from two districts at a depth of 0-15cm and 15-30cm from each ward. The samples were analyzed each for their Physio-chemical properties. The results obtained showed that particle size distribution ranged from loamy sand (LS) to sandy loam (SL). The pH of the area were within 5.0-6.54, a pH range suitable for most agricultural crops, while EC of the soils ranges from 0.10-0.60µmhos/cm. Available phosphorus (P) in the soil ranged from 2.26-20.42mg/kg with a mean value of 8.02mg/kg at depth of 0.15cm and 1.23-14.2mg/kg with a mean value of 5.66mg/kg at depth of 15-30cm, which is below the critical value of 15ppm. Total nitrogen and organic carbon fell below their critical values of 0.78% and 0.64% respectively. Exchangeable cations (Ca, Mg, K, Na) gave mean values of 3.21, 1.14, 1.38 and 0.64Cmol/kg respectively of Ca, Mg, K and Na. Exchangeable acidity has a mean value of 1.0(Cmol/kg) a condition that indicated moderate acidity, meaning that the soil should be properly managed for optimum productivity, with percentage base saturation of 86.91 (mol/kg) mean value.

Keywords

Electrical Conductivity, Exchangeable Cations, Optimum Productivity

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1. Introduction

The fertility of the soil is influenced by various factors such as biological, physical and chemical (Abbot and Murphy, 2003). The level of soil fertility depends on the inherent characteristics of the soil to compaction which are dependent on the parent material (original rocks). These three components of a soil influence each other, it is likely that the physical nature of the soil has the most impact, whereas the soil organisms has greater impact on the chemistry of a soil than the physical components. The physical and chemical are linked by processes. Such as nutrient absorption and desorption from surfaces. The soils are subjected to a variety of disturbances, and it can alter the linkages between the three soil components.(Abbot 2003).

Where the soil is disturbed, the effect on soil fertility are complex, (i.e.) it may be direct (acting on each component separately or indirect whereas a change in a physical aspect leads to a change in the chemical or biological aspect.) (Abbot, 2003). The physical character of soil is determined by the balance of clay, silt and sand particles and by the organic humus content of the soil. The soil structure also influences the soil workability, drainage arid management. The pH has significant influence on the solubility and bio-availability of Nutrients, in calcareous soils with pH (7.5 and above) there is reduced availability of phosphorus (P). The phosphorous in soil with high concentration is washed off. It is not because phosphorus itself can greatly enhance productivity but status is frequently the factor that limits the plant ability to exploit other resources principally Nitrogen,

* Corresponding authorE-mail:
E-mail address: amha_s123@yahoo.com (A. S. Okhonfoh)

and other micro nutrients such as iron, copper, zinc, manganese (Donald Mclntyre, 1990).

Weathering/leaching causes the loss of soluble nutrient, both nitrates No_3 and NH_4. The available potassium (k) varies with soil texture, depending upon the parent material and its degree of weathering. (Donald Maclntryre 1990). Presently very little is known about the fertility Status of soils in Yagba West Local Government Area of Kogi State, no work has been carried out in the area of evaluating the fertility status of soils in the area. The aim of this study was to determine the variability of the soils, as well as to proffer management practices for the soils in the area.

2. Materials and Methods

2.1. The Area of the Study

The study was carried out in Yagba West Local Government Area of Kogi State. The area is located at the Western part of the State adjoining Kwara State, latitude of 8,15N and 5,33E, total land area of 11,276km, and population at 149.023[2006 census]. The local government is made up of two districts and fourteen [14] wards, with the Egbe district made up of seven wards which include Egbe Oke-Egbe, Egbe Idisin, Igbogbo, Ilenla, Isaba, Okua, Ijalu. The other seven wards are Ejiba, Odo-Ere, Odo-Eri, Odo-Ara, Igbaruku/Iyamerin, Okuran/Okoloke, Isanlu Esa, Ogbe. But for the purpose of this research work, only twelve wards were used. The area falls within the humid belt zone of Nigeria, which is characterized by the wet and dry season, the wet season starts towards early April and ends towards late October which is called the raining season. The dry season sets in November and last up to march. The area consist of the Sahel Savannah, trees such as Shea butter, Locust beans trees, Cashew, Mango and Orange trees can be found in the area. The major occupation of the people is farming, but this is practiced on a subsistent level. Food crops majorly staple food such as Maize, Guinea corn, Yam and cassava are grown. Animals such as Goats, Sheeps and poultry birds are reared.

2.2. Soil Sampling

Soil samples were taken from the 12 wards of the Local Government at two depths: 0-15 and 15-30cm. In each ward four samples were taken at different locations and a composite sample was taken from each. The samples were air dried at room temperature, gently crushed and sieved with a 2mm sieve, for physical/chemical analysis in the laboratory. A representative of each sample collected was analyzed. The P^H of each sample was read using a P^H meter according to Mclean, 1982. The electrical conductivity was measured using the EC electron. (Rayment et al., 2011). The percentage clay, silt and sand were determined according to Bouyocous (1962). The textural classes of the soils were determined using the textural triangle. Organic carbon and organic matter were determined by wet dichromate acid oxidation method (Nelson and Sommers, 1982). The nitrogen content of the soil was determined using Kjeldahl method. (Bremner and Mulvancy, 1982). Available phosphorus was determined by Bray and Kurtz (1945) extraction procedure. The exchangeable cationsCa^{2+}, Mg^{2+}, Na^{2+} and K^+ were extracted in ammonium acetate solution (NH_4OAC) buffered at pH 7 (Thomas, 1982). Exchangeable Acidity (Al^{3+} and H^+) were extracted with KCl (Thomas, 1982) and determined by titration with 0.05n NaOH using phenolphthalein as indicator. Percentage base saturation was calculated by multiplying the quotient of TEB to ECEC by 100.

3. Results and Discussion

PHYSICAL PROPERTIES: The physical and chemical properties of soils in the area are presented in Tables 1 and 2 below. From the result in Table 1, particle size distribution of the soil from the studied area showed that silt properties of the soil which had the lowest content ranged from 2.28%-10.28% at a soil depth of 0-15, with a mean value of 6.24% in Ejiba (a) and 2.20-10.28 at depth of 15-30cm in Odo Ere (b) and OdoAra (b) with a mean of 5.07% respectively. The clay properties of the soil ranges from 8.71-17.20% at soil depth of 0-15cm with a mean of 10.7% in Ilemla (6.61)Egbe (a) and Okua (a) (6.58) and 8.71-19.20% at soil depth of 15-30cm in Egbe-Okedisin (b) and Odo Ere (b) with a mean of 13.6%. The sand properties of the soil was highest with values ranging from 72.52-86.05 at a depth of 0-15cm with a mean of 82.2% in OdoAra (a) and Ilemla and 71.52-86.05 at depth of 15-30cm in OdoAra (b) and Egbe-Okedisin (b) with mean value of 80.7% respectively.

Variability in particle size distribution of the different soil in the studied area was not much. The sand fraction appears not to play significant roles in the soil. This is probably because the sand fraction which occur in large fraction are normally in-active in the soil. The textural classes of the soils in the area ranged from sandy loam to loamy sand. Soils had high percentage of sand, with low silt and clay fractions. The sandy nature of the soil could result to low water retention capacity and good aeration. Soil texture is an important soil characteristic. It implies high drainage rate, good aeration low organic matter content Brown (2008). The result also showed that the pH of the soils ranged from 5.12-6.54 at depth of 0-15cm in Ijalu (a) and Igbaruku (a) with a mean of 5.99 and 4.91 and 6.57 at a depth of 15-30cm with a mean of 5.82. This indicates that the area has a pH range that is favourable for the plant growth; there is availability of plant nutrient to the crops planted in the area, as (pH) optimum for most plants is between 5.5 and 7.0. Soils in the area fell at being slightly acidic in nature. However, some number of plants can adapt to pH value outside this range (www.cropnutrition.com).

CHEMICAL PROPERTIES: Electrical conductivity (EC) in the soil ranged from 0.03-0.64μhos/cm at the depth of 0-15cm soil depth with mean value of 0.24μhos/cm and Ilemla had the highest EC at the same depth of 0-15cm. similarly at the depth of 15-30cm, Ijalu had the lowest electrical conductivity value of 0.08 mean, while Ilemla had the highest electrical conductivity value of 0.44uhos/cm with mean value of 0.28uhos/cm. all the soils in the studied area have low electrical conductivity values. Since electrical conductivity in the soil is known to increase with increasing concentration of dissolved salt and it is a very important indicator of soil health, as the higher the EC the higher the salinity of the soil which affects crop yield and, crop sustainability, plant nutrient availability, soil microorganisms activity, and availability of soil water (Adviento-Borbe, et al., 2006). Therefore, the area is suitable for cropping as the electrical conductivity value of the area is less than 1ds/m and it is considered to be non- saline and it does not impact most crops and soil microbial processes (Dahnke and Whitney, 1988.

Table 1. Physical properties of soils of the area used.

WARDS	PSD					
	pH	EC (μmhos/cm)	%Silt	%Clay	%Sand	Textural Class
Ejiba (a)	5.42	0.33	2.28	14.20	83.52	LS
OdoEri (a)	6.17	0.34	8.28	14.20	77.52	SL
Odo ere (a)	6.33	0.47	8.28	10.20	81.52	LS
Odoara (b)	6.28	0.56	10.28	17.20	72.52	SL
Igbaruku (a)	6.54	0.64	4.28	10.20	85.52	LS
Okedisin (a)	6.33	0.10	5.24	10.71	84.05	LS
OkeEgbe (a)	5.83	0.07	7.24	9.71	83.05	SL
Igbogbo (a)	6.35	0.20	6.24	9.71	84.05	LS
Ilemla (a)	6.11	0.03	5.24	8.71	86.05	LS
Isaba (a)	6.02	0.05	3.24	11.71	85.05	LS
Okua (a)	5.39	0.08	7.24	8.71	84.05	LS
Ijalu (a)	5.12	0.04	8.24	12.71	79.05	SL
Mean	5.99	0.24	6.34	10.70	82.20	
Ejiba (b)	5.52	0.23	3.36	14.20	80.52	LS
Odoeri (b)	6.10	0.31	5.28	14.20	77.52	SL
Odo ere (b)	6.29	0.29	2.28	19.20	78.52	LS
Odoara (b)	6.13	0.18	10.28	18.20	71.52	SL
Igbaruku (b)	6.57	0.60	4.28	10.20	84.52	LS
Okedisin (b)	6.01	0.09	5.24	8.71	86.05	LS
OkeEgbe (b)	5.51	0.60	7.24	12.71	80.05	LS
Igbogbo (b)	6.07	0.12	6.24	13.71	80.05	SL
Ilemla (b)	5.89	0.44	4.24	10.71	85.05	LS
Isaba (b)	5.91	0.32	5.24	11.71	83.05	SL
Okua (b)	5.03	0.09	6.24	13.71	80.05	SL
Ijalu (b)	4.91	0.08	3.24	15.71	81.05	SL
Mean	5.82	0.28	5.07	13.60	80.70	

Key: a= 0-15cm, b=0-30cm soil depth. LS=loamy sand, SL=sandy loam

Table 2 showed that the total nitrogen in the area varied from 0.02%-0.08% with a mean value of 0.08% recorded at a depth of 0-15cm, and at the recorded depth of 15-30cm, the total nitrogen was 0.007%-0.064% with a mean value of 0.08%. The value was considered low Jones (1979) because it is below the critical range level of nitrogen (0.15%) needed for optimum crop production. There is need to supplement the N in these areas with chemical fertilizer for agricultural production. It has been observed that the main cause of N deficiency in tropical soils is caused by intense leaching and erosion due to high rainfall (Jones, 1979).

Table 2 showed that available phosphorus ranged from 2.26-20.42mg/Kg with a phosphorus value in the area fell below the critical value of 15ppm (Enwezor *et al*., 1989) except for the soil of Igbaruku (a) which was 20.42mgKg. When P deficiency occurs, it is usually due to severe insufficiency of P in the soil. P concentration required by most plants varies from 0.003ppm-0.3ppm and it depends on the crop species and level of production (John *et al*., 2005).

From the result in the table 2, organic carbon in the studied area ranged from 0.150%-1.83% in Odo Ere (a), OkeEgbe (a) and Igbogbo (a) with a mean value of 0.69% at the depth of 0-15cm, while at the depth of 15-30cm, it ranged from 0.15% - 1.27% in OdoAra (b), Oke-Egbe (b), Igbogbo (b) in Egbe with a mean value of 0.59%. Soil carbon decrease has been linked to the conversion of native vegetation to Agricultural land, restoring the land by encouraging management practices that will increase soil organic content, which could be a means of enhancing fertility of the soil. (MC Lauchlan *et al*., 2006). Table 2 showed that the cation exchange capacity ranged from 6.69-8.55Cmol/kg in Isaba (a) and Ejiba (a) with a mean value of 7.43Cmol/kg at soil depth of 0-15cm, and 6.37-8.91Cmol/kg with a mean value of 7.16Cmol/kg in Igbogbo at Egbe and OdoAra (b) at soil depth of 15-30cm. The soils of the area had ECEC values greater than 5Cmol/kg the critical level for productive soils. In most soils, 99% of the soil cation can be found attached to the micellanous (clay particles) and 1% can be found in solution. Cations in the soil mainly ca, mg, na, and k maintain an equilibrium between adsorption to the negative sites and solution in soil water. The equilibrium produces exchanges where one cation detaches from one site and another cation attaches to it. High CEC indicates that a soil has a high clay content and can hold a lot of cations but soils with low CEC (<5) is an indicator that the soil is sandy with little or no clay content that cannot hold much cations. Humus and clay have higher holding capacity of solution ions to their electrostatic surface charges, hence the higher the fertility of the soil, the higher the pH and ECEC (Havlin and Beaton, 2011).

Table 2. Chemical properties of the soil of the area used.

Wards			Exchangeable cation (Cmol/kg)								
	%N	Available P	K	Ca	Mg	Na	ExB	ExA	ECEC	%OC	PBS
Ejiba (a)	0.21	1.26	0.97	3.64	1.37	0.63	6.61	1.94	8.55	0.41	77.30
OdoEri (a)	0.04	6.85	1.38	3.33	1.20	0.67	6.58	1.11	7.69	0.76	85.50
Odo Ere (a)	0.04	13.57	1.30	3.30	1.22	0.71	6.53	0.91	7.44	0.15	87.70
OdoAra (a)	0.04	1.53	1.71	3.04	1.01	0.99	6.75	1.01	7.76	0.68	86.90
Igbaruku (a)	0.04	20.42	1.12	3.92	1.46	0.62	7.12	0.79	7.91	0.77	90.00
Okedisin (a)	0.34	10.82	1.70	3.29	1.12	0.61	6.72	0.80	7.52	0.67	89.30
OkeEgbe (a)	0.03	7.39	1.32	3.80	0.69	0.43	6.24	1.01	7.25	0.49	86.00
Igbogbo (a)	0.10	9.37	1.53	2.92	1.10	0.44	5.99	0.78	7.77	1.83	88.50
Ilemla (a)	0.02	10.11	1.63	3.30	1.17	0.73	6.83	0.84	7.67	0.39	89.00
Isaba (a)	0.04	3.33	1.24	2.82	0.99	0.67	5.72	0.96	6.69	0.71	85.50
Okua (a)	0.03	6.71	1.30	3.04	1.14	0.52	6.00	1.09	7.09	0.75	84.60
Ijalu (a)	0.04	2.71	1.29	2.49	1.23	0.78	5.79	1.12	6.91	0.69	83.80
Mean	0.08	8.02	1.37	3.24	1.17	0.65	6.41	1.03	7.43	0.69	86.17
Ejiba (b)	0.02	1.73	0.98	3.19	1.11	0.69	5.97	1.19	7.16	0.39	83.40
OdoEri (b)	0.04	3.00	2.10	3.57	1.25	0.81	7.73	0.03	8.16	0.77	94.70
Odo Ere (b)	0.04	6.98	0.94	3.21	1.09	0.57	5.81	1.21	7.02	0.70	82.80
OdoAra (b)	0.01	1.93	1.79	4.01	1.53	0.89	8.22	0.69	8.91	0.15	92.30
Igbaruku (b)	0.03	6.19	1.16	3.73	1.39	0.60	6.88	0.85	7.73	0.66	89.00
Okedisin (b)	0.03	1.23	1.64	3.04	1.09	0.59	6.36	0.69	7.05	0.60	90.20
OkeEgbe (b)	0.02	8.01	1.30	3.69	0.61	0.51	6.11	1.12	7.23	0.39	84.50
Igbogbo (b)	0.07	14.21	1.47	2.74	1.01	0.41	5.63	0.74	6.37	1.27	88.30
Ilemla (b)	0.02	9.21	1.54	3.14	1.11	0.74	6.53	1.10	6.63	0.36	98.40
Isaba (b)	0.03	8.41	1.20	2.70	0.84	0.60	5.34	1.04	6.38	0.45	83.60
Okua (b)	0.04	4.53	1.25	2.94	1.04	0.48	5.71	1.15	6.86	0.71	83.20
Ijalu (b)	0.04	2.49	1.16	2.31	1.19	0.61	5.27	1.20	6.47	0.62	81.40
Mean	0.03	5.66	1.38	3.19	1.11	0.62	6.74	1.00	7.16	0.59	87.65

Key: a= 0-15cm, b=15-30cm soil depth

Calcium, (Ca) from the result carried out in the studied area ranged from 2.49-3.92Cmol/Kg in EgbeIjalu (a) and Igbaruku (a) with a mean value of 3.24Cmol/Kg at 0-15cm soil depth and 2.31-4.01Cmol/Kg in EgbeIjalu (b) and OdoAra (b) with a mean value of 3.19Cmol/Kg. the values from the result range above the critical value of 2.0Cmol/kg (Adeoye, 1998). It indicated that calcium present in high values in the studied area and such soil does not need amendment. Calcium serves as a soil amendment agent, which helps in the maintenance of chemical balance. It reduces soil salinity and helps in improving water penetration in the soil. Calcium deficiency will significantly affect fruit quality (Thomas, 1982). Calcium deficiency is uncommon although crops where calcium is particularly important such as fruit crops e.g. apple peaches, tomatoes, etc (Thomas, 1992).

Magnesium, (Mg) from the result in Table 2 ranged from 0.69-1.46Cmol/Kg in Egbe Oke-Egbe (a) and Igbaruku (a) with a mean value of 9.17Cmol/Kg at 0-15cm soil depth, while at 15-30cm soil depth ranged from 0.61-1.53Cmol/Kg with a mean of 1.11Cmol/Kg. it is also higher than the critical value of 0.4Cmol/Kg (Anon, 1990). This indicates exchangeable magnesium in the soils.

Potassium (K) in the Table 2 ranged from 0.97-1.71Cmol/Kg in Ejiba (a) and OdoAra (a) with a mean of 1.37Cmol/Kg at soil depth of 0-15cm, and 0.98-1.79 Cmol/Kg at soil depth of 15-30cm in Ejiba (b) and OdoAra (b) with a mean of 1.38Cmol/Kg. High potassium deficiency is common mostly in soils that are sandy and where there is frequent cutting of grasses. High potassium in the soil induces low magnesium (ABSA, 2014). Potassium balance is very important, the K

(Ca +Mg) and (K +N) balance must be maintained at proper level to avoid deficiency of Mg and K.

Sodium had a range value of 0.43-0.99Cmol/Kg with mean value of 0.65 Cmol/Kg at a depth of 15-30cm with a mean value of 0.62Cmol/Kg. The exchangeable acidity of the soil aranged from 0.78-1.94Cmol/Kg in OkeEgbe (a), Igbogbo (a) and Ejiba (a) with a mean value of 1.03 Cmol/Kg at 0-15cm soil depth and 0.43-1.19 Cmol/Kg is shown in OdoEri (b) as the least and the highest being Ejiba (b) with mean value of 1.00 Cmol/Kg at 15-30cm soil depth, this fell below the critical level of 4.00Cmol/Kg known to be the accepted exchangeable acidity level value in the soil. It does reflect moderate acidity or neutral pH of the soil. Low pH values require liming, (Joe, 2011).

In the table, percentage base saturation of the soil ranged from 77.3-90.0Cmol/Kg with a mean value of 86.1Cmol/Kg at 0-15cm soil depth and 81.4-98.4 Cmol/Kg at soil depth of 15-30cm with mean value of 87.65Cmol/Kg. from the result, it can be seen that basic nutrient is readily available as the soils in the area have high values of nutrient requirements, which are available at less than 80Cmol/Kg, Mengel (2011), says the higher the amount of exchangeable base cations, the more acidity can be neutralized within a short period of time, therefore a supposed soil with high cation exchange capacity takes much higher time before it acidifies, than a soil which has lower cation exchange capacity.

4. Conclusions and Recommendations

From the results obtained on the study, it can be concluded that most soils in this area of studied have favourable pH range suitable for arable crop production, low level of salinity which by tolerant crops can yield satisfactorily. Most soils of the area fell in the sandy loam and loamy sand textural class.

The cation exchange capacity of the soils in the study area was moderate in value and the percentage base saturation recorded high values from the samples that were analyzed. There is need to raise or increase the level of total nitrogen, organic carbon and available phosphorus in the studied area as the values from the result fell below the required level, thus there is need to improve the levels where deemed necessary. Suitable crop production of these soils of the studied area will require maintenance of its productivity potential by the application of organic manure, which helps to boost yield of most crops, therefore the availability of this study information which enable the farmers in the area to become aware of the Soil Fertility Status of their soil and adopt appropriate, improvement, conservation, maintenance and proper management of the soils. Farmers in the area should apply organic matter with little or no application of acid forming fertilizer because the soils of the areas are already acidic except for Igbaruku. In general, for sustainable agriculture, management practices such as (mulch and green manure) coupled with crop rotation, mixed farming should be practiced, slash and burn practices should be discouraged, proper management will help to increase nutrient availability and productive capacity of the soils in the areas.

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