Journal of Forestry Research and Management. Vol. 14 (1), 84-92; 2017, ISSN 0189-8418

www.frin.gov.ng/frin1/journals.html

Investigative Study on Appropriate Light Intensity Requirement for the Early Growth and Development of Tiama Mahogany (*Entandrophragma angolense* (Welw) C.DC) Seedlings

Oso, A.O*[1]; Agbo-Adediran, O.A[2]; Aderounmu, A.F[2]; Olawumi, A.T[3] and Abodunrin, E.K[2]

1Department of Silviculture, Ministry of Forestry, Abeokuta, Ogun State
2 Department of Forestry Technology, Federal College of Forestry, Jericho Ibadan
3Department of Agricultural Sciences, Tai Solarin University of Education, Ijebu-Ode, Ogun state
4 Forestry Research Institute of Nigeria
*corresponding e-mail: osoolusesi16@gmail.com Phone no: 08035782049

Abstract

The effect of varying light intensities on the growth of *Entandrophragma angolense* (Welw) C.DC seedlings was examined at nursery stage. Seedlings were subjected to four light intensities of 100%, 75%, 50%, 25% respectively using photometer. 100% light intensity served as control for the experiment. The treatments were arranged in Completely Randomized Design (CRD) with ten replicates. Growth variables such as plant height, stem diameter, leaf production and leaf area were assessed. The data collected were subjected to Analysis of variance (ANOVA). The results shows that T_1 (100% light intensity) had the highest mean of height 9.96 cm while treatment T_3 (50% light intensity) had the highest mean value for stem diameter, leaf production and leaf area with 3.76 mm, 3.94 and 53.72cm^2 respectively. Results from the analysis showed that there were significant differences in stem diameter and leaf area while no significance difference was recorded in plant height and leaf production at 5% level of probability. This indicates that *Entandrophragma angolense* will do well under partial shade and in gaps and openings in the forest provided that other factors that can ensure success are in place. Therefore, partial shade (50% light intensity) is moderate and recommended for the proper growth of *Entandrophragma angolense* seedlings especially at early stage.

Keywords: *Entandrophragma angolense*, light intensity, early seedling growth, timber tree species

Introduction

Timber has been used throughout the history of mankind (FAO, 2002). The importance of timber to mankind and the environment cannot be overemphasized. *Entandrophragma angolense* (Welw) C.DC is one of the timber species that produce wide range of utilization for various purposes by man. It is a large tropical forest tree that is commonly called the 'tiama mahogany'. *Entandrophragma* is a genus of eleven species of deciduous trees in the mahogany family Meliaceae, which is restricted to tropical Africa. It is found widely across Africa in lowland and lower montane forests. Some of the species attain large sizes, reaching 40-50m in height exceptionally 60m, and 2m in trunk diameter (Techinda, 2008). It is widely used in ethnomedicinal treatment of various gastro intestinal disorders including peptic ulcer in humans (Abayomi and Adegoke, 2001). The bark is also used in traditional medicine. Bark decoction is drunk to treat fever and is also used in external applications as anodyne against stomach-ache and peptic ulcer, ear ache and kidney rheumatic or arthritic pain (Techinda, 2008). Several efforts made to established the species in plantations failed because nutritional and environmental requirements at early stage growth are poorly understood (Ladipo *et al*., 1994; Rafiqul *et al*., 2004)

Light is one of the most vital environmental factors essential for plants growth. The intensity of light needed vary from species to species. Light is an absolute requirement for plant germination and growth. Light is known to affect the plant leaf formation and also plays a great role in the plants' primary productivity. Light intensity influences the manufacture of plant food, stem, length, leaf colour, flowering and rate of transpiration. Edmond, (2011) reported that plants growing in low light tend to be spindly with light green leaves while plants growing in very bright light tend to have shorter branches and larger dark green leaves. Light also influences stomata action and chlorophyll formation.

The need to improve on the production of *E. angolense* is brought about by the high demand for timber trees by the growing population of Nigeria. Due to the economic importance of *E. angolense* coupled with the high rate at which it is exploited in the forest the tree is scored 'vulnerable' in conservation status according to International Union for Conservation of Nature and Natural Resources, IUCN (2012), Red list. The objective of this research is therefore to evaluate the influence of different light intensities on growth performance on the seedlings of *E. angolense* with the aim of determining light requirement for optimal growth at the nursery stage.

Materials and method

Study site

The experiment was carried out in the nursery section of the Department of Forestry Technology, Federal College of Forestry, Ibadan, Oyo state which is located within the Jericho Government Reserve Area (GRA) of Ibadan South-West Local Government area. The

area lies within Latitude 7°23'15"N; 3°51'00"E and 7°24'00"N; 3°52'15"E of the Greenwich Meridian. The climatic pattern of the area is tropical, annual rainfall ranges from 1,300-1,500mm and average relative humidity of about 65% while the average temperature is about 26°C (FRIN Metrological Station, 2014). It has a West African monsoon climate exhibiting distinct wet and dry season.

Methods

Four weeks old uniformly growing seedlings of *E. angolense* were used for this study. They were transplanted into black polythene pots (4.8 cm x 12 cm) filled with 2kg of top soil. A total of forty (40) seedlings were used for the experiment. These seedlings were placed under light screening chambers. Three wooden chambers were constructed using wooding frames of 60 by 60 by 90cm in dimension. Each chamber was covered on all sides by different layers of 1 mm-size green mesh except the side touching the ground. One, two and three layers of the green mesh were used to cover the screen chambers to achieve different light intensity of 75%, 50% and 25% respectively. Seedlings that were not placed under chamber received 100% light intensity and served as the control for the experiment (Akinyele, 2007; Aderounmu, 2010; Olajuyigbe and Agbo-Adediran, 2015). The available light intensity under each chamber was confirmed by using light meter. The experiment was laid out in Completely Randomized Design (CRD) consisting of four treatments and ten replicates.

Table 1: Layout of the experiment where *Entandrophragma angolense* seedlings were exposed to different light intensities

Treatments	**Replicates**									
T_1	T_2R_4	T_3R_{10}	T_2R_{10}	T_3R_2	T_1R_6	T_1R_4	T_1R_8	T_1R_3	T_2R_3	T_3R_4
T_2	T_2R_7	T_3R_3	T_1R_5	T_2R_1	T_3R_9	T_4R_7	T_3R_5	T_4R_3	T_3R_6	T_4R_6
T_3	T_1R_1	T_1R_7	T_3R_8	T_1R_9	T_3R_7	T_1R_{10}	T_2R_2	T_4R_4	T_4R_5	T_4R_{10}
T_4	T_2R_6	T_3R_1	T_4R_2	T_1R_2	T_4R_9	T_4R_1	T_2R_5	T_4R_{10}	T_2R_8	T_2R_9

T_1 – 100% light intensity (control),
T_2 – 75% light intensity
T_3 – 50% light intensity and
T_4 – 25%light intensity

Data were collected weekly and the parameters assessed for twelve weeks were; Plant height (cm), No of leaves per plant, Collar diameter (mm) and Leaf area (cm^2). Plant height was measured with the use of a meter rule. The number of leaves produced per plant were counted and recorded. A Vernier caliper was used to measure the collar diameter while the leaf area empirical was computed using the method of Clifton-brown (1997)

Statistical analysis

Data collected were subjected to descriptive statistics and analysis of variance at 5% level of probability and the means were separated using Least Significant Design (LSD).

Results

Physical observation of treatments

The seedlings grown under 100% sunlight exposure had yellowish leaves as a result of exposure to direct rays of sunlight. These seedlings also greatly suffered insect defoliation, spot infestation. These were problems of *Entandrophragma angolense* seedling observed during the experiment

Table 2: Mean values for plant height, collar diameter, leaf production and leaf area (mean values with the same letter in the column are not significantly different)

T	Plant height (cm)	Collar diameter (mm)	Leaf production	Leaf area (cm)
1	9.96	3.48^{a}	3.63	37.59^{a}
2	9.94	3.63^{ac}	3.84	38.79^{a}
3	9.63	3.76^{bcd}	3.94	53.72^{bc}
4	9.50	3.59^{ad}	3.72	48.60^{c}

Table 2 showed the mean height per plant was greatest in T_1 (100% light intensity) with 9.96 cm, followed closely by treatment 2 (75% light intensity) with 9.94 cm while treatment 4 (25% light intensity) had the least height with 9.50 cm during the investigation period. However, there was no significant difference among the mean values for plant height. Table 2 also showed that the collar diameter of seedlings exposed to 50% light intensity (T_3) had the highest mean (3.76 mm) followed by T_2 (3.63 mm) and T_1 had the lowest (3.59 mm) respectively. For leaf production, seedlings exposed to 50% light intensity had the highest mean value (3.94) followed by 75% light intensity (3.84) while seedlings exposed to 100% light intensity had the least performance (3.63). For the leaf area, seedlings with 50% light intensity had the highest mean value (53.72 cm^2) followed by 25% light intensity (48.60 cm^2) and 100% light intensity had the least performance (37.59cm^2). Analysis of variance however revealed significant differences in the mean values for collar diameter and leaf area

Journal of Forestry Research and Management. Vol. 14 (1), 84-92; 2017, ISSN 0189-8418
www.frin.gov.ng/frin1/journals.html

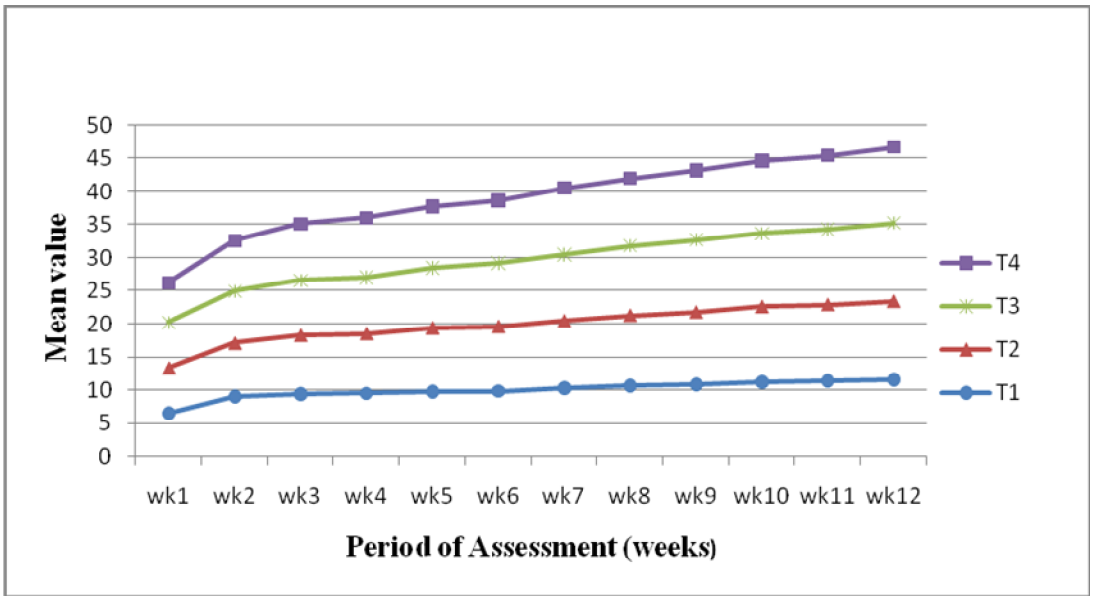

Fig. 1: Mean plot for plant height

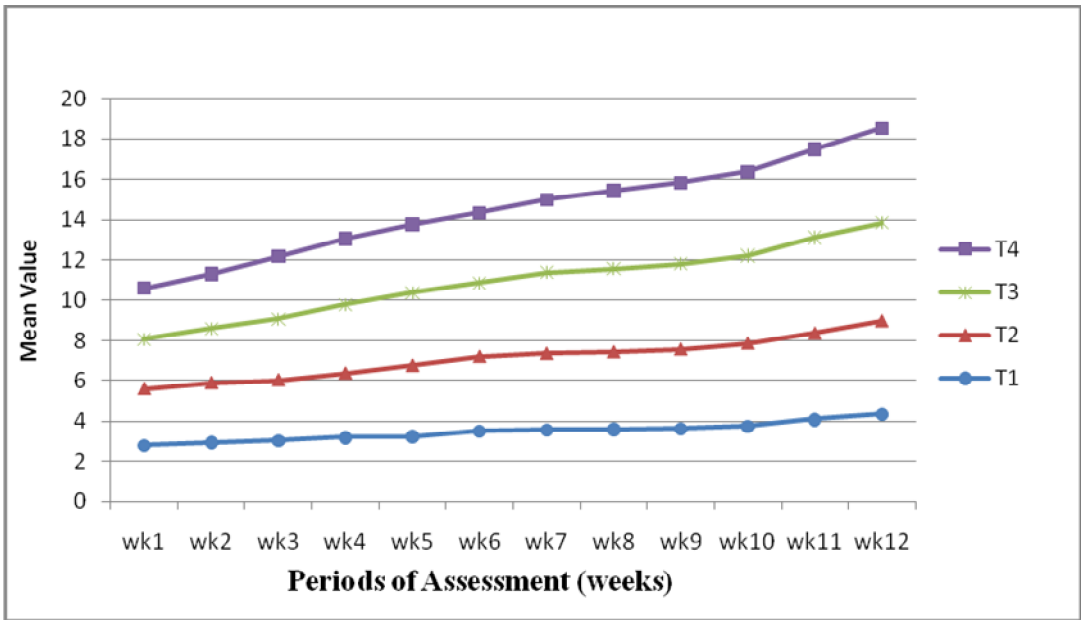

Fig. 2: Mean plot for collar diameter

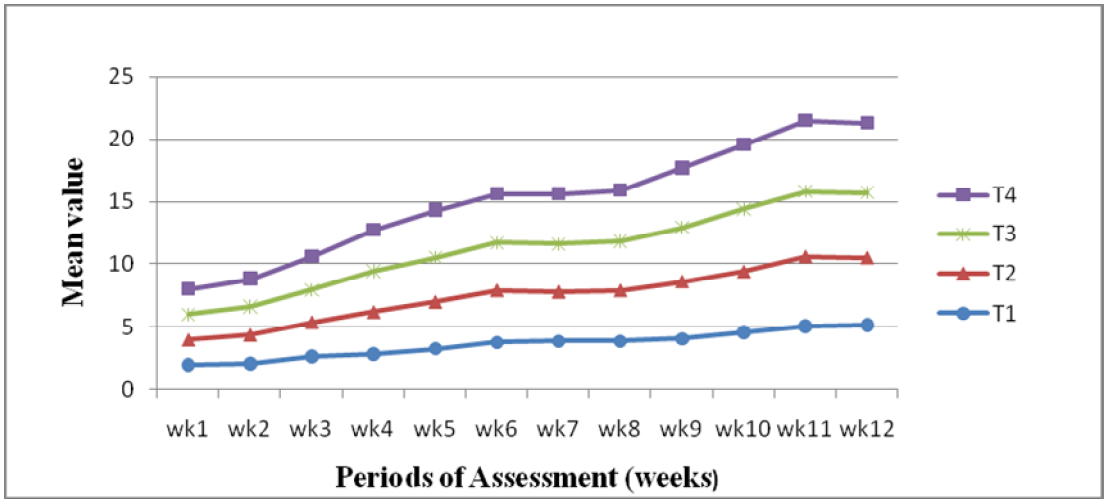

Fig. 3: Mean plot for leaf count

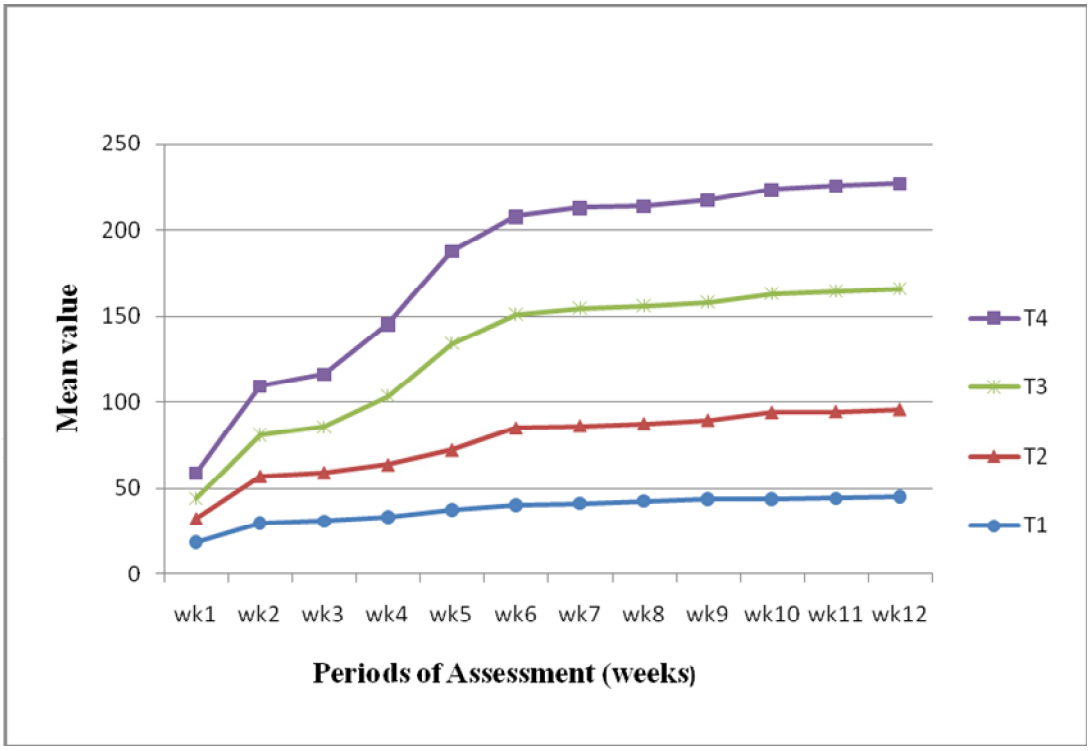

Fig. 4: Mean plot for leaf area

Table 3: Chemical composition of the soil used for the study

Parameters	properties
pH in H2O	6.59
pH in KCL	6.35
Ca	4.40cmol/kg
K	0.36cmol/kg
Na	0.19cmol/kg
Mg	1.94cmol/kg
%C	1.74
TOTAL	0.11N
Av.p	5.69
Mn	19.79mg/kg
Fe	18.06mg/kg
Cu	0.38mg/kg
Zn	6.5mg/kg

Source: Soil Lab, 2015

Discussion

Seedlings response to physiological stress is a complex phenomenon and *Entandrophragma angolense* is not an exception. Light affects a number of plants metabolic activities such as photosynthesis and respiration, it is therefore important to establish seedlings within the range of their tolerance level. Raising seedlings out of this range places the seedlings at a disadvantage. *E angolense* seedlings had best growth when light intensity was reduced to a moderate level. Maximal response was observed in collar diameter, leaf production and leaf area when seedlings are exposed to an average light intensity and this corresponds with the findings of Olajuyigbe and Agbo-Adediran (2015) who found out that height and collar diameter development of *E angolense* seedlings increased as light intensity is reduced when subjected to shade and watered daily. In their own study, Akinyele *et al.*, (2015) reported that *E cylindricum* had the best growth under average light intensity when watered once in three days. No significant variation was recorded for height in this study but the best response was observed when seedlings were exposed to 100% light intensity while 50% gave the best overall performance. This could be as a result of seedlings ability to maximize the use of available solar radiation to its advantage and its continuous growth in reduced light intensity suggests that *E angolense* could qualify as a strong candidate for enrichment planting in degraded forests where gaps are created through exploitation and where competition from other vegetation has a role to play and this corroborated the assertion of Tchinda (2008). The best height growth recorded by Olajuyigbe and Agbo-Adediran (2015) at 25% light intensity could be as a result of the specific physiological response of *E angolense* to the interaction effect of both light and water stress as several authors have

recorded different physiological response by plants to light inhibition especially during early stages of development (Nwoboshi, 1972; Ladipo *et al*., 1994; Veenedaal *et al*., 1996; Medina, 1998; Gehring, 2003; Ashton *et al*., 2006; Akinyele *et al*., 2015).

Conclusion

Entandrophragma angolense could play a prominent role in restoration of degraded and over logged forests. This study revealed that reduction of light intensity did not reduce growth but rather resulted in better performance suggesting that *E. angolense* is a shade tolerant species at its early stage and adapted to moderate shade. The silvicultural implication is that *E. angolense* can thrive as a candidate for enrichment planting in the openings of natural forests as evident in the study where significant results were obtained in collar diameter and leaf area. It is therefore recommended that 50% light intensity should be used in raising *E. angolense seedlings* at the nursery stage for proper growth and development.

REFERENCES

Abayomi, J.O. and Adegoke, E.A. (1996). Studies of Nigerian medicinal plant preliminary survey of alkalis *J.W.A Africa* pp. 420.

Aderounmu, A.F. (2010). Silvicultural requirements for regeneration of *Vitellria paradoxa*. Ph.D. Thesis, submitted to the Department of Forest Resources Management. University of Ibadan, 206pp.

Akinyele A.O. (2007). Silvicultural requirements for the regeneration of *Buchholzia coriacea* Engl. seedlings PhD thesis, Department of Forest Resources Management. University of Ibadan pp 176

Akinyele, A.O., Adegeye, A.O. and Akinrinola, O.A. (2015). Effect of watering regime and light intensity on the growth of *Entandrophragma cylindricum* seedlings. XIV World Forestry Congress, Durban, South Africa, 7-11 September 2015.

Ashton, M.S., Singhakumara, B.M.P.and Gamage, H.K. (2006). Interactions between light and drought effect performance of Asian tropical tree species that have differing topographic affinities. *Forest Ecology and Management* 221: 42-51

Clifton-brown, J. C. (1997). The importance of temperature in controlling leaf growth of miscanthus in temperature climates. PhD Thesis, Trinity College, Dublin.

Edmond, J.B. (2011). Fundamental Horticulture. 4th edition. McGraw –hill, Inc.pp109-130

Food and Agricultural Organization (2002): Environmentally and energy balance of wood producers and substitutes: ISBN 1-38246-3462 pp8.

Forestry Research Institute of Nigeria, FRIN Metrological Station, (2014)

Gehring, C.A. (2003). Growth responses to Arbuscular mycorrhizae by rain forest seedlings vary with light intensity and tree species. *Plant Ecology* 167: 127-139.

International Union for Conservation of Nature and Natural Resources, IUCN (2012). Red list of threatened species, Switzerland: IUCN species survival commission.

Ladipo, D.O., Britwum, S.P.k., Tchoundjeu, Z., Oni, O. and Leakey, R.R.B. (1994). Genetic improvement of West African tree species: past and present. In: Leakey, R.R.B., Newton, A.C. (Eds), Tropical trees: the potential for domestication and the rebuilding of forest resources.

Medina, E. (1998). Seedling establishment and endurance in tropical forests: Ecophysiology of stress during early stages of growth. *Oecologia Australis* 4, 23-43

Nwoboshi, L.C. (1972). Responses of Teak, Idigbo and Opepe seedlings to various light intensities. *Nigerian Journal of Forestry* 2, 48-53

Olajuyigbe, S.O. and Agbo-Adediran, O.A. (2015). Effect of shade and water stress on early growth and biomass accumulation of Tiama mahogany (*Entandrophragma angolense* (Welw.) C.DC) seedlings. *Academic Journal of Science*. 04(01): 27-36

Rafiqul, H.M., Hossian, M.H., Mpoinddon, M. and Hoque, M.M. (2004). Effect of inorganic fertilizers on the initial growth performance of *Anthocephalus chiinesis* (Lam.) seedlings in nursery. *Journal of Applied Science* 4, 477-485

Tchinda,A.T,(2008): *Entandrophragma angolense* (welw) C. DC. In: Louppe, D., Oteng-Amaoko, A.A., and Brink, M. (Eds.) PROTA (Plant Resources of Tropical Africa) Wageningen, Netherlands. PROTA4U. Accesses 21 May 2013, 20 May 2013.

Veenendaal, E.M., Swaine, M.D., Leeha, R.T., Walsh, M.F., Abebrese, I.K. and Owusu-Afriyie, K. (1996). Responses of West African forest tree seedlings to irradiance and soil fertility. *Functional Ecology*. 10:501-511.