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Influence of Light Intensity on Early Growth of *Adansonia digitata* (L.)

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Abstract

This study investigated the influence of light intensity on early growth of A. digitata. The experiment was conducted in the nursery of the Department of forestry and fisheries, Kebbi State University of Science and Technology, Aliero. Five weeks old seedlings were used where fifty seedlings each were allocated to 25, 50, 75 and 100% light intensity chambers. A completely randomized design was used and data was collected on stem height, collar diameter, number of leaves, seedlings dry weight, net assimilation rate, relative growth rate and absolute growth rate. The result revealed that, light intensity had no significant ($p>0.05$) influence on stem height, collar diameter and number of leaves. Although a significant effect was observed in seedlings dry weight where seedlings exposed to 50% light intensity had the highest total dry weight (TDW) (19.75g). It was concluded that light intensity had no significant influence on seedlings stem height, collar diameter and number of leaves but had significantly influenced seedlings dry weight of the species. 50% light intensity was recommended for early growth of A. digitata.

Keywords: Light intensity, Growth, Seedlings and Environment.

Introduction

Forest resources were reported to constitute a significant element in the national economy of many tropical countries[1] and is connected the provision of numerous goods and services to man and animals[2]. In the recent past, forest resources were taken for granted because they were found to be abundant but the situation has now changed as people are more concerned now with the status of forest and are becoming aware of the direct and far-reaching influences of the forest as the forested areas continually diminished at alarming rate and the demand of forest goods and services soar[3]. Germination, early growth and development of trees like *Vitex doniana, Diospyros mespiliformes, Adansonia digitata, Balanites aegyptiaca* and *Parkia biglobosa* serving as sources of NWFPs are known to be affected by the condition of the growth media and climatic condition while there is also limited information about their method of propagation[2]. In line with this, the inability of the local farmers to embark on domestication of these fruit trees is reported to be due to lack of adequate knowledge on the condition necessary for their germination and seedling production techniques[4]. This is directly linked to be the reason why indigenous trees are not targeted in many afforestation programmes for combating desertification in Nigeria[1]. *A. digitata* (L.) belongs to the family *Bombacaceae*, found in many African countries[5,6] and in all ecological zones of Nigeria[7]. The tree has significant contribution to the livelihood of the people with numerous goods and services[8-11]. Despite the economic potentials of *A. digitata* the sustained provision of its goods and services is questionable as it was reported to be threatened and becoming extinct for its inability to regenerate under natural condition as a result of the increasing human pressure, seed dormancy, drought and other environmental factors[12]. Information on the physiological response of seedlings to different light intensities will provide a better understanding of species requirements that will assist in seedling establishment for plantations, domestication and in different forestry programmes[13,14].

Materials and Methods

This study was conducted in Aliero (latitude 12°16′42″N and Longitude 4°27′6″E) with an area of about 350km^2 inhabited by agrarians with special emphasis on Onion and Paper. The climate of the area is tropical continental and is controlled by tropical maritime air from Atlantic and tropical continental from Sahara desert which determine wet (May-September) and dry seasons (October-April). The area is characterized with high temperature (mean 26^{o}C) and mean annual rainfall of about 800mm[1]. The natural vegetation of Aliero is Sudan savanna, with shrubs and scattered trees dominated by grasses and species like *Ziziphus species, Combretum spp., Piliostigma reticulatum* and *Acacia species*.

Five weeks old seedlings were randomly selected from the nursery and allocated to four (4) different light intensities (100%, 75%, 50% and 25%) with ten seedlings per light intensity. Seedlings were arranged in a completely randomized design. Chambers for the experiment were constructed with wood of 5cm x 5cm thickness. The dimension of each chamber was 1.8mx1.2mx1.3m. The wood frames were covered on all side with single, double or triple layers of 1mm synthetic green mesh net. This was to achieve varying levels of light intensities as: frame covered with one layer of mesh reduced light by 25%,

two layers by 50% and three layers by 75%. The 100% light intensity was achieved by exposing the seedlings to full light[2,15,1].

The growth variables measured were: seedling stem height, collar diameter and number of leaves. Metre rule was used to measure height, micro-meter screw gauge for diameter and number of leaves was counted. Biomass (seedlings dry weight) was assessed at the 6th and 12th weeks of the experiment through destructive method[15]. Seedlings were sampled and separated into root, stem and leaves. Leaf area was measured by tracing the area covered on graph sheet. Fresh weight of root, stem and leaves were measured before they were oven dried at 80°C to constant weight. The dry weight and leaf area were used to calculate the Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Absolute Growth Rate using the following formula[16].

Net Assimilation rate (NAR)

$$NAR = \frac{w_2 - w_1 \; X \; LnA_2 - \; LnA_1}{A_2 - \; A_{12} \; X \; t_2 - \; t_1}$$

where, w_1 and w_2 = biomass at time t_1 and t_2, A_1 and A_2 = leaf area at time t_1 and t_2, LnA_1 and LnA_2 = natural logarithm of leaf area at time t_1 and t_2.

Relative Growth Rate (RGR)

$$RGR = \frac{Lnw_2 - Lnw_1}{t_2 - t_1}$$

where, Lnw_2-Lnw_1 = natural logarithm of biomass at time t_1 and t_2, t_1 and t_2 = time interval between first and second harvest.

Absolute Growth Rate (AGR)

$$AGR = \frac{w_2 - w_1}{t_2 - t_1}$$

where, w_1 and w_2 = biomass at time t_1 and t_2, t_1 and t_2 = time interval between first and second harvest.

Results and Discussion

Stem Height: Light intensity had no significant effect (P>0.05) on seedlings height of *A. digitata* at 10 weeks after emergence. 25% light intensity had height of 45.20±7.27cm but not significantly (P>0.05) different with 100% light intensity which had 38.40±2.90cm (Table-1).

Collar Diameter: There was no significant effect on seedlings diameter at ten weeks after emergence. Table-1 shows the mean seedlings diameter as influenced by different light intensities where 100% light intensity had 11.00±1.62mm which was not significantly different (P>0.05) with the least diameter obtained from 25% light intensity (9.8±1.11mm) (Table-1).

Number of leaves: No significant (P>0.05) effect was observed in seedlings number of leaves as influenced by light intensity. Table 1 shows the mean leaf production of seedlings exposed to varying light intensities and the highest leaf production was recorded in seedlings under 50% light intensity (16±3.88) which was not significantly different to 13±3.69 from 100% light intensity.

Leaves Dry Weight (LDW): Light intensity had a significant influence (P<0.05) on LDW at ten weeks after emergence (Table-2). 50% light intensity had the highest LDW (5.75±0.78g) that significantly differed to 100% light intensity (2.40±0.57g) (Table-2).

Stem Dry Weight (SDW): Significant difference was observed on seedlings SDW (P<0.05). Table 2 shows mean SDW where 50% light intensity produced highest SDW (5.45±0.35g) which significantly differed with 100, 75 and 25% light intensities.

Table-1
Effect of Light Intensity on Seedlings growth of *A. digitata*

	Stem Height (cm)		Collar Diameter (mm)		Number of leaves	
Light intensity (%)	**2WAE**	**10WAE**	**2WAE**	**10WAE**	**2WAE**	**10WAE**
100	20.20±6.77	38.40±2.90	5.16±1.21	11.00±1.62	11±1.94	13±3.69
75	13.65±2.26	43.60±6.84	4.78±0.59	10.00±0.00	9±1.56	14±1.48
50	16.50±5.24	40.00±27.46	5.80±1.35	10.32±0.49	10±1.54	16±3.88
25	16.00±3.69	45.20±7.27	5.10±0.76	9.85±1.11	10±1.29	15±5.17
S.E±	1.122	3.076	0.226	0.231	0.368	0.835
Significance	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Significance: 0.05, WAE: Week after emergence.

Root Dry Weight (RDW): No significant effect was observed on RDW under different light intensities (Table 2). Though 50% light intensity had the higher RDW (8.55±2.19g) it was not significantly different (P>0.05) with the least RDW (4.05±0.92g) in 75% light intensity (Table-2).

Total Dry Weight (TDW): A significant effect (P<0.05) was recorded from light intensities on TDW (Table 2) where 19.75±2.61g was the highest mean TDW obtained from seedlings exposed to 50% light intensity which was significantly different (P<0.05) with 75% light intensity (10.35±1.34) (Table-2).

Leaf Area: There was significant (P<0.05) effect on leaf area of seedlings exposed to different light intensities. Figure 1 shows mean leaf area of different light intensities and 100 and 50% light intensities had the highest leaf area of 57.25cm^2 and 37.25cm^2 respectively which significantly differed with 75% (31.50cm^2) and 25% light intensities (8.00cm^2).

Net Assimilation Rate (NAR): Light intensity had no significant effect on NAR between 4th and 10th weeks after emergence. 100% light intensity had NAR of 0.00658 but was not significantly different (P>0.05) with 75, 50 and 25% light intensities (Table-3).

Relative Growth Rate (RGR): There was no significant effect (P>0.05) on seedlings RGR between 4th and 10th weeks after emergence (Table-3).

Absolute Growth Rate (AGR): No significant effect was observed on AGR of seedlings as influenced by light intensity (Table-3). 50% light intensity had AGR of 0.27589 but was not significantly different to 75% light intensity which had 0.04375 (Table-3).

Table-2
Effect of light intensity on seedlings dry weight of *A. digitata*

Light intensity (%)	Dry weight: (g)			
	LDW	SDW	RDW	TDW
100	2.40±0.57^{b}	3.10±1.41^{b}	6.20±1.13	11.70±3.11^{ab}
75	3.50±0.71^{ab}	2.80±0.28^{b}	4.05±0.92	10.35±1.34^{b}
50	5.75±0.78^{a}	5.45±0.35^{a}	8.55±2.19	19.75±2.61^{a}
25	3.60±1.13^{ab}	2.80±0.57^{b}	5.10±2.26	11.50±3.95^{ab}
S.E±	0.508	0.470	0.783	1.615
Significance	*	*	*ns*	*

Means followed by the same letter(s) within a column are not significantly different (P>0.05). LDW: Leaves dry weight, SDW: Stem dry weight, RDW: Root dry weight, TDW: Total dry weight.

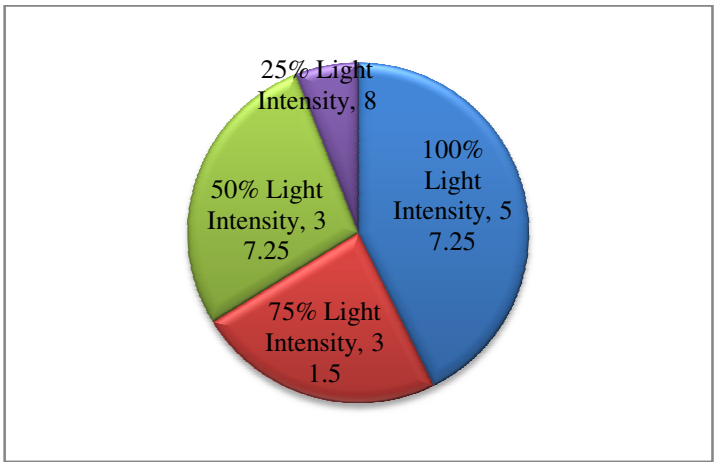

Figure-1
Effect of light intensity on leaf area (cm^2) of *A. digitata* seedlings

Table-3
Effect of light intensity on NAR, RGR and AGR of *A. digitata* seedlings

Light intensity (%)	NAR	RGR	AGR
100	0.00658±0.00195	0.01544±0.00000	0.12589±0.03914
75	0.00107±0.00113	0.01355±0.00517	0.04375±0.03914
50	0.00446±0.00028	0.01531±0.19559	0.27589±0.02651
25	0.00458±0.00648	0.03051±0.00661	0.10982±0.15531
S.E±	0.001184	0.00384	0.03908
Significance	*ns*	*ns*	*ns*

Significance: 0.05. NAR: Net assimilation rate, RGR: Relative growth rate. AGR: Absolute growth rate.

Discussion: Seedlings growth of *A. digitata* was not significantly different under varied light intensities. Although the dry weight (biomass) and leaf area were significantly improved by light intensity. Seedlings exposed to 25% light intensity had the highest height which could be an attempt to reach more light[17]. This is confirmed by Chaudhry A. et. al[18] that shading increases shoot growth at the expense of root growth and shading increases the relative proportion of red light reaching the plants causing stem elongation which is an effort by plants to reach upper canopy for normal light[18]. The result also confirms the findings of George Z. et. al[19] that height increase as the light intensity decreased. The higher number of leaves observed in seedlings under 50% light intensity could be to maximize the use of available light for photosynthesis while highest diameter in seedlings exposed to full light intensity an indication that the process of photosynthesis of *A. digiatata* is more efficient under full light exposure[17]. Seedlings dry weight of *A. digitata* was significantly enhanced by light intensity where reduced light (50%) had highest SDW, RDW and TDW which confirmed the findings of Mattana R.S. et. al [20] who reported higher biomass in reduced light intensity. The non-significant effect obtained in this experiment confirmed the findings of Bolanle O.T. et. al[21] who reported non-significant difference between 30-100% light intensities on early growth of *Kigelia africana*.

Conclusion

Light intensity does not influence height, collar diameter and number of leaves of *A. digitata* seedlings at the initial developmental stages especially nursery.

Recommendation: From the findings of this research, 50% light intensity is recommended for early growth of *A. digitata.*

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