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GROWTH RESPONSE OF *Shorea roxburghii* G. Don SEEDLINGS TO DIFFERENT LEVELS OF LIGHT INTENSITY

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ABSTRACT

Forests are home to different economic tree species, many of these tree species are either vulnerable or endangered due to the high rate of exploitation because of their socio-economic importance to the nation's economy. *Shorea roxburghii* also fall into these categories and light is one of the environmental factors that limit its growth. This experiment was conducted to assess the growth response of *S. roxburghii* seedlings to different levels of light intensity. The experiment was arranged in a Completely Randomized Design with four treatments and four replicates in the forest nursery of the Federal College of Forestry, Jericho, Ibadan for a period of sixteen weeks. The treatments used were 100%, 75%, 50% and 25% light intensities. Seedlings of S. *roxburghii* were raised under these light intensities. The variables assessed were collar diameter, seedling height, number of leaves produced and leaf area. It was observed from the results that there were significant differences (at 0.05 level of probability) in the growth response of S. *roxburghii* seedlings to the different level of light intensity. Seedlings raised in 50% light intensity performed best in terms of the variables measured with 18.83cm in height, average leaf production of 8.96 and 57.07cm^2 in leaf area. It is concluded that *S. roxburghii* seedlings is best raised under moderate shade (50% light intensity) at the early stage and based on the result it is recommended that partial shade is necessary for optimum growth response at the nursery stage.

Keywords: Early growth response, light intensity, *Shorea roxburghii*, Forest ecosystem

INTRODUCTION

There is no area with a complex, high density of trees on the earth than the forest ecosystems (Poorter *et al*., 2006). Forests are very crucial natural resources and have always been central in human life. They provide renewable raw materials and energy, maintains biological diversity, mitigate climate, protect land and water resources. It also provides recreation facilities, improve air qualities and help alleviate poverty. Forests provide a diverse range of services; they store carbon, aid in regulating the planetary climate, purifying water and mitigating natural hazards such as floods. They also function as habitat for organisms, hydrologic flow modulators and soil conservers constituting one of the most important aspects of the biosphere (FSI, 2009). Forests are important natural resources that fuel the continuous economic and social development of many countries, according to a FAO report by Sim *et al*., (2002) this is true for many developing countries in the Asian Pacific region. However this can be extended the developing nations of African continent as well where the rather rapid development by these countries was partly fuelled by exploiting these natural resources in an unsustainable manner using inappropriate logging practices, shifting cultivation, repeated burning and other human interference.

Additionally, Nigeria's timber industries enjoyed a great preference in the world timber market which put our timber resources under great pressure of over exploitation in the hands of illegal feller (Kareem *et al*., 2012). Shorea- a genus of tree species in the 'Dipterocapaceae' family found in the tropical rainforest- an important timber genus with most of its species classified as vulnerable in the IUCN Red List (IUCN 2017) is one of the many victims of these ill acts because of its socio-economic importance to the nation's economy, such as construction purposes, light and heavy flooring staircases, furniture suitable for vehicle bodies toys novelties, rail way and musical instrument (Latham, 2004).

The ability of tree species to regenerate naturally is limited by threats posed by conditions that may arise from climate change. Many factors are known to be related to plant growth and nutrient availability, plant growth and development are controlled by internal regulations that are modified according to these ecologically important environmental conditions which are light, temperature, water and humidity (Kyereh *et al*., 1999). Among these factors light is very critical

for healthy development and survivals of seedlings (Gutterman, 1994). Researches into important environmental factor such as light intensity variations which can limit the growth rate of plants need to be carried out so as to determine the optimum light required for raising healthy *Shorea roxburghii* seedlings in the forest nurseries in order to meet up with depletion in the forest. The objective of this study therefore is to determine the effect of vary light intensity on the early growth of *Shorea roxburghii* seedlings**.**

MATERIALS AND METHODS

The experiment was carried out in the tree nursery of the Federal College of Forestry, Jericho, Ibadan. The college is situated at Jericho quarters, in Ibadan North West Local Government Area of Oyo State. This lies between Latitude 7º 23¹ -7º 24¹ N and Longitude 3º 51¹- 3º 52¹ E of the Greenwich Meridian Time (GMT).

The climate of the area is dominated by rainfall pattern ranging from 1400mm to 1500mm. the average temperature is about 26^0C and relative humidity is about 65% it has two distinct seasons namely dry season (usually commencing from November to March) and the raining season from April to October (FRIN Meteorological Station, 2016)

Three light screening chambers were constructed for the experiment. The light intensity chamber were constructed in such a way that three wooden frames were built and covered with layers of 1 mm mesh net on all the side expect the side facing the ground, several researchers had demonstrated that a layer of 1mm green mesh net reduces light intensity by 25% (Akinyele, 2007; Aderounmu, 2010; Akinyele and Dada, 2015; Olajuyigbe and Agbo-Adediran, 2015; Oso *et al.*, 2017). In order to achieve 75% light intensity in the chamber, the wooden frame was covered with one layer of the mesh net, 50% light reduction was achieved by covering the wooden frame with 2 layers of 1 mm mesh net, while 3 layers was used to achieve 25% light intensity. 100% light intensity was achieved by exposing the seedlings to direct sunlight. The light intensities were monitored regularly using light photometer

The experiment was arranged in a complete Randomized Design with four treatments and four replicates. The following growth variables were assessed weekly for a period of sixteen weeks-

plant height, collar diameter, leaf production and leaf area. A mini vernier caliper was used to measure the collar diameter, a measuring tape was used for the seedlings height while graphical method was used for leaf area.

The data collected were subjected to Analysis of Variance (ANOVA) and where significant differences occurred, LSD was used to separate the means.

RESULTS

Height

The result presented above shows that seedlings raised under 50% light intensity chamber had the best performance in height with the mean value of 18.83cm. Seedlings raised in 75% light intensity, performed second best with an average mean of 17.42cm while seedlings raised under direct sunlight performed least with the mean value of 14.25cm. The results obtained showed significant differences in the treatments (Table 1).

Table 1: Result of the analysis of variance for plant height within period of the study

SV	DF	SS	MS	F
Treatment	3	76.58	25.53	1486.74*
Error	16	0.28	0.017	
Total	19	76.86		

* Significant at 5% level of Probability ($P < 0.05$)

Analysis of variances table above reveals that there is significant difference among the treatments at 5% level of probability which implies that the light intensities have significant effect on the height of S*horea roxburghii* seedlings.

Leaf production

The result obtained on leaf production revealed that the seedlings under 50% light intensity produced the highest number of leaves with an average of 8.96 leaves, followed by the seedlings with exposure to 75% light intensity (7.64), while seedlings raised under 25% light intensity had

the least performance with the average mean of 7.04 leaves. Further test reveals that seedlings were significantly different from one another (Table 4).

Table 2: Results of the analysis of variance for the leaf production within the study period

SV	DF	SS	MS	F
Treatment	3	10.83	3.61	505.99*
Error	16	0.11	0.007	
Total	19	10.95		

* Significant at 5% level of probability (P < 0.05)

Table 2 indicated that there was a significant difference among the treatment at 5% level of probability. This implies that the light intensities have significant effect on the leaf production of *Shorea roxburghii* seedlings.

Collar diameter

Result on the stem diameter showed a different pattern from those of seedling height and leaf production. Seedlings raised under direct sunlight had the best performance in the stem diameter with the mean value of 0.54 mm followed by seedlings raised 50% light intensity with the mean of 0.53mm. Both seedlings raised under 75% and 25% light intensities had the same mean value of 0.48mm. However seedlings exposed to full light and 50% light intensity were significant different from others (Table 5).

Table 3: Result for the analysis of variance for the collar diameter within study period

SV	DF	SS	MS	F
Treatment	3	0.013	0.0043	6.38*
Error	16	0.011	0.0007	
Total	19	0.024		

* Significant at 5% level of probability (P < 0.05)

Table 3 indicated that there was a significant different among the treatments at 5% level of probability. This implies that the light intensities have significant effect on the collar diameter of *Shorea roxburghii* seedlings.

Leave area

Result on the leaf area shows that seedlings raised under 50% light intensity had the best performance with the mean value of 57.07cm^2 followed by the seedlings raised 75% light intensity with an average of 47.47cm^2. Seedlings raised under direct sunlight (100% light intensity) followed with the mean of 13.38cm^2, while the seedlings raised under 25% light intensity had the least performance with the average of 7.04cm^2.

Table 4: Results of the analysis of variance for the leaf area

SV	DF	SS	MS	F
Treatment	3	5300.13	1766.71	16846.65*
Error	16	1.68	0.11	
Total	19	5301.8		

* Significant at 5% level of probability (P < 0.05)

Analysis of variance for leaf area (table 4) revealed that there is significant difference among the treatments at 5% level of probability This implies that the light intensities have significant effect on the leaf population of *Shorea roxburghii* seedlings.

Table 5: Means and follow-up test for the effect of different light intensities on the height, stem diameter, leaf area and leaf production.

Treatment	Height(cm)	Leaf production	Collar diameter(mm)	Leaf area(cm^2)
T_1	14.25d	7.32c	0.54a	13.38c
T_2	17.42b	7.64b	0.48b	47.47b
T_3	18.83a	8.96a	0.53a	57.07a
T_4	14.44c	7.04d	0.48b	7.04d

Note: Means with the same letter are not significantly different from each other.

Key: T_1- Seedlings of *Shorea roxburghii* raised under 100% light intensity, T_2- Seedlings of *Shorea roxburghii* raised under 75% light intensity, T_3 - Seedlings of *Shorea roxburghii* raised under 50% light intensity and T_4- Seedlings of *Shorea roxburghii* raised under 25% light intensity.

DISCUSSION

Plant growth and development are controlled by internal regulations that are modified according to environmental conditions, and light is one of these ecologically important environmental factors (Medina, 1998). Appropriate amount of light is critical for healthy growth and development of seedlings, while too much shade leads to etiolation and elongation of seedlings which make them weak and prone to fungal attack, high light intensity cause them to have short stocky (Bartlett and Remphrey, 1998; Sack, 2004). Light quantity, quality and duration are the principal characteristics that affect plant growth (Gehring, 2003). Light quantity refers to the intensity or concentration of sunlight, the amount of sunlight a plant receives determines the capacity of the plant to produce its food through photosynthesis (Luttge *et al*., 2003). The result revealed that at the early stage of development, *Shorea roxburghii* exhibit high rate of leafy development in terms of leaf production and leaf area under low intensities up to a certain point

but when the intensity was lowered to 25% the development retarded. This may be as a result of etiolation as suggested by Sack (2004). The increase in height, leaf production and leaf area with shading observed may be as a result of the physiological response of the seedlings to light inhibition at early stage of development, this assertion is supported by several authors (Ladipo *et al*., 1994; Veenendaal *et al*., 1996; Ashton *et al*., 2006, Olajuyigbe and Agbo-Adediran, 2015). The ability of *Shorea roxburghii* seedlings to survive and continue to grow under medium shade means it may be used for enrichment planting where small to medium sized forest gaps are present. This is evident from the result as seedlings exposed to 50% light intensities showed the highest response in terms of all the parameters measured

Edmond *et al*., (2011) observed in their study that light intensity influences the manufacture of plants food and that plants grown in low light tend to be spindly with light green leaves while plant grown in very bright light tend to have larger leaves, and the results obtained in this study agreed with their findings in that under moderate shade *Shorea roxburghii* performed well but when the light intensity was highest or lowest there were significant differences. Seedlings under full light also showed yellowish coloration and suffered from insect defoliation, spot infestation and eventual leaf fall. Olajuyigbe and Agbo-Adediran (2015) had suggested that *Entandrophragma angolense* could be a potential candidate for enrichment planting in degraded forest where there are gap openings for reduced insolation because of its capacity to grow well under shading and *Shorea roxburghii* has demonstrated similar ability in this study.

Collar diameter gave the best result in seedlings placed under direct (full) sunlight and this result agrees with that of Akinyele and Dada (2015) who reported best result for seedlings of *Terminalia superba* raised in full sunlight. Several authors have also recorded different variations in growth response to light availability in many tropical tree species such as *Bombax buonopozense, Cedrella odorata, khaya ivorensis, Terminalia ivorensis, Terminalia superb, Nauclea diderrichii, Entandrophragma angolense* and many others whose physiological development were affected by too much or too little light supply (Nwoboshi, 1972; Gyima and Nakao, 2007; Olajuyigbe and Agbo-Adediran, 2015; Akinyele and Dada, 2015).

CONCLUSION

This study has shown that understanding *Shorea roxburghii* seedlings' response to different level of sunlight supply is critical to its management and as light is one of the important environmental factors necessary for the growth and development of plants, its judicious use by plants goes a long way to determining the survival of the plant. As it is shown, light intensity influenced the growth of *Shorea roxburghii* and proper management of it can result into optimum growth and development. This study also revealed that *Shorea roxburghii* can survive under moderate shading and it bodes well for the future as a candidate for enrichment planting in degraded forests.

RECOMMENDATION

The species at the nursing stage needs some shade for optimum performance. Hence, silviculturists and nursery attendant should provide the optimum condition in terms of light supply and other important environmental conditions necessary for the growth and development of this important species at the nursery stage because its survival in the field depends heavily on these.

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