European Journal of Academic Essays 3(2): 100-104, 2016
ISSN (online): 2183-1904
ISSN (print): 2183-3818
www.euroessays.org

Evaluation Of Alluvial And Upland Soils Of Obubra Local Government Area Of Cross River State, Nigeria For Okra (*Abelmoschus Esculentus)* Production

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Abstract: This experiment was carried out at the green house of Agronomy Department, Faculty of Agriculture and Forestry, Obubra Campus, Cross River University of Technology ($06^0 5^1$N, $8^o 20^1$E) , with the aim of evaluating upland and alluvial soils for Okra production. Samples were obtained from the riverine areas of Obubra in Cross River State, Nigeria and research farm of Cross River State University of Technology. The soils of Obubra are formed from Shale, reddish Brown and gravelly and have been described as Lithic Dystropept (Dystric Cambisol) and the okra variety planted was the Clemson Spineless. Six random samples were bulked together for both chemical and physical analysis. The physical properties had values of 76.3% and 86.1% for sand for alluvial and upland soils, 12.7% and 6.5% silt for alluvial and upland soils and 11.0% and 7.4% clay for alluvial and upland soils respectively. The two soils had pH values of 4.7 and 5.6 for alluvial and upland soils respectively. The result of both physical and chemical properties of the investigated soil samples revealed that, the alluvial soil is more acidic than the upland soil. The organic matter of the alluvial soil was 2.69gkg^{-1} compared to that of upland soil that had 0.46gkg-^{1}. Total nitrogen of both soils were 0.14gkg-^{1} for alluvial and a lower value of 0.03gkg-^{1} for upland soil. The alluvial soil with a higher level of organic matter as a result of accumulation of alluvial deposit, gave a significant yield of 2.42kg compared to the upland soil with a yield of 1.39kg at harvest. Finally, the difference observed in the yield of the okra variety was due to the fertility status of thesesoils.

Keywords: Alluvial and Upland soils, Okra Variety and Yield

1. Introduction

Alluvial soil are mostly brought about by flood water, when rivers over flow its bank. During this time, more sediment is decayed and add nutrient to the soil due to deposition of these alluvial materials.

According to Carsky, (1992) alluvial soil is located in areas that are susceptible to flooding during the wet season and are somewhat well drained during the dry season. They are generally formed in valleys or by alluvial parent materials formed at varying slopes from almost flat to hilly topography (William *et al*; 1979). This soil may be sandy as in beach deposits or derived from sandstone, but are more frequently clayed. They are said to be very fertile with maximum water holding capacity. Brinkman (1986) observed that alluvial soils have texture ranging from clay to sand silt with the greatest variation in the surface horizon.

Alluvial soil also known as flood plain soils are the major and mostly dominant soil type that contributes nearly 60% of the agricultural wealth in some part of the forest zone of southern Nigeria (Oku *et al*, 2004). The soil is derived from the alluvial deposition laid down by numerous tributaries feeding the Cross River that flows across the Obubra Area. The streams of tributaries bring with them the products of rock weathering and organic debris of various degree of fineness and deposit them as they traverse the plains. The flood plain soil includes deltaic alluvium, Calcareous alluvial soil and alluvium (ICAR, 2004). Ojanuga *et al*; (1996) seems to regard flood plains as that which he consider as purely an ecological habitat or a sizable land permanently or seasonally flooded for a considerable period of the year that normally support hydrophilic plants and animals. It is normally associated with a low-lying topography. Well-drained tropical soils are usually reddish in colour. When drainage is poor, the soil is either bluish grey, greenish grey (Ahn, 1993). The surface horizons are usually mottled during the dry season, whether cultivated or not, the molting is a result of yellowish or brownish or spots of black concentration of iron and manganese compound distributed in a geo matrix and that upon flooding mottles disappear. (Iri *et al*., 1958)

Upland soil is a type of soil characterized by excessive run off mostly un-described topography, low organic carbon, low Nitrogen content and exchangeable bases due to the predominant agricultural activities taking place in the upland soil of Obubra, (Cross River Geological MAP;2004)

Okra is tolerant of wide range of soils and climatic conditions but grows best on well manured loams that are not susceptible to excessive soil moisture. Okra does best on well drained sandy loam soils. Poorly drained soils may result in drowning (low oxygen) of the plants. Okra prefers slightly acidic soils with a pH between 5.8 and 6.5. On clay soils, seedlings have difficulty emerging and transplanting is recommended. Okra is very sensitive to soil with a hard pan, and soil compaction severely restricts plant growth (Debie, 1977). Well drained sandy loam, high in organic matter is the most desirable soil condition for okra cultivation. It is difficult to get good stands on heavy clays. Okra is susceptible to several soils borne disease and pest (nematodes, southern stem slight and wilts) thus crop rotation should be planned to avoid these diseases where possible (Douglas, 1999).

The main objective of this Study was to evaluate the fertility status of both Alluvial and Upland Soils for Okra Production in Obubra, Cross River State, Nigeria and to recommend measures that will enhance the Productive Potentials of both Alluvial and Upland Soils of Study Area.

2. Materials And Methods

The study was conducted at the green house of Department of Agronomy, Cross River University of Technology Obubra Campus and lies between longitude 6^0 5^1 and 8^0 20^1E and latitude 5^0 4^1 and $6^0 10^1$N. Green house experiment was conducted from October to December 2011, to evaluate the fertility states of alluvial and upland soils using two varieties of okra.

The soils of Obubra are formed from Shale, reddish Brown and gravelly and have been described as Lithic Dystropept (Dystric Cambisol) were collected at the beginning of experiment, bulked and analyzed for physical and chemical parameters.

Particle size was determined using hydrometer method according to Day (1965). The hydrometer was used to measure the proportion of sand, silt and clay.

Soil pH was determined in a 1:2.5 soil: water suspension using a glass electrode pH meter. Organic carbon was determined by Walkely and Black Wet-Oxidation method as described by Juo(1979). The values for organic matter were obtained by multiplying the organic carbon values by1.724. (Van Bemmelen factor).

Total nitrogen was determined on soil sample passed through 0.5mm diameter sieve and analyzed according to the micro kjedahl method (Jackson, 1969).

Available phosphorus was extracted by the Bray 2 method (Bray and Kurtz, 1945) and the P read by Murphy and Riley method (1965).

Exchangeable cations were determined by extracted the samples with neutral normal NH_4OAC. Exchangeable calcium and magnesium were determined by the EDTA titration method while potassium and sodium in the leachate were read using EEL flame photometer. The exchangeable acidity was determined by extracting 5g of the soil extracts with INKCI and titrating with 0.5N NaOH using phenolphthalein indicator (Mclean, 1965). Effective cation exchange capacity (ECEC) was taken as the sum of exchangeable cations.(Ca^{2+} + Na^++ K^++Mg^{2+}) and the exchangeable acidity. The percentage Base Saturation (PBS) was calculated as follows:

Percentage Base saturation = $\frac{Ca^{2+} + Mg^{2+} + K^+ + Na^+}{ECEC} \times \frac{100}{1}$

A randomized complete block design (RCBD) was used with four replications. A total of 192 poly bags were used for the experiment 24 poly bags for each replicate and 96 poly bags for each soil type. The soils had uniform treatment of 20g : 10g :10g of NPK mixed fertilizer. The poly bags were filled with the two types of soils. Soil A upland, and B alluvial soil respectively. The two soils were air dried for two days; this was done to allow adequate aerations to ease the penetration of root.

The Okra seeds were sown on 4^{th} of October, 2011; two seeds per poly bags at a depth of 2cm. Weeding was done manually by hand to pick the pre and post emergence weeds at 2 weeks interval. The crops were harvested on maturity at two weeks interval for the three harvests and weighing took place immediately after harvest.

3. Result and Discussions

TABLE 1: Physical and Chemical Properties of the Investigated Soil

Parameters	Alluvial	Upland
pH 1:2.5	4.7	5.6
sand %	76.3	86.1
Silt%	12.7	6.5
Clay %	11.0	7.4
O.mgkg^{-1}	1.69	0.46
TN gkg^{-1}	0.14	0.03
Avail. P mgkg^{-1}	16.5	40.5
Ca cmolkg	9.0	3.8
Mg cmolkg^{-1}	1.2	0.6
K cmolkg-^{1}	0.7	0.10
Na cmolkg^{-1}	0.10	0.05
Exch. Acidity %	0.96	1.28
ECEC cmolkg^{-1}	11.43	5.83
Base sat. %	19.0	7.8

Table 1 Shows that the pH value of the upland soil is higher with a value of 5.6 while the alluvial soil had a pH value of 4.7. From the result, it shows that the alluvial soil is slightly more acidic than the upland soil. The physical properties of the soils reveal that the alluvial soil had lower percentage of sand fraction 76.3% compared to that of upland soil which had higher value of 86.1%. The proportion of silt in the alluvial soil was higher with a value of 12.7% compared to that of upland soil with a value of 6.5%. The clay particle had a value of 11.0% compared to that upland soil which had a value of 7.4%. Generally, soils with sand proportion such as this, the root of the crops are not properly anchored.

The result of the studied soils shows that the alluvial soil had higher value of organic matter compared to that of upland soil, with a value of 1.69 gkg^{-1} compared to that of upland soil with a value of 0.46gkg^{-1}, the higher value of organic matter observed in the alluvial soil could be the result of the delayed organic residue of the vegetation which reduced the soil density. According to Ogbodo and Nnabude (2009), improved soil retention of the alluvial soil was an attribute of reduced density, improved porosity and higher organic matter content and reduced runoff compared to the cultivated soil. Also the flooding nature of the alluvial soil is another factor that brings about the debris on the top soil of this low land to add to the organic matter of soil, even runoff from the upland soil comes with some sediments to deposit on the top soil over time, they decay and increase organic matter of the alluvial soil.

Total nitrogen was lower in the upland soil with a value of 0.03gkg^{1} compared to that of alluvial soil which had a higher value of 0.14gkg^{1}. Though both soil total nitrogen were below the critical level of 0.15gkg^{1} set for crop production in Southern Nigeria.

(Enwezor et al; 1981; Agboola; 1984). The high total nitrogen value observed in the alluvial soil is due probably to increase microbial activities which enhance mineralization of organic matter. Soil available P was higher in the upland soil with a value of 40.5 mgkg^{-1} compared to that of alluvial soil which had a value of 16.5 mgkg^{-1}, both soils had available P values above the critical level of 15mgkg^{1} regarded as the critical level of available P for crop production in Southern Nigeria.

Significant higher values of Ca, Mg, K and Na were recorded in the alluvial soil with values of 9.0cmolkg^{-1} for exchangeable calcium, 1.2cmolkg^{-1} for exchangeable magnesium, 0.2cmolkg^{-1} exchangeable potassium and 0.10cmolkg^{-1} in exchangeable sodium compared to that of upland with lower exchangeable calcium with value of 3.8cmolkg^{1} , exchangeable magnesium Mg had a value of 0.6cmolkg^{-1} ,exchangeable potassium had a value of 0.10 cmolkg^{1} while exchangeable sodium was lower in the upland soil with a value of 0.05cmol/kg^{-1}. This could be as a result of the eroded materials from the upland soil during runoff and deposition by flood water. Leaching could also have contributed to the reduction of these elements in the upland soil. This result agrees with the finding of Esu (1989) for some alluvial soils in Nigeria.

According to Ogbodo and Nnabude (2009), the higher Na content observed in the alluvial soil is that naturally, flooded water carries along salts which are deposited on the soil surface as flood water recedes and as evaporation takes place leaving salt crust and crystals. This situation was adduced for the higher Na content of the alluvial soil.

The exchangeable calcium and magnesium are similar to those reported by several other workers for the soils of the humid tropics (Agbede, 1996, kamalu, *et al;* Enwezor *et al;* 1981 and on soils of Cross River State (Attoe, et al; 2006).

Enwezor, et al (1981) classified exchangeable potassium into low if the values are less than 0.2cmolkg^{1} medium when the values are between 0.2 – 0.4cmolkg^{1} and high when the values are above 0.4cmolkg^{1} , using this criteria, it shows that the upland soil is deficient.

The effective cation exchange capacity in the upland soil was low and had a value of less than 10.0cmolkg^{-1} compared to the alluvial soil with a value 11.43cmolkg^{-1}. This is a characteristic of low activity clay in Southern Nigeria dominated by kaolinite (Udo, 1977, Juo,1981; Ojanuga, 1996; Agbede 1996; Attoe and Amalu, 2005).

The low CEC of the upland soil indicated the poor ability of the soils to retain nutrient within the soil and hence facilitating high leaching rate (Agbede, 1996). The CEC was dominated by exchangeable acidity as reflected in the base saturation. This is attributed to the high degree of weathering of the soil and the high rainfall pattern of the of Cross River State, resulting in the displacement of the basic cations such as hydrogen and aluminum (Juo, 1981, Udo, 1977; Attoe, et al; 2006).

Some important soil chemical characteristics that influence the rating of soils suitable for crop production includes P^{H}, organic matter, total N, available P, and exchangeable cations (Enwezor, et al; 1981).

However, the observed higher organic matter values of the alluvial soil reflect higher productivity and reduced decomposition and mineralization rates in Wetland environment. Kyuma, (1985), and Patrick (1990) reported that such situation result in accumulation of Organic matter.

TABLE 2: Fruit Yield of Okra in Grammes (gms)

Okra varieties	**Soil type**		
	Alluvial Soil	**Upland soil**	**Mean**
First harvest			
V1	427.50	408.75	418.13
V2	421.00	403.00	412.00
Mean	424.25	405.87	
Second harvest			
V1	550.00	502.50	526.25
V2	540.00	506.25	523.13
Mean	545.00	504.38	
Third harvest			
V1	481.25	458.16	469.71
V2	469.75	453.83	461.79
Mean	475.50	455.99	
	First Harvest	Harvest	**Second** harvest **Third**
LSD (0.05) for two soil types	14.3	25.5	18.7
LSD (0.05) for the okra varieties	5.4	2.1	6.4

4.Summary, Conclusion and Recommendation

This research carried out during the 2011 cropping season in the department of Agronomy Green House of Cross River University of Technology was to evaluate the Alluvial and Upland soils of Obubra in Cross River State, Nigeria for the Production of Okra (*Abamoschus esculentus)*. The areas sampled were located at Ofatura river bank and Cross River University of Technology Research Farms. Samples were collected for physical and chemical analysis. Soil parameters assessed were soil P^{H}, Particle size Distribution, Organic Matter Content, Total Nitrogen, Available P, Cation Exchange Capacity, Exchangeable Acidity, ECEC and Base Saturation.

Based on the result, it is apparent that the upland soil is slightly more acidic, low in organic matter, total Nitrogen, except for available P, that was higher; the other elements are low for optimum crop production. According to the rating capacity of Landon (1984) and Enwezor, et al; (1988), 50 percent of these above mention chemical properties form the separation index between fertile soils and less fertile soils. These nutrients are low in terms of fertility and cannot sustain optimum crop production, nevertheless, for improved crop yields on short term bases mineral fertilizers could be recommended for the upland soils to promote higher yield of crops. However, on a long term bases for sustainable crop production, Soil fertility restoration measures affordable to farmers around Obubra should be adopted. Among these measures, is the use of organic manure, green manuring practices and burnt rice husk which is abundant in the area to improve the soil physical and chemical constraints.

Finally, the research further confirmed that the inhabitants engage the upland soil in the production of predominantly root and cereal crops while the alluvial soil has been abandoned over the years as unsuitable for crop production. The study has also revealed that alluvial soil had higher fertility status due to the alluvial deposit brought about by flood water and runoff than the upland soil.

However, in other to ensure optimum okra production in the upland soil, there is need to alleviate the inherent fertility constraints of the soil; application of lime, to increase the level of acidity and the use of organic based fertilizers and the practice land fallowing system of between 3-5 years to enable mostly the upland area regain its lost fertility for maximum crop production and erosion should be controlled by constructing drainage and terraces across the areas used for planting.

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