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Investigation of Soil Characteristics of Sambisa Game Reserve, Borno State, Nigeria

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ABSTRACT:

The study was carried out to investigate the soil characteristics providing the medium for growth of flora species as they provided varying cover and food resources based on the requirements of the wildlife species of the game reserve**.** Preliminary study was carried out for the purpose of identifying and delineating major wildlife habitats of the game reserve based on the major plant communities of the reserve. These are Riparian vegetation (RP), *Annogeissus-Piliostigma* association (AP), *Balanites-Ziziphus* association (BZ), *Acacia-Zizphus* complex (AZ) *and Khaya-Combretum* association (KC). To achieve this, physiochemical and microbial properties were analysed from soil samples collected at random using random numbers. Soil samples for physical and chemical properties were taken at 0-20 cm depths using soil auger, mixed thoroughly, passed through 2mm sieve and taken to the laboratory. Soil sample collection for microbial populations was done with a trowel at depth of 0-10cm, put into sterile polythene bags and carried to the laboratory within 24 hours of collection. Soil invertebrates were searched for at each sampling point. The soil of the study area varied from sandy to sandy loam. Particle size of soils, pH, EC, organic carbon, total nitrogen, available phosphorus, total potassium, calcium, magnesium and sodium were subsequently analysed. A total of 9 micro-organisms and 8 invertebrates were identified from soils of the study area. The values of the chemical properties of the soils are too low for better plant growth. Hence, fertilization of the rangelands with nitrogenous and phosphate fertilizers is recommended.

INTRODUCTION

Soil is the outermost part of the earth that support plant growth and are essential medium for the growth of plants (Alao and Shuaibu 2011). According to Agbede (2009), soil is a dynamic natural body composed of mineral and organic materials and living organisms in which plants grow. McNaughton and Wolf (1979) reported that bacteria and fungi occur in the soil to an extent of a few million individuals per gram of soil, particularly in the region of organic matter and that fungi are equally abundant in acid soils. According to them, many of the bacteria and fungi in the soil are useful agents in decomposing organic matter thereby enriching the soil with plant nutrients and contributing to the formation of good soil structure and that primary productivity in an ecosystem is broadly related to animal abundance and diversity in the soil. The effect of the distribution and abundance of plant resources could determine the composition of animal communities and especially the number of animal species inhabiting a particular plant community (Trivedi, 2004).

Dutta (2005) reported that for better plant growth, the following limits of soil chemical groups and elements by volume must be met; 50-70% mineral particles; 5-15% of organic matter; 1.5-3.0% potassium; 0.1-2.0% calcium; The need to provide baseline information on the soil nutrient status for better plant growth for sustainability of the wildlife resources of the game reserve prompted this study

MATERIALS AND METHODS

Study Area

Sambisa Game Reserve is located between Longitude 13^{o} 30’ and 14^{o} 00’ East and Latitude 11^{o} 00’ and11^{o} 30’ North. It is about 70km south of Maiduguri in Borno State and is located 14km off Kawuri village along Maiduguri-Bama road. The reserve is located in an area of low human population density cutting across three local government areas of the state, namely Konduga, Gwoza and Bama.

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The major tribes are Kanuri, Fulani, Gamargu and Gwoza whose occupations are majorly farming and livestock rearing.

The reserve covers an area of 518km^2 on a fairly flat land drained by three seasonal flowing streams (Kwada, Sambisa and Yuwe) which are tributaries of River Yedzeram. The drainage is poor and the land is liable to flooding with the entire game reserve getting waterlogged and marshy in the rainy season (M.N.R., 1978). The climate is characteristic of Sudan Savannah marked by hot, dry and wet climate with mean annual temperature of 28^{o}C and a maximum temperature of 45^{o}C at the onset of the rains (BOSG, 2012) Minimum temperature of 21.50^{o}C is recorded between December and February during the harmattan period. The rains commence in May and ends in September with a mean annual rainfall of 708mm and a relative humidity of 49% (BOSG, 2012). The vegetation of the area is broadly that of Sudan Savannah with open woodlands and patches of gallery forests comprising of drought resistant and fire tolerant tree species. The combined long time effect of grazing, fire and felling of trees have significantly altered much of the natural vegetation. The reserve has relatively abundant fauna resources (CBNP, 2000). Commonly sighted are primates, antelopes, hares, squirrels, guinea fowls, francolins and weavers

Study Design and Data Collection

Preliminary study was carried out for the purpose of identifying and delineating major wildlife habitats of the game reserve based on the major plant communities of the reserve. These are Riparian vegetation (RP), *Anogeissus-Piliostigma* association (AP), *Balanites-Ziziphus* association (BZ), *Acacia-Ziziphus* complex (AZ) and *Khaya-Combretum* association (KC).Physiochemical and microbial properties were analysed from soil samples. Samples were collected at random using random numbers as described by White and Edwards (2000). Starting point along each transect was selected using random numbers. Figures were written on pieces of paper, folded and put in a container and selected after having shaken them around to mix. After noting the number, the piece of paper is replaced and soil sample collected at that point. Ten (10) samples as used by Usman and Adeagun (2011) were collected in each vegetation type. Soil samples for physiochemical properties were collected using soil auger at 0-20cm soil depths from each sampling point. Soil sample collection for microbial populations was done with a trowel at depth of 0-10cm, put into sterile polytene bags and carried to the laboratory within 24 hours of collection (Sanchez, 1975). Soil invertebrates such as centipedes, millipedes, termites and earthworms were searched for at each sampling point. A composite sample according to Usman and Adeagun, (2011), were mixed thoroughly, passed through 2mm sieve to remove extraneous materials and taken to the laboratory for physiochemical analysis. The following physiochemical properties were subsequently analyzed:

1. Particle size using hydrometer
2. pH was determined using pH meter
3. EC was determined using EC meter
4. Organic carbon was determined using the wet oxidation method of Walkley and Black (1947)
5. Total nitrogen was determined using the macro / Kjeldahl method as described by Bremner (1965)
6. Available phosphorus was determined using the Bray No.1 method described by Bray and Kurtz (1945)
7. Total potassium was determined by the flame photometric method described by Jackson (1962)
8. Calcium, Magnesium and Sodium were determined by titrimeter

RESULTS

Physical Properties

The result of physical properties of soils in Sambisa Game Reserve is shown in Table 1. The textural composition was dominated by sand in all habitat types. The soils of the reserve varied from sandy to sandy loam.

Chemical Properties

The chemical properties of the soil in Sambisa Game Reserve at 0-20cm soil depth are shown in Table 2. Total nitrogen was highest in the Riperian vegetation with a value of 0.15% while the least value of 0.06% was obtained in *Khaya-Combretum* association. Organic carbon was highest also in the Riparian vegetation (2.61%) and least (1.18%) also in *Khaya-Combretum* association. The highest pH

of 7.05 was recorded in *Khaya-Combretum* association habitat, while the least (5.90) was recorded in the *Anogeissus-Piliostigma* association. Result of exchangeable cations shows that Calcium and Magnesium were dominant in all the habitats. Calcium ranges from 1.25 meq. /100 soil to 3.80 meq. /100g soil, while magnesium varied from 1.35meq./100 gm soil to 2.70meq.100g soil. Sodium and Potassium were generally low. Sodium ranges from 0.13 meq/100g soil to 0.15 meq./100g soil, while potassium varied from 0.01 meq./100g soil to 0.06 meq./100 gm soil. Available phosphorus was highest (11.13 ppm) in the Riparian vegetation and least (10.10ppm) in the *Balanites-Ziziphus* association (Table 2). Also, the result of Analysis of variance shows that there were significant difference among the soil chemical properties investigated (Table 3).

Soil Micro-Organisms and Invertebrates

Micro- organisms in the soils of Sambisa Game Reserve are shown in Table 4. These include bacteria, fungi, algae and protozoa at varying densities. The Riparian vegetation, *Balanites-Ziziphus* association and *Acacia-Ziziphus complex* contained all the nine (9) species identified. *Anogeissus-Piliostigma* association contained 8 species while *Khaya-Combretum* association contained 7 species. The Riparian vegetation and *Acacia-Ziziphus* complex were higher in micro-organisms than all the other habitats while *Khaya-Combretum* association was the poorest (Table 4). Species List of soil invertebrates showed that two (2) species of crustaceans of the genus *Ocypoda* and 6 other invertebrates were inventoried from the soils of Sambisa Game Reserve (Table 5).

Table1. Physical Properties of Soil at 0-20 cm Soil Depth

	Habitat Type				
Parameter (%)	**RP**	**AP**	**BZ**	**AZ**	**KC**
Sand	91.50	88.00	85.00	7.8	79.00
Silt	7.50	11.00	14.00	16.50	17.00
Clay	1.00	1.00	1.00	5.50	4.00
Textural class	Sandy	Sandy	Sandy loam	Sandy loam	Sandy loam

Source: Field Survey (2010)

In the above Table: RP- Riparian Vegetation, AP- *Anogeissus- Piliostigma* Association, BZ- *Balanites- Ziziphus* Association, AZ- *Accacia- Ziziphus* Complex and KC- *Khaya- Combretum* Association.

Table2. Chemical Properties of Soils at 0-20cm Soil Depth

Parameter	**RP**	**AP**	**BZ**	**AZ**	**KC**	**Mean**
T.N. (%)	0.15	0.10	0.09	0.08	0.06	0.10
O.C. (%)	2.61	2.24	2.10	1.40	1.18	1.91
pH	6.26	5.90	6.50	6.33	7.05	6.41
EC(meq./100g soil)	0.65	0.45	0.50	0.35	0.30	0.45
CEC(meq./100g soil)						
Ca	2.98	3.80	1.25	1.90	2.00	2.39
Mg	2.50	2.10	2.10	1.35	2.70	2.05
Na	0.14	0.13	0.15	0.14	0.15	0.14
K	0.06	0.02	0.03	0.01	0.05	0.03
Available phosphorus(ppm)	11.13	10.15	10.10	10.15	10.20	10.35

Source: Field Survey (2010)

In the above Table: RP- Riparian Vegetation, AP- *Anogeissus- Piliostigma* Association, BZ- *Balanites- Ziziphus* Association, AZ- *Accacia- Ziziphus* Complex and KC- *Khaya- Combretum* Association.

Table3. Analysis of Variance for Soil Chemical properties

S.V	**D.F**	**SS**	**MS**	**F_{Cal}**	**F_{Crit}**
Treatment	8	493.601	61.700	300.442^{*}	2.244
Location	4	1.516	0.379	$1.845^{n.s}$	2.668
Error	32	6.52	0.205		
Total	44	501.688			

n.s = Significant

** = Not Significant*

Table4. Abundance of Soil Micro-organisms at 0-20cm soil Depth

Habitat Type					
Species	**RP**	**AP**	**BZ**	**AZ**	**KC**
Bacteria					
Bacillus spp	+++	+	+	++	+
Pseudomonas spp	+++	-	+	+	-
Stahpylococus spp	+++	++	++	++	+
Streptococcus spp	++	++	++	+++	+
Actinomycetes spp	++	++	+	++	+
Fungi					
Aspergilius spp	+++	+	+	++	+
Penicillium spp	+++	++	++	++	-
Algea	+++	++	++	++	+
Protozoa	++	++	++	+++	++
Total	**9**	**8**	**9**	**9**	**7**

In the above table: +++ = Abundant, ++ = Scanty, + = Very scanty and - = Absent

Source: Field Survey (2010)

Table 5: Species List and Abundance of Soil Invertebrates

Common Name	**Scientific Name Abundance**
Sand crab	*Cypoda Africana* ++
Ghost crab	*Cypoda curser* ++
Compost beetle	*Oryctes boas* +++
Driver ant	*Dorylus helvoulus* +++
Centipede	*Spirostreptus assiniensis* ++
Millipede	*Pachymerium ferrugeneum* ++
Earth worm	*Hyperiodrilus africana* +++
Mole cricket	*Gryllotalpa africana* +++

Source: Field Survey (2010)

In the above table: +++ = Abundant, ++ = Scanty

DISCUSSION AND RECOMMENDATION

Findings on the soils of the study area indicated that they were predominantly sandy. According to Aluko (1998), sandy soils implies low moisture retention capacity. Furthermore, result of the nutrient status of the soils revealed low nutrient status. The highest values of total nitrogen (N) and organic carbon (C) were 0.15% and 2.16% respectively. The values are too low when compared to those reported by Dutta (2005) [N= 0.3-1% and C=5- 15%} for better plant growth. Soil nutrient were generally low in all the habitats which was attributed to low level of organic matter because of low litter cover as a result of incessant burning and illegal grazing by pastoralists limiting the activities of bacteria and fungi. The primary productivity in an ecosystem is broadly related to animal abundance and diversity in soils. This agrees with the statement of McNaughton and Wolf (1979) that many of the bacteria and fungi in the soil are useful agents in decomposing organic matter thereby enriching the soil with plant nutrients and contributing to the formation of good soil structure. Also the activities of soil invertebrates on litter results in the formation of humus which consists of carbohydrates, proteins, fats, organic acids, lignin, tannins and resins.

A programme for reseeding and replanting of the habitats with native and exotic e.g. Stylozanthes species is recommended for the improvement of the ranges in the game reserve. Application of artificial fertilizer (NPK) to improve the nutrient status of the soils, control of wildfire and illegal grazing are also recommended. This will provide the needed food resources and cover for the wild animals and consequently boost their populations.

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