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LIGHT INTENSITY VARIATION AND EARLY GROWTH PERFORMANCE OF *Anona muricata* Linn SEEDLINGS IN SOUTH-WESTERN NIGERIA

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ABSTRACT

The study was carried out in the Silviculture nursery of Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Nigeria. Fruits were collected from Ogun, Osun, Ondo and Oyo States. The seeds were extracted, air dried and seedlings raised. Each seedling was transplanted into a polythene pot filled with top soil. . A total of 160 seedlings were exposed to four different light intensities (100%, 75%, 50% and 25%) under light screening chambers made from wooden frames and covered mesh on all sides with single, double or triple layers of synthetic 1mm mesh netting. The seedlings raised in the open nursery were receiving 100% light intensity and served as control. Seedlings were watered daily. Growth variables were taken fortnightly for eight months. The seedling height, collar diameter and number of the leaves were assessed. The results showed that the number of leaves of Anona muricata varied significantly among the three factors and the control. The highest number of leaves was found in seedlings exposed to 100% (23.2), 75% (20.65), 25% (20.2) and 75% (20.4) light intensities for seedlings raised from seeds from Ogun, Ondo, Osun and Oyo respectively. The least leaf number was found in 25% (19.9), 50% (19.25), 50% (2318.0) and 100% (19.5) in Ogun, Ondo, Osun and Oyo States respectively. The ANOVA revealed that there were no significant differences at 5% probability level in all the four seed sources. The highest diameter was found in seedlings exposed to 100% (4.47 mm), 75% (4 mm), 100% (4.14mm) and 75% (3.90 mm) light intensities in Ogun, Ondo, Osun and Oyo States respectively while the least was observed in 25% (3.06mm), (3.60 mm), (3.61 mm) and (3.36 mm) in all states. There were significant differences at 5 % probability level among the treatment in Ogun, Osun and Oyo States while in Ondo State, there was no significant difference at 5% probability level. The highest height was found in 75% (31.01 cm), (32.44 cm), (31.69 cm) and (33.43 cm) light intensity while the least was found in 25% (21.01 cm), (22.46cm), (25.28cm) and (22.86 cm) light intensity in all sources. The ANOVA revealed no significant differences at 5% probability level in all the four sources used. Therefore, it was concluded that A. muricata requires partial shade (75 % light intensity) and seeds from Oyo State were found best among the sources.

Keywords: Light intensity, *Annona muricata*, southwestern Nigeria, early growth performance

INTRODUCTION

Edible tree species become substitute sources of food with high potential of vitamins, minerals and other vital elements especially during seasonal food shortage (Umaru *et al*., 2007). *Annona muricata* commonly known as soursop belong to a member of the Annonaceae family comprising of 130 genera and 2300 species (Okoli *et al.*, 2016). The fruit is usually called soursop due to its slightly acidic taste when ripe (Mashira *et al.*, 2013). The acetogenin compounds present in *A. muricata* has pronounced it anti-cancer, the leaf extracts from *A. muricata* are used for anti-tumor properties in various types of cancer cells and other ailments (Yang *et al*., 2015).

*A. muricata*is known to the warmest tropical areas in South and North America and is now widely distributed throughout tropical and subtropical parts of the world, including Malaysia, India and Nigeria (Adewole and Ajewole, 2009). *A. muricata*is an evergreen erect tree reaching 5–10 m in height and

features an open, roundish canopy with large, glossy, dark green leaves (Pinto *et al*., 2005). The edible fruits of the tree are large, heart-shaped and green in color, and the diameter varies between 15 and 20 cm (De Souza *et al.*, 2009). A mature tree of *A. muricata* grows up to 5-10m in height and it is found majorly in forest zone of Nigeria (Moghadamtousi *et al*., 2015).

A major factor that is important in successful forest plantation establishment is the quality of the forest planting stocks that is being supplied for planting especially in large forest site. According to Elmagboul *et al*. (2014), provenance trials serve as useful tool to support a rational planting, decision on sustainable basis for forest improvement, fruit and wood production in this rapidly changing environment. In the forestry sector, the study of similarities in the climates to match forest seed materials to certain sites in order to assist species selection is a good approach for efficient and sustainable forest production (Williams *et al.*, 2007). The studies of provenance trial remain valuable in the selection of seeds with desired qualities for propagation especially for seedling production both for commercial nurseries and plantation establishment. The survival of forest plantation, growth performance, volume and quality of forest produce harvested over time in a given plantation is by no doubt influenced by the seed qualities which give birth to quality seedling production. Therefore, with these reasons forest seedlings should be of high quality that can withstand different stresses on the field and produce high yielding potentials for improved forest productivities especially production of forest fruit trees. This process could be achieved by determining a better seed zone for most fruit species thereby reducing the risk of planting poor forest stock that pose a great threat to sustainable forest growth (Hamann *et al*., 2000); but there is need in making use of well adapted plant stock that is able to withstand any environmental challenges.

Response to light biologically can be described as simple functions of irradiance and rate of photosynthesis in plants is a typical example. Although photosynthesis is a function of irradiance while growth is determined by the sum of photosynthetic carbon fixation over time which is in turn, a function of the amount of light received by the plant over that period, thus, growth, yield and many other long-term effects of light, are best described by the accumulation of photosynthetic radiation, for example by daily light intensity (Korczynski *et al*., 2002; Dielen *et al*., 2004). Light damage is also often a function of accumulated dose, as with many whole-plant responses to ultra violet radiation (Gonzalez *et al*., 1998). The quantity of light reaching the surface at a given period of time is usually referred to as 'light intensity (Kitaya *et al*., 1998).

Annona muricata is a multipurpose tree species usually cultivated mainly in home gardens and behave significantly with different environmental conditions. The species has been verified potent as contemporary treatment for cancer and other devastating ailments in humans (Agu *et al*., 2017). Despite this notable potentials information as regards, the growth and response to change in habitat and some environmental conditions are limited. Hence, this study examined the effect of light intensity variation on the growth of *A. muricata* seedlings from different provenances in Southwest Nigeria.

MATERIALS AND METHODS

Study Area

The experiment was carried out in the central nursery of Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan. The area is between Latitude 7^{o} N and 7.2^{o} N and Longitude 26^{o} E and 27^{o} E. The climate is mainly tropical with rainfall patterns ranging between 1000mm and 14500mm, the average temperature is about 30 ^{o}C while relative humidity is about 65%. There are two different climatic seasons which are the dry (November - March) and the rainy seasons (April - October). The climate of the area is dominated by rainfall pattern ranging from 1400 mm to 1500 mm. The average temperature is about 26 ^{o}C and relative humidity is about 65% (FRIN Meteorological Station, 2019)

Experimental Design

Two Hundred (200) mature seeds of *A. muricata* were sourced from each of four Southwest Nigeria States (Ogun, Ondo, Osun and Oyo). The seeds were sown into the germination trays and monitored

for 5 weeks. One Hundred and Sixty (160) uniform and healthy seedlings each per each source were selected. Each seedling was transplanted into a poly bag measuring 18.5 cm x 25.5 cm, filled with top soil of 5kg each. Seedlings were monitored inside the green house. Watering was done daily. Weeding was carried out regularly and when required.

Light screening chambers were constructed for the experiment. The light intensity chambers were constructed in such a way that wooden frames were built and covered with layers of 1 mm mesh net on all the side except 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). Hence, 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 per seed source. The following growth variables were assessed weekly for a period of eight months: stem height (cm), stem diameter (mm) and number of leaf. A mini veneer caliper was used to measure the stem diameter; a measuring tape was used for the stem height while counting was used to determine the number of leaves

Data Analysis

Growth data collected were subjected to analysis of variance (ANOVA) while means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS

Effect of light intensity on number of ~~leaf~~ leaves of *Annona muricata*

The results (Table 1) revealed that the mean number of leaves *A. muricata* varied significantly among the three factors and the control. In Ogun State results on the mean number of leaves showed that the control had the highest mean number of leaves with 23.2 followed by 50% and 75% with the mean values of 20.7 and 20.0 respectively while 25% had the least mean value of 19.9. In Ondo State the mean number of leaves was highest (20.68) for 75% light intensity and least (19.25) for 50%. In Osun State, the result of the mean number of leaf showed that seedlings under 25% light intensity had the highest mean number of leaves (20.2) followed closely by seedlings exposed at light intensity of 75% having the leaf number of 20.0 while the least mean number of leaves was recorded in seedlings exposed to 50% light intensity with leaf number of 18.8 (Table 1). The result on number of leaves in Oyo State showed that the mean number of leaves for seedlings exposed to 75% had the highest mean number of leaves (20.4) while the control (100 % light intensity) had the least value of 19.5 (Table 1). There was no significant difference at 5% probability level in all the four seed sources used in this study (Table 2).

Effect of light intensity on stem diameter growth of *Annona muricata*

In Ogun State the mean diameter growth showed that the control (100%) had the highest mean diameter of 4.47mm. This was closely followed by seedlings exposed to 75% light intensity with mean diameter of 4.13mm, while seedlings under 50% and 25% light intensity had a mean diameter of 3.82mm and 3.06mm respectively (Table 1). In Ondo State the mean diameter showed that 75% light intensity had the highest mean diameter of 4.00mm followed by the 50% light intensity which had 3.70 mm while the least mean diameter of 3.60mm was observed in seedlings exposed to 25% light intensity (Table 1). In Osun State, the result of the mean diameter showed that control had the highest mean diameter of 4.14mm; while those under 25% light intensity had the least diameter of 3.61 mm. The result of diameter growth in Oyo State showed that the seedlings under 75% light intensity had the highest mean diameter of 3.92mm, followed by the control which had 3.83 while seedlings under 50% and 25% had 3.43 mm and 3.38 mm respectively (Table 1). There were significant differences at 5% probability level among the treatment in Ogun, Osun and Oyo States while in Ondo State, there was no significant difference at 5% probability level (Table 2).

Effect of light intensity on stem height growth of *Annona muricata*

In Ogun State the mean height growth showed that the seedling under 75% had the highest mean height of 31.01cm; followed by the control with a mean height of 29.88 cm, while seedlings under 50% and 25% light intensity had diameters of 26.04 cm and 21.01 cm respectively (Table 1). In Ondo State 75% light intensity had the highest stem height growth of 32.44cm followed by the control which had 23.84 cm while the least mean height was observed in seedlings subjected to 25% light intensity with the value of 22.46 cm (Table 1). In Osun State, seedlings subjected to 75% light intensity had the highest mean height (31.69 cm) while those under 25% light intensity had the least height of 25.28cm. The result of light intensity in Oyo State showed that the mean height of seedlings exposed to the 75% of light intensity had the highest mean height of 33.43cm, followed by the control which had 26.25 cm while the least value was recorded in seedlings subjected to 25% having the value of 22.86 cm (Table 1). There was no significant difference at 5% probability level in all the four sources used in this study.

Table 1: Seedling growth variables for *Annona muricata* (Mean ± Standard Error)

Treatment	Growth variables	Ogun State	Ondo State	Osun State	Oyo State
75% Light	Leaf No	20.0±0.863^{ns}	20.68±0.852^{ns}	20.0±0.894^{ns}	20.4±0.850^{ns}
	Height (cm)	31.01±1.356*	32.44±1.360*	31.69±1.353*	33.43±1.404*
	Diameter (mm)	4.13±0.155	4.0±0.133^{ns}	4.06±0.146	3.92±0.137
50% Light	Leaf No	20.7±1.006^{ns}	19.25±0.917^{ns}	18.8±0.796^{ns}	19.9±1.001^{ns}
	Height (cm)	26.04±0.913*	23.60±0.877*	26.56±1.032*	26.04±0.924*
	Diameter (mm)	3.82±0.134*	3.7±0.132*	3.99±0.133*	3.43±0.120*
25% Light	Leaf No	19.9±1.150^{ns}	20.4±0.998^{ns}	20.2±1.005^{ns}	19.8±1.098^{ns}
	Height (cm)	21.01±0.785*	22.46±0.675*	25.28±0.824*	22.86±0.782*
	Diameter (mm)	3.06±0.116*	3.60±0.108^{ns}	3.61±0.115*	3.38±0.109*
100% Light	Leaf No	23.2±1.087^{ns}	20.1±1.043^{ns}	19.913±1.024^{ns}	19.5±0.819^{ns}
	Height (cm)	29.88±1.076*	23.84±0.838*	28.49±1.149*	26.25±0.981*
	Diameter (mm)	4.47±0.162*	3.66±0.129^{ns}	4.14±0.151*	3.83±0.144*

**significant and ns = not significant at P < 0.05*

DISCUSSION

The seedlings height increment across the State in this study revealed that 75% light intensity had the overall best height and it was closely followed by 100% light intensity in Ogun and Osun. This showed that *Annona muricata* needs nothing less than 75% percentage of light to thrive well. The intensity of light plays a key role in regulating the height growth of *A. muricata* (Nhut *et al.*, 2003, Johkan *et al.*, 2012). Increasing stem height under increased light intensity may be due to increased irradiance received by the plants, increased height growth resulting from more photosynthesis. Increased plant height under a higher light intensity in Cardinal flower (*Sinningia cardinalis*) has also been reported previously. This result is in agreement with earlier research of Armitage (1991) in which 67% shade increased plant height in various field-grown cut-flower species because 67% shade increase was close to 75% light intensity in this study that gave best height increase indicating that *A. muricata* may need shade avoidance mechanism to overcome a lower light intensity problem.

These results are not in agreement with decreased shoot length at high light intensity because 75% of light intensity penetration is closer to the control having 100% penetration gave the highest height increment in all sources. However, Elmagboul *et al.*, (2014) pointed out that stem elongation may not occur when irradiance is reduced to a level where plant developmental processes become photosynthetically limited. This observation may apply to the plants subjected to 25% and 50% having a decrease in height growth respectively. Light intensity is a factor that affects the

photosynthetic activity of plants (Marenco *et al*., 2006).

The process of opening and closing of stomata is mainly related to the intensity of light. Thus, the functioning of the stomata and leaf area influence the productivity of the plant. *A. muricata* seedlings might not be given enough for photosynthetic activities to produce the carbohydrate needed for a plant to support the growth and this may cause delay or inhibition the height under low light variation for the seedlings subjected to 25% and 50% light intensity as temperature have been reported in other plants to stimulate plant growth. According to Lima *et al.*, (2008) studying the growth of *Caesalpinia ferrea Mart. ex Tul*. (Leguminosae, Caesalpinoideae) found that this species had limitations imposed on light conditions (50 and 70% shading), reducing biometric variables that affect better growth and this can be applied to this study for the seedlings subjected to 25% and 50% light intensity and Oyedeji and Akinyele (2016) found that *Dialium guineense* tree species demands high light intensity especially in the early stage for proper growth and development.. Meanwhile, the study showed that there was no effect of light intensity on the number of leaves produced. All the conditions to which the seedlings were subjected to gave same outcome

In terms of stem diameter growth, seedlings fewer than 100 % light intensity (control) performed better followed by seedlings subjected to 75% had the highest diameter value. The overall best performance in stem diameter was noticed from seedlings subjected to 75% and 100% light intensity. According to Matsuda *et al*., (2004) and Jao *et al*. (2005) for a plant to grow effective light source is important for the development. This study is not in agreement with the report by Kim *et al.* (2004) that high percentage of the light source may suppress the shoot growth. This finding is consistent with what is known about light effects playing more conspicuous roles in low-light environments (Zhang *et al.,* 2011; Wang *et al*., 2015).

CONCLUSION

Light intensity has great influence on seedling growth and development of *A. muricata* especially in the early stage for proper growth and development. The seed sources have effect on seedlings height, diameter and leaf number at nursery stage. It can be concluded that *A. muricata* requires partial shade (75 % light intensity) for seedling growth and development in proper plantation establishment for this particular species. Oyo State was found best among the sources. The height and other growth parameters depend on light intensities received by the plant. Therefore, 75 % light intensity was recommended.

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