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Potentials of Seedling Growth Parameters as Selection Indices in *Tetrapleura tetraptera* (Schum & Thonn) Taub. From Southwestern Nigeria

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Abstract

The study investigated variations among progenies of Tetrapleura teraptera*(Schum & Thonn) (Taub.) from four sources in South Western Nigeria with a view to identifying early growth traits that could be useful for the selection of superior genotypes for breeding and improvement of the species. The three seed sources include: Emure-Ekiti (Latitude 70′ 26' N and Longitude 50′ 30' E); Ikoyi-Ile (Latitude 80 15' N and Longitude 40′ 49' E); Osogbo (Latitude 70′ 46' N and Longitude 40′ 35' E) and Sapele (Latitude 50′ 55' N and Longitude50′ 46' E). Seedlings used for the experiment were part of those produced from an earlier germination experiment carried out in the nursery of the Department of Forest Resources Management, University of Ibadan. After the germination experiment, 32 uniformly growing and vigorous seedlings were pricked out from each progeny into medium size polypots (25 cm x 14.5 cm x 7.5 cm). At fortnightly intervals, four seedlings were selected from each progeny for study. On each occasion, seedling height, collar diameter, number of leaves and total dry weights were assessed. Net Assimilation rates and Relative Growth Rates were calculated on each occasion. The study lasted for 12 weeks. The data generated were subjected to Analysis of Variance and the least significant difference was calculated to separate significantly different means. Results indicate highly significant variations in seedling heights, collar diameter and Relative Growth Rates among the 4 progenies. Ikoyi-Ile progeny had the highest mean values of seedling height (12.9 cm) mean diameter (1.4 cm); mean number of leaves (15.6) and Relative Growth Rate (0.239 gm/m2/wk). Osogbo progeny recorded the least mean values for height (10.3 cm) mean collar diameter (1.3 cm), mean number of leaves (13.6) and total dry weight (0.123 gm). The effect of age was highly significant on all the parameters measured. This is an indication that reasonable variations occur within the population of* T. tetraptera *in the study area. It is recommended that genetic investigations be carried out on this species to corroborate the observations made in this study.*

Key words: *Tetrapleura tetraptera,* Progeny, variation, seedling characteristics

Introduction

The forest has been a great benefactor of man ever since creation. The benefits man derives from the forest include food, shelter, clothing medication as well as ecological and aesthetic values. Food is very basic to the survival and healthy living of man and other living organisms. Globally, household food security is accorded a high priority. The continued existence of man on earth depends largely on the quality and quantity of food available to him as well as the availability of good healthcare services.

Tropical forests supply a wide variety of food materials consumed by man. Many plants and animals from the forest supplement substantially the dietary needs of man. However, it is unfortunate that man has abused and misused the forest due to over-exploitation and irrational uses resulting from demographic pressures and reckless drive for socio-economic development. The germplasms of many of the food-yielding forest trees have been placed under intense pressure leading to threat to their continued availability (Oni and Gbadamosi, 1998).

Tetrapleura tetraptera is an example of species of great socio-economic and ecological importance whose germplasms are being threatened with extinction (Opeke, 1987) due to our failure to address the problem of their domestication and improvement. T. *tetraptera* is consumed in many parts of Nigeria (Essien *et al.*, 1994) as a spice and flavouring material because of its strong aroma. Both the fruit and the seeds are important as components of many traditional medicines for cough, fever and *post partum* contraction (Adesina, 1985). In Eastern Nigeria, the strong aroma from the fruit is used to repel snakes from households (Onyekwelu, 1990). The fruit pulp is used as a flavour in pepper soup in many parts of Nigeria (Opeke, 1987 and Essien *et al.* 1993). Essien *et al.* (1993) assessed the nutritional quality of the fruit and observed that the fruit's shell, pulp and seeds contain varying amounts of protein, lipids and minerals of comparable or even higher level than those found in such popular spices as red pepper, onion, curry and ginger. Furthermore, Nwaiwu and Akah (1986) confirmed the anticonvulsant effect of the volatile oil from the fruit of this species while Oyedapo and Famurewa (1995) also reported the anti protease and membrane stabilizing activities of the fruit extract. Presently, the main method of propagation of the species is through the seeds, which are also used for different purposes as earlier highlighted. The seeds also exhibit dormancy, which makes its regeneration difficult. In order to ensure the continued availability of this wild food at a sustainable level, it is essential that meaningful steps be taken to domesticate and improve the species for incorporation into traditional farming systems and orchards. According to Ditlevsen (1980), the starting point of any tree improvement programme is the presence of natural genetic variability in the species to be improved. Unlike agronomic crops, with long history of selection and domestication, forest tree species have only recently been domesticated, selected and bred. The existence of taxonomically different varieties within the natural range of edible forest trees (Okafor, 1991) offers a great opportunity for selection, breeding, improvement and domestication of these species. Though *T. tetraptera* is a promising indigenous tree species in terms of nutritional and medicinal potentials, there is paucity of information on the artificial regeneration of the species. Continued pressures on the remaining germplasm of the species for domestic and commercial purposes may endanger its sustainability. It is therefore necessary that urgent steps be taken to explore the available natural variations within the population of the species with a view to identifying superior genotypes, which may be selected for breeding and improvement programmes and subsequent domestication. Though it is known that variations in species populations could be due to both environmental and genetic factors. Since the seedlings were raised under the same environmental conditions, any variation(s) noticed in the growth characters may be ascribed to differences in their genetic backgrounds. Therefore, variations in the morphological and physiological characteristics of the seedlings will be used as indicators of superior genotypes in this study.

The objective of the study is to identify superior early growth characters for selection of desirable seed sources for future breeding and improvement programmes for *Tetrapleura tetraptera*.

Material and Methods

The Study Species

Tetrapleura tetraptera is widely spread in tropical Africa (Keay, 1989) and it grows wild in tropical West Africa (Adewumi, 1989). In Nigeria, it is found mainly in the Southern parts where it occurs in rainforests, secondary forests, fringing forests and derived savannah where the rainfall and relative humidity are relatively high (Jimoh and Okali, 1999). Taxonomic details of the species had been given by Keay (1989).

Study sites

Seeds for the production of seedlings used for this experiment were collected from four different sources in South Western Nigeria viz: Emure-Ekiti (Ekiti State), Ikoyi-Ile (Oyo State), Osogbo (Osun State) and Sapele (Delta State) (Table 1).

Table 1: Locations of Seeds of *T. teraptera u*sed for the Investigations

S/N.	Seed Sources	State	Country	Latitude	Longitude	Altitude (M.)	Mean annual rainfall (cm.)	Mean annual relative humidity (%)
1	Emure Ekiti	Ekiti	Nigeria	7 o 26’ N	50 30’ E	310	2200	80
2	Ikoyi-Ile	Oyo	“	8 o 15’ N	40 49’ E	380	1200	70
3	Osogbo	Osun	“		40 35’ E	304.5	1316	75
4	Sapele	Delta	“	7 o 46’ N	50 46’ E	4.1	2600	85

5o 55’ N

Source: Field survey 2000.

Seedlings for the experiment were obtained from the germination studies of Jimoh and Okali (1999). Thirty two (32) uniformly growing and vigorous seedlings (of the same age) from each source were pricked out at two leaves stage into medium-sized polythene pots measuring 25cm x 14.5cm x 7.5cm and filled with forest top soil. The seedlings were arranged in four replicates in a Completely Randomized Design on benches in the green house of the Department of Forest Resources Management, University of Ibadan. Seedlings from each source were labeled appropriately for easy identification. The seedlings were watered once daily at 8.00hrs. After two weeks of transplanting, the following parameters were measured at fortnight interval for twelve weeks (3 months): (i) total seedling height (ii) collar diameter and (iii) number of leaves. The seedling heights and collar diameters were measured with a meter rule and a Veneer caliper respectively. On each occasion, sixteen seedlings were randomly selected (one from each of the four replicates) for each of the four seed sources. The seedlings measured for metrical characteristics were carefully uprooted and all soil particles carefully removed by thorough washing in distilled water before biomass determination. The seedlings were separated into roots, stems and leaves components. The fresh weights of the different components were determined using an electronic balance. The plant parts were then oven-dried to constant weight at $90^{o}C$ for dry weight determinations. This was done fortnightly for 10 weeks.

The data obtained from the biomass assessment were used to calculate the Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) using the method of Oni (1989). All the data were further subjected to Analysis of Variance using SAS computer package. Least Significant Difference (LSD) and Co-efficient of Variation were also calculated to determine significantly different values.

Results

Seedling Morphological Characteristics

Height

The effects of progeny and time of harvest on height of the seedlings were significant at 0.05 and 0.01 levels of probability respectively. The interaction between age and progeny however had no effect on the height of the seedlings (Table 2). Ikoyi-Ile progeny was significantly different in height from other sources with the seedlings recording a mean value of 12.9 cm. Osogbo progeny was also different significantly from the other two progenies, with a mean of 10.4 cm, while Sapele and Emure-Ekiti progenies were not significantly different from each other. They had mean values of 11.3 cm and 11.6 cm respectively (LSD = 0.9082; Table 3). Height increased almost linearly during the period of assessment with Ikoyi-Ile and Emure-Ekiti progenies exhibiting faster height growth (Fig, 1a).

Table 2: Analysis of variance Table showing variations in some morphological characteristics of seedlings of *Tetrapleura tetraptera* from Southwestern Nigeria.

Source of Variation	DF	Height (cm)		Diameter (cm)		No. of Leaves	
		MS	F-ratio	MS	F-ratio	MS	F-ratio
Progeny	3	26.99	10.83*	0.08	5.35**	19.15	1.86N.S.
Harvest Time	5	183.97	73.97**	2.51	176.30**	1757.21	170.7**
Progeny x Harvest time	15	3.54	1.42N.S.		2.09*	10.15	0.99N.S.
Error	69	2.49		0.003		10.29	

**Significant at 0.01 level of probability; *Significant at 0.05 level of probability; N.S. Not significant

Diameter Growth and Leaf Production

The effects of progeny and time of harvest (age) were highly significant on diameter growth (P < 0.0l) although the interaction effect between seedling age and progeny was only significant at P < 0.05. The LSD indicated that Ikoyi-Ile and Emure -Ekiti progenies were not significantly different from each other but were different from the other two progenies. Each of them had a mean diameter value of 1.4cm. Also the Osogbo and Sapele progenies were not significantly different from each other. Their mean value was 1.3cm (LSD= 0.0686;Table3). Diameter increased fairly uniformly during the assessment period. It however remained constant between the 6th and 8th weeks before a sharp increase from weeks 8 to 12 (Fig. 1b).

Leaf Production

Time of harvest (age) had a highly significant effect on leaf production in the seedlings ($P < 0.01$). The effect of progeny on leaf production was not significant. There was also no significant interaction between age and progeny in the species (Table 2). The LSD test indicated no significant difference between Sapele and Emure and Osogbo progenies but the Ikoyi-Ile progeny was significantly different from those of Osogbo, Emure Ekiti and Sapele (LSD = 1.9; Table 3). Figure 1c shows that there was a general steady increase in leaf production among all the progenies during the period of assessment.

Table 3: Mean values of morphological characteristics of seedlings of *Tetrapleura tetraptera* from Nigeria. (Means with the same letters are not significantly different).

Progenies	Height (cm)	Diameter (cm)	No. of Leaves
Emure-Ekiti	11.6b	1.4a	13.9ab
Ikoyi-Ile	12.9a	1.4a	15.6a
Osogbo	10.4c	1.3b	13. 6b
Sapele	11.3b	1.3b	14. 0ab
Coefficient of variation (%)	13.7	8.7	22. 5
LSD	0.091	0.07	1. 9

Dry Matter Accumulation

The effect of progeny on dry matter accumulation was significant ($P<0.05$), while seedling age had a highly significant impact on this parameter ($P < 0.01$). There was however no significant interaction between age and progeny (Table 4).

Table 4: Analysis of variance table showing variations in Total Dry Weight, Net Assimilation Rate and Relative Growth Rate in seedlings of *Tetrapleura tetraptera from* Nigeria.

Source of Variation	DF	Dry Matter Accumulation (gm.)	Net Assimilation Rate (gm.m^{-2} wk^{-1})	Relative Growth Rate (gm.$^{m-2}$ wk^{-1})

		MS	F-ratio	MS	F-ratio	MS	F-ratio
Progeny	3	0.0192	0.0283*	0.006	0.8474N.S.	0.0258	0.0001**
Harvest time	3	0.1282	0.0001**	0.0970	0.0147**	0.0119	0.0001**
Progeny x Harvest time	9	0.0049	0.6223N.S.	0.0135	0.0135**	0.0150	0.0001*

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability; N.S. Not significant

The LSD test revealed no significant difference between Ikoyi-Ile and Emure-Ekiti progenies in dry matter accumulation (Table 5). The Osogbo progeny differs significantly from the others with a mean value of 0.123gm. (LSD = 0.049). Fig. 2a also indicates a closer relationship in the dry matter accumulation curves for Ikoyi-Ile and Emure- Ekiti progenies while Osogbo progeny is distinctly behind the other three.

Relative Growth Rate (RGR)

Progeny and time of harvest (age) had highly significant effects on the Relative Growth Rates of the seedlings ($P < 0.01$). The interaction between age and progeny was also significant ($P < 0.05$) (Table 4). The LSD test showed significant difference between the mean values of Relative Growth Rates of the seedlings from Ikoyi-Ile and Emure-Ekiti. (LSD = 0.005). Emure-Ekiti had a Relative Growth Rate of 0.199 $gm.m^{-2}$ wk^{-1}. And Ikoyi–Ile had a Relative Growth Rate of 0.239 $gm.m^{-2}$ wk^{-1}. Each of these two is significantly different from both Osogbo and Sapele progenies (Table 5). However, Osogbo and Sapele progenies were not significantly different from each other.

Table 5: Mean values of Physiological characteristics of Seedlings of *Tetrapleura tetraptera* from Nigeria. (Means with the same letters are not significantly different).

Progenies	Dry Matter Accumulation (gm)	Net Assimilation Rate ($gm.m^{-2}$ wk^{-1})	Relative Growth Rate ($gm.m^{-2}wk^{-1}$)
Emure-Ekiti	0.192a	0.156a	0.199b
Ikoyi-Ile	0.184a	0.111a	0.239a
Osogbo	0.123b	0.117a	0.157c
Sapele	0.157ab	0.119a	0.155c

Coefficient of variation (%)	46.94	125.45	4.005
LSD	0.049	0.112	0.005

Figure 2b shows that the Relative Growth Rates vary appreciably among the four seed sources throughout the period of assessment. Ikoyi–Ile progeny was clearly above the others in the first six weeks of the experiment but soon dropped sharply at the end of the sixth week. It increased again between weeks eight and ten. Except for the Osogbo progeny whose graph is almost a straight line between weeks two and eight, the general trend of the RGR graphs followed the usual sigmoid growth curve.

Net Assimilation Rate (NAR)

The Analysis of Variance test shows that Net Assimilation Rates did not differ significantly between the four progenies although the effect of harvest time (age) was highly significant ($P < 0.01$) (Table 4). There was also a significant interaction between progeny and age. Figure 2c shows that the Emure and Sapele progenies were very efficient in Net Assimilation Rate, with the Emure progeny showing superiority in this trait.

Discussion and Conclusion

The main item of commerce in *Tetrapleura tetraptera* is the fruit, which is used as food flavour and for medicinal purposes. Cultivation of the species in plantation is yet unrecorded. To encourage this practice, identification of progenies with fast seedling growth traits is very useful. Morphological characteristics such as height, diameter and leaf production are important indices of plant growth. According to Dutta (1981), no two individual organisms are exactly the same. Individual differences exist between members of any natural population. The differences that occur within and between populations of a species are known as “variations”. Variations are a product of interaction between genetic and environmental factors. This phenomenon has assisted organisms to adapt to their environments. Hence, maintenance of enough variation in a population is essential to forestall possible extinction, because a population must be able to remain adapted by altering its genetic structure in response to inevitable changes in the environment in order to continue to exist. According to Roberts and Waveing (1975), tree species with a wide geographical distribution show marked differentiations into population characteristics. It therefore follows that the geographical source or origin of seeds will have a marked effect on the subsequent performance of the seedlings. Though it has been argued that the rate of natural mutations in higher organisms is very low (Boughey, 1973), it is believed that genetic plasticity is responsible for the ability of a population to produce variables and make adaptive shifts in phenotypes through the recombination of concealed genetic variations already present in the populations but unexpressed in the phenotypes of most individuals. The significant variation noticed in height and diameter growths of *T tetraptera seedlings* may therefore be useful in selecting superior progeny in breeding programmes for the species. In this respect the Ikoyi-Ile progeny, which recorded faster growth rate in respect of these parameters, may contain superior genetic materials for these traits.

Leaves are the main sites of photosynthesis. The highly significant effect of harvest time on leaf production is an indication that the number of leaves increased with the seedling's ages. This is expected because the seedlings are at the very active stage of development where they require adequate supply of photosynthates, which are necessary for growth. According to Nwoboshi (1982), growth in plant is as a result of the difference between gross photosynthate and respiration. It therefore follows that for plants to grow normally they must possess the requisite number of leaves and photosynthesis must progress normally such that the rate of photosynthesis will exceed the rate of respiration.

Relative Growth Rate and Dry Matter Accumulation are both functions of photosynthetic ability of a plant. Photosynthetic ability could also be linked with the genetic properties of plants. Growth in plants is as a result of accumulation of carbon compounds from the fixation of carbon dioxide in the process of photosynthesis. Fryer and Leding (1972), had linked differences in photosynthetic ability to variations in the genetic compositions within population and provenances of tree species. However, in phenotypic variation, individual organisms or species may adapt or acclimatise in response to specific changes in environmental factors especially when the phenotypic changes have occurred in the developmental stage of the species, the variation may become fixed. Also differences in environmental factors such as soil, topography, climate, altitude and solar intensity have been reported to cause variations within plants' population ((Kang and Moman 1977, Orimoyegun, 1978). Jimoh and Okali (1999) have reported significant variation in seed germination rate and total germination percentage of *T. tetraptera* from different sources in Southwestern Nigeria. This may not be unconnected to the presence of significant differences in the genetic backgrounds of the species owing to differences in environmental factors prevailing in the seed sources, which affects the genetic codes of the seeds and subsequent performance of the seeds when sown. The significant differences observed in Dry Matter Accumulation and Relative Growth Rate in this study may also be attributed to significant differences in the genetic backgrounds of the seedlings, which may have been subjected to modifications over the years owing to differences in geographical locations, and hence environmental factors of the seed sources.

From all considerations, the progenies from Emure-Ekiti and Ikoyi-Ile performed better in the morphological and physiological characteristics studied. This suggests that these progenies may be more efficient in photosynthetic activities and hence growth. Generally, there is evidence of variation in the growth characteristics of *T. terapteura* that could be useful in selection, breeding and improvement programmes for the species. It is however recommended that genetic studies be carried out to corroborate the observed variations in the morphological and physiological characteristics of the seedlings.

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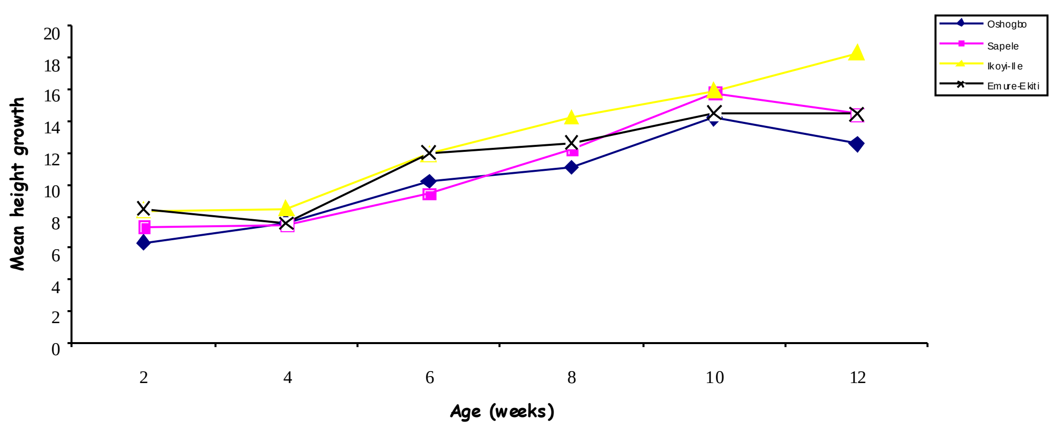


Fig.1a: Effects of progeny and harvest time on height in early seedling growth of *T. tetraptera* from southwestern Nigeria.

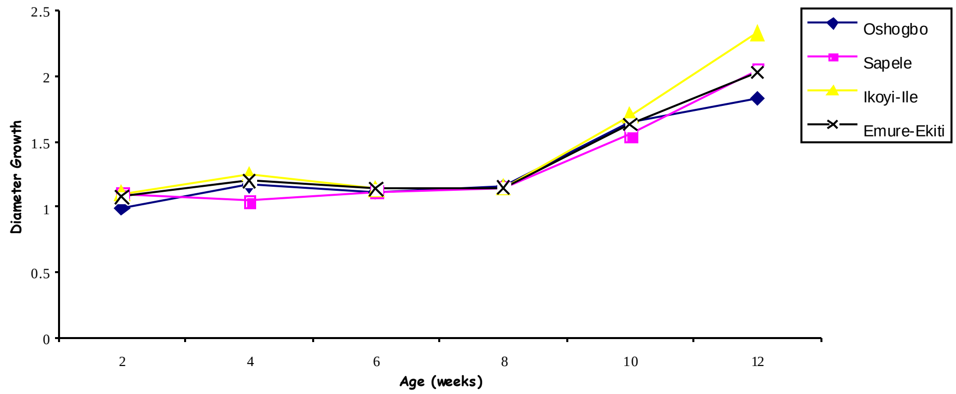


Fig. 1b: Effects of progeny and harvest time on diameter growth in early seedling growth of *T.tetraptera* from Southwestern Nigeria.

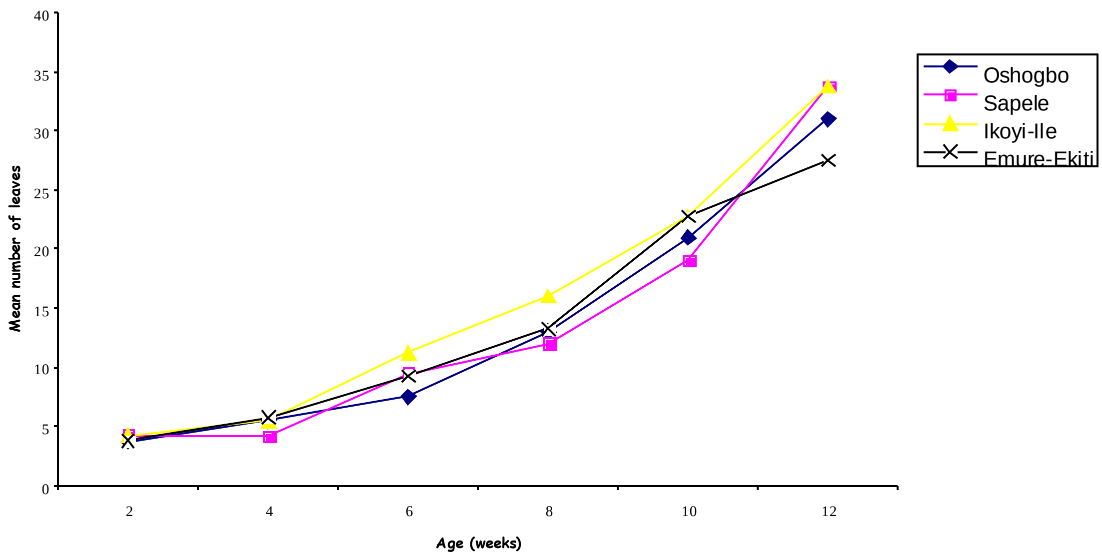


Fig1c: Effects of progeny and harvest time on Leave Production of T. tetrapleura seedlings from Southwestern Nigeria.

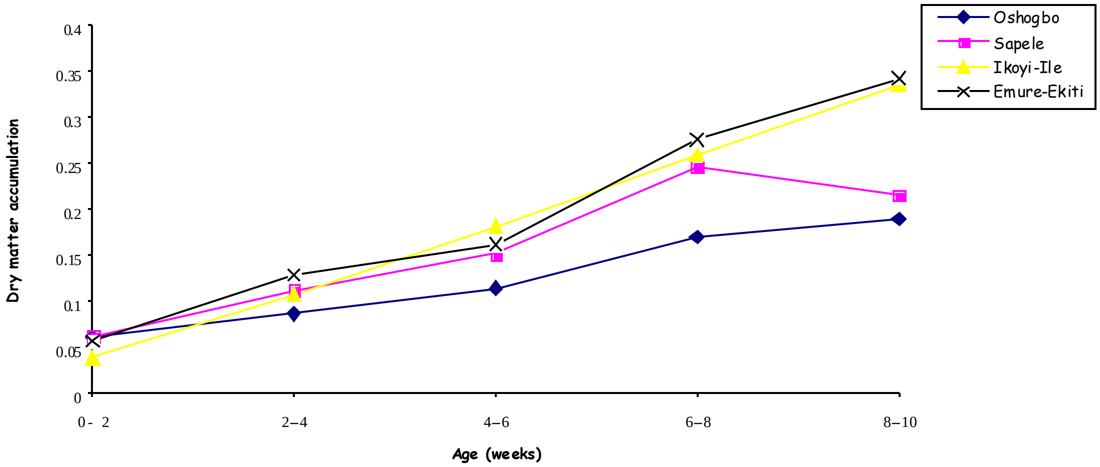


Fig. 2a: Effects of progeny and harvest time on Dry matter accumulation of early seedling growth of *T. tetraptera* from Southwestern Nigeria.

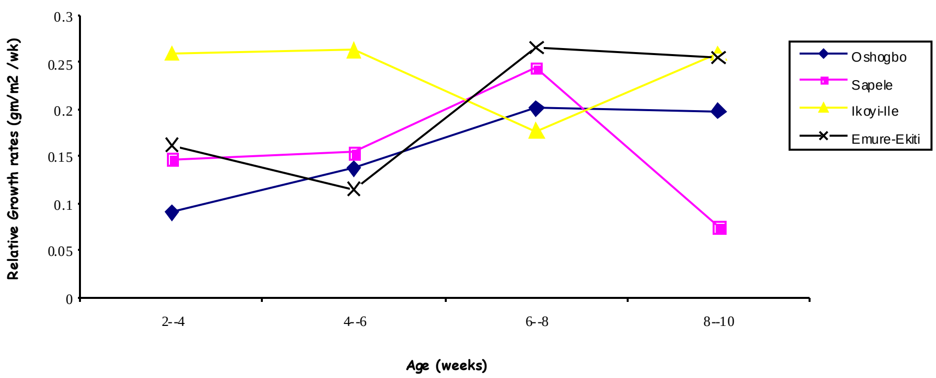
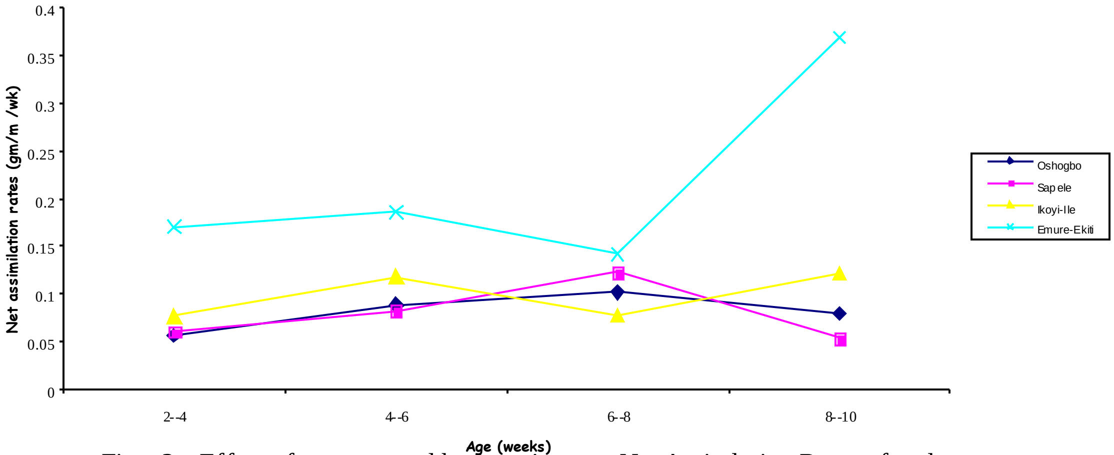


Fig.2b: Effects of progeny and harvest time on Relative Growth Rate of early seedling growth of *T. tetraptera* from Southwestern Nigeria.



Figs. 2c: Effect of progeny and harvest time on Net Assimlation Rates of early seedling growth of *T. tetrapleura* from Southwestern Nigeria