

Effects of Soil Types on the Early Growth Rate of *Tetrapleura Tetraptera* (Del) Seedlings

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ABSTRACT

Most indigenous trees of economic importance such as *Tetrapleura tetraptera* (Schum and Thonn) Taub are seriously over exploited in most parts of Southeastern Nigeria and are at the verge of extinction. Therefore, there is the need to develop appropriate conservation strategies for raising and domestication this tree species. On the basis of this, a study was conducted to assess the effects of soil types on the early morphological and physiological characteristics of this tree species with a view to recommending the best soil type to farmers and tree planters. Matured seeds of *Tetrapleura tetraptera* were collected from the mother tree in Uyo Local Government Area, Uyo, Akwa Ibom State and seedlings raised for this study. Four different soil types (sandy loam, loamy sand, sandy clay loam and silty clay loam) were collected and analyzed to determine their description and nutrient status. At two – leaf stage, the raised seedlings were transplanted into polyethene pots filled with these four different soils and laid out in a Randomized Complete Block Design in three replicates. The following growth parameters were determined fortnightly; seedling height (cm), stem collar diameter (cm), number of leaves. Data were collected fortnightly on seedling height (cm), stem collar diameter (cm), and number of leaves per seedling while some physiological growth parameters (Relative Growth Rate (RGR), Average Growth Rate (AGR) and shoot/Root Ratio) and biomass production were determined monthly. Results indicated that in all the parameters assessed, (height, diameter, number of leaves, and shoot dry weight) loamy sand had the best performance except for the root dry weight which was highest in sandy clay loam. Also, loamy sand performed best with respect to RGR, AGR and S/R compared other soil types. Therefore, loamy sand would support *Tetrapleura tetraptera* growth and facilitates its domestication.

Keywords: Soil Types, Early Growth Rate, *Tetrapleura Tetraptera*, Seedlings

INTRODUCTION

Forest contributes significantly to the daily food and fuel wood needs of the populace in Nigeria, particularly the rural poor. This perhaps explains why Etukudo *et al.* (1994) observed that under good management, a forest should be able to fulfill its key roles to humanity, notably protection, production and recreation. Forest also provides potentially fertile forest land for farming. Besides, the natural forests of west and central Africa are rich in natural resources and have tremendous biodiversity (Okafor, 1975; FAO, 1983; Burkill 1985; Denton *et al.*, 1988; Olajide *et al.*, 1999; Fasola, 2000), particularly plants that provide for ornamentals, spices and ingredients with medicinal value such as *Tetrapleura tetraptera*.

Unfortunately, tropical forest, where most of these spices and ingredients with medicinal values are harvested from the wild is fast disappearing at the rate of 17 million hectares per year. Some of the edible forest plant species that are disappearing in Nigeria (Akachuku, 1997, 1999, 2006; Adedire, 1991; Ojo, 1996) as a result of deforestation in particular are: *Tetrapleura tetraptera* (Schum and Thonn) Taub., *Xylopia aethiopica* (Dunal) A. Rich, *Irvingia gabonensis* (Aubry-Iecomte ex O'Rorke) Baill, *Pentaclethra macrophylla* (Benth.) and *Dennettia tripetala* (Bak. f).

Tetrapleura tetraptera (Schum and Thonn) Taub is originated from Tropical Africa and is commonly found on the fringes of the West African rainforest, riverine forest, Southern Savannah-woodland in the forest outlier in the African plain and especially in secondary forest (Keay, 1989). In Nigeria, the species is predominantly found in forest region of the Southern parts including Akwa Ibom State, Cross River State, Rivers State and Abia State It belongs to the family: Mimosaceae (Ndukwu *et al.*,

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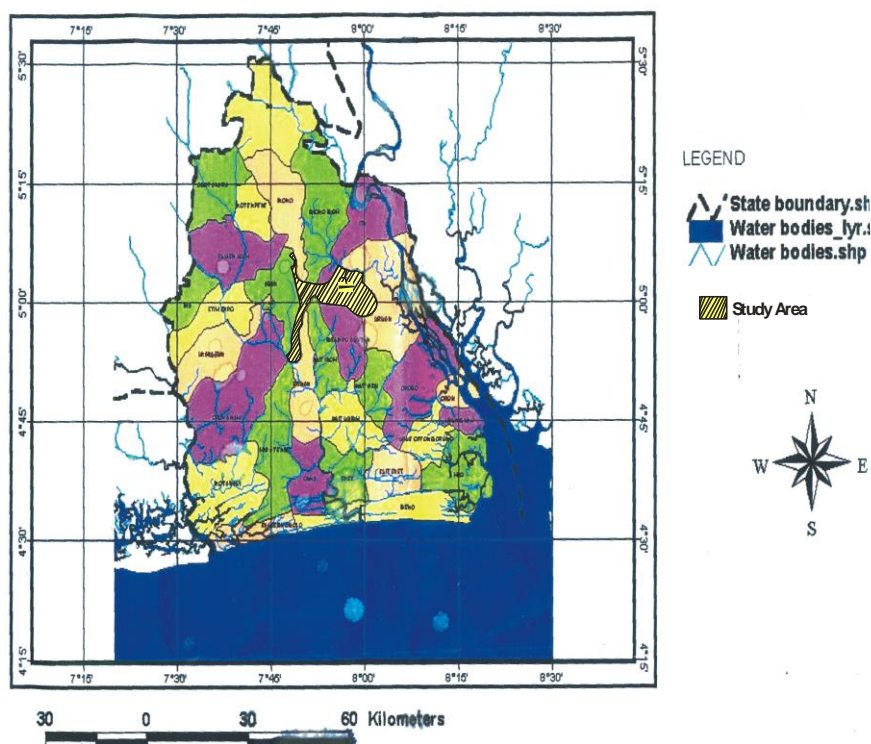
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2006). It is rarely cultivated but when found in the wild are protected (Ndukwu *et al.*, 2006). The species is known by several local names in Nigeria. In Efik, it is called Edeminyang, Ibibio – Uyayak, Yoruba – aridan, Edo – Ighimiakia, Ishan – Ighirehimi, Etasoko – Imiminje, Ijaw - apapa, Igbo – Oshosho, Boki - ebuk (Iwu, 1993). *Tetrapleura tetraptera* (Schum and Thonn) laub. is among the best known spices from our forest that is mostly used in our local dishes (Etukudo, 2000) as the fruits and seeds add good aroma and flavour to food thereby increasing the pleasure of food consumption. Medicinally, it is used to cure fever and as an enema for constipation. The species also produces valuable timber with its nutritional and medicinal values, and its demand outweighs its supply and thus needs serious artificial regeneration and large scale establishment in plantations. According to Etukudo *et al.* (1994), artificial regeneration of any tree species starts from the nursery and nursery development is best on fertile soils. Moreover, a good knowledge of soil type that is suitable for growing a particular plant species is necessary as there are variations in soil requirements for different forest plant species. Adequate information on the suitability of different soil types for raising of this species will contribute to its effective domestication and for large scale plantation development. Soil is an important ecological factor affecting tree growth (Nwoboshi, 1982). Unfortunately, there is inadequate information on the type of soil required for raising this species in the nursery. Therefore, the focus of this study is to evaluate the effects of four different soil types on early morphological and physiological characteristics of *Tetrapleura tetraptera* (Schum and Thonn) Taub.

MATERIALS AND METHODS

Study Area: This study was carried out at the nursery of the Department of Forestry and Wildlife, Faculty of Agriculture, University of Uyo, Uyo Akwa Ibom State, Nigeria. It lies within the tropical rain forest zone of Nigeria between latitudes 4°58' and 5°05' N and longitudes 7°54' and 8°00' E. It comprises twenty one villages and a total land area of 15,750 hectares (Akpabio and Chukukere, 2004)

The relief of Uyo Urban is that of relatively gentle slope. Rainfall ranges from 800 – 3200 mm per annum. It begins in March and continues till October with peaks in June and September (Akpabio and Chukukere, 2004). Dry season starts from November and lasts till February while annual temperature varies between 22.8°C and 30.13°C. The mean relative sunshine is 8.31. The soil type of Uyo is ultisol (Offiong, 2008). There is abundant sunshine and long growth period (Etukudo, 2001) to sustain luxuriant vegetation all year round (Figure 1).



MAP OF AKWA IBOM STATE SHOWING STUDY AREA

Seed Collection, Processing and Sowing

Matured fruits of *Tetrapleura tetraptera* (Schum and Thonn) Taub were collected from the mother tree in Uyo Local Government Area, Akwa Ibom State. The seeds were removed from the pod by splitting the pod (Plates 1 and 2), wind-blown and sundried for 24 hours to enhance germination. A total of 1800 seeds with no visible sign of infection were selected from the lot and sown in germination boxes measuring 28 cm x 14 cm x 14 cm filled with washed and sterilized river sand to raise seedling for this study. Watering was done twice daily for effective germination.



Plate1. Matured Fruits of *Tetrapleura Tetrap Tera*



Plate2. Seeds of *Tetrapleura Tetraptera*

Growth Medium: Four different soil types were sampled and obtained from 0 – 15cm and from 15 – 30cm depths in 20 randomly selected points and analyzed. Specifically, the soil were Sandy loam (S L), Loamy sand (LS), Sandy clay loam (SCL) and Silty clay loam (SICL). Soil analysis was carried out on these soils to determine their description and nutrient status (Table 1)

Table1. Physico-Chemical Properties of the Soil Types Used

SOIL TYPE	pH(in water)	Textural Properties%.....			Exchangeable Bases(mg/100g)				EC mol/ Kg	Base Sat. %	Organic Matter %	Total N %	EA	AV.P (mg/kg)
		SAND	SILT	CLAY	Ca	Mg	K	Na						
Sandy loam(SL)	6.20	76.10	20.0	3.90	3.00	1.30	0.11	0.05	7.12	65.45	4.40	0.11	2.46	20.99
Loamy sand (LS)	6.10	88.10	80.0	3.90	3.10	1.40	0.10	0.05	6.95	66.91	4.60	0.16	2.30	24.33
Sandy clay loam(SCL)	6.00	88.0	72.0	36.0	2.96	1.20	0.10	0.05	3.20	57.39	3.11	0.08	3.20	19.66
Silty clay loam (SICL)	6.00	26.00	76.00	40.00	2.98	1.20	0.09	0.04	3.10	58.22	4.08	0.10	3.10	18.99

E C E C=Effective Cation Exchange capacity, EA=Exchangeable Acidity, Av.P=Available phosphorus, N=Nitrogen

Growth Evaluation: At two - leaf stage, a total of 320 fairly uniformed growing seedlings were selected with 80 seedlings per treatment, pricked and transplanted into polyethene pots measuring 26 cm x 16 cm x 19 cm filled with the four soil types. These were laid out on the field in a Randomized Complete Block Design and replicated three times. Watering was done twice daily. Two weeks after transplanting, the following morphological growth parameters were measured at fortnight interval for three months, seedling height (using a ruler calibrated in cm), stem collar diameter (Using vernier caliper calibrated in cm), number of leaves and branches (visual counting).

Biomass Production Assessment

Biomass production was assessed at monthly interval. On each occasion, five seedlings were randomly selected from each treatment. The seedlings were watered and carefully uprooted from the soil to avoid damage to the roots. The roots were carefully washed in distilled water and the shoot was separated from the root for biomass determination. These components were dried at 80⁰c for 24 hours (Surgifield – SM9023A Laboratory oven). The dry weight was determined by weighing them on an electronic weighing balance calibrated in grams. The data collected were used to calculate the following physiological growth parameters (Offiong, 2008).

$$\text{Relative growth rate (RGR) (g/m)} = \frac{(\text{LnTDW}_2 - \text{LnTDW}_1)}{t_2 - t_1}$$

$$\text{Average Growth Rate (AGR) (g/m)} = \frac{(\text{TDW}_2 - \text{TDW}_1)}{t_2 - t_1}$$

$$\text{Shoot/ Root Ratio} = \frac{\text{Dry weight of shoot}}{\text{Dry weight of Root}}$$

Where: TDW₁ = Initial total dry weight, TDW₂ = Final total dry weight,

Ln = Natural Logarithm, t₁ = Initial time (months), t₂ = Final time (months)

Data collected were subjected to a two - way analysis of variance at 5% probability level and the least significant difference (LSD) was to compare means where significant differences was observed (Akindele, 1996).

RESULTS AND DISCUSSION

Results

Soil characteristics and Seedling Height (cm)

The result of the soil analysis indicated that the status of Nitrogen, potassium and sodium (macro nutrients) were low compared to other nutrients in each of the soil type (Table 1). Soil type had significant effect (P<0.05) on seedling height (Table 2). Seedlings grown on loamy sand (LS) were significantly taller (18.04 cm) than from other soil types (Table 3). Sandy loam (SL) soil had seedlings with the mean value of 16.88 cm. The shortest seedlings with the mean value of 14.24 cm were from sandy clay loam (SCL) while silty clay loam (SICL) recorded a mean value of 14.84 cm (Table 3).

Table2. Summary of Analysis of Variance for Tetrapleura tetraptera Seedlings Growth Parameters as affected by Soil types

Variable	Degree of Freedom	Height (cm) MS	Diameter(cm) MS	Number of Leaves (MS)	SDW (g/m) MS	RDW (g/m) MS
Treatment	3	1.477 *	0.001 ^{Ns}	0.702 ^{Ns}	0.0019 ^{Ns}	0.005 ^{Ns}
Block	2	0.909 ^{Ns}	0.0006 ^{Ns}	0.880 ^{Ns}	0.0016 ^{Ns}	0.0010 ^{Ns}
Error	6	0.164	0.0002	0.552	0.0022	0.0009
Total	11	2.495	0.0005	0.651	0.0013	0.008

SDW – Shoot Dry Weight, RDW – Root Dry Weight, g/m – grams / month, MS – Mean Square, * - Significant at 5 % probability level, Ns – Not Significant at 5 % probability level

Seedling Diameter (cm) and Number of Leaves per Seedling

Seedling diameter was not significantly affected (P > 0.05) by soil types (Table 2). However, the biggest stem diameter on the average was obtained from the seedlings grown on loamy sand (0.53 cm)

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while sandy clay loam recorded the least (0.43 cm). Seedlings planted on sandy loam (SL) and silty clay loam (SICL) recorded mean collar diameter of 0.49 cm and 0.46 cm, respectively (Table 3).

The result showed that soil types had no significant effect ($P > 0.05$) on the number of leaves per seedling (Table 2). The highest number of leaves per seedling on the average was however obtained from LS (18.36). The least was from SL (14.68) while SICL and SCL had 16.55 and 16.48 number of leaves per seedling, respectively (Table 3).

Table 3. Summary of Effects of Soil Types on Mean of Tetrapleura tetraptera Seedlings Growth Parameters

TREATMENT	MEAN				
	Height (cm)	Diameter (cm)	NLVS	SDW (g/m)	RDW (g/m)
Sandy loam (SL)	16.88	0.49	14.68	0.14	0.08
Loamy sand (LS)	18.04	0.53	18.36	0.26	0.12
Sandy clay loam (SCL)	14.24	0.43	16.48	0.25	0.16
Silty clay loam (SICL)	14.84	0.46	16.55	0.13	0.11
LSD	1.5	NS	NS	NS	NS

NLVS – Number of leaves

Shoot Dry Weight (g/m) and Root Dry Weight (g/m)

Seedling shoot dry weight was not significantly affected ($P > 0.05$) by soil types (Table 2). However, the highest shoot dry weight on the average was obtained from LS (0.26g/m) while the least (0.13g/m) was from SICL. Seedlings from SCL and SL treatments had of 0.25g/m and 0.14g/m mean shoot dry weight values, respectively (Table 3). Seedling root dry weight was not significantly affected ($p > 0.05$) by soil types (Table 2). Sandy Clay Loam however had the highest (0.16g/m) mean Root Dry Weight on the average while SL recorded the least (0.08g/m). Mean Root Dry Weight values of 0.12g/m and 0.14g/m were obtained from SL and SICL, respectively (Table 3)

Relative Growth Rate (RGR), Average Growth Rate (AGR) and Shoot to Root (S/R) Ratio

Result showed that among the soil types, seedlings raised with LS (Table 4) gave the highest mean value (1.89g/m) while the least (1.10g/m) value of RGR was from SCL. Sandy loam and SICL recorded mean values of 1.22g/m each. The result indicated that among the soil types, seedlings raised with LS had the highest mean AGR with mean of 0.18g/m while seedlings raised in SL had the least (0.10g/m) mean AGR. Sandy clay loam and SICL had seedlings with mean values of 0.14g/m and 0.11g/m, respectively (Table 4) Seedlings grown on LS had the highest shoot to root ratio (2:3) while SICL recorded the least S/R (1:3). Mean values of 1:9 and 1:6 were obtained from LS and SCL, respectively.

Table 4. Effect of Soil Types on Mean Value of RGR, AGR and Shoot to Root Ratio of Tetrapleura tetraptera Seedlings

Treatment	RGR(g/m)	AGR(g/m)	S/R
Sandy Loam	1.22	0.10	1:9
Loamy Sand	1.89	0.18	2:3
Sandy Clay Loam	1.10	0.14	1:6
Silty Clay Loam	1.22	0.11	1:3

Discussion

Results of this study have revealed that seedlings of *Tetrapleura tetraptera* increased in height, number of leaves and other growth parameters with time. These findings agree with that of Edward (1993) that growth is a process by which a plant increases in the number and size of leaves and stems. Physiologically, it is regarded as a synthesis of protoplasm, accompanied by a permanent change in form and increase in mass of the growing organism (Edward, 1993). Also, it has been stated that plant constantly produces new tissues and structures throughout their life from the meristems located at the tip of organs or between mature tissues (Baurle *et al.*, 2003) and this was observed in this study.

The results of this study show that loamy sand soil had the highest seedling height among the other soil types. This could be attributed to the high Nitrogen, phosphorus and potassium content of this soil type. This result agrees with the findings of Donahue *et al.*, (1990) that nitrogen, phosphorus and potassium are essential nutrients for plant growth particularly at the early stage. It also agrees with the findings of Kannan and Pailiwall (1997) who reported that nitrogen increased seedlings growth of *Senna siamea* at the nursery stage.

Similarly, seedling diameter was also highest in LS compared to others. This is perhaps due to more favorable pH condition of this soil type. This agrees with the findings of Donahue *et al.* (1990) that soil pH influences the presence and solubility of elements such as calcium, phosphorus, nitrogen and potassium.

A similar result was also obtained from the number of leaves which was highest in LS and was attributed to the presence of Nitrogen, Potassium and Phosphorus in adequate amount. This agrees with the findings of Nwoboshi (2000) who described the Nitrogen, Potassium and Phosphorus nutrients as being essential in the formation of proteins, chlorophyll molecule, root and stem growth and carbohydrate utilization. The presence of these elements in LS might have triggered a better leaf number formation, its growth and development than the other soil types (SL, SCL and SICL). Also, the more number of leaves in LS signified the abundance of food as more leaves were available for photosynthesis following the trapping of more solar radiation.

Shoot and root dry weights were higher under LS and SCL, respectively. This could be due to the preponderance of phosphorus, Nitrogen and suitable soil texture which perhaps had greater capacity to hold water and at the same time release the soil nutrients when needed by the plant. This correlates with the findings of Nwoboshi (2000) and Donahue *et al.*, (1990) who observed difference in plant growth under different soil texture. The difference observed in shoot and root dry weight is also partly attributed to differential soil moisture absorption by the plants under diverse soil types.

The highest relative and average growth rate under LS are apparently due to abundance of essential nutrients like phosphorus and effective cation exchange capacity. The importance of soil nutrients and favourable soil reaction (pH) in the growth and development of plants had been emphasized by Donahue *et al.*, 1990. The seedlings exhibited no marked variations in shoot/root ratio among soil types. However, the outstanding ratio of 2:3 seems to suggest that a soil type does not necessarily affect the ratio of shoot to root. These findings agree with that of Nwoboshi (2000) who noted that soil types to a great extent determines the growth of trees and detect the type of management required for optimum performance.

CONCLUSION

Soil types had significant influenced on some early morphological and physiological characteristics of *Tetrapleura tetraptera*. Seedlings grown on LS generally performed better than other soil types in height, stem collar diameter, and number of leaves per seedling.

Therefore, loamy sand soil (LS) should be used in growing of *Tetrapleura tetraptera*. The species should be fully incorporated into afforestation programmes in order to facilitate its domestication.

REFERENCES

- [1] Adedire, M. O. 1991. Saving the declining fortunes of tropical forest through conservation. Paper presented at the 1991 *Biennial Conference* of the Ecological Society of Nigeria, University of Lagos. Aloka Lagos. 18th-21st August, 1991.
- [2] Akachuku, A. E. 1997. Prospects and constants of biodiversity. In I.A. Ayua and O. Ajayi (eds) *implementing the biodiversity convention: Nigerian and African perspectives*. Published by Nigeria Institutes of Advance Legal Studies, Lagos. Chap. 13, PP 138-152.
- [3] Akachuku, A. E. 1999. Prospects and Constraints of Biodiversity Conservation in South-western Nigeria. In PC. Obiaga, J. E. Abu (eds): *Natural Resources and Threatened Environment Proc. Forestry Ass. Nigeria*. Pp. 200-211.
- [4] Akachuku, A. E. 2006. Disappearing forest, the consequences and the challenge of sustainable development of Nigeria. *Pro. of Forest Ass. Of Nigeria*. Pp 48-61.
- [5] Akindele, S. O. 1996. *Basic Experiential Design in Agricultural Research*. Royal Bird ventures, Mushin, Lagos. Pp 29.
- [6] Akpabio, I. A and Chukukere, O. C. 2004. Profitability of poultry Egg production in Uyo metropolis of Akwa Ibom State, Nigeria. Discussion paper NO.10, Department of Agric. Economics and extension, University of Uyo. 29pp.
- [7] Baurle, I. Laux, T. 2003. Apical meristems: the plant's fountain of youth. 961 – 970pp.

- [8] Burkill, H. M. 1985. The useful plants of west tropical Africa. 2nd ed. The white fraicers Press Ltd. UK. Pp. 61.
- [9] Denton, O. A. Adelaja, B. A and Edema, A. O. 1988. Developments in fruits and vegetables. In *Abulum G. O. and Kalu, B. A. (eds). Proceedings of the National farming system Research Network Workshop, Jos, plateau State, Nigeria. Pp. 285 -304.*
- [10] Donahue, R. L. Miller, R. W. and shckluna, J. C. 1990. Soils; and Introduction to soil and plants growth. The prentice – Hall of India, Private Ltd.
- [11] Edward, B. R. 1993. Plant Growth and Development as the Basis of forage Management, *Unpublished* Pp. 94
- [12] Etukudo, I .G., Udofia, A. Akpan -Ebe, N. 1994. *Element of Forestry*. Usanga and sons enterprises. Uyo, Nigeria. Pp.75.
- [13] Etukudo, I .G. 2000. *Forest our Divine Treasure*. Dorand publishers. Uyo, Nigeria. Pp.11.
- [14] Etukudo, I .G. 2001. Potential of forest Resources Development in Akwa Ibom Economy. In *Udo, E.S(ed). Proceedings of first workshop of the Forestry Association of Nigeria Akwa Iborn State Branch. Pp.56.*
- [15] FAO. 1983. Food and fruit-bearing forest species. 1: Examples from Eastern Africa. FAO Forestry paper. FAO and ITA. NO.44/1.172pp.
- [16] Fasola, T. R. 2000. Screening Nigeria plants for their medicinal importance: *Journal of Science Research* 1:55-57.
- [17] Iwu, M. M. 1993. Hand book of African medicinal plants Boca Raton CKS press. Nigeria. Pp. 435.
- [18] Kannan, D and pailiwall, K. 1997. Fertilization response on growth, photosynthesis, starch accumulation and leaf nitrogen status on *Cassia siamea* Lamm. Seedlings under nursery
- [19] Keay, R. W. J. 1989. *Trees of Nigeria*. Oxford science publication, Clarendon press. Oxford. Pp. 476.
- [20] Ndukwu, B. C. Ben-Nwadibia, N .B. 2006. Ethnomedicinal Aspects of plants used as spices and conditions in the Niger Delta Area of Nigeria. *Unpublished* thesis presented to the Department of plant science and biotechnology, University of Port Harcourt. Pp 210.
- [21] Nwoboshi, L .C. 1982. Tropical silviculture: Principles and Techniques. Ibadan University Press, Ibadan, Nigeria. Pp. 333.
- [22] Nwoboshi, L. C. 2000. The Nutrient Factor in sustainable Forestry. Ibadan University press, Ibadan. Pp 22 – 24
- [23] Offiong, M O.2008. Variation in Growth and physiological characteristics of *Xylopi aethiopica* (DUNAL) A. Rich from Akwa Ibom and Cross River State. *Unpublished* Ph. D. Thesis Department of forest resource management. University of Ibadan, Ibadan, Nigeria. 225pp.
- [24] Okafor, J. C 1975. The place of wild (Uncultivated) fruits and vegetables in the Nigerian diet. In: Ojehonmo, O. O. Town, P. A and Mclean, K. *proceedings of the first seminar on fruits and vegetables*, Ibadan, Nigeria. Pp 13 - 17.
- [25] Olajide, A. O. Ajayi, F. F. Ektulari, A. I. Awe, S. O, Makinde, J. M. and lade, A, R. 1999. Biological effect of *Myristical fragrans* (Nutmeg) extract. *Phytotherapy research* 13:344-345.
- [26] Ojo, O. (1996). Socio-economic and socio-cultural impact of climate and sea level rise in west and central Africa. In: Robert, W. Steel (ed). *Global change and the common wealth*. Hong Kong. Pp. 52-61.

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