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Soil Physico-Chemical Characteristics of Kanawa Forest Reserve (KFR), Gombe State, Nigeria.

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Abstract: *The soil physico-chemical characteristics namely (Soil texture, pH, soil moisture, total nitrogen, potassium, organic carbon, available phosphorus, carbon exchange capacity, and available micronutrients) at Kanawa Forest Reserve (KFR) in Yamaltu /Deba, LGA of Gombe State, Nigeria was investigated. Soil samples were collected from six sites following the vareity of landforms in the study area and subjected to physico – chemical analysis. Results for soil analysis showed site I, III and V1 (loamy sand type), site II, 1V and V (sandy loam type). Soil moisture was moderate. Soil pH was generally acidic (6.60) with the exception of site VI (7.10) which was slightly alkaline. Organic matter content (18.85gkg^{-1}) and total nitrogen (1.27gkg^{-1}) were high, available phosphorus (22.40mgkg^{-1}) was medium. Exchangeable bases were generally low except for potassium in site VI (0.17 Cmol (+) kg^{-1}) which was moderate. Zinc (1.28mgkg^{-1}) was low, copper (0.86 mgkg^{-1}) and iron (9.11 mgkg^{-1}) were medium and, manganese (15.56 mgkg^{-1}) was high. The results obtained were analyzed using two way ANOVA, in order to find out if there were any differences within the physico-chemical properties of the different sites. It was concluded that Soils of Kanawa forest reserve (KFR) has a high fertility related parameters which helped it to support a luxuriant vegetation types.*
Keywords: *Kanawa Forest Reserve (KFR), soil analysis, fertility, physico- chemical.*

I. Introduction

The bulk of Nigerian Vertisols occur in the Sudan and Northern Guinea Savannah zones in the Northeast of the country in sub humid and semi-arid environments (Kowal and Knabe, 1972). Gombe State lies within the Sudan Savanna zone, and a considerable portion of Gombe State is underlain by a weakly leached ferruginous tropical soil. Though Vertisols can be found in pockets (Hassan *et al.*, 2006). The geology and geomorphological processes that shaped the landforms greatly influenced the soils. The underlying geology of Gombe is said to be Tertiary continental sandstone. They are chiefly characterized by the accumulation of free iron oxides within their profile, particularly in the subsoils horizons, they often have strong yellowish or reddish brown colours and regularly contain iron concretions (Hassan *et al*.,2006). These soils contain illitic as well as kaolinitic clay minerals. Their cat ion exchange capacity was 20- 40 Cmol (+)kg^{1}. Base saturation is also moderately high to low, usually being greater than 40 per cent. Kanawa Forest Reserve however has a rich black soil that is good for plant growh. No work was carried out on the physico- chemical properties of the reserve. Therefore this study was undertaken in order to investigate the physico –chemical composition of the forest reserve.

II. Materials And Methods

Description of the Study Area.

Kanawa Forest Reserve (KFR) is located in Yamaltu/Deba Local Government Area of Gombe State, Nigeria and it lies in the Southern part of the Sudan Savanna between latitude 10^{o} 16'N and longitude 11^{o} 18' E with an altitude of 336m-390m above sea level. The size of the forest was 41 hectares (Gombe Native Authority, 1945). The entire forest reserve is presently 53 hectares plot because of acquired farmlands by the Gombe state government.

The study area is basically underlined by sedimentary rocks which consist of Yolde formation, Gombe formation and Pindiga formation. This formations, comprises varied lithollogies, ranging from fine to medium and coarse grained sandstones, silt and clay. The area forms par Gongola basin of the upper Benue trough of Northern Nigeria (Samaila, 2011).

The terrain is generally undulating; the drainage pattern is generally dendritic shallow V-shaped stream channels that tend to broaden into plains as the streams in the area approaches the lowlands (Samaila, 2011).

The vegetation of the study area is a mosaic made up of dense Sudan Savanna vegetation especially around the hilly part of the reserve and marshy, riparian, lowland rainforest vegetation near the Poli stream, grassland with tall grasses and tropical thorn forests, in the drier part of the forest.

The climate of the area is characterized by two distinct seasons: a humid and wet season from April through October and a dry season which runs from November through March .Of the climatic factors, rainfall, temperature and relative humidity normally exert the most powerful influences upon vegetation.

For the purpose of soil sampling, three transects A,B,C were laid per site and three replicate soil samples were collected along each transect for each sampling site across the forest using soil auger. Soil samples were collected at two depths namely 0-15cm (top soil) and 15-30cm (sub soil), respectively. The sampling was restricted to this depth because it provides the bulk of plant nutrients (Russell, 1978).

Laboratory Studies.

The soil samples were air dried after which the big lumps were broken up with the aid of a mortar and pestle. The samples were then mixed thoroughly and sieved through a 2 mm sieve and then stored in polythene bags ready for analysis.

Particle size analysis was determined using the Bouyoucous hydrometer method after dispensing the soil with 5% Sodium hexametaphosphate (Day, 1965; Bouyoucous, 1962). Soil moisture content determinations (Thermogravimetric method) (Topp and Ferre, 2002a,b). Soil pH (in 1:1 soil-water and 1:2 soil $CaCl_2$ suspension) was determined potentiometrically (Anonymous, 1994b, Watson and Brown, 1998). Total nitrogen (N) were determined by macroKjeldahl digestion-distillation methods (Bremner, 1965). Available phosphorus (P) determination (Bray, 1965). Organic carbons (OC) were determined by Walkley and Black wet –combustion methods (Walkley and Black, 1965) as modified by Jackson (1969). Bray No 1 method was employed for the NH_4 saturation method where the NH_4OA_C filtrate was saved for estimating the exchangeable bases : Ca, Mg, K, Na on an Atomic Absorption Spectrophotometer (AAS), the values were used to calculate the per cent base saturation. Available micronutrients (Zn, Cu, Na, and Mn) were extracted by the Mehlich 1 method, as described by Wear and Sommer (1948) their content in the extract was estimated on an AAS.

Statistical analysis

Analysis of variance was carried out using PROC ANOVA subroutine of SAS (SAS, 1998)

The means of soil properties were separated using the Duncan's multiple range test (DMRT) at 5 % level of significance ($P < 0.05$).

III. Results

Based on textural classification, soils of Site I, II and V1 were of loamy sand type, while Site II, 1V and V soils were of sandy loam type (Table 1). Site V1 recorded the highest values of sand (86.23) while site V had the lowest values of (71.53) for sand. Silt recorded the highest values of (17.34) at site V, while the lowest values were recorded at site V1.The highest values of clay (15.50) were recorded for site II while site III had the lowest values for clay (10.40) at site III.

Site II had the highest percentage of moisture (40.66 %) while site VI had lowest percentage of moisture (0.27%) (Table 2). Site VI had the highest content of pHw (7.10) while site IV had the lowest value of pHw (5.53) (Table 2). Site VI had the highest content of pHc (6.45) while site IV had the lowest value of pHc (4.94) (Table 2). Site I had the highest value of organic carbon (18.85 gkg) while site V had the lowest value of organic carbon (7.31 gkg) (Table 2). Site IV had the highest amount of nitrogen with (1.27 gkg^{-1}) while site VI had the lowest amount of nitrogen (0.77 gkg^{-1}) (Table 2). Site 1 had the highest amount of available phosphorus with (22.40 $Mgkg^{-1}$) while site VI had the lowest amount of available phosphorus (6.02 $Mgkg^{-1}$) (Table 2). Based on the ratings provided by Esu (1991), the soil pH was generally acidic with the exception of site VI which was slightly alkaline in nature. Organic matter content was very high, total nitrogen was high, and available phosphorus was medium.

Table 1: Soil particle size distribution at Kanawa Forest Reserve (KFR), Gombe State, Nigeria during 2009-2010.

Site	Sand	Silt %	Clay	Textural class
Site I	83.24a	5.12c	11.64b	Loamy sand
Site II	73.21b	11.29b	15.50ab	Sandy loam
Site III	85.25a	4.35c	10.40ab	Loamy sand
Site IV	78.00b	9.36b	12.64b	Sandy loam
Site V	71.53b	17.34b	11.13b	Sandy loam
Site VI	86.23a	3.17c	10.60b	Loamy sand
Mean	79.98	7.9	12.38	
SE±	0.79	1.61	1.14	

Means followed by the same letter in a column are not significantly different at 5% probability level using Duncan Multiple Range Test.

Table 2: Soil moisture, pH, organic carbon, total nitrogen and available phosphorus of soils of Kanawa Forest Reserve (KFR), Gombe State, Nigeria during 2009-10

Site	Moisture%	pHw 1.1	pHc 1.1	Organic carbon gkg-^{1}	Total N gkg-^{1}	Available phosphorus mgkg-^{1}
Site I	25.19c	5.88c	5.14c	18.85a	1.20ab	22.40a
Site II	40.66a	6.06bc	5.26c	9.35b	0.98cd	10.01c
Site III	34.96b	6.17bc	5.31c	10.78b	1.04bc	7.75c
Site IV	29.61c	5.53c	4.94c	16.88a	1.27a	16.94b
Site V	0.65d	6.60ab	5.94b	7.31b	0.78d	6.93c
Site VI	0.27d	7.10a	6.45a	7.54b	0.77d	6.02c
Mean	21.89	6.25	12.45	11.79	1.01	11.67
SE±	1.51	0.17	0.15	0.87	0.06	1.45

Means followed by the same letter in a column are not significantly different at 5% probability level using Duncan Multiple Range Test

<u>Key to sites</u>
Site 1 = Riparian
Site 11 = Lowland rainforest
Site 111 = Grassland
Site 1V= Marshy
Site V= Thorn
Site V1= Sudan savanna

Site IV had the highest level of calcium (4.68 Cmol (+) kg^{-1}), while site V had lowest level of calcium (2.02 cmol (+) kg^{-1}) (Table 3). Site I had the highest level of magnesium (0.95 cmol (+) kg^{-1}), while site V had the lowest level of magnesium (0.41 cmol (+) kg^{-1}) (Table 3). Site IV had the highest level of potassium (0.31 cmol (+) kg^{-1}), while site VI had the lowest level of potassium (0.17 cmol (+) kg^{-1}) (Table 3). Site II and V had the highest level of sodium (0.18 cmol (+) kg^{-1}), while site VI had the lowest level of sodium (0.11 cmol (+) kg^{-1}) (Table 3). Site IV had the highest level of cation exchange capacity (11.42 cmol (+) kg^{-1}), while site II had the lowest level of cation exchange capacity (4.88 cmol (+) kg^{-1}) (Table 3). Based on classification by Esu, (1991) exchangeable bases in the study area were generally low except for potassium in site VI which was moderate. Site I had a high concentration of zinc (1.28 mgkg-^{1}), while site VI had the lowest concentration of zinc with (0.18 mgkg-^{1}) (Table 4). Site IV had the highest concentration of copper with (0.95 mgkg-^{1}), while site VI had lowest concentration of copper (0.25 mgkg-^{1}) (Table 4). Site V had the highest concentration of iron (9.11 mgkg-^{1}), while site IV had the lowest concentration of iron (3.19 mgkg-^{1}) (Table 4). Site V had the highest concentration of manganese (17.51 mgkg-^{1}), while site IV had the lowest concentration of manganese (6.73 mgkg-^{1}). Based on the soils rating scale by Esu, 1991, concentration of zinc in the study area was low, medium in copper and iron and high in manganese.

Table 3: Exchangeable bases from soils at Kanawa Forest Reserve (KFR), Gombe State during 2009-2010

Site	Ca	Mg	K	Na	CEC
		Cmol(+)kg^{-1}			
Site 1	4.19a	0.95a	0.27ab	0.20a	10.14a
Site II	3.65ab	0.77a	0.24abc	0.18ab	8.44b
Site III	3.57ab	0.68a	0.22bc	0.15ab	7.16b
Site IV	4.68a	0.89a	0.31a	0.17ab	11.42a
Site V	2.02c	0.41b	0.19bc	0.18ab	5.00c
Site VI	2.23bc	0.53b	0.17c	0.11b	4.88c
Mean	3.39	0.71	0.23	0.17	7.17
SE±	0.37	0.15	0.02	0.02	0.53

Means followed by the same letter in a column are not significantly different at 5% probability level using Duncan Multiple Range Test

Table 4: Exchangeable micronutrients of soils at Kanawa Forest Reserve (KFR), Gombe State during 2009-2010.

Site	Zn	Cu	Fe	Mn
		mg kg^{-1}		
Site 1	1.28a	0.86ab	5.12bc	10.54ab
Site II	0.93a	0.57bc	3.74c	15.49ab
Site III	0.34b	0.38d	3.22c	10.98ab
Site IV	1.06a	0.95a	3.19c	6.73b
Site V	0.26b	0.36bcd	9.11a	17.51a
Site VI	0.18b	0.25d	6.68b	15.56ab
Mean	0.68	0.42	5.18	12.80
SE±	0.12	0.12	0.67	1.96

Means followed by the same letter in a column are not significantly different at 5% probability level using Duncan Multiple Range Test.

Key to sites
Site 1 = Riparian
Site 11 = Lowland rainforest
Site 111 = Grassland
Site 1V= Marshy
Site V= Thorn
Site V1= Sudan savanna

IV. Discussion

The soil types of Kanawa Forest Reserve (KFR) were variable comprising of loamy sand, sandy loamy soils. The mean textural class shows higher sand than silt and clay contents. Several workers have earlier described more sand contents in the savanna soils (Tomlinson, 1965; Klinkenberge and Higgins, 1970; Ayashe, 1995; Geerling, 1973; Green and Amanche 1987 ; AbdulHameed 2002; and Abdullahi 2001) reported similar pattern for Yankari game reserve soils. Although the percentage of sand in the present study was higher than that reported by Abdullhameed (2002) and Abdullahi (2001) for Yankari game reserve soils, the percentage of silt and clay were higher in Yankari game reserve than that of the present study. This could be due to the annual rainfall of 930mm which was sufficient to allow for leaching out and washing in of clay and other materials in Kanawa Forest Reserve (KFR).

The soil types of the study area generally had moderate moisture contents. The highest value could be due to higher percentage of clay in the particular site (II), hence higher water retention capacity. The lowest percentage of moisture content (site VI) could be due to higher percentage of sand, hence lower water retention capacity.

The soil pH of the study area was generally acidic with the exception of site VI which was alkaline. The type of soil pH determines the type of plants grown in a particular area (Abaje, 2007). This finding agrees with the works of Abdullahi, (2001), Young (1990); Aduayi and Ekong (1981); Raji *et al.,* (1996); and Hassan *et al.*,(2006) who worked on Yankari game reserve soils, Northern Nigerian Savanna soils and Walban-Deba in Gombe State. Soil reaction has a great influence on the availability of plant nutrients which is generally highest between pH 6 and 7.5. Most plants are known to thrive under a pH range of 6.0-7.5. This condition in soil is favourable for nutrient uptake by plants and tree growth (Tisdale and Nelson, 1975). Aduayi and Ekong (1981) also stated that the factors partly responsible for the high pH values in the Savanna include the presence of and return of exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) to the surface soil by the plant vegetation in an area. Soil pH therefore greatly influences how soluble different available phosphorus compounds are in the soil.

The moderate acidity obtained in the study area may also partly be explained by the underlying geology that weathered to give rise to the soils formed. The alkalinity obtained in the study area could be due to the sandy nature of the soils in the particular site (VI). Forest vegetation tends to be more acidic than those developed under grassland vegetation. Soil pH also provides a good indication of the chemical status of the soil and can be used in part to determine plant growth.

The soils of the study area according to the rating scale of Esu (1991) could be described as having high organic matter content ranging 18.85-7.31 gkg^{-1} with a mean of 11.79gkg^{-1}. The high organic matter content may be due to the fact that forest soils contain high leaf and stem litter fall and undisturbed activities of micro organisms in the soil for many years leading to the production of leaf mould which makes the soil soft and dark brown. Soil organic matter also consists of plant and animal residues in various stages of decay. Adequate levels benefit soil in many ways; most benefits are derived from product released as organic residues and decomposed in the soil. A similar trend was observed by Iwara *et al.*, (2011) who reported that high contents of organic carbon in the soil of an area may be attributed to the rate of minerals returned to the soil through the fall and subsequent decay of litter made possible by the high temperature and precipitation in the area compared to soil outside their influence. Maximum organic matter was noted in all the soil types dominated by all the plants species present in the study area. However, this vital nutrient present a low to medium range in the soils of Yankari game reserve soils as reported by (Abdullhameed, 2002: Abdullahi, 2003) and Hassan *et al*.,(2006) for soils at Walban-Deba in Gombe State, and grossly lacking in the semi-arid West Africa as reported by Jones and Willd (1975).

The soils of the study area could be generally classified as having very high total nitrogen. The mean total nitrogen was 1.01 gkg^{-1}. This very high nitrogen content could be due to increase in decomposition of leaf litter from adjoining trees especially in the damper sites leading to increase in leaf cell number and cell size with an overall effect of increased leaf production giving rise to the thriving plant vegetation types. This was consistent with the findings of Iwara *et al*.,(2011) and the values for tropical regions, but not consistent with the findings of AbdullHameed (2002) who observed a low nitrogen content of about 0.44gkg^{-1} in the soils of Yankari game reserve and Hassan *et al.*, (2006) who also observed low nitrogen content of about 0.2-1.8 gkg^{-1} in his study of Walban –Deba .

According to Aduayi and Ekong (1981), adequate nitrogen in the soil is important for the optimum growth of plants; all their functional processes are associated with the presence of nitrogen this probably is one of the most important of the plant nutrients occurring in the soil mainly as ammonium compounds or nitrates. It regulates the efficient use of phosphorus and potassium (Sachs, 1999).

From the present findings, the amounts of phosphorus were generally classified as having medium to low amounts. The medium amounts present in site 1 and 1V could be due to high fertility related parameters in the site while the low amount of phosphorus in site II,III,V,VI could be due to the acidity of the soil, and leaching effects /precipitation as insoluble iron and aluminium phosphates and phosphorus –fixing capacity as attested by soil reaction and sesquioxides form in the soils which could be due to kaolinite formation in the soil. This agrees with the findings of (Lombin and Gosh,1986; Ayuba, 1992; Abdullahi, 2010) who worked on the soils in Konduga L.G.A in Borno State , Nigeria and Yankari game reserve soils and obtained low phosphorus levels.

The calcium content in the study area was generally low ranging from (4.19-2.02) with a mean of 3.39 cmol (+) kg^{-1}. Their distribution was lowest in site V and VI because of the soil type in the site and leaching effects of rainfall. This is in contrast to the findings of Abdullahi (2010) on Yankari game reserve soils whose values were high (12.0-14.2 cmol (+) kg^{-1}). Calcium is required in small quantity by plants; however lack of it in the soil generally leads to an inefficient use of water by plants. There is need to maintain and even improve the calcium level of the soils in the study area. This is in line with the findings of (Wikum and Wali, 1974, Kutintara, 1975; Bunyavejchewin, 1983, 1985; Foth,2006) who also obtained low values of calcium. Potassium and Calcium influence species and community distributions.

The best role of potassium is found in stomata opening and closing. It is present in growing regions. Potassium helps in the growth of the plants and enables it to produce flowers, seeds and fruits. Potassium is also important in helping plants to adapt to environmental stresses and in maintaining a balance between potassium and other nutrients (especially nitrogen, phosphorus, calcium and magnesium). It is also an important goal in managing soil fertility (Brady and Weil, 1999). The results of potassium in the study area was categorized as very low (0.17-0.3) cmol (+) kg^{-1}). It was lowest in site V and VI probably due leaching effects of rainfall and plant uptake. This is in contrast with the findings of Abdullahi (2010) in his study of Yankari game reserve soils where the results of potassium were high (0.3-2.9) cmol (+) kg^{-1}). The implication of this finding is that there is need to raise the potassium level by application of fertilizers .

From the result of soils in the study area, (Mg^{2+}) was classified as low (0.41-0.95) cmol (+) kg^{-1}) due to leaching effects and plant uptake. This is in contrast to the findings in Yankari game reserve soils where the values were high (7.1- 8.9) cmol (+) kg^{-1}). This is because magnesium is more soluble and subject to more leaching. However, it followed the order Ca > Mg > Na > K which confirm the work of other researchers (Jones, 1973; Jones and Wild, 1975, Ojanuga, 1975). However, most tropical crops required less magnesium compared with calcium. The down word movement of magnesium depends on clay as well as organic matter content of the soils (Akubuilo, 1977). Imbalance between calcium and magnessium in the soil could accentuate magnessium deficiency. And when calcium to magnessium ratio becomes too high, plants may take up less magnessium.

Sodium (Na^+) in the soils of the study area was classified as low and it ranges from (0.11-0.20) with a mean of 0.17 cmol (+) kg^{-1}). The low amount could be due to continuous leaching caused by increased precipitation. It is in contrast with the findings of Abdullahi (2010) where the values of sodium ranged between (0.2-1.9) cmol (+) kg^{-1}) which was high.

Cation exchange capacity (CEC) is an overall assessment of the fertility of a soil, and the values depend on pH (Brady and Weil, 1999).The CEC was generally low ranging from 4.69-2.02 cmol (+) kg^{-1} with a mean of 3.39. The low range is probably indicating that the soils have low ability to store and retain nutrients cations against leaching indicating the presence and dominance of 1:1 kaolinitic and/or Fe and Al oxide clays. The distribution within the sites were irregular in pattern . Though, the content followed the order Ca Mg Na K which is in agreement with other workers (Jones, 1973, Jones and Wild, 1975, Ojanuga, 1975)

The extractable micronutrients concentrations were low in zinc, medium in copper and iron and high in manganese. Similarly, the abundance of the micronutrients seems to adequately support the growth of different vegetation types. The accession proved the findings of (Lombin, (1985); Cox, (1987); Raji *et al.*, (2000).

The low concentration of zinc ranging from 1.28 -0.18 $Mgkg^{-1}$ with a mean of 0.675 could be due to involvement of natural and anthropogenic factors that limit adequate plant nutrient availability and create nutrient imbalances. This is in contrast to the findings of Hassan *et al.*, (2006) in his study of soils at Walban – Deba where he obtained moderate to high amounts but was is in line with the findings of Fageria *et al.*, (2002) who obtained low amounts. Zn deficiency in soil has been reported widely from different parts of the world (Thorne 1957; Katyal and Vlek 1985; Welch *et al.*, 1991). The problem is more acute in India, where enhancing productivity through intensive cropping has occurred in the past four decades. Elsokkary (1979) in Egypt showed that Zn adsorption by soil was highly associated with CEC, Fe_2O_3 and clay. Mclaren *et al*., (1997) also concluded that CEC and organic matter influenced the adsorption and desorption of Zn. Although the amount of zinc needed for crop growth is far less than that of macronutrients. It therefore, follows that for successful and sustainable plant growth in all the sites studied, Zn application will prove beneficial.

It was noted, however, that soils from all the sites contained medium Cu contents ranging from 0.95-0.25 $Mgkg^{-1}$ with a mean of 0.42 .The medium content could be due to the acidic nature of the soil in the study area ,and it will support good growth of plants ,so no advocating for Cu application. This accession proved the findings of Lombin (1985) and Raji *et al* (2000).

Iron (Fe) in the soils of the study sites was classified as medium ranging from 3.19-9.11 mgkg-1 with a mean of 5.18. This could be due to the acidic nature of the soil. It is therefore, unlikely that Fe deficiency is experienced in these soils. This was consistent with the findings of Hassan *et al.*, (2006) in his study of soils of Walban –Deba in Gombe state. This is true especially when viewed against the report by (Chen and Barak, 1982; Sakal *et al.*, 1984; Mengel and Geurtzen, 1986) that Fe deficiency is unlikely in acid soils; as Fe is known to be soluble under relatively acidic and reducing conditions (Chesworth, 1991).The presence of high concentrations of Fe in soils could lead to its precipitation and accumulations and upon complex chemical reactions, lead to the formation of soft unindurated plinthite (laterite). This, upon alternate wetting and drying, could irreversibly form hard indurated material called petroplinthite (Iron stone) which would restrict rooting depth and drainage, amongst others.

Manganese status is rated “High” ranging from 17.51-6.73 Mgkg-1 with a mean of 12.80. The high content of available Mn in the soils may be related to the acidic nature of the soils. The values obtained for these soils are similar to those obtained for some Ustults in Bauchi, Nigeria (7.89 – 12.00; mean of 9.10 mgkg-1) but averages about 19.0 – 69 .3 mgkg-1 reported by Kparmwang (1996) in similar Nigerian soils. It has been reported (Sillanpaa, 1982) that above soil pH of 7.5, the availability of Mn is very low because of the formation of hydroxides and carbonates.

In conclusion, the variation in vegetation types within the study area, enables it to support a variety of species, and so each of the vegetation types contributes differently to the overall diversity of the study area. The distribution of species is based on various factors including both abiotic/ biotic and climatic components of the ecosystem. However, these factors are closely interrelated and interdependent. However, understanding the relationship between certain soil properties and specific flora species would act as a guide to farmers, horticulturists and land use planners alike to recognize the likely soil conditions that are suitable for a particular purpose. Such knowledge may be applied in mineral prospecting (Veeranjaneyulu and Dhanaraju, 1990) and also as a way to restore areas greatly in sparse supply.

V. Conclusion And Recommendation :

Soils of Kanawa forest reserve (KFR) were acidic, sandy with high organic matter and low exchangeable bases which helped it to support a luxuriant vegetation types. It is recommended that the forest be protected by fencing to reduce soil degradation by humans encroaching illegally into the forest to obtain the fertile soil.

References

[1]. Abaje , I.B (2007) . Introduction to soils and vegetation. Personal touch productions, Kaduna state, Nigeria. 121-124pp.

[2]. Abdullahi, M.B (2001). The Flora of Gaji River Valley, Yankari National Park, Nigeria. Unpublished M.Sc Thesis, Department of Biological Sciences. University of Maiduguri, 78pp.

[3]. Abdulhamed, A (2002). Phytosociological Investigation of some sites within and Adjoining Yankari National Park, Bauchi. Unpublished Ph.D Thesis, Abubakar Tafawa Balewa University, Bauchi, Nigeria 99pp.

[4]. Aduayi, E.A. and Ekong E.E. (1981). General Agriculture and soils. Cassel Limited, an Affiliation of Macmillan Publishing Co. Inc, 8th edition, New York:

[5]. Akubuilo, C. J.C (1977). An introduction to practical agriculture. Macmillian publishers, Lagos.

[6]. Anonymous (1994)b. pH: 1:2 soil to water ratio, in R.G. Gavlak, D.A. Horneck, and R.O. Miller, Eds., Plant, Soils, and Water Reference Methods for the Western Region, Western Regional Extension Publication WREP 125, University of Alaska, Fairbanks, 17–18pp.

[7]. Ayashe T.I (1995) Nigerian dark clay and associated soils, FAO Corporate Document Repository .Available :http//wwwfao.org/wairdoes/1Lri/x 5493e/5493c00.HTM.

[8]. Ayuba, H.K (1992). Effect of continued cultivation on the soil and vegetation in Konduga L.G.A of Borno State. Unpublished M.Sc dissertation.University of Maiduguri.

[9]. Bouyoucos G.H (1962). Hydrometer method improved for making particle size analyses of soils. Journal of Agronomy. **53**:464-465pp.

[10]. Brady, C.N and. Weil, R.R. (1999).The Nature and properties of soil.12th edition.Prentice Hall, Upper saddle River, New Jersey.758pp.

[11]. Bray R.H. and Kurtz, L.T. (1965). Determination of total and available forms of Phosphorus in Soils. Journal of Soils Science, **53**:39-45pp.

[12]. Bremmer, J.M. (1965). Total Nitrogen in C.A. Black (ed). Methods of Soil Analysis, Part 2, Agronomy Series 9 American Society of Agronomy, Madison, Wisconsin USA, 1149-1170pp.

[13]. Bunyavejchewin, S. (1985). Analysis of the tropical; dry deciduous forest of Thailand, II. Vegetation in relation to topographic and soil gradients. Natural History Bulletin of the Siam Society.33-20pp.

[14]. Bunyavejchewin, S. (1983). Canopy structure of the dry dipterocarp forest of Thailand. Thai Forest Bulletin **1**:1-93pp.

[15]. Chen, Y, Barak, P (1982). Iron nutrition of plants in calcareous soils. Advances in Agronomy. **35:** 217 -240pp.

[16]. Chesworth, W (1991). Geochemistry of nutrients. In: J. J. Mortredt, L.M., Shuman and R. M. Welch (Eds). Micronutrients in Agriculture. 2nd Edition Soil Science Society of America Inc., Madison, Wisconsin, USA. 427 -476pp.

[17]. Day, P. R (1965). Particle fractionation and particle-size analysis. Chap. 43 in Methods of Soil Analysis. Part 1. C.A. Black, ed. American Society of Agronomy,Madison. 545-567pp.

[18]. Dezzeo, N., N. Chacón, E. Sanoja and G. Picón (2004). Changes in soil properties and vegetation characteristics along a forest-savanna gradient in Southern Venezuela. For. Ecol. Manage. **200**: 183-193pp.

[19]. Elsokkary, H.I., (1979). The chemical fractionation of soil zinc and its specific and total adsorption by Egyptian alluvial soils. Plant Soil. **53**: 117-129pp.

[20]. Esu I.E (1991). Detailed Soil Survey of NIHORT farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria. Nigeria. 72 pp.

[21]. Fageria, N. K; Baligar, V. C.; Clark, R. B (2002). Micronutrients in crop production. Advances in Agronomy, New York. **77**. 189-272 pp.

[22]. Foth, H.D (2006). Fundamentals of Soil Science. 8th Edition. New York: John Wiley and Sons. 384pp.

[23]. Geerling, C (1973). The Vegetation of Yankari Game Reserve: Its Utilization and Condition. Bulletin 3. Department of Forestry, University of Ibadan, Nigeria, 136pp

[24]. Gombe Native Authority (1945). Preliminary report on proposed Gombe Native Authority Forest reserve . No 4 of the former Gombe Native Authority, Northern Nigeria. Now Gombe State, Nigeria.1-10pp.

[25]. Green, A.A. and M.S. Amanche (1987). Management Plan for the Yankari Game Reserve, Bauchi State, Nigeria.WWF Project 3632, NCF Technical Report 2, Lagos, 212pp.

[26]. Hassan, A.M and Shu'aibu Musa (2006).Physico-chemical properties of the soils at Walban-Deba,Gombe State,Nigeria. Crop Production Programme, Abubakar Tafawa Balewa University, Bauchi, Nigeria. Horticultural Soceity of Nigeria. Proceedings of the 24th Annual Conference 2006. 163-168pp.

[27]. Iwara, A.I; Gani, B.S.; Njar, G.N and Deekor, T.N. (2011). Influence of Soil Physico-chemical Properties on the Distribution of Woody Tree/Shrub Species in South-Southern Nigeria. Journal of Agrcultural Science. **2(2)**: 69-75pp.

[28]. Jackson, M.L. (1969). Soil Chemical analysis, I.I.T.A. **43**: 35-38pp.

[29]. Jones, M.J (1973).The organic matter content of the savanna soils of West Africa. Journal of soil science **24**:42-53pp.

[30]. Jones, M.J and Wild, A (1975). Soils of West African Savanna. Common wealth Agricultural bureau of Technical communication. Harpenden.U.K. 55: 1-246pp.

[31]. Katyal, J.C. and P.L.G. Vlek (1985). Micronutrient problems in tropical Asia. Nutrient Cycling Agroecosystem. **7**: 69-94pp.

[32]. Klinkenberg, K. and Higgins, G.M. (1970). An outline of Northern Nigerian Soils. Nigerian Journal of Science 2 **(2)** :91-11pp

[33]. Kparmwang, T, Malgwi W.B (1997). Some available micronutrients in profiles of Ultisols and Entisols developed from sandstone in northwestern Nigeria. In: B.R. Singh (Ed.). Management of Marginal Lands in Nigeria.Proceedings of the 23rd Annual Conference of Soil Science Society of Nigeria, UDU, Sokoto, Nigeria. 245-255pp.

[34]. Kutintara, U (1975). Structure of the dry dipterocarp forest, Ph.D, dissertation, Colorado State University, Fort Collins.

[35]. Lombin, G (1983). Evaluating the micronutrient fertility of Nigeria's semi-arid Savanna soils. 2. Zinc. Soil Science. **136**: 42-47pp.

[36]. Mclaren, R.G, D. Singh and K.C. Cameron, (1997). Desorption of native and added zinc from a range of New Zealand soils in relation to soil properties. Aust. J. Soil Res., **35**: 1253-1266pp.

[37]. Mengel K and Geurtzen G (1986). Iron chlorosis on calcareous soils.Alkaline nutritional conditions as the cause of chlorosis. Journal of Soil Science and Environmental Management. **9:** 161-173pp.

[38]. Ojanuga A.G. (1975). Morphological, Physical and chemical characteristic of soils of Ife and Ondo. Nigerian journal of science. **9**: 225-269pp.

[39]. Raji, B.A. Esu, I.E. Chude, V.O, Owonubi, J.J. and Kparmwang, T (1996). Properties, classification and management implication of soils of Iiela sanddune northwestern Nigeria. Journal of science of Food and Agriculture.**71;** 425-432pp.

[40]. Russel, E.W (1967) . Soil condition and Plant Growth, 9th edition. Longman London 688pp.

[41]. Razanamandranto, S., Tigabu, M., Neya S., Oden P.C (2004). Effects of gut treatment on recovery and germinability of bovine and ovine ingested seeds of four

[42]. woody species from the Sudanian savanna in West Africa. Flora, **199**: 389-397pp.
[43]. Sakal, R, Singh B.P, Singh A.P (1984). Determination of threshold value of iron in soils and plants for the response of rice and lentil to iron application in calcareous soils. Plants and Soils. **82:** 141-148pp.
[44]. Samaila, M (2011). The geology of Kanawa and its environs, part of Gombe sheet 152 NE, Gombe State, Nigeria. An unpublished B.Sc thesis. Department of geology , Gombe State university, Gombe, Nigeria. 47pp.
[45]. Swaine, M. D. (1992). Characteristics of dry forest in West Africa and the influence of Fire. Journal of Vegetation Science **3**:365–374pp.
[46]. Tisdale, S.L. and Nelson, W.L (1975). Soil Fertility and Fertilizers. 3rdedition Macmillan, New York. 356-396pp.
[47]. Topp, G. C and Ferre, P. A (2002a). Methods for Measurement of Soil Water Content:Gravimetric Using Microwave Oven-Drying. In: J.H.Dane, and G.C.Topp (Ed.) Methods of Soil Analysis: Part 4. Physical Methods. Soil Science Society of America, Inc. 425-428pp.
[48]. Topp, G.C and Ferre, P.A (2002b). Methods for Measurement of Soil Water Content:Thermogravimetric Using Convective Oven-Drying. In J.H.Dane Soil Science Society of America, Inc. 422-424pp.
[49]. Tomlinson, P.R. (1965). Soils of Northern Nigeria, Samaru Miscellaneous Paper 11: 1-6pp.
[50]. Thorne, W (1957). Zinc deficiency and its control. Advances in Agronomy. **9:**31-65pp.
[51]. Veeranjaneyulu, K and Dhanaraju, R.M (1990). Geobotanical studies on Nalakenda Copper Mine. Tropical Ecology.**31**: 59–65pp.
[52]. Walkley, A. and I.A. Black (1965.) An examination of the Degtjareff method for determining soil organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci. 63:251-263.
[53]. Watson, M.E. and J.R. Brown (1998). pH and lime requirement, in J.R. Brown, Ed.,Recommended Chemical Soil Test Procedures for the North
[54]. Central Region, North Central Regional Research Publication Number 22 (revised), Missouri Agricultural Experiment Station SB 1001, University of Missouri, Columbia, 13–16.
[55]. Wear J.J and Sommer A.C (1948) Acid extractable in soil in Relation to the occurrence of deficiency symptoms of com. Soil Science Society of American Proceedings.
[56]. Welch, R.M.,. Allaway, W.H. House, W.A and Kudata, J. (1991). Geographic Distribution of Trace Element Problems. In: Micronutrient in Agriculture, Mortvet, J.J., F.R. Cox, L.M. Shuman and R.M Welch (Eds.). SSSA, Madison, WI., USA.31-57pp.
[57]. Wikum, D.A and Wall, M.K (1974). Analysis of an Ivorian Gakota gallery forest; vegetation in relation to topographic and soil gradients. Ecological Monographs **44;**441-464pp.
[58]. Young, A (1990).Tropical Soils and Soil Survey. Cambridge University Press, Cambridge.486
[59]. pp.
[60]. Kowal J M and Knabe D T. 1972. An agroclimatological atlas of the northern states of Nigeria with explanatory notes. Ahmadu Bello University Press, Zaria, Nigeria.