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SPATIAL DISTRIBUTION OF PLANT NUTRIENTS AND SOIL $_P$H IN *ANTHONOTHA MACROPHYLLA* P. BEAUV, DOMINATED VEGETATIONS IN UYO LOCAL GOVERNMENT AREA, AKWA IBOM STATE, NIGERIA.

UBOM, R. M; *OGBEMUDIA, F. O. & BENSON, H. A
Department of Botany and Ecological studies
University of Uyo, Uyo, Akwa-Ibom State,
Nigeria.
E-mail of corresponding author: femeg2005@yahoo.com,
+2348033778770

ABSTRACT
Spatial distribution of plant nutrients and soil pH was studied in *Anthonotha macrophylla* dominated vegetations in Uyo Local Government Area, Akwa Ibom State. Systematic sampling method was used in sampling the four study sites using a quadrat size of 5m x 5m. A total of forty soil samples (ten from each study area) were obtained to a depth of 15cm per quadrat using soil auger. Results showed that 55 plant species were encountered in the four vegetations. *Anthonotha macrophylla* was the dominant species in the four sites with 100% frequency of occurrence, followed by *Manniophyton fulvum* and *Icacina trichantha* with 80% occurrence in sites 2 and 4, respectively. *Anthonotha macrophylla* also dominated in terms of density, height, basal area and crown cover and importance value in all study sites except in site 1 where *Lonchocarpus* cyanescens was the tallest (3.50 $\pm$ 0.70m/ha). In site 3, *Lannea acida* was tallest (2.60$\pm$0.00m^2/ha) with the largest crown cover (2.99$\pm$0.00m/ha) and in site 4 *Lonchocarpus griffonianus* had the largest crown cover (7.27$\pm$ 0.00m^2/ha). Soil analysis showed that the soils were slightly acidic in all sites. Total Nitrogen (0.04 $\pm$ 0.005%) and available phosphorus (32.10$\pm$ 6.33mg/kg) were highest in site 4 but low in site 2 with values 0.03$\pm$0.005% and 27.47$\pm$2.89mg/kg respectively. Potassium (0.19$\pm$0.02cmol/kg) was high in site 2 but low in site 3 (0.16$\pm$ 0.08cmol/kg). The soil had the highest sand content of (87.5 $\pm$ 1.69%) in site 4, silt content (8.8$\pm$2.32%) in site 1 and clay content of (10.92$\pm$2.36%) in site 3. The soil textures in the four sites were loamy sand. Analysis of variance showed that there were variations in means among the vegetation parameters (significant at P = 0.05). The results are discussed.

Key words: Spatial distribution, Vegetation, N.P.K, *Anthonotha macrophylla*, Nutrients

INTRODUCTION
Several studies and investigations have been carried out on nutrients release, variability and distribution in soils (Bhup, 2008). Palm and Sanchez (1990) noted that nitrogen release by legumes with high polyphenolic concentrations will be slower than that of legumes with low polyphenolic concentrations. This has important implications to nitrogen cycling and the selection of legumes for agro forestry systems.
Studies on the variations in macronutrient concentrations by Nicholas *et al*. (1997) revealed that with increasing leaf age, the concentrations of Nitrogen (N), phosphorus (P), potassium (K) decrease.

Gong *et al.* (2006) showed that the quantity and quality of forest litter have important impact on soil nitrogen supply potential and microbial biomass. Antonio (2003) examined the effect of tree canopy on the spatial distribution of soil nutrients. Zhao *et al*. (2005) suggested that the different spatial variability of available nutrients were deeply affected by their mobility. Liu *et al.* (2005) had a different view which suggested that these nutrients are mainly determined by the parent material. According to Wang *et al*. (2006), Zhang *et al.* (2008) and Pang *et al* (2009), the spatial variabilities of organic matter, available N and available K were mainly affected by structural factors while that of available phosphorus (P) was affected by random factors. Ma *et al.* (2009) revealed the structural factors to be, topography, soil type, soil organic matter and soil texture and random factors to be, fertilizer, crop management and human actions

An investigation on soil nutrient level is very important in improving the quantity and quality of plants. This is because the growth of an individual plant is crucially dependent upon or limited by the availability of nutrients (Li *et al.*, 2009). According to Huang (2007), soil nutrient is of primary importance for maintaining soil productivity, which is an important indicator of soil quality. Studies by Li *et al.* (2009) revealed that soil nutrients of different seasons and different locations had significant difference with distinct annual variation trends. This led to a suggestion by Lu *et al.* (2010) that the distribution characteristics of total soil nutrients in different soil layers will provide a theoretical basis for farmland management.

Anthonotha macrophylla P. Beav, locally known as "Nya" in Akwa-Ibom is an angiosperm, a dicotyledonous perennial and a leguminous shrub which belongs to family Fabaceae. In general, the members of the family Fabaceae are herbs, vines, shrubs, trees and lianas found in both temperate and tropical areas. They comprise one of the largest families of flowering plants, with 630 genera and 18,000 species. The seeds often have a hard coat with hourglass- shaped cells and sometimes bear a v-shaped line called a "pleurogram" (Bisby *et al*., 2007). In traditional farming systems, the plant or plant products like leaves and pods are left in the farm as it is believed to restore soil fertility. The leaves are used for wrapping. The plant products are used for both ceremonial and religious practices. Bark decoctions are used to cure veneral diseases, intestinal disorders; as vermifuges and pain killer. Leaf decoction is used as antidotes to venomous stings, bites; diarrhea, dysentery; skin infections and mucosae. Leaf exudates are used as dyes, stains, inks, mordants and for tattoos. Root decoction is used to cure intestinal disorder. Wood is used for carving and making musical instruments, games and toys. Seed-pods can be used for composting and manuring. Timber products are used for carpentry and related applications, for farming, foresting, hunting, and fishing apparatus. It is a popular fuel wood. The wood is tough and thus popular as handles of weeding hoes (Breteller, 2006).

MATERIALS AND METHODS

Study Sites

This study was conducted in four sites in the University of Uyo Main Campus in Uyo Local Government of Akwa Ibom State using random sampling at a distance of 50metres each. Uyo is situated between latitudes $5^0$3' North and longitudes $7^0$56' East (Maplandia, 2005). Akwa Ibom State is situated between latitudes $4^0$32' and $5^0$53' North and longitude $7^0$25' and $8^0$25' East. It covers a total land area of 8,412km^2 (AKSG, 2008). The location of Akwa Ibom is just north of the equator and within the humid tropics and its proximity to the sea makes the state generally humid. On the basis of its geographical location the climate of Akwa Ibom State can be described as a tropical rainy type which experiences abundant rainfall with very high temperature. The mean annual temperature of the state lies between 26^{0}C and 29^{0}C and average sunshine cumulates to 1,450 hours per year, while mean annual rainfall ranges from 2,000mm to 3,000mm, depending on the area. Naturally, maximum humidity is recorded in July while the minimum

occurs in January. Thick clouds of cumulonimbus type are commonly experienced in the months of March to November. Evaporation is high with annual values that range from 1500mm to 1800mm.

Vegetation and Soil Sampling

A systematic sampling method (that is sampling at equal distances within transects), was randomly used in sampling the four study sites. Fifty metre size for each site was used in the determination of species data collection. Species were sampled in 5m x 5m quadrats. In each quadrat, plants encountered were enumerated and identified to species level (Cochran, 1963). The number of individuals for each species was counted. Species data determined were frequency for each species found, height, density, basal area, and the crown cover. Ten soil samples each were obtained from four different sampling sites to a depth of 15cm per quadrat using soil auger. Soil samples were obtained from two perpendicular points at the base of each sample plant (*Anthonotha macrophylla)*. A total of 40 soil samples were collected in the four sites and were later bulked into 20 samples that were used for the analyses. The soil samples were put into different polythene bags properly labeled and conveyed to the Soil Science Laboratory of the University of Uyo. The samples were air-dried immediately in order to minimize changes in the concentration of extractable nutrients and some organic constituents. The soil samples were further crushed in a mortar and passed through a 2.00mm mesh sieve and were stored in labeled polythene bags for physicochemical analysis.

Frequency

The frequency of each plant species occurrence was calculated as:

$$\text{Frequency} = \frac{\text{Number of occupied quadrats of a species}}{\text{Total number of quadrats thrown}} \times 100$$

Density

The density of each plant species in the study was estimated by enumerating all individuals of each species present in each quadrat. The mean number of individual species was taken as a proportion of the area of the quadrats to a given density in m^2 which was multiplied by 10,000m^2 (Cochran, 1963).

$$\text{Mean of the species} = \frac{\text{No of individuals of the species}}{\text{No of transect x No of quadrat}}$$

$$\text{Density per } m^2 = \frac{\text{Mean}}{\text{Area of quadrat}}$$

$$\text{Density/ha} = \text{density per } m^2 \times 10{,}000.$$

Height

The height of each plant species was measured using a Haga altimeter. Before measurement, every woody species was carefully inspected for damage. For each of the woody plant height, the Haga altimeter was used thus: the reading was taken from the base of the tree at a distance of 15m from the plant by sighting the base and the tip of the crown was also sighted through the eyepiece of the altimeter and the upper reading taken. The height (m) of each species was calculated using the relation, algebraic sum of the readings of the upper and base of each plant multiplied by the horizontal distance from observer to each species divided by scale factor used on the altimeter.

$$\text{Height (m)} = \frac{\text{Algebraic sum of readings of the upper and base of ith species x horizontal distance from observer to the ith species}}{\text{Scale factor used on the altimeter.}}$$

Basal Area

The girth of the plant species was measured using girthing tape. The tape was wrapped round each individual plant at breast height (gbh) that is between 1.3 and 1.4m. Where the species height was below breast height, girth was measured at less than breast height. The basal area was calculated as:

Basal Area = $C^2/4\pi$

Where C is girth size of the ith species

Crown cover

The crown cover of plant species encountered in the vegetation was determined by the crown cover diameter method (Muller-Dombios and Ellenberg, 1974). This involves measuring crown diameter projection on the ground of all woody plants. A tape was laid out on the ground from one end of the crown perimeter to the other. This gives one diameter reading. A second diameter reading was taken in a similar manner but perpendicular to the first one. These gave two diameter readings which were used in calculating crown horizontal area for each plant species.

$$\text{Crown cover } (m^2/ha) = \left(\frac{d_1 + d_2}{2}\right)^2 \pi/4$$

Where $\pi/4 = 0.785$

d_1 = First diameter measurement

d_2 = Second diameter measurement

Grass cover

Percentage grass cover was estimated as basal cover. Each sampling site was divided into belt transects of 50cm X 50 cm . Within each belt transect, a 50cm central line transect was laid using measuring tape. At every metre point a metal was dropped perpendicularly and it was noted whether it hit the base of a grass or not and when it does, the grass species was collected and identified and vice versa (Greig-Smith, 1983).

Physicochemical Analysis of Soil Samples

Soil samples were analyzed following the standard procedures outlined by the Association of Official Analytical Chemist (AOAC, 1975). Soil pH was measured using Beckman's glass electrode pH meter (Meclean, 1965). Organic carbon was determined by the Walkey Black wet oxidation method (Jackson, 1962), Available phosphorus by Bray P-1 method (Jackson, 1962). The total nitrogen content was determined by Micro-Kjeldahl method (Jackobson, 1992). Soil particle size distribution was determined by the hydrometer method (Udo and Ogunwale, 1986) using mechanical shaker, and sodiumhexametaphosphate as physical and chemical dispersant. Exchange acidity was determined by titration with 1N KCl (Kramprath, 1967). Total exchangeable bases were determined by EDTA titration method while Sodium and Potassium were determined by photometry method. The Effective cation exchange capacity (ECEC) was calculated by the summation method (that is summing up of the Exchangeable bases and Exchange ecidity (EA). Base saturation was calculated by dividing total exchangeable bases by ECEC multiplied by 100. Two ways analysis of variance was used to evaluate treatment of data with the application of student t-test.

RESULTS

Table 1 shows mean value of the vegetation characteristics of study site 1. The result showed that 15 plant species were identified for study. *Anthonotha macrophylla* was the most dominant species with 100% frequency of occurrence, followed by *Dialium guineense* Willd with 60%. Five plant species with occurrence of 10% were the least dominant. *A.macrophylla* had the highest density of 3200±3.00 stems/ha which was closely followed by *Dialium guineense* (1320±3.57 stems/ha) while *Barteria nigritiania* Hook. F, with 40± 0.32 stems/ha was the least.

Lonchocarpus cyanescens (Schum &Thonn.) Benth, with height of 3.50± 0.70m/ha was the tallest plant species followed by *Anthonotha macrophylla* (2.86 ± 0.43m/ha) while *Randia acuminata* Benth, *with* 0.35± 0.35m/ha was the shortest. *A.macrophylla* had the largest basal area of 0.004 ± 0.00m^2/ha while 5 plant species had the least basal area with the value 0.001± 0.00 m^2/ha. *A. macrophylla* had the largest crown cover of 3.61±1.84m^2/ha while *Baphia nitida* Lodd, with 0.007 ± 0.00m^2/ha was the smallest. *Anthonotha macrophylla* had the highest importance value of 98.54 while *Chromolaena odorata* (Linn.) King & Robinson and *Randia acuminata* both had the lowest importance value of 6.41.

Table 2 shows mean values of the vegetation characteristics of site 2. Result showed that 11 plant species were identified from the study area. *Anthonotha macrophylla* was the dominant species with 100% frequency of occurrence, followed by *Manniophyton fulvum* Muell. Arg,with 80%. Four plant species with 10% frequency of occurrence were the least dominant. *A. macrophylla* with density of 3040±1.96 stems/ha was the highest, while both *Anthocleista vogelli* A. Chev and *Baphia nitida* had the least density of 40± 0.32 stems/ha. *Anthonotha macrophylla* was the tallest species with height of 6.00±1.20m/ha while *Icacina trichantha* Oliv, was the shortest with height of 0.40±0.00m/ha

A. macrophylla and *Combretum micranthum* G. Don, had the largest basal area of 0.03±0.01m^2/ha and 0.03±0.00m^2/ha, respectively while *Manniophyton fulvum* and *Palisota hirsuta* (Thumb.) K. Schum had the least basal area of 0.002± 0.00m^2/ha. *A. macrophylla* had the largest crown cover of 5.30±3.92m^2/ha, followed by *Cnestis ferruginea* D. C (3.60±3.47m^2/ha while *Icacina trichantha* had the least with value of 0.0002±0.00m^2/ha. *A. macrophylla* had the highest importance value of 119.74, followed by *Lonchocarpus cyanescens* with importance value of 45.54; *Baphia nitida* had the least importance value of 3.76.

Table 3 shows mean values of the vegetation characteristics of site 3. The result showed that 14 plant species were identified. *Anthonotha macrophylla* was also the most dominant species with 100% frequency of occurrence while 6 plant species were the least dominant with 10% frequency of occurrence. *A. macrophylla* had the highest density of 3040±5.22 stems/ha, followed by *Scleria naumanniana* Boeck, which had density of 680±2.36 stems/ha while *Lannea acida* A. Rich and *Lonchocarpus cyanescens* had the least density of 40±0.32 stems/ha. *Lannea acida* was the tallest plant species with height 2.60±0.00m/ha, followed by *A. macrophylla* with the height of 2.00±0.23m/ha. *Commelina benghalensis* Linn, had the shortest height with of 0.17±0.17m/ha

Anthonotha macrophylla had the largest basal area of 0.009±0.00m^2/ha followed by *Manniophyton fulvum* with basal area of 0.006±0.00m^2/ha while *Alchornea cordifolia* (Schum. & Thonn.) Mull. Arg, had the least basal area of 0.00001±0.00m^2/ha. *Lannea acida* had the largest crown cover of 2.99±0.00m^2/ha, followed closely by *Anthonotha macrophylla* with value of 2.90±2.16m^2/ha. *Cnestis ferruginea* had the least crown cover value of 0.008±0.00m^2/ha. With respect to importance value, *A. macrophylla* had the highest value of 120.74, followed by *Manniophyton fulvum* with importance value of 49.09. *Cnestis ferruginea* had the least importance value of 4.06.

Table 4 shows mean values of the vegetation characteristics of site 4. Results showed that 15 plant species were identified in the study site. *Anthonotha macrophylla* was the most dominant species with 100% frequency of occurrence, followed by *Icacina trichantha* with 80%. Eight plant species were least

dominant with 10% frequency of occurrence. *A. macrophylla* had the highest density of 2240±2.31stems/ha, followed by *Icacina trichantha,* with 600±0.98 stems/ha while *Harungana madagascariensis* Lamb. ex. Poir*., Palisota hirsuta* and *Urena lobata* Linn, had the least density of 40±0.32 stems/ha. *A. macrophylla* with height of 3.01±0.81m/ha was the tallest, followed by *Urena lobata*,S*enna alata* and *Lonchocarpus griffonianus* (Schum. & Thonn.) Benth,with height of 2.50±0.00m/ha, 2.39±0.88m/ha, and 2.25±0.00m/ha, respectively. *Palisota hirsuta* was the shortest with a height of 0.50±0.00m/ha.

Anthonotha macrophylla had the largest basal area of 0.003±0.00m^2/ha, followed by *Urena lobata* with basal area of 0.002± 0.00m^2/ha. *Cnestis ferruginea* had the least basal area of 0.00003±0.00m^2/ha. *Lonchocarpus griffonianus* had the highest crown cover value of 7.27±0.00m^2/ha, followed by *A. macrophylla* and *Senna alata* Linn with values of 5.04± 3.25m^2/ha and 3.97±3.88m^2/ha, respectively while *Scleria naumanniana* had the least value of 0.04±0.03m^2/ha. *A. macrophylla* had the highest importance value of 98.24, followed by *Icacina trichantha* and *Manniophyton fulvum* with importance value of 36.87 and 29.80, respectively. *Harungana madagascariensis* had the least importance value of 3.78.

Table 5 shows mean values of the physicochemical properties of the soil of the four sites. With respect to pH, results showed that in all sites, the soils were slightly acidic. Site I had the highest electrical conductivity of 32.2±5.03 ds/m while site 2 had the lowest (25.40±4.50 ds/m). Organic carbon, total nitrogen and available phosphorus were low in all sites. Site 4 had the highest organic carbon with mean values of 1.48±0.21%, total nitrogen were the same in site 3 and 4 with mean value of 0.04±0.005% and available phosphorus was highest in site 4 with mean value of 32.10±6.33% respectively, while site 2 had the lowest values of organic carbon, total nitrogen and available phosphorus which where 1.14±0.16%, 0.03±0.005% and 27.47±2.89%, respectively.

The most abundant exchangeable cation was calcium with the highest mean value of 3.04±1.00 cmol/kg in site 1. Site 4 had the least amount of calcium with a value of 2.92±0.63 cmol/kg. This was followed by magnesium with highest value of 1.48±0.33 cmol/kg in site 3 and least value of 1.32±0.27 cmol/kg in site 4. Potassium had the highest value of 0.19±0.02 cmol/kg in site 2 and least value of 0.16±0.08 cmol/kg in site 3. The mean value of sodium was the same in all areas.

Exchange acidity (EA) and ECEC with the mean values of 2.22±0.12 cmol/kg and 6.79±1.31 cmol/kg were highest in site 4 and 3 respectively. Site 1 had the least amount of exchange acidity and ECEC with values 1.82±0.15cmol/kg and 6.52±1.05 cmol/kg respectively. Site I had the highest base saturation of 71.78 ±2.82% while site 4 had the least base saturation of 65.80±4.00%.

With respect to particle sizes, result showed that sand fraction was the most abundant in all sites. Site 4 had the highest sand fraction of 87.5±1.69% while site 2 had the least sand fraction of 81.56±7.16%. Site 1 had the highest silt fraction of 8.8±2.63% while site 4 had the least silt fraction of 2.32±1.68%. The clay fractions were higher than the silt fraction in all sites. Site 3 had the highest clay fraction of 10.92 ±2.36% while site 1 had the least clay fraction of 8.92 ±3.13%. Result also showed that all sites had loamy sand soil textures. Tables 1-5 were statistically analyzed using two ways analysis of variance (ANOVA), with the application of student t-test to compare means of the vegetation data and all the results showed that there were significance differences among species and soil physic-chemical properties in the data, which were significant at $P<.05$.

Analysis of variance (ANOVA) showed that there were variations in means among the different vegetation parameters (significant at p= 0.05) but no variation among different species in Site 1, 2 and 3 While in Site 4, there were variations among the different vegetation parameters and among different species which was significant at p= 0.05 Analysis of variance for soil parameters showed that there were variations among the four areas which was also significant at p= 0.05.

Table 1: Mean (±SE) Values of the Vegetation Characteristics of Study Site 1

	Plant Species	Author(s)	Family	Freq. %	Density (stems/ha)	Height (m/ha)	Basal Area (m^2/ha)	Crown cover (m^2/ha)	Importance value index (IVI)
1	*Aframomum sceptrum*	(Oliv. & Hanb.) K. Schum	Zingiberaceae	20	720±4.74	1.50±0.00	-	-	14.06
2	*Anthocleista vogelli*	A. Chev.	Loganiaceae	10	80.00±0.63	0.40±0.00	0.001±0.00	0.79±0.00	11.79
3	*Anthonotha macrophylla*	P. Beauv.	Fabaceae	100	3200±3.00	2.86±0.43	0.004±0.00	3.61±1.84	98.54
4	*Baphia nitida*	Lodd.	Fabaceae	10	160±1.26	1.75±0.00	0.001±0.00	0.007±0.00	12.81
5	*Barteria nigritiania*	Hook. f.	Passifloraceae	10	40.00±0.32	0.50±0.00	-	0.44±0.00	2.95
6	*Chromolaena odorata*	(Linn.) King & Robinson	Asteraceae	20	120± 0.66	2.05±0.35	-	0.98±1.11	6.41
7	*Cnestis ferruginea*	D.C	Connaraceae	10	120± 0.95	1.50±0.00	0.001±0.00	0.20±0.00	12.30
8	*Combretum micranthum*	G.Don	Combretaceae	20	80.00±0.41	2.00±1.50	0.003±0.00	0.44±0.34	30.89
9	*Costus afer*	Ker-Gawl	Costaceae	10	640± 5.06	2.44±0.00	-	-	10.60
10	*Dialium guineense*	Willd	Fabaceae	60	1320±3.50	1.64±0.58	0.001±0.00	1.23±0.75	39.80
11	*Icacina trichantha*	Oliv.	Icacinaceae	50	360±1.11	0.59±0.28	-	0.13±0.11	16.79
12	*Lonchocarpus cyanescens*	(Schum. & Thonn.) Benth.	Fabaceae	20	160±0.98	3.50±0.70	0.001±0.00	0.40±0.38	15.25
13	*Randia acuminate*	Benth.	Rubiaceae	20	120± 0.66	0.35±0.35	-	0.07±0.00	6.41
14	*Rauvolfia vomitora*	Afzel	Apocynaceae	30	400±1.90	1.34±0.61	-	0.35±0.29	12.42
15	*Scleria naumanniana*	Boeck.	Cyperaceae	20	320± 1.93	0.88±0.17	-	-	8.96

Values are means of 14 determinations ± SD

Table 2: Mean (±sd) Values of the Vegetation Characteristics of Study Site 2 (values are means of 10 determinations ±SD)

	Plant Species	Author(s)	Family	Freq. %	Density (stems/ha)	Height (m/ha)	Basal Area (m^2/ha)	Crown cover (m^2/ha)	Importance value index (IVI)
1	*Aframomum sceptrum*	(Oliv. & Hanb.) K. Schum	Zingiberaceae	10	80.00±0.63	1.55±0.00	-	0.45±0.00	4.58
2	*Anchomanes difformis*	Bl. Engl.	Araceae	20	80.00±0.41	0.50±0.00	-	0.22±0.22	7.52
3	*Anthocleista vogelli*	A. Chev.	Loganiaceae	10	40.00±0.32	2.10±0.00	0.02±0.00	0.19±0.00	22.45
4	*Anthonotha macrophylla*	P. Beauv.	Fabaceae	100	3040±1.96	6.00±1.20	0.03±0.01	5.30±3.92	119.74
5	*Baphia nitida*	Lodd.	Fabaceae	10	40.00±0.32	1.10±0.00	-	1.04±0.00	3.76
6	*Cnestis ferruginea*	D.C	Connaraceae	20	80.00±0.41	1.55±0.77	0.02±0.00	3.60±3.47	26.21
7	*Combretum micranthum*	G.Don	Combretaceae	20	80.00±0.41	0.90±0.56	0.03±0.00	0.40±0.38	10.33
8	*Icacina trichantha*	Oliv.	Icacinaceae	10	120±0.95	0.40±0.00	-	0.0002±0.00	5.40
9	*Lonchocarpus cyanescens*	(Schum.& Thonn.) Benth.	Fabaceae	40	280±1.04	2.11±0.75	0.03±0.03	0.99±0.64	45.54
10	*Manniophyton fulvum*	Muell. Arg.	Euphorbiaceae	80	840± 1.52	1.89±1.26	0.002±0.00	1.56±1.35	42.61
11	*Palisota hirsute*	(Thumb.) K. Schum	Commelinaceae	20	200±1.08	2.82±0.12	0.002±0.00	0.14±0.07	11.85

Table 3: Mean (±sd) Values of the Vegetation Characteristics of Study Site 3 (Values are means of 13 determinations ± SD)

	Plant Species	Author(s)	Family	Freq. %	Density (stems/ha)	Height (m/ha)	Basal Area (m^2/ha)	Crown cover (m^2/ha)	Importance value index (IVI)
1	*Alchornea cordifolia*	(Schum. & Thonn.) Mull. Arg.	Euphorbiaceae	10	120±0.95	1.73±0.00	0.00001±0.00	0.46±0.00	4.74
2	*Andropogon tectorum*	Schumach. & Thonn.	Poaceae	20	400±2.31	1.29±0.98	-	0.79±0.00	11.92
3	*Anthonotha macrophylla*	P. Beauv.	Fabaceae	100	3040±5.22	2.00±0.23	0.009±0.00	2.90±2.16	120.74
4	*Asystasia gangetica*	(Linn.) T. Anders	Acanthaceae	10	160±1.26	0.45±0.00	-	0.61±0.00	5.33
5	*Chromolaena odorata*	(Linn.) King & Robinson	Asteraceae	30	240± 1.08	1.43±0.81	-	0.36±0.29	12.15
6	*Cnestis ferruginea*	D.C	Connaraceae	10	80.00±0.63	1.35±0.00	-	0.008±0.00	4.05
7	*Commelina benghalensis*	Linn.	Commelinaceae	30	400±1.93	0.17±0.17	-	-	14.70
8	*Lannea acida*	A. Rich.	Anacardiaceae	10	40.00±0.32	2.60±0.00	0.0009±0.00	2.99±0.00	7.87
9	*Lonchocarpus cyanescens*	(Schum. & Thonn.)Benth.	Fabaceae	10	40.00±0.32	1.80±0.00	0.003±0.00	0.79±0.00	18.27
10	*Manniophyton fulvum*	Muell. Arg.	Euphorbiaceae	40	520±1.77	1.77±0.64	0.006±0.00	1.05±0.29	49.09
11	*Microdesmis puberula*	(Hook. f.) ex. Planch.	Euphorbiaceae	10	200±1.58	1.22±0.00	-	1.16±0.00	5.96
12	*Randia acuminate*	Benth.	Rubiaceae	20	200±1.08	0.88±0.10	0.0007±0.00	0.47±0.00	12.21
13	*Scleria naumanniana*	Boeck.	Cyperaceae	40	680± 2.36	0.41±0.04	-	0.12±0.00	21.94
14	*Uvaria chamae*	P. Beauv.	Annonaceae	20	160±0.98	1.39±0.83	0.0006±0.00	0.89±0.15	11.07

Table 4: Mean (±sd) Values of the Vegetation Characteristics of Study Site 4 (Values are means of 14 determinations ± SD)

	Plant Species	Author(s)	Family	Freq. %	Density (stems/ ha)	Height (m/ha)	Basal Area (m^2/ha)	Crown cover (m^2/ha)	Importance value index (IVI)
1	*Anthonotha macrophylla*	P. Beauv.	Fabaceae	100	2240±2.31	3.01±0.81	0.003±0.00	5.04±3.25	98.24
2	*Chromolaena odorata*	(Linn.) King & Robinson	Asteraceae	10	80.00±0.64	2.00±0.00	0.0005±0.00	0.49±0.00	29.76
3	*Cnestis ferruginea*	D.C	Connaraceae	30	200±0.85	1.15±0.50	0.00003±0.00	0.73±0.10	10.53
4	*Costus afer*	Ker-Gawl	Costaceae	10	520±4.11	2.13±0.00	0.00004±0.00	0.33±0.00	11.80
5	*Harungana madagascariensis*	Lam. Ex. Poir	Hypericaceae	10	40.00±0.32	1.20±0.00	0.00007±0.00	2.41±0.00	3.78
6	*Icacina trichantha*	Oliv.	Icacinaceae	80	600±0.98	0.85±0.26	0.0007±0.00	0.46±0.21	36.87
7	*Lonchocarpus griffonianus*	(Schum. & Thonn.) Benth.	Fabaceae	10	80.00±0.63	2.25±0.00	0.0002±0.00	7.27±0.00	6.08
8	*Manniophyton fulvum*	Muell. Arg.	Euphorbiaceae	60	520± 1.33	1.66±1.23	0.0006±0.00	1.09±0.77	29.80
9	*Microdesmis puberula*	(Hook.f.) ex. Planch	Euphorbiaceae	20	320±1.93	1.20±0.07	-	0.70±0.44	10.04
10	*Palisota hirsuta*	(Thumb.) K. Schum.	Commelinaceae	10	40.00±0.32	0.50±0.00	0.0002±0.00	0.79±0.00	5.38
11	*Rauvolfia vomitora*	Afzel.	Apocynaceae	10	80.00±0.63	1.40±0.00	0.0001±0.00	1.28±0.00	4.85
12	*Scleria naumanniana*	Boeck.	Cyperaceae	40	440±1.45	0.58±0.24	-	0.04±0.03	16.58
13	*Selaginella myosurus*	(Sw.) Alston	Selaginellaceae	10	240± 1.89	-	-	--	6.42
14	*Senna alata*	Linn.	Fabaceae	40	280±1.04	2.39±0.88	0.0007±0.00	3.97±3.88	22.38
15	*Urena lobata*	Linn.	Malvaceae	10	40.00±0.32	2.50±0.00	0.002±0.00	1.77±0.00	27.49

Table 5: Mean (±SD) Physicochemical Properties of the Four (4) Study Sites

Soil Properties	Values			
	Site 1	**Site 2**	**Site 3**	**Site 4**
pH	6.30± 0.05	6.40±0.06	6.37±0.07	6.39± 0.05
EC (ds/m)	32.20±5.03	25.40±4.50	31.50±5.72	31.00±8.38
Organic Carbon (%)	1.23± 0.22	1.14± 0.16	1.46±0.18	1.48±0.21
Total Nitrogen (%)	0.03± 0.006	0.03± 0.005	0.04±0.005	0.04± 0.005
Phosphorus (mg/kg)	28.99±4.37	27.47±2.89	30.74±7.05	32.10±6.33
Calcium (cmol/kg)	3.04± 1.00	2.96±0.63	3.00±1.17	2.92±0.63
Potassium (cmol/kg)	0.18± 0.03	0.19± 0.02	0.16±0.08	0.17± 0.02
Magnesium(cmol/kg	1.44± 0.27	1.48± 0.26	1.48±0.33	1.32± 0.27
Sodium (cmol/kg)	0.04± 0.005	0.04± 0.006	0.04±0.01	0.04± 0.005
EA (cmol/kg)	1.82± 0.15	2.11± 0.24	2.11±0.13	2.22± 0.12
ECEC (cmol/kg)	6.52± 1.05	6.79± 0.67	6.79±1.31	6.57± 0.70
Base Saturation %	71.78± 2.82	68.59±4.89	68.01±5.80	65.80±4.00
Sand %	82.28±2.86	81.56±7.16	85.80±2.67	87.5±1.69
Silt %	8.80±2.62	8.15± 6.15	3.70±1.39	2.32± 1.68
Clay %	8.92±3.13	10.29±2.56	10.92±2.36	10.18±2.32
Soil Texture	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand

DISCUSSION

The vegetation characteristics (frequency, density, basal area and crown cover) of the species varied considerably. This is a reflection of species response to environmental factors. The variability in the values of these vegetation characteristics in the study sites portrayed the developmental stages of trees, shrubs and herbs. The low height of most plant species indicated immature growth stages of the plant species. Krebs (1994) pointed out that basal area is an important measure of species performance. Tables 1 - 4 also showed that *Anthonotha macrophylla* dominated the four sites with 100% frequency of occurrence. *Anthonotha macrophylla* also dominated in terms of density, height, basal area, crown cover and importance value in all sites.

The high importance values of *Anthonotha macrophylla* in all sites simply indicated the overall importance of this species in these sites. Verma and Agarwal (2007) pointed out that importance value determines the overall importance of each species in the community structure.

With respect to density, Verma and Agawal (2007) pointed out that density gives an idea of degree of competition. There is evidence for this as the numerical strength of *Anthonotha macrophylla* is greater in all sites. Verma and Agrawal (2007) also opined that the crown cover is a good measure of the herbage availability. This is also evident in this study, since the crown cover of *A. macrophylla* restricts undergrowths in all areas. The dominant nature of *A. macrophylla* in terms of basal area indicates high performance in all sites which is consistent with the result of Krebs (1994). The dominance of *A. macrophylla,* could be because of the topography of the land, spatial distribution of readily available soil nutrients and its ability to adapt to environmental factors such as soil pH, soil texture, organic carbon and

available phosphorus. The low level of dominance of other plant species may be due to their poor adaptability to environmental stresses (Krebs, 1994).

Soil analysis had revealed that the soil was dominated by sand separates followed by clay, while silt ranked last which was significance at $P< 0.05$. Texturally the soil was loamy sand. These combined to influence other soil properties. Loamy sand soils are nutrient rich because of the ability to retain nutrients well and retain water while still allowing the water to flow freely. Webster and Wilson (1980) agreed with this and stated that soil texture influences the nutrient status and water holding capacity of the soil, pointing out that soil texture also affects the presence of soil Nitrogen content. Since pH can affect the availability of nutrients in the soil, the slightly acidic soil of these areas results in low values of the macro-nutrients which are readily available for plant use. Shukla and Chandel (2008) stated that N content in surface mineral soils is about 0.02-0.5% and that soil N occurs as part of organic molecule. This is evident in this work as N content falls within this range. Naturally, major nutrients (NPK) are usually lacking or low in the soil because plants use large amounts for their growth and survival (Allen and Pilbeam, 2007). The percentage organic carbon present reflected the level of humus contents in the soil. This could be attributed to decomposition of dead roots, and leave under the action of soil bacteria and fungi. According to Boto and Wellington (1985), the supply of nutrients to plants in appropriate quantities at the correct time is essential for plant growth. The different and low concentrations of N, P, K, may have led to the sparse distribution of plant species in the study sites.

CONCLUSION

In this study, statistical analysis using two ways analysis of variance through student t-test has shown that variation exists among plant species, nutrients composition and environmental data. It also reveals that since the soils in all areas were slightly acidic in nature and loamy sand in texture, these nutrients (N, P, K) are readily available in free and exchangeable forms and also in adequate amount for use by plants.

RECOMMENDATION

The information obtained from this work could be essential in the agricultural sector in Akwa Ibom State and Nigeria as a whole. With proper pruning of *Anthonotha macrophylla* in such vegetations, harvestable crops could be cultivated alongside *A. macrophylla trees* in an agro-forestry system which will result in greater yield of crops, better management of natural resources and sustainable use of land.

REFERENCES

Allen, V.B and Pilbeam, D. J. (2007). *Handbook of Plant Nutrition.* Taylor & Francis/ CRC Press. New York, 304p.

Akwa Ibom State Government (AKSG) (2008). Geography and Location. About Akwa Ibom State. *www.aksgonline.com*. Retrieved 17-12-2010.

Antonio, G. (2003). Effect of tree canopy on the spatial distribution of soil nutrients in a Mediterranean Dehesa. *Pedobiologia,* 47(2):117-125.

Association of Official Analytical Chemist (A.O.A.C) (1975). *Methods of Analysis*, *12th edition*. AVI Publishing Company Inc. Washington DC. 986p.

Bhup, K. (2008). Legume play major role to maintain soil fertility and its Quality. Organic Farming. *http://www.agriculture information.com.* Retrieved 19-11-2010.

Bisby, F. A., Roskov, Y. R., Ruggiero, M. A., Orrell, T. M., paglinawan, L. E., Brewer, P. W., Bailly, N., and Van Hertum, J. (2007). *Species 2000 and ITIS catalogue of Life: 2007 Annual Checklist,* Reading, U. K.

Boto, K., and Wellington, J. (1984). Soil characteristics and nutrient status in a Northern Australian Mangrove Forest. *Estuaries,* 7:61-69.

Breteller, F. J. (2006).Two *Anthonotha* species from Gabon transfered to Englerodendron (Fabaceae, Caesalpniodeae). *Adansonia*, 28(1): 105-111.

Cochran, W. G. (1963). *Sampling Techniques, 2nd edition*. Wiley Eastern Limited, New Delhi. 413p.

Cole, J. J. (1982). Interactions between bacteria and algae in aquatic ecosystems. *Annual. Review. Ecoogicall. System,* 13:291-314.

Gong, W., Hu, T., Wang, J., Gong, Y., and Ran, H. (2006). Impacts of litter on soil Nitrogen supply potential of the natural evergreen broadleaved forests after artificial regeneration in Southern Sichuan Province. *Nigerian Journal of Soil Science.* 9:1597-4488.

Greig-Smith, P. (1983). *Quantitative Plant Ecology*. Blackwell Scientific Publications, Oxford, 339p.

Huang, S. (2007). Analysis of spatial distribution of soil nutrients in Suburb Region based on GIS. *Journal of Anhui Agricultural Sciences*, 2007-08.

Jackobson, S.T. (1992). Chemical reactions and air change during decomposition of organic matter. *Resource.Conserve and Recycle.* 6:259-266.

Jackson, M. I. (1962). *Soil Chemical Analysis*. Prentice-Hall Inc. Englewood Cliffs, New Jersey; 498p.

Kramprath, E. J. (1967). Conservation of soils and tissue testing for accessing the phosphorus status of soils. In: *The Role of phosphorus in Agriculture*. American Society of Agronomy. pp. 433-469.

Krebs, C. J. (1994). *Ecology: The experimental analysis of distribution and abundance 4th ed.* Harper and Row Publishers, New York. 625p.

Li, Q., Ding, Z., Wang, Y., Zhang, X., and Hang, Y. (2009). Soil nutrients levels and annual dynamic changes of Laoshan Tea Gardens. *Chinese Agricultural Science Bulletin.,* 2009-13.

Liu, S., Gao, L., Pu, Y., Deng, L., and Zhang, S. (2005). Status of soil P and K nutrient and their influencing factors in Tibet. *Journal of Soil Water conservation,* 2005-01.

Lu, G. (2010). Spatial distribution of soil total nutrients in farmland of Liaoning province. *Journal of Anhui Agricultural Sciences,* 2005-07.

Ma, B., Ma, K., He, X., Xu, Z. Luo, D. and Han, C. (2009). Spatial heterogeneity of available soil Nutrients in the loess plateau of Southern Ningxia. *Plant nutrition and fertilizer Science,* 2009.

Maplandia (2005). UyoMap-Satellite Images of Uyo Map-Satellite Images of Uyo *http://www.maplandia.com/nigeria/akwaibom/uyo/uyo.* Retrieved 14-11-2010.

Meclean, I. O. (1965). Aluminum. *Agronomy Journal,* 9:978-988.

Nicholas, C. S., Fasehun, F. E, and Okali, D. U. U (1997). Leaf nutrient dynamics of two tree species and litter nutrient content in Southern Bakundu Forest Reserve, Cameroun. *Journal of Tropical Ecology*, 13:1-15.

Pang, S., Li, T., Wang, Y., Yu, H. and Wu, D. (2009). Spatial variability of soil available N, P and K and influencing factors. *Plant Nutrition and Fertilizer Science,* 2009-01.

Shukla, R. S. and Chandel, P. S. (2008). *Plant Ecology including Ethnobotany and Soil Science*, S Chand, New Delhi, 544p.

Ubom, R. M. (2006). Soil properties influencing the abundance and distribution of *Isoberlina* Woodlands is Nigeria. *Int. J. Soil Sci.,* 1: 207-217.

Udo, E. J. and Ogunwale, J. A. (1986). *Laboratory Manual for the Analysis of Soil, Plants and Water Sample.* University of Ibadan Press, Ibadan.

Verma, P. S. and Agarwal, V. K. (2007). *Cell Biology, Genetics, Molecular Biology, Evaluation and Ecology.* Schand & Company Ltd., New Delhi, 790p.

Wang, J., Wang, J., Hu, Y., and Zhao, Z. (2006). Studies on spatial variability of soil nutrients and

sampling methods in a field of chest nut Soil. *Agricultural Research in the Arid Areas:* 2006-05.

Webster, C. C. and Wilson, P. N. (1980). *Agriculture in the Tropics*, *2nd edition*, Longman Group Ltd., New York, 640p.

Zhang, X., Sui, Y., Zhang, S., Yu, T., and Chang, W. (2008). Spatial heterogeneities of total carbon, nitrogen, phosphorus and potassium content in black thin-Layer soil. *Bulletin of soil and water Conservation:* 2008-02.

Zhao, Y., Chen G, and Wang, Y. (2005). A study on spatial variability o*f soil nutrients based on GIS. AETA Agriculturae Boreali Occidentalis Sinica:* 2005-08.