Journal of Bioresource Management

Volume 10 | Issue 1 Article 13

Early Growth Assessment of Triplochiton Scleroxylon Progeny Development From Conserved Forests in Nigeria

Shafiu Kilishi Halidu
Federal College of Wildlife, Management, Forestry Research Institute of Nigeria, P. M. B. 268, New-Bussa, Nigeria

Olaoluwa Ayodeji Adebayo
Federal College of Forestry, Forestry Research Institute of Nigeria, PMB 5087, Ibadan, Oyo State, Nigeria, oriobatemyl@gmail.com

Olufunlola Odunayo Akinola
Federal College of Forestry, Forestry Research Institute of Nigeria, PMB 5087, Ibadan, Oyo State, Nigeria

Jude Chikezie
Federal College of Wildlife, Management, Forestry Research Institute of Nigeria, P. M. B. 268, New-Bussa, Nigeria

Christiana Adeyinka Odebunmi
Derived Guinea Savannah Research Station, Forestry Research Institute of Nigeria, Aaduin, Ogbomoso, Oyo State

See next page for additional authors

Recommended Citation

Halidu, S. K., Adebayo, O. A., Akinola, O., Chikezie, J., Odebunmi, C., Ibrahim, O., Ogbu, S., Olayiwola, O., & Wahab, M. A. (2023). Early Growth Assessment of Triplochiton Scleroxylon Progeny Development From Conserved Forests in Nigeria, *Journal of Bioresource Management, 10* (1).
ISSN: 2309-3854 online
(Received: Feb 17, 2022; Accepted: Feb 20, 2023; Published: Mar 30, 2023)

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Cover Page Footnote

The authors are grateful to the participants that were involved in the collection of the seeds used for the experiment.

Authors

Shafiu Kilishi Halidu, Olaoluwa Ayodeji Adebayo, Olufunlola Odunayo Akinola, Jude Chikezie, Christiana Adeyinka Odebunmi, Olalekan Azeez Ibrahim, Sunday Edigbo Ogbu, Oladimeji Austin Olayiwola, and Munir Karounwi Adegoke Wahab

EARLY GROWTH ASSESSMENT OF *Triplochiton scleroxylon* PROGENY DEVELOPMENT FROM CONSERVED FORESTS IN NIGERIA

SHAFIU KILISHI HALIDU[1], OLAOLUWA AYODEJI ADEBAYO[2]*, OLUFUNLOLA ODUNAYO AKINOLA[2], JUDE CHIKEZIE[1], CHRISTIANA ADEYINKA ODEBUNMI[3], OLALEKAN AZEEZ IBRAHIM[1], SUNDAY EDIGBO OGBU[1], OLADIMEJI AUSTIN OLAYIWOLA[3], AND MUNIR KAROUNWI ADEGOKE WAHAB[4]

[1]*Federal College of Wildlife, Management, Forestry Research Institute of Nigeria, P. M. B. 268, New-Bussa, Nigeria*
[2]*Federal College of Forestry, Forestry Research Institute of Nigeria, PMB 5087, Ibadan, Oyo State, Nigeria*
[3]*Derived Guinea Savannah Research Station, Forestry Research Institute of Nigeria, Aaduin, Ogbomoso, Oyo State*
[4]*Department of Wildlife and Ecotourism Management, Osun State University, Ejigbo Campus, Osun State*

*Corresponding author's email: oriobatemyl@gmail.com

ABSTRACT

This study examined the intraspecific differences at the early growth of *Triplochiton scleroxylon* of mixed progeny origins purposively collected from Okoklo Forest Reserve (OFR), Benue State, Cross-River National Park (CRNP), Cross-River and Okomu National Park (ONP), Edo State, Nigeria. The data collected were the height, root collar diameter, internode elongation length, number of leaves and nodes of the early growth assessment of *Triplochiton scleroxylon* which was for a period of sixteen weeks. At the end of the 16th week of germination, OFR *Triplochiton scleroxylon* provenance had the highest height (22.66 cm), root collar diameter (0.85 cm), number of leaves (22) and nodes (16) while CRNP *Triplochiton scleroxylon* provenance had the longest internode length elongation (1.52 cm). There were significant differences ($p < 0.05$) in the height ($F = 7.67$), root collar diameter ($F = 6.65$), number of leaves ($F = 17.15$) and internode length elongation ($F = 49.31$) across the *Triplochiton scleroxylon* provenances vis-à-vis the 16 weeks growth period of the seedlings. The growth time of the seedlings, height, root collar diameter, number of leaves, number of nodes and internode length elongation significantly ($p < 0.05$) and positively inter-relate amongst each other. The study concluded that the early growth of OFR *Triplochiton scleroxylon* provenance performed best in height growth, root collar diameter growth, leaf and node production and could be used in the National plantation establishment and afforestation programs while the CRNP and ONP *Triplochiton scleroxylon* provenances could be improved upon genetically for better growth performance.

Keywords: *Triplochiton scleroxylon***,** early growth, progeny development, conserved forests**,** Nigeria.

INTRODUCTION

Deforestation in Nigeria is on the high level and largely in the tropical environment (James 2006, Mfon et al., 2014). It has recently come to be of exceptional problem to forest ecologist and environmental managers, even though the related forfeiture of germplasm has been diagnosed to be of threat for future breeding or enhancements in our numerous forest species and in particular the local hardwoods (Ogunwale, 2015). Tropical forests typically are constantly been depleted both quantitatively and qualitatively (Leakey 1986, Lewis 2006, Morris 2010). The notion of an extensive and considerable tropical forest with

almost inexhaustible wood resources is rapidly becoming an allegory (Kio 1979, Nygren 2006).

However, the consciousness of the endangerments innate in the degradation and depletion of the previously 'inexhaustible' resources of the forests has led to several activities, targeted at typically averting these concerns (Acheampong et al., 2019). Thus, efforts are being directed towards the setting up of plantations of indigenous high forest tree species earlier preferred in afforestation programmes (Bremer and Farley 2010, Acheampong et al., 2019). For this to be enhanced, provenance, progeny and clonal research studies must be carried out to identify and ascertain the best seed sources, mother trees and clones for large scale afforestation using these indigenous species (Cavers and Cottrell 2015, Macdonald et al., 2015).

On the other hand, as these studies can also describe, explicate, and justify the intraspecific variations in these tree species, which will thus provide information for the efficient and effective use of selection procedures (Arnold and Fristrup 1982, Stevens et al., 2010), efforts in this capacity are indispensable. Sequel to the existent exploration on provenance differentials in *Triplochiton scleroxylon*, knowledge and information acquired will benefit Silviculturists to mark out both seed collection locations for the establishment of production plantations and successively breeding units for tree improvement programmes for these indigenous hardwoods.

Triplochiton scleroxylon is economically an important timber tree native to West Africa. Thus, vegetative propagation techniques are an important alternative for providing planting material for reforestation, as a viable seed of this species is rarely available, (Leakey et al., 1982; 1985; 1992). Though it has been replicated on a large scale in Cameroon and Cote d'Ivoire (Ladipo et al., 1994), little research on the species has been previously undertaken in Nigeria especially on its provenance differentials in intraspecific variations. Hence, this information is of relevance for sustainable forest management. Therefore, the main objective of this study was to assess the provenance differentials in intraspecific variations of *Triplochiton scleroxylon* progeny development in Nigeria. The specific objectives of the study are to ascertain the height, root collar diameter, number of leaves, number of nodes and the internode length elongation across the *Triplochiton scleroxylon* provenances vis-à-vis the age of the seedlings.

Test of Hypothesis

The following hypotheses were tested in the null form.

H_{01}: There are no significant differences in the height, root collar diameter, number of leaves, number of nodes and the internode length elongation across the *Triplochiton scleroxylon* provenances vis-à-vis the age of the seedlings;

H_{02}: There are no significant associations in the height, root collar diameter, number of leaves, number of nodes and the internode length elongation across the *Triplochiton scleroxylon* provenances vis-à-vis the age of the seedlings.

MATERIALS AND METHOD

The research was conducted at the tree nursery of Federal College of Wildlife Management (FCWM) which is situated in New Bussa, Borgu Local Government, Niger State. It is in the Guinea Savannah agro-ecological zone of Nigeria. New Bussa is located between 9.8829° N, 4.5109° E at an elevation of 152m above sea level.

Triplochiton scleroxylon seeds of mixed progeny origin from three provenances were used for the study. The seeds were collected from forests in the Middle Belt (Southern Guinea Savannah

ecological zone) and Niger-Delta (Lowland Rainforest ecological zone) regions of Nigeria. Purposive sampling method was used to select the locations of the sources seeds used for the experiment.

The Cross River National Park is a national park of Nigeria, located in Cross River State, Nigeria. It is situated on 5.580451°N 8.748379°E. There are two separate sections, Okwangwo (established 1991) and Oban (established 1988). The park has a total area of about 4,000 km^2, most of which consists of primary moist tropical rainforests in the North and Central parts, with mangrove swamps on the coastal zones.

The Okomu National Park, formerly the Okomu Wildlife Sanctuary, is a forest block within the 1,082 km2 (418 sq mi) Okomu Forest Reserve in the Ovia South-West Local Government Area of Edo State in Nigeria. The park is about 60 km (37 mi) north west of Benin City

Okoklo Forest Reserve with a total area of 13.3 ha, in Otukpo Local government of Benue State. It is located between lattitude 7° 13" N to 8° 9" E and longitude 7°21" N to 8° 15" E. The relief is 250 ft above sea level and it is characterized by with undifferentiated woodland and savannah type (Dagba *et al.*, 2017).

The seeds of *Triplochiton scleroxylon* were pre-treated by dampening between the layers of moist cotton wool. This process was carried out for the reason that the germination rate of *Triplochiton scleroxylon* seeds is often low. The fruits with wings were removed and shallowly buried in germination pots, which were placed under shades of high humidity propagators, thus providing uniform condition for all stock (Howland 1975, Howland and Bowen 1977, Polansky 2018). The seedlings are pricked out at the first leaf stage into medium-sized polyethene bags (36cm x 13cm x 5cm) filled with the standard West African Hardwoods Improvement Project potting mixture as described by Adegoke et al., (2014). The process was done as an outcome of the fragility and sensitivity of the seedling to damping off (Dumroese et al., 2016).

Thirty-six young seedlings from each of the provenance were available for the study and these were afterwards potted out and arranged in the shade to nurture to prevent early losses. After this, the seedlings were arranged in the open air space.

The experiment was laid out in a completely randomized design (CRD) with three treatments (CRNP, OFR and ONP *Triplochiton scleroxylon* seedlings) each replicated three times. There were four polythene pots, each with a seedling per replicate which were randomly located in the nursery. This gave a total of thirty-six (36) pots. The experiment was conducted under a sixty percent green net-shade to minimize loss of water. The seedlings were irrigated two times in a day i.e. before noon and late in the evening when obligatory during the period of the experiment.

This was done by the use of watering can except on rainy days to avoid too much water. Weeds were removed manually by hands whenever they occurred. No inorganic fertilizer was supplied to the seedlings.

The variables assessed were height, root collar diameter, internode elongation length, number of leaves and nodes of studied seedlings. These variables were assessed weekly for sixteen weeks. Data obtained were subjected to analysis of variance and the measure of the strength of a linear association between these studied variables were subjected to the Pearson Product Moment Correlation Coefficient.

RESULT

The figures below showed the variables assessed during the experiment. These variables include height, root collar diameter, number of leaves and nodes and internode length of the three provenances of *Triplochiton scleroxylon* assessed for 16

weeks. Each value was a mean of 6 observations.

Figure 1 showed the height of *Triplochiton scleroxylon* seedlings from three provenances. The seedlings from OFR source had the highest height (6.04 cm) at the initial stage (Week 1) while seedlings from CRNP and ONP sources had a height of 5.09 cm and 3.53 cm at the initial stage (Week 1), respectively. At the end of the 16th week of assessment, the height of seedlings from OFR, CRNP and ONP was at 22.66 cm, 22.62 cm and 19.46 cm, respectively.

In the case of root collar diameter, *Triplochiton scleroxylon* seedling from OFR source had the highest growth of 0.17 cm at Week 1 while those from CRNP and ONP respectively had 0.15 and 0.12 cm (Figure 2). At the end of the 16th week of assessment, the root collar diameter of seedlings from OFR, CRNP and ONP sources were at 0.85 cm, 0.82 cm and 0.72 cm, respectively.

Figure 3 showed the number of leaves of *Triplochiton scleroxylon* seedlings from three provenances. CRNP source had the highest number of leaves (4 leaves) at the initial stage (Week 1) while OFR and ONP sources each had three (3) leaves at the initial stage (Week 1), respectively. At the end of the 16th week of assessment, the seedlings from OFR, ONP and CRNP sources had 22 leaves, 18 leaves and 16 leaves, respectively.

Figure 4 showed the number of nodes of *Triplochiton scleroxylon* seedlings from three provenances. CRNP source had the highest number of nodes (3 leaves) at the initial stage (Week 1) while seedlings from OFR and ONP sources each had two (2) nodes at the initial stage (Week 1), respectively. At the end of the 16th week of assessment, the seedlings from OFR source had 16 nodes while that from ONP and CRNP sources had 15 nodes each.

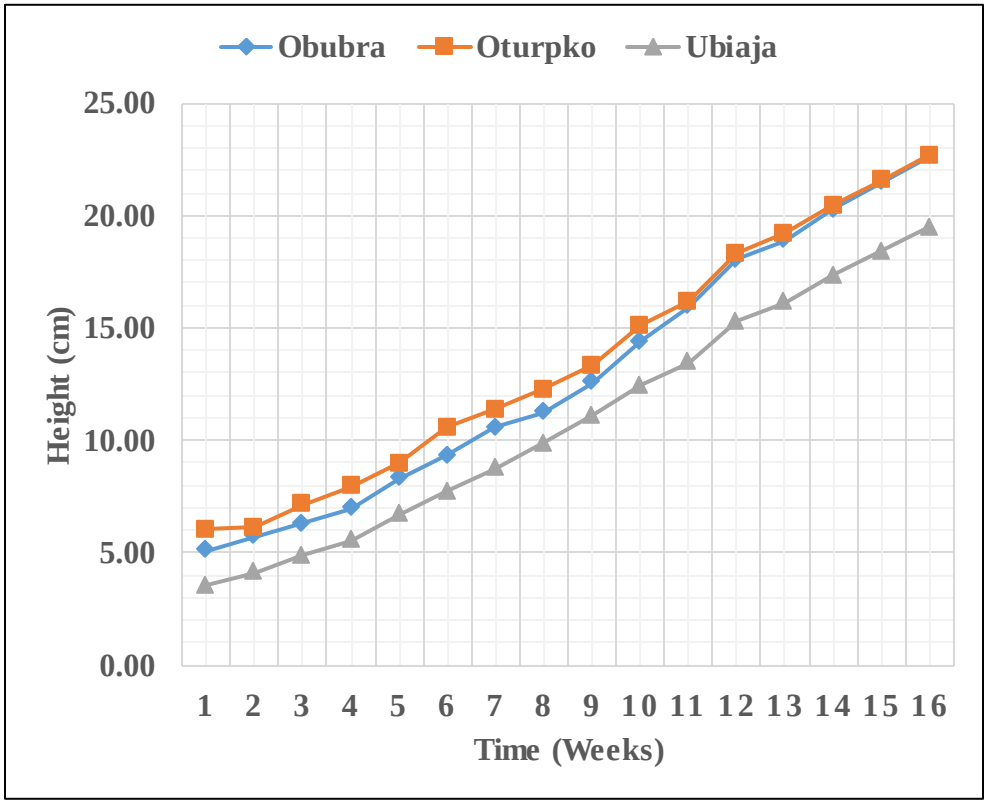

Figure 1: Height of three provenances of *Triplochiton scleroxylon*

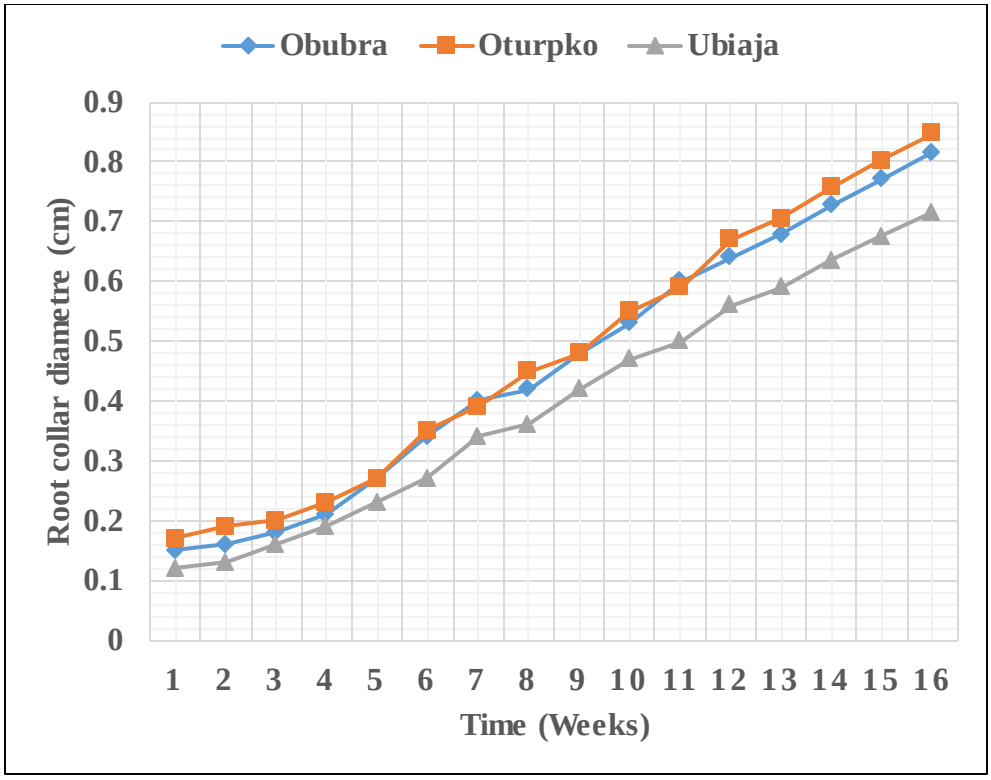

Figure 2: Root collar diametre of three provenances of *Triplochiton scleroxylon*

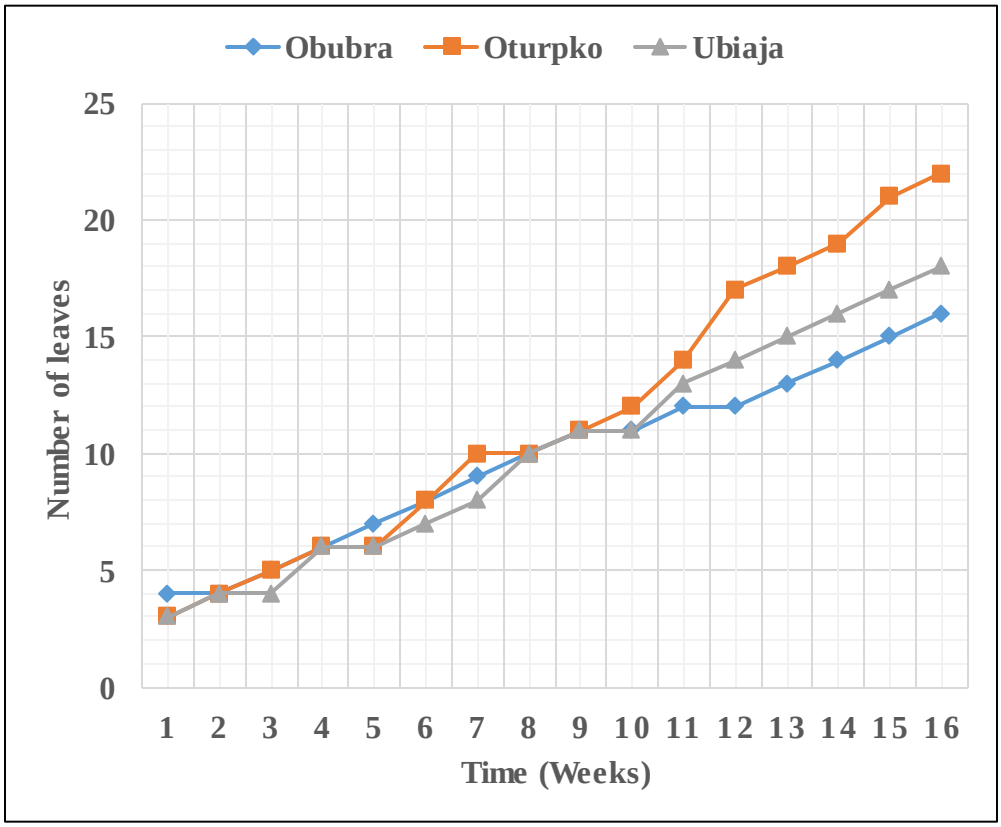

Figure 3: Number of leaves of three provenances of *Triplochiton scleroxylon*

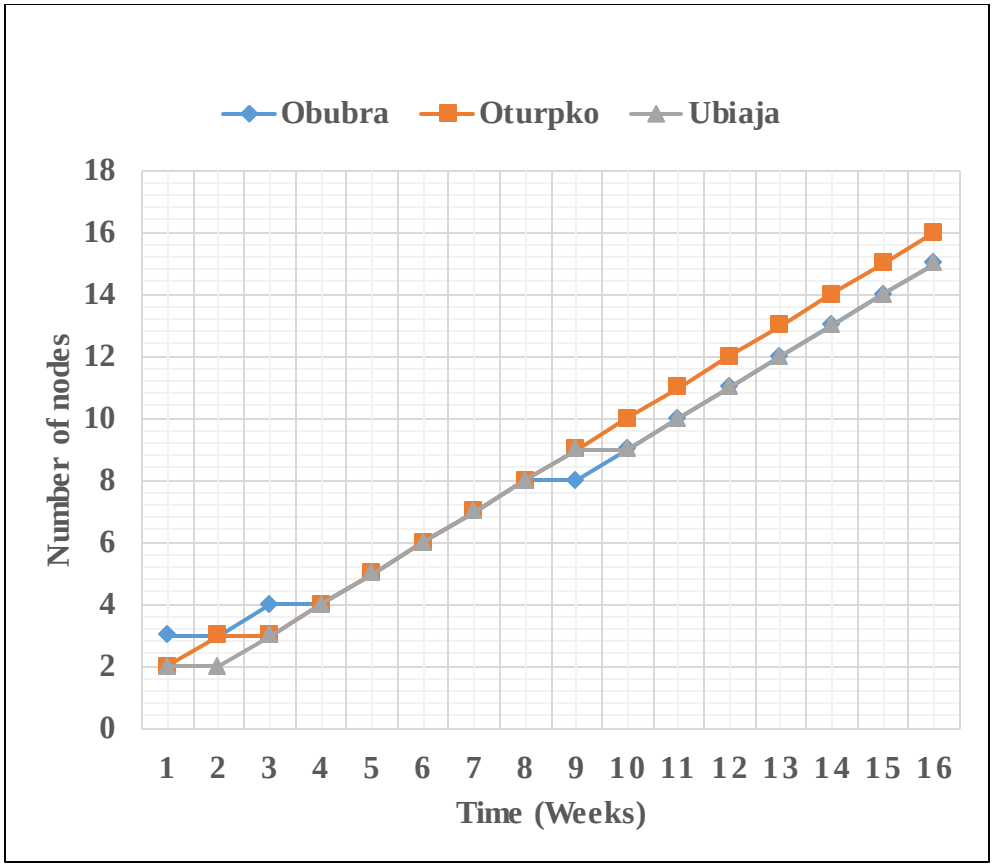

Figure 4: Number of nodes of three provenances of *Triplochiton scleroxylon*

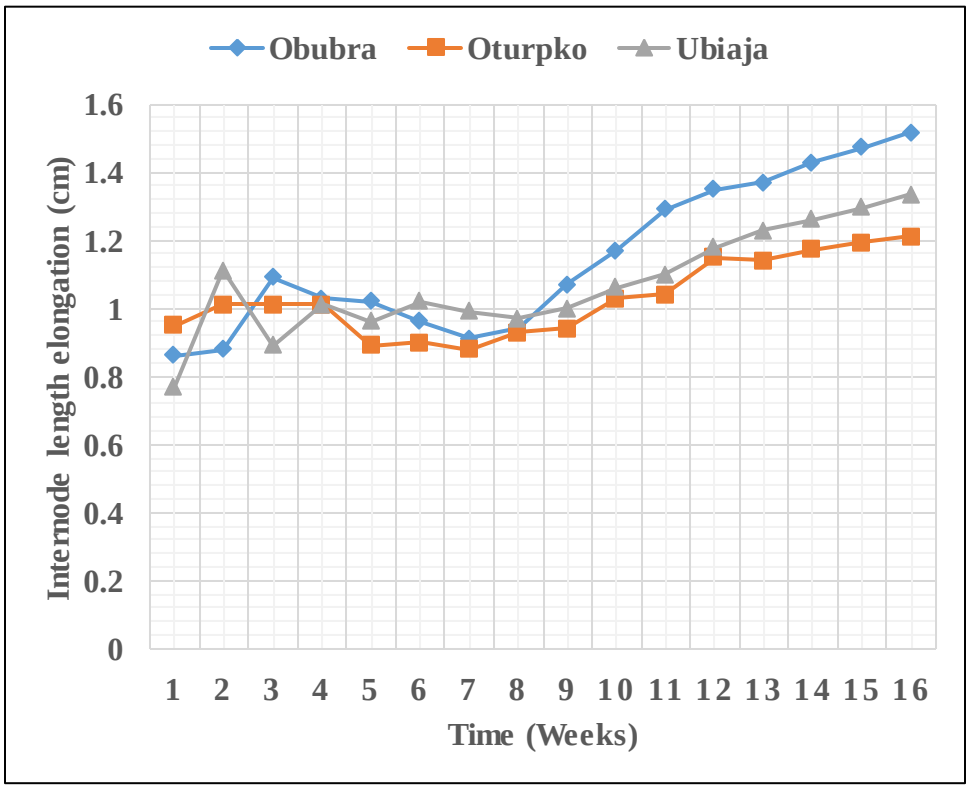

Figure 5: Internode length elongation of three provenances of T*riplochiton scleroxylon*

The graph of the internode length elongation showed that *Triplochiton scleroxylon* seedlings from OFR source had the longest internode length elongation (0.95 cm) at the initial stage (Week 1) while seedlings from CRNP and ONP sources had an internode length elongation of 0.86cm and 0.77 cm, respectively (Figure 5). At the end of the 16th week of assessment, the internode length elongation of the seedlings from CRNP, ONP and OFR was 1.52 cm, 1.33 cm and 1.21 cm respectively.

At the end of the experiment, the ANOVA test of the null hypothesis of the measured variables is presented in Table 1 while Table 2 showed the Post-Hoc (Duncan) range test of study variables across *Triplochiton scleroxylon* provenance seedlings. The result showed that there were significant differences ($p < 0.05$) in height ($F = 7.671$), root collar diameter ($F = 6.647$), number of leaves ($F = 7.154$) and the internode length elongation ($F = 49.310$) of the *Triplochiton scleroxylon* across the three provenances.

The implication from this result is that the height, root collar diameter, number of leaves and the internode length elongation of the seedlings do vary across their respective provenances. Thus, this might be as a result of the differences in their genetic composition and environmental factors influencing the structural development of the seedlings over time in their various sources of collection.

The inter-correlations among the study variables of *Triplochiton scleroxylon* provenance seedlings are represented in Table 3. The correlations are in the positive directions ranging from 0.638 and 0.995. The growth time, height of seedlings, root collar diameter, number of leaves, number of nodes and internode length elongation are significantly ($p < 0.05$) and positively inter-correlated amongst each other. This implied that as one growth parameter increases, other parameters also increase.

Table 1: Differences in study variables across *Triplochiton scleroxylon* provenance seedlings to growth time

		Sum of Squares	df	Mean Square	F	Sig.
Height of seedling (cm)	Between Groups	19.181	2	9.591	7.671	0.022
	Within Groups	7.501	6	1.250		
	Total	26.683	8			
Root collar diameter (cm)	Between Groups	0.025	2	0.012	6.647	0.030
	Within Groups	0.011	6	0.002		
	Total	0.036	8			
Number of leaves	Between Groups	49.556	2	24.778	17.154	0.003
	Within Groups	8.667	6	1.444		
	Total	58.222	8			
Number of nodes	Between Groups	2.000	2	1.000	1.000	0.422
	Within Groups	6.000	6	1.000		
	Total	8.000	8			
Internode length (cm)	Between Groups	0.121	2	0.060	49.310	0.000
	Within Groups	0.007	6	0.001		
	Total	0.128	8			

Note: Analysis of Variance is significant at the 0.05 level

Table 2: Post-Hoc (Duncan) range test of study variables across *Triplochiton scleroxylon* provenance seedlings

Variable	Provenance			SEM
	ONP	CRNP	OFR	
Height of seedling (cm)	18.41[b]	21.45[a]	21.55[a]	0.61
Root collar diameter (cm)	0.68[b]	0.80[a]	0.77[a]	0.89
Number of leaves	17.00[b]	15.00[b]	21.00[a]	0.22
Number of nodes	14.00[a]	14.00[a]	15.00[a]	0.33
nternode length elongation (cm)	1.30[b]	1.19[c]	1.47[a]	0.04

Note: a, b means with different superscripts differ significantly (p < 0.05)

Table 3 - Inter-correlations among study variables of *Triplochiton scleroxylon* seedlings

Parameter	Growth time	Height of seedling (cm)	Root collar diameter (cm)	Number of leaves	Number of nodes	Internode length elongation (cm)
Growth time	1					
Height of seedling (cm)	0.973**	1				
Root collar diameter (cm)	0.982**	0.995**	1			
Number of leaves	0.963**	0.953**	0.950**	1		
Number of nodes	0.994**	0.979**	0.983**	0.977**	1	
Internode length elongation (cm)	0.793**	0.799**	0.803**	0.683**	0.767**	1

Note: ***. Correlation is significant at the 0.01 level (2-tailed).*

DISCUSSION

Significant variations were recorded in the height, root collar diameter, number of leaves, number of nodes and the internode length elongation amongst the provenances to the age of the seedlings.

The significant effects recorded for the provenances in these variables confirmed the existence of variations among these provenances. This outcome agreed with the results of Ehlers et al., (2016), Umaña and Swenson (2019) on intraspecific variation in this species. This probably confirmed the fact that the height, root collar diameter, number of leaves, number of nodes and the internode length elongation of seedlings could be the dynamic aspect here to be considered in tree breeding and silvicultural technology. The significant effects of provenance to the age of the seedlings on leaf production, the number of nodes and internode length as earlier indicated could have been undermined by leaf size or leaf palisade layer characteristics, which are features not examined in this work. These could be responsible for the significant differences observed for overall growth between these provenances. The values obtained from the correlation analysis showed a high positive correlation (r = 0.995) between height and root collar diameter. The number of leaves and nodes were also shown to be highly correlated positively (r = 0.977). Kricbel et al., (1976), Baye et al., (2011) and Sodini et al., (2018) reported that a strong correlation between two characters is a function of growth rate genes. They recorded a high correlation coefficient (r = 0.85 to 0.90) for height and root collar diameter. In this study, the high correlation coefficient obtained for two variables is probably also due to inherent factors. In breeding, these relationships showed that a

character could be improved by selection based on the other one.

CONCLUSION

It could be inferred that the significant effects recorded for the provenances in some of the characters studied in this work could be an indication of exploitable variations within the provenances studied. Correspondingly, after good identifications, seed sources can be identified to enable the correct choice of sources of seeds which will enable the forester to minimally at least improve returns from his plantations. These stands for the close relationships between the studied characters as their associations could aid in tree improvement efforts in the selection for the improvement of the best species. However, OFR provenance performed better in height growth, root collar diameter growth, leaf and node production and it was recommended that it should be used in the National plantation establishment and afforestation programmes while the CRNP and ONP *Triplochiton scleroxylon* provenances could be improved upon genetically for a better growth performance.

AUTHORS CONTRIBUTION

The authors confirm contribution to the paper as follows: Study conception and design: Adebayo OA, Halidu SK.Data collection: Odebunmi CA, Ibrahim OA, Ogbu SE, Olayiwola OA. Analysis and interpretation of results: Adebayo OA, Akinola OO, Chikezie J. Draft manuscript preparation: Adebayo OA, Wahab MKA.
All authors reviewed the results and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors have no conflict of interest.

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