GERMINATION AND EARLY SEEDLING GROWTH OF *Tetrapleura tetraptera* (Schumand Thonn) Taubert UNDER DIFFERENT LIGHT INTENSITIES

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ABSTRACT
This study aimed at assessing seed germination potential and early seedling growth performance of *Tetrapleura. teraptera* seedlings under different light intensities. Treatments used were 100, 75, 50 and 25% light intensities. A total number of 400 seeds of *T. tetraptera* were used for the germination experiment. Observation on germination was made and recorded daily. 80 seedlings of the same size with equal number of leaves, equally divided among the four different light intensities were transplanted into polybags filled with sterilized forest topsoil. Evaluation of early seedling growth was based on height, collar diameter, leaf production and biomass. Observations on seedling growth performance was made monthly for five months. Seeds sown under 75% light intensity had the highest mean germination percentage (GP; 42%), while those under 25% light intensity had the lowest GP (23%). Significant differences ($p < 0.05$) were observed in seedling growth parameters. Seedling height was highest under 50% light intensity at months 1, 3, 4 and 5 and 75% light intensity at month 2 while the lowest height was observed under 100% light intensity at month 1and 25% light intensity at months 2 to 5. Highest collar diameter was observed under 75% light intensity at months 1 to 3 and 100% light intensity at months 4 and 5 while the lowest collar diameter was observed in seedlings growing under 25% light intensity at months 1 to 5. Highest leaf production at months 1 to 5 was observed at 75% light intensity. Also, highest shoot fresh weight and dry weight were observed under 100% and 75% light intensity, respectively, while the lowest shoot fresh weight and dry weight were observed under 25% light intensity. Therefore, 50% and 75% light intensities are recommended for raising *T. tetraptera* for enhanced germination and early seedling growth.
KEYWORDS: *Tetrapleura tetraptera,* light intensities, germination, seedling growth, biomass

INTRODUCTION

Tetrapleura teraptera commonly called Aidan tree is a species of flowering plant belonging to the family Fabaceae. The generic name originates from a Greek word meaning 'Four ribs' referring to the ribbed fruit (Orwa *et al*., 2009). The species is a deciduous tree to tropical Africa where it is distributed from Mauritania to Tanzania (Katend *et al*, 1995; Blay, 1997). Although its preferred habitats are Savannah, woodlands, dry forest and riverine forest, it is most common in dense rainforests and preserved forest patches around villages. The species is commonly known as "prekese" in Ghana and "Aridan" in Nigeria (Taylor, 1960). The meaning of these local names reflects the knowledge and use of the species by local communities. It grows up to 20-25 meter high, with a diameter at breast height (DBH) of 1.5 - 3.0m (Orwa *et al*., 2009).

This plant has nutritional as well as medicinal value. The stem, bark, and leaf of the plant are very important and play a very crucial role in the health and livelihood of the society. According to Aladesanmi, (2007), the fruit possess a fragrant, characteristic pungent aromatic odour while the seeds add good flavour and aroma to food, which increases the desire of food consumption. It is popularly used as a seasoning spice in Southern and Eastern Nigeria (Okwu, 2003). The fruits are used for the management of leprosy, convulsions inflammation and rheumatism (Ojewole and Adesina, 1983), and are used to prepare soup for nursing mothers from the first day of birth to prevent post-partum contraction (Enwere, 1998). *Tetrapleura tetraptera* is equally valued in timber as fairly hard heartwood (Orwa *et al*., 2009).

The environmental factors most commonly known to regulate germination include the absence or presence of light (Ferreira, 2001). Light is necessary for seed germination in some species, which are identified as positively photoblastic while negatively photoblastic species germinate better in limited light (Lone *et al*., 2014). Although seeds of most cultivated plants can germinate in both the presence and absence of light (Lone *et al*., 2014), light is one of the main factors that promote germination in soils with good water availability. According to Anjah *et al*. (2012), light is an important physical factor affecting tree growth, especially at the seedling stage. Some species require light for germination at near optimum temperatures while some species are indifferent to light under these conditions (Benítez-Rodrígues *et al*., 2004).

The classification of seeds in terms of light sensitivity is an important factor in germination testing (Villiers, 1972; Mayer and Poljakoff-Mayber, 1989). According to Daniel and Turna, (1998), most species found in the humid lowland tropical forest of the world can be divided into two major groups: light-demanders and shade-tolerators. Shading reduces the intensity of the incident radiation reaching the plant and the soil (Anjah *et al*., 2013). Droppelmann *et al.*, (2000) also noted that under conditions of shading, evapotranspiration is reduced, which favours moisture conservation for use by plants. Light acts on both dormancy and release and

is a mechanism that adapts plants to specific niches in the environment, often interacting with temperature (Warren and Adams, 2001; Lajzerowicz *et al*., 2004).

Despite the importance of *T. tetraptera*, its regeneration has been greatly neglected. According to Akpan and William (2016), some of the edible forest plant species that are disappearing in Nigeria as a result of deforestation in particular are *Tetrapleura tetraptera* (Schum and Thonn) Taub., *Xylopia ethiopica* (Dunal) A. Rich, *Irvingia gabonensis* (Aubrey-Lecomte. ex O'Rorke) Baill, *Penthaclethra macrophylla* (Benth.) and *Dennettia tripetala* (Bak. f). Onyekwelu (1990) noted that the population of *T. tetraptera*is declining at an alarming rate is probably due to the inability of seeds to germinate (Dormancy) and overexploitation (Nya *et al*., 2000). Because of the usefulness of all parts of *T. tetraptera* (fruit, root, bark, seeds), high pressure is applied and this has led to the species being endangered. Many forest tree species are classified as endangered (Turner *et al.*, 2011), with a high possibility of going into extinction if nothing is done to conserve them and to increase their populations. Most of these species are found in the wild, in farmlands or fallow lands. If the current practice of allowing them to grow only naturally is allowed to continue, the probability of obtaining their valued products on a sustainable basis will be low (Onyekwelu *et al*., 2012). Artificial Regeneration of the species becomes a very viable option of saving tropical forest tree species from extinction and ensuring that their products are supplied on a sustainable basis. Furthermore, there is inadequate information on the silviculture of *T. tetraptera*, particularly on the effects of light intensity on its germination and early seedling growth for regeneration and silvicultural purposes, creating the need for this study.

The need for the regeneration of threatened and endangered useful plant species for sustainability cannot be overemphasized. In view of the importance and popularity of *Tetrapleura tetraptera* in tropical Africa especially with regard to its medicinal and health benefits, it becomes imperative to ascertain the best conditions to raise healthy seedlings for artificial regeneration. This study therefore investigated seed germination potential and early growth performance of *Tetrapleura teraptera* seedlings under different light intensities in the nursery.

MATERIALS AND METHODS

Experimental site

This research was carried out at the Research and Experiment Nursery of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt. The University of Port Harcourt is located on a land area of about 400 hectares in Obio/Akpor Local Government Area of Rivers State at latitude 4.90794 and 4.90809N and longitude 6.92413 and 6.92432E (Chima *et al*., 2017).

Fruit collection and processing

Mature pods of *Tetrapleura tetraptera* were bought from the market within the study area. The pods were depulped to get the seeds. The floatation method of seed viability test was employed to detect the viable seeds. Seeds that floated after 30 minutes were regarded as non-viable and discarded while the seeds that did not float were regarded as viable and mixed properly to form seed lot before being used for the experiment.

Experimental Design

Germination

The experiment was laid out in a Completely Randomized Design (CRD) involving 400 randomly selected seeds for the four (4) different light intensities (100, 75, 50 and 25%) i.e. 25 seed x 4 replicates x 4 light intensities = 400 experimental units. The different intensities were achieved by using a wooden frame covered with a mesh net with one layer, to produce 75 % light intensity, two layers to produce 50 % light intensity, and three layers to produce 25 % light intensity. In the case of 100% light intensity, seeds and seedlings were left under direct full sunlight (Mukhtar, 2016). Seeds were sown in germination trays measuring 17cm x 13cm x 35cm and filled with sterilized sharp sand. No fertilizers or bacterial and/or mycorrhizal inoculation were applied.

Seedling growth

At the two leaf stage, young seedlings of equal height were transplanted into polypot filled with topsoil and measuring 15 x 20 when flat. A completely randomized design was used. A total number of 80 seedlings equally divided among the four light intensities were used to determine the most appropriate amount of light required by *Tetrapleura tetraptera* for germination and early seedling growth. Watering and weeding was carried out regularly and when required throughout the period of the experiment.

At the end of the experiment, five seedlings per treatment were randomly selected and carefully removed from the pots and the root system exposed by carefully washing off the growth media from the roots, absorbent paper was used for blotting excess moisture from the plants. Seedlings were then separated into shoot and root components by cutting at the collar. The fresh weight of shoot (including the leaves) and root were taken and then placed in a paper bag for drying. The shoot and the root samples were oven dried at 70°C for three days (72 hours) and weighed to determine the moisture content of the shoot and root.

Data collection

Germination

Observation on germination was made and recorded daily; this was terminated after thirty days.

Germination percentage was calculated as:
Germination Percentage (GP) = (Number of seeds that germinated/Total number of seeds own) * 100

Seedling Growth

Initial shoot parameters measurement was done on all seedlings immediately after transplanting and monthly thereafter for four months. The seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a vernier calliper and leaf production was determined by directly counting the number of leaves as they emerged. The seedlings were weighed using a digital weighing scale calibrated in grams (g) to determine plant fresh and dry weights, while moisture content was calculated using the following equation.
Moisture Content = Fresh weight – dry weight

Data Analysis

Data collected on germination and early seedling growth were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). One-way analysis of variance was used to determine variation and F value was significant at $p \leq 0.05$. Duncan multiple range test was used to indicate compare means and indicate levels of difference.

RESULTS

Germination Percentage

Results on seed germination percentage (GP) of *Tetrapleura tetraptera* seeds subjected to different light intensities are presented in Figure 1. Light intensity did not significantly ($p > 0.05$) affect germination percentage of *Tetrapleura tetraptera* seeds. Mean germination percentage varied from 23% to 42%. Seeds sown under 75% light intensities had the highest mean germination percentage, followed by 50% light intensity and 100% light intensity (32%) while seeds sown under 25% light intensity had the lowest GP.

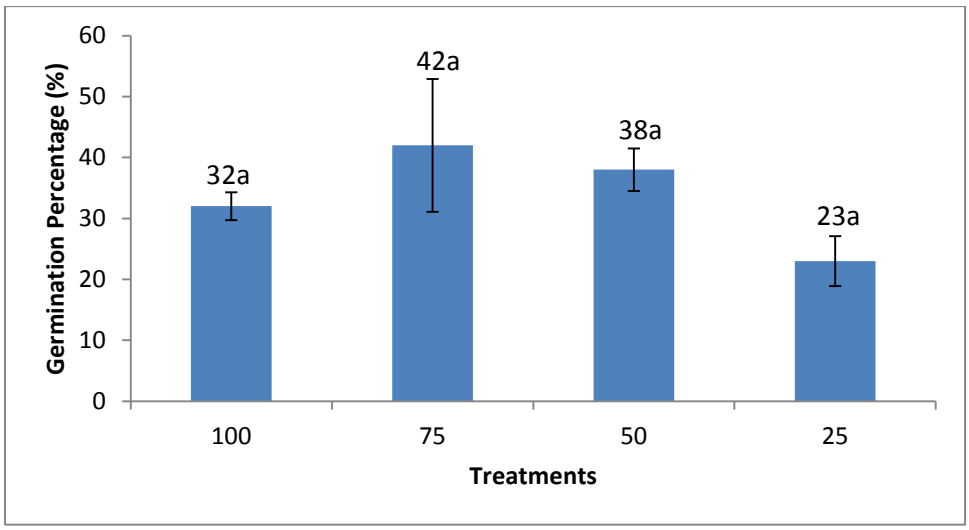

Figure 1. Effect of Light Intensities on the Germination of *Tetrapleura tetraptera*. Bars with the same alphabet are not significantly different *(p > 0.05)*

Seedling Height

Seedlings of *Tetrapleura tetraptera* planted under different light intensities displayed significant differences ($P \leq 0.05$) in height at months 1 to 5. Overall mean seedling height after 1-5 months varied from 6.53 cm at month 1 to 27.28 cm at month 5. Highest height was observed under 50% light intensity at months 1, 3, 4 and 5 and 75% light intensity at month 2 while the lowest height was observed in seedlings planted under 100% light intensity at month 1 and 25% at months 2 to 5. The summary of this result is presented in Table 1.

Table 1. Effect of light intensity on mean seedling height (cm) of *Tetrapleura tetraptera* seedlings

	Seedling Height (cm) (Monthly)				
Treatments	HT1	HT2	HT3	HT4	HT5
25	6.97±0.24^{ab}	7.73±0.30^{b}	10.94±0.35^{c}	20.63±0.66^{b}	24.63±1.27^{a}
50	7.59±0.35^{a}	9.05±0.52^{ab}	15.89±0.54^{a}	24.68±1.05^{a}	31.09±1.11^{a}
75	6.14±0.47^{bc}	10.57±0.84^{a}	15.22±0.84^{a}	22.26±1.26^{ab}	28.08±1.34^{ab}
100	5.36±0.56^{c}	9.66±0.37^{a}	12.87±0.61^{b}	20.65±0.90^{b}	25.22±0.88^{a}
Mean	6.53±0.23	9.25±0.30	13.74±0.37	22.08±0.52	27.28±0.64
P-value	0.002	0.004	0.000	0.016	0.001

Means on the same column with the same alphabet are not significantly different ($p \leq 0.05$)
HT1-5 = height of seedlings at month 1 to 5.

Seedling Collar diameter

Seedlings of *Tetrapleura tetraptera* subjected to different light intensities displayed significant differences ($P \leq 0.05$) in collar diameter at months 1 to 5. Overall mean seedling collar diameter after 1-5 months varied from 1.13mm at month 1 to 4.17 mm at month 5. Highest collar diameter was observed under 75% light intensity at months 1 and 3 and 100% light intensity at months 4 and 5 while the lowest collar diameter was observed in seedlings planted under 25% light intensity at months 1 to 5. The summary of this result is presented in Table 2.

Table 2. Effect of light intensity on mean seedling collar diameter (mm) of *Tetrapleura tetraptera* seedlings

	Seedling Collar Diameter (mm) (Monthly)				
Treatments	CD1	CD 2	CD 3	CD 4	CD 5
25	0.70±0.06^{c}	1.07±0.08^{b}	1.52±0.09^{b}	2.14±0.10^{c}	3.06±0.19^{c}
50	1.31±0.05^{ab}	1.81±0.08^{a}	2.31±0.09^{a}	2.95±0.11^{b}	4.03±0.16^{b}
75	1.40±0.07^{a}	1.90±0.07^{a}	2.55±0.12^{a}	3.27±0.19^{ab}	4.65±0.25^{ab}
100	1.14±0.09^{b}	1.78±0.06^{a}	2.41±0.10^{a}	3.52±0.19^{a}	4.97±0.30^{a}
Mean	1.13±0.04	1.64±0.05	2.19±0.07	2.96±0.10	4.17±0.14
P-value	0.000	0.000	0.000	0.000	0.000

Means on the same column with the same alphabet are not significantly different ($p \leq 0.05$)
CD 1-5 = collar diameter at I month to 5 months.

Seedling Leaf Production

Seedlings of *Tetrapleura tetraptera* grown under different light intensities displayed significant differences ($P \leq 0.05$) in leaf production at month 1 to 5. Overall mean seedling leaf production after 1-5 months varied from 5.67cm at month 1 to 46.95cm at month 5. Highest leaf production at months 1 to 5 was observed at 75% light intensity and the lowest leaf production at months 1 to 5 observed at 25% light intensity. The result on seed production is presented in Table 3

Table 3. Effect of light intensity on mean seedling leaf production (mm) of *Tetrapleura teraptera* seedlings.

	Seedling Leaf Production (Monthly)				
Treatments	LP1	LP 2	LP 3	LP 4	LP 5
25	5.30±0.11^{b}	8.20±0.38^{b}	14.35±0.65^{b}	21.80±1.14^{b}	32.60±2.29^{b}
50	5.35±0.17^{b}	15.10±0.83^{a}	23.90±0.95^{a}	34.70±1.73^{a}	50.40±2.13^{a}
75	6.05±0.22^{a}	17.551.17^{a}	29.00±2.53^{a}	37.35±2.79^{a}	52.70±3.56^{a}
100	6.00±0.27^{a}	16.68±1.32^{a}	26.89±2.45^{a}	32.98±2.75^{a}	52.37±3.34^{a}
Mean	5.67±0.11	14.35±0.64	23.49±1.10	31.69±1.27	46.95±1.71
P-value	0.008	0.000	0.000	0.000	0.000

Means on the same column with the same alphabet are not significantly different ($p \leq 0.05$)
LP 1-5 = leaf production at month 1 to 5.

Plant Biomass

Shoot Biomass and Moisture Content

Seedlings of *Tetrapleura tetraptera* subjected to different light intensities displayed significant differences ($P \leq 0.05$) in their biomass. Highest shoot fresh weight was observed under 100% light intensity, while lowest shoot fresh weight was observed under 25% light intensity. Highest shoot dry weight was observed under 75% light intensity while lowest shoot dry weight was observed under 25% light intensity. Shoot moisture content was highest under 100% light intensity and lowest under 50% light intensity.

Root Biomass and Moisture Content

Highest root fresh weight was observed under 100% light intensity while the lowest root fresh weight was observed under 25% light intensity. Highest root dry weight was observed under 75% and 100% light intensities while lowest root dry weight was observed under 25% light intensity. Root moisture content was highest under 100% light intensity and lowest under 25% light intensity. Overall, lowest root biomass was observed in seedlings at 25% light intensity as shown in Table 4.

Table 4. Effect of light intensity on Plant Biomass of *Tetrapleura teraptera* seedlings

Biomass	Light Intensity (%)				
	25	50	75	100	*P value*
Shoot Fresh Weight (g)	1.80±0.13^{c}	2.24±0.27^{ac}	3.80±0.40^{b}	5.06±0.34^{a}	0.000
Shoot Dry weight(g)	0.54±0.03^{c}	1.22±0.16^{b}	1.98±0.23^{a}	1.96±0.09^{a}	0.000
Shoot Moisture Content(g)	1.26±0.14^{b}	1.02±0.28^{b}	1.82±0.39^{b}	3.10±0.38^{a}	0.000
Root Fresh Weight(g)	1.16±0.08^{c}	2.44±0.36^{b}	4.58±0.37^{a}	4.76±0.34^{a}	0.000
Root Dry weight(g)	0.46±0.05^{c}	1.20±0.16^{b}	2.00±0.19^{a}	2.00±0.13^{a}	0.000
Root Moisture Content(g)	0.70±0.03^{b}	1.24±0.22^{b}	2.58±0.21^{a}	2.76±0.22^{a}	0.000

Means with the same alphabet on the same row are not significantly different ($p \leq 0.05$)

DISCUSSION

The quantity and quality of light are among the environmental factors that affect seed germination, seedling survival and establishment (Pons, 2000; Onyekwelu *et al.,* 2012). The result of this study showed that there was no significant difference in germination percentage although seeds sown under 75% light intensity had the highest mean germination percentage when compared to others, with 25% light intensity having lowest germination percentage. This implies that *Tetrapleura tetraptera* seedlings can germinate both in light and dark conditions preferably under partial shade. The non-significant difference obtained in this experiment confirmed the findings of Akinyemi and Sakpere (2015) who observed lack of significant differences between seeds germinated in the light and dark conditions but contradicts that of Jahn *et al.*(1986) who reported that germination of *M. oleifera* is affected by light conditions and recommended half shade for germination. Droppelmann *et al.* (2000) noted that under condition of shading, evapotranspiration is reduced which favours moisture conservation for use by plant. According to Sacande and Some, (1992), some species require heavy shade before germination to keep the soil moist and fresh while others germinate without shade. Similarly, Onyekwelu *et al.* (2012) noted that the effect of light intensity on seed germination varies and may be species dependent.

Light availability is a major ecological factor influencing plant growth and survival (Guenni *et al.,* 2008). Significant differences were observed in seedling growth parameters of *Tetrapleura tetraptera* with seedling grown under 50 and 75% light intensities exhibiting higher seedling height, collar diameter and leaf production. This implies that seedlings of *T. tetraptera* need some amount of shade for early growth. Significant differences observed in seedling growth of *T. tetraptera* is in line with the result of Aref, (2002) who observed significant differences in seedling growth of tree species among light intensity treatment but disagrees with that of Bolanle *et al* (2014) who reported non-significant differences between 30-100% light intensities on early growth of K*igelia africana*. Highest seedling height observed in 50% light intensity could be indicative of the fact that *Tetrapleura tetraptera* seedlings require moderate light for optimum height growth. This is buttressed by Chaudhry *et al* (2004) who opined that shading increases shoot growth at the expense of root growth. The findings equally agree with the result of Akinyele (2007) who reported highest height from 50% light intensity on *Buchholzia corriacea* seedlings.

The higher collar diameter and leaf production observed at 75% light intensity agrees with the findings of Onyekwelu *et al.* (2012), who reported that *Chrysopyllum albidum* seedlings need some amount of shade for establishment and early growth, due to its survival and growth under low light environments and that of Wardiana and Herman (2011) who recorded higher collar diameter and number of leaves for *Reutealis trisperma* seedlings under reduced light environment when compared to full light, but disagrees with that of Ahmed (2000) who reported best growth of two Acacia species under full light intensity. According to Droppelmann *et al*. (2000) and Anjah *et al*. (2013), seedlings of different tree species have different light requirements.

The highest biomass in terms of shoot and root fresh weights observed at 100% light intensity concurs with the findings of Adeoye and Onyekwelu (2014) on early growth of *P. biglobosa* seedlings where 100% light produced higher biomass; and George *et al*. (2012) who reported highest biomass in full light intensity on *Salvia officinalis* seedlings. However, Mattana *et al.* (2006) reported higher biomass in reduced light intensity. It should be noted that the biomass in terms of shoot dry weight was highest under the 75 % light intensity while the root dry weight was highest at both the 75 % and full light intensity. Lowest height, collar diameter, number of leaf and biomass observed at 25% light intensity is an indication that *Tetrapleura tetraptera* seedlings are not shade-loving.

CONCLUSION

Germination of *T. tetrapleura* seeds was not significantly influenced by light intensity, but seedling height, collar diameter, leaf production, biomass, and moisture content, were significantly affected by light intensity The result showed that

100% (full) and 25% (low) light intensities did not enhance the germination of *T. tetraptera* while 75% and 50% (medium shading) light intensities enhanced its germination. Also, 50% and 75% light intensities are the most suitable for the early growth of this species with reference to height, collar diameter and leaf production.

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