EFFECT OF FALLOW LENGTH ON SELECTED SOIL PHYSIO-CHEMICAL PROPERTIES IN EKOLI FARMING AREA OF EBONYI SOUTHEASTERN NIGERIA.

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ABSTRACT:

Fallow management and improvement is as old as agriculture itself. Fallow is currently still intrinsic part of many tropical farming systems. Based on this an experiment was carried-out at the hilly area of Ekoli Edda in Ebonyi State of Nigeria to determine the effect of fallow length on selected soil physio-chemical properties. The different fallow lengths which were identified and used as treatments were Obasioha at one year fallow length, Alioha at two year fallow length, Ujara at three year fallow length, Ugwu Akwu at four year fallow length, Ama Ezi Edda at five year fallow length, Aliogo at six year fallow length and Oba at seven year fallow length. Fifty Soil samples were collected with a core sampler attached to a soil auger from each of the seven sites from 0 – 30 cm soil depth. Each of the 50 soil samples from each site were bulked, thoroughly mixed up and 5 representative samples were collected from each set. On the whole a total of 35 disturbed soil samples were analyzed for soil fertility indices. Another set of 35 undisturbed soil samples were collected and used for the determination of some selected physical properties. The experiment was laid out in a completely randomized design with 7 treatments and 5 replications.. The raw data emanating from the research was subjected to analysis of variance (ANOVA) and dictated significant differences were separated using Fischer's least significant difference (F-LSD) at 5% probability level. Results of the analysis showed that the soil textural classes were sandy loam having formed from the same parent material. Further, there was no significant difference when the bulk density and total porosity of the sites were compared with one another but the available moisture contents of the sites differed significantly. The results further revealed significant difference when pH, organic matter (OM), total nitrogen (TN), sodium (Na), calcium (Ca), magnesium (Mg), exchangeable acidity (EA), effective cation exchange capacity (ECEC) and available phosphorus of the soils were compared with one another. Also organic carbon (OC), potassium (K) and base saturation (BS) of the soil revealed significant differences. The results suggested that longer fallow lengths hold the promise of invigorating the soil and sustaining it for increased crop production.

Key words: Chemical, Ebonyi , Ekoli, Fallow, Nigeria ,Physical, Soil

INTRODUCTION

Fallow management and improvement is as old as agriculture itself. Fallow is currently still intrinsic part of many tropical farming systems. Some classifications of farming system have been based on fallow characteristics (Boserup, 1965. and Ruther berg 1980). Kille Fallow is commonly referred to as a resting period for agricultural land between two cropping cycles during which soil fertility is restored, it has more roles than just Fertility restoration. Fallow functions include weed control and the interruption of pest and disease cycles. They provide cash income in times of immediate need and help to balance food supply (styger., 1 999). They produce wood, Fibers and medical plants for households and can serve as pastures for livestock. For resources poor farmers with constraints on their labor, input, and access to new technique, Fallows are economically often a good option for optimizing agricultural production, especially when non crop products can be harvested. Fallow can also be important reservoirs of above and belowground biodiversity. A wealth of indigenous knowledge is associated with the diversity and richness of these fallow systems.

The oldest form of Fallow management was shifting cultivation where very long fallow period (>20 years) attenuated with short Cropping periods (1 -2years).A mutate of fallow system has developed across the tropics over many countries diverging from this primary model as farmer have developed strategies for intensified fallow use. Two major pathways of fallow intensification were identification of shifting cultivation in south East Asia in 1997. (Cairns 2004b). The first strategy was also its main objective, increasing fallows economic productivity. Fallow length stay the same or are even lengthen as farmers add value by introducing economic perennial species and take appropriate steps to enhance soil fertility. These systems include interstitial tree - based improved fallows, perennial annual crop rotations, and what are called complex agro-forest fallows. The second strategy aims to improve the biological efficiency of a particular fallow system seeking to achieve greater benefits within the same or shorter time frame. These include shrub - based accelerated

fallows and short term herbaceous fallows. They can be referred to as more effective fallows. Biophysical and economic benefits can accrue from either strategy (Cairns 2004a).

Given the wide range of fallow systems dynamic and continually changing the operational definition of managed legumes husbanded as dry .-season fallow for a few months, to long term complex agro- forest, which capitalize on multiple synergies, trapping opportunities at various heights and depths above and below ground. For improvement and optimization of farming systems, the management of fallow and cropping cycles needs to address continually the dual aims of production and soil fertility enhancement.(Brookfield, 2004). Characterize such systems as farmer guided ecological change rather than as fallow improvement since the objective include biological diversity and quality and quantity of livelihoods rather than just soil improvement combating soil degradation. It was based on the need to assess the extent to which soil fertility is restored in Ekoli farming areas under different fallow lengths that an experiment to evaluate the effect of fallow length on selected soil physical and chemical properties in Ekoli farming area of Ebonyi South east Nigeria was embarked upon.

MATERIALS AND METHOD

Study area

The experiment was carried-out at the hilly area of Ekoli-Edda in Edda Local Government area of Ebonyi State. It is located at latitude (05^0,47'N) and longitude (07^0,50'E) in South east of the high rainfall zone of Nigeria. The mean annual rainfall is about 2000mm-2500mm spread between March - December, and the bedrock geology is shale residium. The soil is shallow with unconsolidated parent materials within 1m of the soil surface classified as dystricleptisol. The mean annual minimum and maximum air temperature are 27^0c and 31^0c respectively with an average relative humidity range of 35-60% from dry season to the rainy season respectively. The climatic zone is high rainfall dominated by tall trees and shrubs. The major occupation of the people is small scale farming. Land preparation is by slash and burn while soil fertility regeneration is mainly by 9 year bush fallowing. Other socio-economic activities include palm oil processing, stone quarry and small/medium enterprises. Approximately 85% of the population depend on agriculture for their livelihood. The agricultural productions include crops, oil palm, and livestock produced at both subsistence and export levels.

Laboratory Analysis

The soil samples were air dried, crushed and sieved to pass through 0.02mm before subjecting them to various analysis, evaluations and classification.

Physical Properties

Particle size distribution was determined by hydrometer method in water and calgon; where sodium hexametaphosphate solution was used as dispersing agent (Gee and or, 2002).

Bulk density was determined using core method (Gross and Reinch, 2002). It was calculated thus;

$$Bulk\ density = \frac{mass\ of\ oven\ dried\ soil}{volume\ of\ core\ sampler}$$

It is expressed in g/cm^3 (Brady and Weil, 2010).

Total porosity was calculated from result of bulk density and particle density.

Porosity, $Tp = \left(1 - \frac{pd}{ps}\right) X\ \frac{100}{1}$ (Brady and Weil, 2002)

Where;

Tp	=	porosity
Pd	=	bulk density (g/cm^3)
Ps	=	particle density (assumed to be 2.65g/cm^3 for tropical soils)

Moisture content was determined by gravimetric method. It was calculated thus;

$$\%\ MC = \frac{w_2 - w_3}{w_3 - w_1}\ X\ \frac{100}{1}$$

Where;

% Mc	=	Percentage moisture content
W_1	=	Weight of moisture can
W_2	=	Weight of air-dried soil + moisture can
W_3	=	Weight of oven-dry soil + moisture can

Chemical Properties

Soil PH was measured using 1:2.5 soil liquid in both water and KCL (Thomas, 1996). Organic carbon was determined by the wet oxidation procedure according to Walklay and Black method. (Nelson and Somners, 1982). Total nitrogen was determined using the modified micro Kjeidhal method according to the procedure of Bremner and Mulvaney (1982).Available phosphorus was determined using the molybdenum blue colour bray II method according to (Olsen and Somners 1982). Exchangeable base was determined from Ammonium acetate (NH_4OA_c) leachate of the soil (Thomas, 1982). Exchangeable calcium and magnesium was determined by the EDTA (Ethylene diamine tetra-acetic acid), versenate titration method while exchangeable sodium and potassium was determined by flame photometer method. (Jackson, 1962). Exchangeable acidity ($Al3^+ + H^+$) was determined by leaching the soil with INKCL and titrating with 0.05N Na0H (Mclean, 1965). Effective cation exchange capacity was derived by the summation of the total exchangeable bases (TEB) and exchangeable acidity (Al^{3+} H^+) (Brady and Weil, 2002.)

Data Analysis and Statistics

For purposes of this research only the primary data were collected from results of soil analysis. The two year data were analyzed for means and per cent ages according to Gomez and Gomez, (1984) and the fertility status determined by comparing the data with

Landon,1991 and FAO (2010) soil fertility standards for rice production.

RESULTS AND DISCUSSION

The effect of treatment on soil bulk density ,total porosity and moisture content are presented in Table 1.

Table 1: The Effect of Soil Physical Properties of Fallow Length in Ekoli Edda Area of Ebonyi State.

Treatment	Bulk Density(g.Cm^{-3})	% Total Porosity	%Moisture Content
Obasioha	**1.91**	**27.0**	**31.0**
Alioha	**1.95**	**1.84**	**25.2**
Ujara	**1.93**	**27.3**	**28.7**
Ugwu Akwu	**1.94**	**26.7**	**27.7**
Ama Ezi Edda	**1.92**	**27.6**	**30.0**
Aliogo	**1.90**	**28.2**	**33.7**
Oba	**1.96**	**26.0**	**26.7**
SX	**0.02**	**4.57**	**0.55**
F-LSD(p=0.05)	**NS**	**NS**	**2.22**

Bulk Density

The results showed that there was a non- significant different at (P<0.05). The values of bulk density as recorded by the treatments ranges from I .90g/cm^3 to 1 .96g/ cm^3. Among the fallow plots, Aliogo had the lowest bulk density of I .90g/cm3 while Oba had the higher values of bulk density Obasioha, Alioha, Ujara, Ugwu-Akwu and Ama-Ezi-Edda recorded I .91g/cm, I .95g/cm, 1 .93g/cm, I .94g/cm and I .92g/cm respectively. When the treatment were compared with other it showed that Obasioha, Ama-Ezi-Edda, Ujara, Ugwu-Akwu,Alioha and Oba were 0.0lg/cm, 02g/crn,0.03g'cm,0.04 g/cm and 0.05g/cm higher than Aliogo. Also Ama-Ezi-Edda, Ujara, Ugwu-Akwu, Alioha and Oba were 0.01g/cm,0.02g/cm,0.03g/em,0.04g/cm and 0.05g/cmhigher than Obasioha And also Ujara, Ugwu-Akwu, Alioha and Oba were 0.0lg/cm,0.02g/cm.0.03g/cm and 0.04g/cm higher than Ama-Ezi-Edda, Ugwu-Akwu,Alioha and Oba were O.0lg/cm,0.02g/cm and 003g/cm higher thanUjara, Alioha, and Oba were 0.1 g/cm and 0.02g/cm^{3}higher than Alioha, When Oba was higher than Alioha by0.01 .g/cm^3.

Total porosity

The effect of treatment on soil total porosity as present in table (1) showed that there was a non-significant difference. Values of total porosity as record by the treatments ranges from 1 8.4% to 28.2%. Among the treated plots, Oba has lowest total porosity as 1 8.4% while Aliogo had the highest total porosity. 28.2%. Obasioha, Alioha, Ujara, Ugwu-Akwu& Ama Ezi Edda recorded 27.8%, 18.4%, 27.3%, 26.7% and 27.6% respectively. When the treatments were compared with each other it showed that Oba, Ugwu-Akwu, Ujara, Ama-Ezi-Edda,Obasioha and Aliogo were 7.6%,8.3%,8.9%,9.2%,9.4% and 9.8 % higher than Alioha. treatments 4,3,5,1 and 6 were 0.7%, 1.3%, 1.6%, 1 .8% and 2.2% higher than Obaliogo treatments 3,5,1 and 6 were 0.6%,0.9%, 1.10% and 1 .5% higher than Ugwu-Akwu, Ama-Ezi-Edda 5, Oliog Obasioha and A had 0.3%,0.5% and 0.9% higher than Ujara,Abasioha and Aliogo were 0.2 and 0.6 higher than Ama-Ezi-Edda, when A was higher than Obasioha by 0.4%.

% Moisture Content:-

The effect of treatment on soil % moisture contentShowed that there was a significant difference. The values of % moisture content as recorded by the treatments ranges from mm 25.7°/o to 33.7% among the treated plots, T6 (33.7) had the highest value' of % moisture content. Obasioha, Alioha, Ujara, Ugwu-Akwu, Ama-Ezi-Edda, recorded 31.0%, 25.7%, 28.7%, 27.7% and 30.0% respectively.When treatment were compared with one another, it showed that Oba, Ugwu-Akwu.Ama-Ezi-Edda , Obasioha and Aliogo were 1.0%,2.0%,3.0%.4.3%,5I o and 8.0% higher than Alioha. Also Ugwu-Akwu,Ujara,Ama-Ezi-Edda , Obasioha and Aliogo were 1.0%,2.0%,13%,4.3%. and 7.0% higher than Oba and also Ujara, Ama-Ezi-Edda, Obasioha and Aliogo were I .0%, 2. 3.3%, 2.0% and 6.0% higher than Ujara. Obasioha were Aliogo 1.0 and 4.0 higher than Ama-Ezi-Edda when T6 was higher than Obasioha by 3.0%.

SOIL TEXTURE

Soil texture is a qualitative classification tool used in determination of soil classes for agricultural separating sand, Silt and clay using grading sieves. The results (Table 2), indicated that all the treatment were sandy 1oam (SL) according to soil classification using textural triangle according Landon (1991).

TABLE 2: The Textural Class and Particle Distribution of Soil Physical Properties of Fallow Length on Ekoli Edda Area of Ebonyi State

Treatment	Sand (g.Kg^{-1})	Silt (g.Kg^{-1})	Clay (g.Kg^{-1})	Textural Class
Obasioha	**694.7**	**203.0**	**102.3**	**Sandy Loam**
Alioha	**528.0**	**363.0**	**109.0**	**Sandy Loam**
Ujara	**701.3**	**197.0**	**101.7**	**Sandy Loam**
Ugwu Akwu	**696.0**	**190.0**	**114.0**	**Sandy Loam**
Ama Ezi Edda	**694.7**	**198.0**	**102.3**	**Sandy Loam**
Aliogo	**724.7**	**170.0**	**105.3**	**Sandy Loam**
Oba	**701.3**	**194.0**	**102.7**	**Sandy Loam**

The result also showed that Obasioha (YR 1) has 1 0.2% clay, 20.3% silt and 69.5% sand and Alioha (YR2) has 10.9%clay, 36.3%si9 and 52.8%sand and Ujara (YR3) has 1 0. 1 %clay, I 9.7%silt and 70.1 % sand and Ugwu-akwu (YR4) has I l.2%clay,19.0%silt and 69.6%sand and Ama-Ezi-Edda (YR5) has 10.2%clay, 19.8%silt and 69.5% sand and Aliogo (YR6) has 10.5%clay,17.0%silt and 72.5%sand; and Oba (YR7I has 10.2%clav.19.4% silt and 70.1 % sand. The result shown in the table (2) indicated that value of °/ clay and silt were lesser than % sand, where sand recorded the highest values.

Effect of Fallow Length on Soil Selected Chemical Properties

The effect of the different fallow lengths on the selected soil chemical properties is presented in Table 3.

pH

The effect of fallow length on soil pH indicated a non-significant difference at (p=0.05). These effect indicates that among the treatments, Alioha had the highest value of (0.19) when compared with Ujara again Ujara gave 0.2, 0.33, 0.4, and 0.52 arid 0.62 less pH concentration respectively when compared with Ujara. Treatment 6,7,5,4 and produced 0.43, 0.33, 0.24, 0.14 and 0.10 respectively which has more (pH) in the soil than Alioha. Also the comparison showed that there were 0.13. 0.2. 0.32 and 0.42 less In Ujara respectively when compared with Ugwu-Akwu, Ama-Ezi-Edda and Aliogo. Furthermore, Ugwu-Akwu when Compared with Ama-Ezi-Edda revealed that 0.23 was less in (pH) concentration in Obasioha and Aliogo also differed with Obasioha by 0.32 and 0.42 respectively. There were 0.19 and 0.09 more of pH in Ama-Ezi-Edda than Oba and Aliogo respectively. There was further 0.1 less In pH concentration in Oba when compared with Aliogo. In pH it indicated that starting from Obasioha to Oba were slightly acidic. Soil acidity is a situation which arises in the soil whereby its pH is lowered below 7. Thus, an acid soil is one whose pH is less than 7. Under this soil situation the soil has a high concentration of hydrogen and aluminum ions to impair plant growth.The ranking of the fertility level of pH) in the soil spread over a fallow period of seven years showed that all the treatments starting from Obasioha to Oba had slightly acidic values of(pH) at the soil fertility position. By (Nnoke , 2001)

Phosphorus (p)

The effect of fallow length on the concentration of available phosphorus (P) Revealed a non- significant difference at (p< 0.05). When different years of Fallow were compared with one another. There was I .67mg/kg higher Concentration of phosphorus (P) in Ama-Ezi-Edda when compared with the T6.

Table 3: Soil Chemical Properties Of The Different Fallow Lengths In Ekoli Edda Area Of Ebonyi State

Treatment	Ph	%OC	%OM	%TN	Na	K Cmol.Kg^{-1}	Ca	Mg	EA	ECEC Cmol.Kg^{-1}	%BS	Avil.P Cmol.Kg^{-1}
Obasioha	6.46	1.87	3.24	0.26	3.69	0.3	4.87	3.53	0.84	13..23	93.63	40.73
Alioha	6.45	2.96	5.26	0.31	4.21	0.33	4.37	3.77	0.81	13.48	94.02	40.40
Ujara	6.26	1.72	3.47	0.38	4.81	0.39	4.73	3.20	0.42	13.56	96.94	38.70
Ugwu Akwu	6.59	1.10	1.97	0.37	5.31	0.41	1.73	4.00	2.48	16.93	85.32	45.97
Ama-Ezi- Edda	6.69	2.05	3.72	0.39	5.78	0.42	5.20	3.67	2.18	17.25	87.37	35.73
Aliogo	6.88	1.43	2.54	0.42	6.41	0.49	4.47	3.53	1.71	16.61	89.72	37.10
Oba	6.78	1.59	2.75	0.54	7.84	0.52	3.97	3.23	0.80	19.08	95.18	40.57
SX	0.09	0.97	0.51	1.09	0.03	0.08	2.91	0.19	0.05	1.26	0.51	1.60
F-LSD (p=0.05)	NS		NS	NS	NS	0.11	NS	NS	NS	NS	2.02	NS

AgainAma-Ezi-Edda had. 2.97mg/kg, 4.67mg/kg 4.87mg/kg, 5.0mg/kg and 10.24mg/kg less in phosphorus concentration respectively when compared with Aliogo Treatments 4, 1,7,2,3 produced 8.57mg/kg 33mg/kg,3. 7mg/kg,3.Omg/kg and 1 .3mg/kg respectively more of phosphorus (P) in the soil than 'l'5 Also the comparison indicated that 7.27mg/kg, 2.0Th I .8'7mg/kg and 1 .7mg/kg less in 13 respectively when compared with Alioha, Obasioha and Ugwu-Akwu. Furthermore Alioha when compared with Oba revealed that 0. 1 7mg/k o m phosphorus concentration.Obasioha and Ugwu-Akwu also differed with Alioha by 5.57mg/kg and 0.33mg/kg respectively.there were 5.4mg/kg and 0. I 6mg kg ore of phosphorus in Ugwu-Akwu than Oba and Obasioha soils respectively. There was further O.4mg/kg more of phosphorus concentration in Ugwu-Akwu, when compared with soil under Obasioha farming area.

In available phosphorus the fallow length status indicated that Obasioha to Oba were medium in the soil. 1 his implies that phosphorus is needed in a smaller quantity in the soil to react with soil component to form compound relatively insoluble and therefore unavailable to plant. Due to its importance in tropical agriculture, it is highly needed by plants. The ranking of the fertility level of available Phosphorous in the soil spread over a fallow period Of seven years indicated that all the treatments starting from Obasioha to Oba had medium Fertility status (Landon 1991).

Organic carbon:

The effect of fallow length on the concentration of organic carbon in table (3) showed that there was a non-significant difference at (p 0.05). These effects indicate that among the treatments, Alioha had the highest values of organic carbon ranges from 296Cmol/kgwhile Ugwu Akwu had the lowest value of organic carbon of.1.10Cmol /kg. The value of organic carbon range From 1 .10Cmol/kg to 2.96Cmol/kg in an increasing manner of' the treatment values of organic carbon. Ama-Ezi-Edda, Obasioha, Ujara, Oba and Aliogo had 2.O5Cmol/kg, 1 .87Cmol/kg, I.72Cmol/kg, I .59Cmol/kg and 1.43Cmol/kg respectively. When the treatments are compared.With each other, Aliogo was 0.33Cmol/kg higher than 14 valueOba, Ujara, Ama Ezi Edda and Alioha were 0.49Cmol/kg, 0.62Cmol/kg, 0.77Cmol/kg. 0.95C mol/kg and I .85Cmol/kg respectively higher than Ugwu Akwu that had 1.10Cmol/kg.Also Oba.Ujara, Obasioha , Ama-Ezi-Edda and Aloha were 0.1 6Cmol/kg. ().29Cmol/kg.0.44mol/kg.062'mo'kg and 1 .53Cmol/kg respectively higher than Aliogo Soil. Again Ujara, Obasioha,AmaEzi Edda and Alioha soils differed with Oba soil by 0.13Cmol/kg. 0.28Cmol/kg, 0.46Cmol/kg and 1.37mol/kg respectively. There were 0. 1 5Cmol/kg. 0.33Cmol/kg and I .24C mol/kg of more organic carbon in Obasioha, Ama-Ezi-Edda and Alioha soils than in Ujara Soil

In organic carbon the Alioha soil had thehighest value of organic carbon which indicated that it will be good for agricultural purposes and more nutrient was accumulated in the soil.The ranking of the fertility level of organic carbon in the soil spread overFallow period of' seven (7) years showed that Obasioha. Ujara, Ugwu-akwu ,Ahiogo and Oba soils were low while Aliohu and Ama Fzi-Edda soils had medium level of organic carbon in the soil, This is in line with the rating of organic carbon fertility level by (London, I 991),

Organic matter

The effect of fallow length on the concentration of organic matter in table (3) indicated that there was i non— significant difference at (p<O,05). 'The effect was observed when different years of fallow were compared with one another. There was 0.57g/kg higher concentration of organic matter (O.M) in Aliogo when compared with Ugwu Akwu gave the value of 0.78g/kg, I .27g/kg, I .5g/kg, .75g/kg and 3.29g/kg less in organic matter concentration respectively when compared with Aliogo.Treatments 25.3, 1 and 2 yield 2.72g/kc, I g'kg.0 93g/kg, 0 7g/kg amid 0.21 g/kg respectively, more of organic matter (OM) in the soil than Ugwu Akwu, also the comparison showed that there were 2.5 1 g/kg,0,97g/kg.0.49g/kg mess in Oba respectively when compared with Obasioha, Ujara, and Ama-Ezi-Edda 5 furthermore, Obasioha when compared with Ujara showed that 0,2 3g1 kg less in organic matter concentration of Ujara and Obasioha also differed with Alioha by 2.02g/kg and 0.4g/kg respectively. Nevertheless, there was I .79g/kg and 0. 25g/kg more of organic matter in Obasioha than in Ujara and Ama Ezi Edda respectively. And there was further I .54/kg less of organic matter concentration in Ama Ezi Edda when compared with Ujara.In organic matter the Alioha had the highest value of organic matter which indicated that, it was good for agricultural purposes and more manure was accumulated in the soil which implies that the soil was more fertile.

The ranking of fertility level of organic matter in this soil spread over a fallow period of seven (7) years showed that all the treatments starting from Obasioha to Oba soils had medium > 2.0% based on organic matter soil rating by (Enwezor, *et al.*,1990).

Calcium (Ca)

The effect of fallow length on the concentration of calcium in table (3) showed that there was a non-significant difference at (pO.05). This study was observed on different years of fallow duration. The values of Ca recorded on each treatment are Obasioha (4.81 Cmol/kg). Alioha (4.37Cmol/kg), Ujara (4.7Cmol/kg), Ugwu-Akwu (4.73Cmol/kg), Ama Ezi Edda(5.20Cmol/kg), Aliogo (4.47(mol/kg) and Obasioha (3.97Cmol/kg). from the above treatments.Ama Ezi Edda had the highest value of 5 .20CmoI/kg) of Ca while the lowest value was recorded in Oba Soil (3.97Cmol/kg). Also Obasiohahas the second higher values of Ca while Ujara and Ugwu-Akwu had the same value of Ca as 4.73Cmol/kg Alioha, Aliogo and Oba had the following values of Ca as 4.3 7Cmol I/kg,4.47CmoI/kg and 3.97Cmol/kg respectively When these treatments were compared with each other, Alioha, Aliogo, Ujara&Obasioha and Ama-Ezi-Edda were 0.4Cmol/kg, 0.5CmoI/kg, 0.76Cmol/kg, 0.76Cmol/kg, 0.9Cmol/kg and 1 .23Cmol/kg higher than Ujara in Ca. Aliogo,Ujara, Ugwu Akwu,Obasioha and Ama-Ezi-Edda soils were 0. 1 Cmol/kg, 0.36CmoI/kg, 0.36Crnol/kg, 05Cmo1/kg 0.83CmoI/kg higher than Alioha. Also Ujara,Ugwu Akwu and Ama-Ezi-Edda were 0.26Cmol/kg,0.4Cmol/kg and 0.73mo1/kg higher than Aliogo. Again treatment Ugwu-Akwu, Obasioha and Ama-Ezi-Edda were 0.00Cmol/kg. 0. 1 4Cmol/kg and 0.47Cmol/kg higher than Ugwu-Akwu, whereas Obasioha was considered to be lowest by 0.33Cmol/kg when compared with Ama-Ezi-Edda. The order ofcaIcium increment in the values are Ama-Ezi-Edda > Obasioha ->Ugwu Akwu and Aliogo soils. When Ama-Ezi-Edda (4.37Cmo1/kg) Ugwu-Akwu(4.73Cmol/kg)Aliogo (4.47Cmol/kg) Alioha (4.37Cmol/kg). Oba (3 .97Cmol/kg).In calcium the '(Ama Ezi- Edda) had the highest value of' calcium in the soil. Calcium is absorbed by plant as cation. Calcium enhances the absorption of nitrate, nitrogen and in that way promotes protein synthesis.

The ranking of' the fertility level calcium (Ca) in the soil spread over a fallow period of seven (7) showed that all the treatment starting from Obasioha (4.87) to Oba (3.97) were high when (> 0.15) in the fertility status.According to soil h.rti1ity rating by (Enwezor, *et al.*, I999).

Magnesium(Mg)

The effect of fl1ow length on the concentration of magnesium (Mg) in table (3)showed that there was a non-• significant difference at (p<0.05). This effect was observed when different years of fallow were compared with one another. The values of magnesium recorded on each treatment in Obasioha (3 .53CmoI/kg). Alioha 3.77Cmol/kg),Ujara (3.2Cmol/kg), Ugwu-Akwu (4.0(mol/kg), Tama Ezi Edda 3.61 mol/kg).Aliogo (3.5 Cmol/ kg), and Oba (3 .23Cmol/kg). from the above treatment Ugwu-Akwu had the highest value which (4.OCmol/kg) while the lowest are 3,2cmol/kg in Ujara. When this treatments were compared with each other, treatment 7, 6,5,2 and 4 were 0.03Cmol/kg, 0.33Cmo1/kg, 0.33Cmol/kg, 0.47Cmol/kg, 0.57Cmol/kg and 0.8Cmol/kg higher than Ujara, The soils of Obasioha ,Aliogo. Ama-Ezi-Edda,Aloha and Ugwu-Akwu were 0.3Crnol/kg,0.3Cmol/kg,0.44Cniol/kg,0.54 and 0.7 7Cmol/kg higher than Oba soil. Again 'T6, Alioha and Ugwu-Akwu were 0.00Cmol/kg, 0.14cmol/kg. 0.24Cmol/kg, 0.47cmol/kg higher than Ama-Ezi-Edda.Ama-Ezi-Edda,Alioha, Ugwu Akwuwere the same values when compared with Obasioha, Alioha and Ugwu-Akwu were 0. 1 Cmol/kg and 0.33Cmol/kg higher when compared with the Ugwu Akwu. And Ugwu-Akwu(0.23Cmol/kg) were the lowest when compared with Alioha. The order of magnesium increment in the values (4.00Crnol/kg)> Alioha (3.77Crnol/kg)> Ama Ezi Edda(3 .67Cmol/kg)>Aliogo(3 .53Cmol/kg) Obasioha (3 .53Cmol'kg)>Oba(3 .23 mol/kg)>Ujara (3.2Cmol/kg).

In magnesium (Mg) Ugwu—akwu had the highest value by 4.0CmoI/kg in the soil. Magnesium is

absorbed by plant as the cation Mg^{2t}Magnesium plays two major roles in plant. Firstly it is a signiificance constituent chlorophyll, the autotrophic higher plants will unable to photosynthesis, Secondly, and magnesium is needed for the activation of many enzymes required in phosphorylation and other important cell metabolic reaction in plants.

The ranking of fertility level of magnesium (Mg) in the soil spread over a fallow period of seven (7) years indicated that all the treatments starting from Obasioha(3.53CmoI/kg) to Oba (3.23Cmol/kg were higher when (1 .0-48Crnol/kg)ferti1ity status by (Landon I 984)

Exchangeable Acidity

The effect of fallow length on the concentration of exchangeable acidity indicated a significant difference at (p<O.05). These effect indicated that among the treatments which ranges fromObasioha (0. 84Cmol/kg), Alioha(0.81Cmol/kg), Ujara(0.42Cmol/kg). Ugwu Akwu(2.48Cm l/kg), Ama Ezi Edda (2. 8 mol/kg),Aliogo (I .71 Cmol/kg) toOba (0.89cmol/kg),Ugwu Akwu had the highest value while Alioha (0.81Cmol/kg)' has the lowest value of exchangeable Acidity (Ea). Alioha.Obasioha, Oba, Aliogo, Ama-Ezi-Edda and Ugwu-Akwuwere 0.39Cmol/kg, 0.42Cmol/kg, 0.47Cmol/kg, 1.49Cmol/kg, I .76Cmol/kg and2.06Cmol/kg higher than Ujara Obasioha, Oba, Aliogo, Ama Ezi Edda and Ugwu-Akwu were 0.03Cmol/kg, 0.08Cmol/kg, 1.1 Cmol/kg I.Cmol/kg. I .37 Cmo1/kg and I .67Cmol/kg higher than Alioha Also Oba, Aliogo, Ama-Ezi-Edda and Ugwu-Akwu contained 0.05moI/kg, .O7mol/kg. 1 .34Cmol/kg and 1.64cmol/kg higher than Obasioha, again Aliogo, Ama-Ezi-Edda and Ugwu-Akwu was 1.02Cmol/kg. I .29Cmol/kg. I .59Cmol/kg higher than Oba, Ama-Ezi-Edda and Ugwu-Akwu was 0.27Cmol/kg and 0.057 higher than Aliogo.Furthermore, Ugwu-Akwu revealed 0.3Cmol/kg less changeable acidity concentration when compared with Ama-Ezi-Edda.

% Total Nitrogen

The effect of fallow length on the concentration of' total Nitrogen in table (2) showed that there was a non-significance difference at (p 0.05). This effect indicated that among the treatments, Oba had the highest value I Total Nitrogen of' 0.54 % while Obasioha had the lowest value of' 0.26%. The value of total nitrogen ranges from 0.26%-0.54% in an increasing manner of Alioha,Ugwu Akwu, Ama-Ezi-Edda, Aliogo and Oba gave 0.05%,0. 11 %,0.1 2° 0,0.13 %, 0. 1 6° o and 0.28% was higher than Oba soil respectively Treatment Ugwu Akwu, Ujara,Ama Ezi Edda, Aliogo and were 0.06%. 0.70, 0.80%, 0.Iand 0.23% higher than Alioha soil. Also Ujara, Ama Ezi Edda, Aliogo and Oba soils were 0.01 %, 0, 0.02%, 0.05 ° and 0. 17 % greater than Ugwu-Akwu.Again Ama Ezi Edda, Aliogo and Oba were 0.01%, 0.04% greater than Ama-Ezi-Edda, where Oba was considered to be the lowest by 0. 1 2 %when compared with Aliogo. In percentage nitrogen the fertility status of fallow length was high. Nitrogen is essential for plant growth and reproduction because it is a characteristics constituent element of' protein and hence of protosplasm of living cells. Therefore high quantity of' it is needed for agricultural purposes. The ranking of the fertility level total Nitrogen in the soil spread over a Fertility period of seven (7) years indicated that all the treatments starting From Obasioha (0.26%) to Oba(0.54%) were high in fertility status . According to soil fertility rating by Enwezor *et al.*,1990).

POTASSIUM (K)

The effect of fallow length on the concentration of potassium (k) revealed non- significant difference at (p 0.05) when different years of fallow were compared with one another Nevertheless these was Obasioha(0.31 Cmol/kg), Alioha(0.33Cmol/kg), Ujara(0.39Cmol/kg),Ugwu-Akwu(0.4 I Cmol/kg),Ama Ezi Edda(0.49Cmol/kg)and Oba(0.52Cmol/kg). Oba soil had the highest value as (0.52Cmol/kg),while Obasioha had the lowest values as (0.3 I Cmol/kg of potassium (k). Alioha, Ujara, Ugwu-Akwu, Ama Ezi Edda, Aliogo and Oba soils had 0.02Cmol/kg, 0.08Cmol/kg, 0.01Cmol/kg,0.11 Cmol/kg,0. 1Cmo/ kg and 0.21Cmol/kg higher than Obasioha, whereas Ujara, Ugwu-Akwu, Ama-Ezi-Edda, 'Obasioha,Aliogo and Oba had 0.O6Cmol/kg,0.O8Cmol/kg, 0.O9Cmol/kg.0. I 6CmoI/kg and 0.1 9Cmol/kg higher than Alioha. Again Ugwu-Akwu, Ama Ezi Edda, Aliogo and Oba soils were 0.O2Crnol/kg,0.O3Cmol/kg,0. I Cmol/kg and 0.13Cmol/kg higher than Ujara. Also Ama-Ezi-Edda ,Aliogo and Oba had 0.01Cmol/kg,0.Qmoi/kg0.0i lCmol/kg higher than Ama Ezi Edda. Oba was lower than Aliogo by 0.3Cmol/kg.

The ranking of the fertility level of potassium (k) in the soil spread over a fallow period of seven (7) years indicated that all the treatments starting from Obasioha (0.3 1 Cmol/kg) to Oba (0.52Cmol/kg) were higher in the fertility status. According to soil fertility rating by (Enwezor et al., 1990).

Sodium (Na)

The effect of fallow length on the concentration of sodium (Na) revealed a significant difference at (p<0.05). Treatment of different years of fallow were compared with one another, there was 0.54Cmol/kg higher concentration of sodium ofAlioha when compared with Obasioha, AgainAlioha had, I .14.Cmol/kg 1.62Cmol/kg, 2.11Cmol/kg, 2.74Cmol/kg and 4.l7Cmo/kg less sodium (Na) concentration respective1y when compared with Obasioha treatment 6, Ama-Ezi-Edda,Ugwu Akwu and Ujara produced 3.63Cmol/kg, 2.2Cmol/kg, 1 .57Cmol/kg, 1.1Cmol/kg and 0.6Cmol/kg more sodium the soil than Alioha. Also Ujara had 0.50Cmol/kg,0.97Cmol/kg, 1.6Cmol/kg and 3.03CmoI/kg lesser when compared with Ugwu-

Akwu, Ama-Ezi-Edda, Aliogo, and Oba respectively, Furthermore, Ugwu Akwu when compared with Ama-Ezi-Edda revealed 0.47Cmol/kg less Na concentration. Aliogo and Oba also differed with Ugwu-Akwu by 1.1Cmol/kg and 2.53Cmol/kg respectively. There were 0.63Cmol/kg and 2.O6Cmol/kg more sodium in Oba than in Ama-Ezi-Edda and Aliogo respectively. There was further I.43Cmol/kg treatment staring from Obasioha0.31Cmol/kg) to Oba (0.52Cmol/kg) higher than Aliogo soil.The ranking of fertility level of sodium in the soil spread over fallow nod of seven years indicated that all the treatments from Obasioha(3.67Cmo/kg) to Oba (7.84Cmol/kg) were rated high when (>0.15) in the fertility status. According to soil fertility rating by (Enwezor*et al*, 1990).

ECEC

The effect of fallow length on the concctra1icn of ECEC in table (2) indicated that there was non-significant difference at ($p<0.05$).ECEC value ranges between Obasioha (13.23Crnol/kg)-Oba (19.08Cmol/kg) at the fallow length. The highest value observed was Alioha which had 0.25Cmol/kg of ECEC.Treatment of different years of fallow was compared with one another. Again Alioha had 5.85Cmol/kg, 4.02Cmol/kg.3 .7Cmol/Kg,3.38mol/kg and 0.33Cmol/kg less ECEC concentration respectively when compared with Obasioha,Oba, Ama-Ezi-Edda,Ugwu Akwu,Aliogo and Ujara had 5.60Cmol/kg, 3 .77Cmol/kg, 3 .45Cmol/kg, 3. 13Cmol/kg and 0.08cmol/kg respectively more ECEC in their soil than Alioha soil. Also the comparison of Aliogo soil showed that there were 3.05Cmol/kg, 3.37Cmol/kg, 3.69Cmol/kg, and 5.52cmol/kg higher in Ugwu-Akwu soil when compared with Aliogo ,Ugwu Akwu, Ama-Ezi-Edda and Oba soils respectively. Furthermore, Ugwu Akwu when compared with Ama-Ezi-Edda and Oba soils also differed with 0.64Cmol/kg and 2.47Cmol/kg respectively. Nevertheless there were 0.32Crnol/kg and 2. 1 5Cmol/kg more ECEC in Oba soil than in Ama-Ezi-Edda and Ugwu-Akwusoils respectively, There was further 1.83Cmol/kg more ECEC concentration in Oba when compared with Ama-Ezi-Edda soils.The ranking of the fertility level of ECIT in [he soil spread over a fallow period of seven (7) years indicated that all treatment from Obasioha(13.23Crnol/kg) to Oba(1 9.08Cmol/kg) were medium based on rating on Nigeria soil (Enwezor*et al.*, 1990; Adeputu. 2000).

% Base saturation

The effect of fallow length on concentration of % base saturation in the Table (2) showed a significant different at ($p=0.O5$). This effect as observed on different years of fallow duration. The values of % base saturation recorded on each treatment are Obasioha (93.63%), Alioha (94.02%). Ujara (06.94%) Ugwu akwu (85.32%) Ama-Ezi-Edda(87.374), Oba(95.I 8%). From the above treatments Ujara had the highest value of (96.94%) base saturation while the lowest value recorded in Ugwu-Akwu (85.32%). When treatments were compared with one another it showed that Ama-Ezi-Edda, Obasioha,Alioha,Obaand Ujara were 2.05%. 4.4%, 51°/,8.7,%9.86% and 11.62% higher than Ugwu-Akwu. Also Aliogo, Obasioha, Alioha, Oba and Ujara had 2.35,6.65%, 781% and 9.57% higher than Ama-Ezi-Edda .And Obasioha,Alioha, Oba,and Ujara were 3. 1 9%, 4.3%5.46% and 7.22% higher than Aliogo: Alioha,Obaand Ujara were 0.39%, 1.55% and 3.3 1% higher than Obasioha, Oba and Ujara were 1.16% and 2.92% higher than Alioha, when Ujara was higher than Oba by 1.76%. The ranking of soil fertility ranges of% base saturation (%1-3S) in the soil spread over a fallow period of seven (7) years showed that he soil were acidic in nature (>50% base saturation) by (Landon 1984).

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