EFFECT OF DIFFERENT SOWING MEDIA AND LIGHT INTENSITY ON THE GROWTH OF IROKO *(Milicia excelsaWelw. C.C. Berg)* SEEDLINGS

Ojekunle, O. O., Aduradola, A. M., and Francis, I. G.
Department of Forestry and Wildlife Management, College of Environmental Resources Management,
Federal University of Agriculture, Abeokuta, Nigeria.
opeyemiayooade@yahoo.com

Abstract
Miliciaexcelsa(Iroko) is a multipurposehardwood tree species of commercial importance and is of great importance in the wood industries. The contributions ofsoiland light to tree growth cannot be overemphasized. The effects of soil type(sandy soil, loamy soil, and sandy loamy soil) and varying intensity of light, (100%, 50% and 25%)on the growth of Miliciaexcelsaseedlings were examined in this study.A split-plot experiment, using Complete Randomized Design,was used. Seedling morphological and physiological variables were collected. The datawere subjected to Analysis of Variance and Duncan's Multiple Range Test was adopted for meanseparation.Sandy soil had the best performance in the stem height (21.05cm), leaf number (7), leaf area (59.26cm^2) and seedling height (35.15cm). Loamy soil gave the least performance.Although there was no significant effect (p>0.05). Light intensity of 50% recorded highest collar diameter (11.12cm) and seedling height (33.14cm) while 100% light intensity showed an early increase only in height but had lower values for leaf number and collar diameter.There was significant difference in all the morphological variables except for the numberof leaves (p>0.05). With respect to interaction between sowing media and light intensity, seedlings raised on sandy soil under 50% light intensity had the best result for all physiological parameters (chlorophyll content, Relative turgidity, Net assimilation rate, Relative growth rate and Absolute growth rate)while those raised on sandy soil of 25% light intensity had the least values.

Keywords: *sowingmedia, light intensity, Miliciaexcelsa, interaction, growth, seedlings*

Introduction

Forests covered almost a third of all land on Earth, providing vital organic infrastructure for some of the planet's densest, most diverse collections of life. Innumerable species are supported by the forest including our own, yet we are still allowing them to disappear. Humans now clear millions of acres from natural forests every year, especially in the tropics, letting deforestation threaten some of Earth's most valuable ecosystems (Russell, 2019).The use of plant materials as raw materials now stands next in importance to their uses as food directly or indirectly. Wood is still the world's major structural materials for building and other construction purposes. The mechanical and chemical conversions of wood to pulp for the manufacture of paper and certain synthetic textiles consume enormous quantities of wood. The distillation of wood yields a variety of valuable industrial chemicals such as methanol, acetic acids, turpentine, tanning materials and other products. In this age of energy shortages and oil politics, the practice, use and establishment of energy plantation or true plantation to harvest solar energy through bioconversion are being increasingly explored (Anon, 2012).

The Food and Agriculture Organization of the United Nations lists the requirement of sustainable forest management as: extent of forest resources, biological diversity, forest health and vitality, productive functions of forest resources, protective functionsof forest resources, socio-economic functions and a legal, policy and institutional framework. A lot of damage has been done to Nigeria's land through the processes of deforestation, notably contributing to the overwhelming trend of desertification. (Osa-Edoh, 2008). The rise in population decades past had increased the demand for quality and quantity of both wood and non-wood products giving rise to forest plantation establishment in Nigeria (Magarette, 1998).

Miliciaexcelsa commonly known as African teak or Iroko which belongs to Meliaceae family is a hardwood tree species from tropical Africa. The species is a large deciduous tree that grows up to 50 m in height, diameter at breast height (dbh) of 4 m, with high crown that is umbrella-likeand growing from a few thick branches (Christine, 2010). African teak has strong dark brown hardwood, resistant to termites and is used for construction, furniture, joinery, paneling, floors and boats. The tree can be used in the control of erosion. It makes a good shade tree and is useful as a roadside tree in urban areas. It grows rapidly, can be coppiced and is ready for cutting after about fifty years. The tree is nitrogen fixing and the leaves are used for mulching (FAO, 2012)

Soils are dynamic and diverse natural systems that lie at the interface between earth, air, water, and life. They are significant ecosystem service providers for the sustenance of humanity.Soil is a material composed of five ingredients minerals, soil organic matter, living organisms, gas, and water. Soil minerals are divided into three size classes clay, silt, and sand; the percentages of particles in these size classes is called soil texture(Brady and Weil, 2008).However, soil is not uniform, but exists in various forms or types. Soil types usually refer to the different sizes of mineral particles in a particular sample and each type plays a significantly different role (Joe and Jackie, 2015).

In forest ecosystems, soils can determine species composition, timber productivity, and wildlife habitat, richness, diversity, maintaining water quality and long-term site productivity (Joe and Jackie, 2015).How best a soil can be managed to obtain the highest yield and silvicultural treatment to apply is determined by the soil type (Nyland, 2002). From the perspective of tree growth, a soil is considered productive if it has the following qualities; adequate water intake, adequate water holding capacity, good aeration, adequate depth and adequate supply of essential nutrients. Soil management in silviculture involves attempt to obtain the right combination of these conditions (Brady and Weil, 1996). A forest manager must be able to appreciate these factors which governs the ability of a soil to supply air, water, nutrient, as well as stability to trees (Clark, 2007).

Light is also an important factor in tree growth. . A wide range of signals and information for morphogenesis and many other physiological processes is triggered by light (Chen et al.2004). Its effect on tree growth depends on quality, intensity, and time. Light intensity affects tree growth through its effect on photosynthesis, it also affects height growth, leaf size and structure of both the leaves and stems through its effect on cell enlargement and differentiation (Kozai,2016). When more light is available more energy is absorbed, more sugars are formed, more growth takes place (Flowerdew 2011).

The effects of soil texture are reflected in the composition and rate of growth of forest vegetation. The soil structure determines the porosity and pore size distribution of soil. They also determine the movement of air and water within the soil. Iroko seeds are recalcitrant and thus lose viability rapidly, hence the need to carefully examine the soil type that will be more effective for their growth.

Without light, a plant would not be able to produce the energy it needs to grow. While plant needs light to grow, not all light or plants are the same (Heather, 2015). Some plants are shade tolerant, while others are can be referred to as sun plants. The amount of light required by these plants varies considerably. It is therefore also important to study each plant under different light intensities to know which is best soothing for a particular plant, and supports its growth.

Materials and Methods

Study Area and Plant Materials

The experiment was conducted at the Federal University of Agriculture, Abeokuta Forestry Nursery Unit. The University is located at N7°13'54.343”E3°26'5067”. The region enjoys an average temperature of 25°C with double maximal rainfall regime. The humidity is relatively low in conjunction with air motion. The items used include Milicia excelsa seedlings, watering can, polythene pots, sandy soil, loamy soil, sandy loam soil, light meter, nets, hand trowel, head pan, ruler, field recording book, and water. Healthy seedlings of Milicia excelsa were obtained from Forestry Research Institute of Nigeria, Ibadan, Oyo State.Loamysoil, sandy soil, and sandy loam soil was collected from different areas within the school premises.

Sowing Media and Experimental Layout

Polythene pots were filled with different sowing media (Loamysoil, sandy soil, and sandy loam soil)replicated five times and the seedlings of Miliciaexcelsa of equal height and approximately of the same number of leaves were transplanted into the pots.

Table 1: Experimental layout

SOIL TYPE	LIGHT INTENSITY	TREATMENTS		REPLICATES				
				I	II	III	IV	V
Sandy soil S_1	L_1 (25%)	S_1L_1	1					
	L_2 (50%)	S_1L_2	2					
	L_3 (100%)	S_1L_3	3					
Loamy soil S_2	L_1 (25%)	S_2L_1	4					
	L_2 (50%)	S_2L_2	5					
	L_3 (100%)	S_2L_3	6					
Sandy loam S_3	L_1 (25%)	S_3L_1	7					
	L_2 (50%)	S_3L_2	8					
	L_3 (100%)	S_3L_3	9					
Clay soil S_4	L_1 (25%)	S_4L_1	10					
	L_2 (50%)	S_4L_2	11					
	L_3 (100)	S_4L_3	12					

Experimental Design

A 3 X 3 split-plot experiment using complete randomized designwas conducted to study effect of different sowing media and light intensity on the growth of Milicia excelsa seedlings.

Determination of Light Intensity

A light meter was used to measure the different light intensities under which the growth of the seedlings was studied and net was used to regulate the light intensity for each level. Light intensity of 25%, 50% and 100% was used for each soil type.

Data Collection on Morphological Parameters

The seedlings were watered daily and record of growth was observed fortnightly for a period of twelve weeks. Data on the stem height, seedling height, collar diameter, leaf number, leaf area were collected. Stem height was taken using a ruler and tape rule which was done by placing a ruler by the seedling such that the 0 mark will be pointing to the soil. The collar diameter was taken using a veneer caliper calibrated in millimeters (0.1 –0.9). Leaf area is the product of leaf length and leaf breadth, leaf number was obtained by counting the number of leaves on a stem.

Data Collection on Physiological Parameters

Destructive sampling was carried out on seedlings to obtain the relative turgidity, chlorophyll content, shoot to root ratio, NAR(Net assimilation rate), RGR (Relative growth rate), AGR (Absolute growth rate).

$$\text{Relative Turgidity (RT)} = \frac{FreshWeight - DryWeight}{Turgidweight - DryWeight} \times 100$$

$$\text{Root to shoot ratio} = \frac{\text{Root weight}}{\text{Shoot weight}}$$

$$NAR = \frac{\text{Final weight } (W_2) - \text{Initial weight } (W_1)}{\text{Change in time } (T) \times \text{Leaf area}}$$

$$RGR = \frac{W_2 - W_1 \times 100}{T}$$

$$AGR = \frac{W_2 - W_1}{T}$$

Data Analysis

A 3 X 3 split-plot experiment using complete randomized design(CRD)was adopted. The datawere subjected to analysis of variance, using Duncan's Multiple Range Test for the separation of means at 5% level of probability

Results

Effect of different sowing media on the morphological parameters of Miliciaexcelsaseedlings.

The result showed that different sowing media has no significant effect on the morphological parameters of Miliciaexcelsaseedlings($p>0.05$). The highest value for the stem height (21.05cm) was observed in seedlings raised on sandy soil while the least value (18.47cm) was from seedlings raised on loamy soil. For the collar diameter, seedlings raised on sandy loam soil has the highest value of 9.90mmwhile those raised on loamy soil recorded the least value of 4.96mm.Leaf number was highest at S1 (6.61) and lowest at S3 (5.92). The leaf area has the highest value of 59.26cm^2 at S1 and the lowest value of 51.89cm^2 at S3 that is seedlings raised on sandy loam soil. Seedling height was highest at S1 (35.15cm) and lowest at S2 (30.70cm) for seedlings raised on loamy soil(Table 2).

Table 2: Showing the effect of different sowing media on morphological parameters of *Miliciaexcelsa*seedlings

	STEM HEIGHT (cm)	COLLAR DIAMETER (mm)	LEAF NUMBER	LEAF AREA (cm^2)	SEEDLING HEIGHT (cm)
S1	21.05^{a}	6.81^{a}	6.61^{a}	59.26^{a}	35.15^{a}
S2	18.47^{a}	4.96^{a}	6.01^{a}	52.53^{a}	30.70^{a}
S3	20.68^{a}	9.90^{a}	5.92^{a}	51.89^{a}	32.70^{a}

Mean values with the same subscripts in each column are not significantly different (p > 0.05)
S1- Sandy soil, S2- Loamy soil, S3- Sandy loam soil.

Effect of Different Sowing Media on the Physiological Parameters of Milicia Excelsa Seedlings.

The result showed that there was no significant effect (p>0.05) on the physiological parameters of Miliciaexcelsaseedlings as they grow on different sowing media. The maximum and minimum values for chlorophyll content, relative growth rate, and absolute growth rate were almost of the same value. The highest value for the relative growth rate was observed to be 38.92g/wk for seedlings grown on sandy soil, while the lowest value was found under loamy soil of 37.12g/wk. Net assimilation rate showed highest value at S1 and the lowest at S3. (Table 3)

Table 3: Effect of Different Sowing Media on the Physiological Parameters of *Miliciaexcelsa S*eedlings.

	Chlorophyll Content	Relative turgidity	Net assimilation rate	Relative growth rate	Absolute growth rate
S1	1.105^{a}	38.92^{a}	0.00081^{a}	0.013^{a}	0.036^{a}
S2	1.108^{a}	37.12^{a}	0.00005^{a}	0.01031^{a}	0.0238^{a}
S3	1.105^{a}	38.86^{a}	-0.00129^{a}	0.01737^{a}	0.0400^{a}

Mean values with the same subscripts in each column are not significantly different (p > 0.05)
S1- Sandy soil, S2- Loamy soil, S3- Sandy loam soil.

Effect of Different Light Intensity on the Morphological Parameters of Miliciaexcelsa Seedlings

The result showed that there was no significant effect of light intensity on the morphological parameters of M. excelsa seedlings (p>0.05). Considering the stem height, it was observed that light intensity of 100% produced the maximum value which is 24.38cm while 50% light intensity produces the minimum value of 23.01cm. Collar diameter has the maximum value of 11.12mm under light intensity of 50%, and a minimum value of 7.59mm under 25% light intensity. With respect to the leaf number, L3 which is 25% light intensity has the maximum value of 15.79 while the minimum value of 12.08 was observed under 50% light intensity. Leaf area ranges from 53.024cm^2– 56.227cm^2 under light intensity of 50% and 100% respectively. The seedling height was highest at 50% light intensity and lowest at 100% light intensity. (Table 3)

Table 4: Effect of Light Intensity on the Morphological Parameters of *Miliciaexcelsa S*eedlings.

	STEM HEIGHT (cm)	COLLAR DIAMETER (mm)	LEAF NUMBER	LEAF AREA (cm^2)	SEEDLING HEIGHT (cm)
L1	24.38^{a}	9.907^{a}	13.021^{a}	56.227^{a}	32.310^{a}
L2	23.009^{a}	11.115^{a}	12.085^{a}	53.024^{a}	33.138^{a}
L3	23.983^{a}	7.595^{a}	15.797^{a}	54.909^{a}	32.850^{a}

Mean values with the same subscripts in each column are not significantly different (p > 0.05)
L1-100% Light intensity, L2- 50% Light intensity, L3- 25% Light intensity.

Effect of Light Intensity on the Physiological Parameters of Miliciaexcelsa Seedlings

The result showed that light intensity has no significant effect on the physiological parameters of Miliciaexcelsaseedlings(p>0.05). Seedlings that was grown under 100% light intensity did not survive to the end of the experiment and at such, no physiological parameters was taken on them. The other two light intensities of 50% and 25% respectively showed no significant difference in their analysis of variance. For the chlorophyll content, net assimilation rate, relative growth rate and absolute growth rate, L2 (50%) has the maximum values while L3(25%) has a maximum value only for the relative turgidity. (Table 5)

Table 5: Effect of Light Intensity on the Physiological Parameters of *Miliciaexcelsa S*eedlings.

	Chlorophyll Content	Relative Turgidity	Net Assimilation Rate	Relative Growth rate	Absolute Growth Rate
LI	W	WWWW			
L2	1.116[a]	38.011[a]	0.001022[a]	0.02606[a]	0.0600[a]
L3	1.0960[a]	38.512[a]	-0.0003896[a]	0.00290[a]	0.00667[a]

Mean values with the same subscripts in each column are not significantly different (p >0.05)
W-Wilted before commencement of measurement.
L1-100% Light intensity, L2- 50% Light intensity, L3- 25% Light intensity.

Effect of Different Sowing Media and Light Intensity on the Morphological Parameters of Miliciaexcelsa Seedlings

The result showed a significant difference between S1L1 and S2L1 with the values 23.33cm and 17.30cm respectively for the stem height. This means that the seedlings grown on sandy soil under 100% light intensity has the maximum value for stem height. Collar diameter indicates there is a significant difference between S1L1 and S3L3. For the leaf number, there was no significant effect (p>0.05) of soil and light on the seedlings, but the maximum value of 7.95 was found under treatment S1L3. There was also a significant difference between S1L1 and S2L1 of the leaf area. With respect to the seedling height, the result showed a significant difference between S1L1 and S2L1 where the maximum value of 38.229cm was recorded for S1L1 and the minimum value of 26.396cm was found from S2L1. (Table 6).

Table 6: Showing the effect of different sowing media and light intensity on the morphological parameters of *Milicia excelsa* seedlings.

	STEM HEIGHT (cm)	COLLAR DIAMETER (mm)	LEAF NUMBER	LEAF AREA (cm^2)	SEEDLING HEIGHT (cm)
S1L1	23.333[a]	3.125[a]	5.79[a]	73.40[a]	38.229[a]
S1L2	19.996[ab]	2.967[ab]	6.67[a]	50.47[ab]	34.292[ab]
S1L3	19.550[ab]	2.882[ab]	7.95[a]	54.04[ab]	33.100[ab]
S2L1	17.300[b]	2.943[ab]	4.96[a]	38.49[b]	26.396[b]
S2L2	19.313[ab]	2.865[ab]	6.54[a]	54.16[ab]	32.208[ab]
S2L3	18.405[ab]	2.931[ab]	6.90[a]	67.58[ab]	33.125[ab]
S3L1	19.667[ab]	3.062[ab]	5.63[a]	55.23[ab]	31.729[ab]
S3L2	20.333[ab]	2.949[ab]	6.00[a]	55.19[ab]	31.938[ab]
S3L3	21.825[ab]	2.345[b]	6.55[a]	45.12[ab]	35.350[ab]

Mean values with the same subscripts in each column are not significantly different (p > 0.05)

Mean values with the same subscripts in each column are not significantly different (p > 0.05)

S1L1-Sandy soil under 100% Light intensity, S1L2- Sandy soil under 50% Light intensity, S1L3-sandy soil under 25% light intensity, S2L1- Loamy soil under 100% Light intensity, S2L2- Loamy soil under 50% Light intensity, S2L3- Loamy soil under 25% Light intensity, S3L1- Sandy loam soil under 100% Light intensity, S3L2- Sandy loam soil under 50% Light intensity, S3L3- Sandy loam soil under 25% Light intensity.

Effect of Different Sowing Media and Light Intensity on the Physiological Parameters of Miliciaexcelsa Seedlings.

The result here also showed that sowing media and light intensity does not have a significant effect on the physiological parameters of the seedlings (p>0.05). It is noteworthy that seedlings grown under 100% light intensity did not survive through the entire experiment. It was also observed that S1L2 has the maximum values for all the physiological parameters (Table 7).

Table 7: Showing the Effect of Different Sowing Media and Light Intensity on the Physiological Parameters of *Miliciaexcelsa S*eedlings.

	Chlorophyll Content	Relative Turgidity	Net assimilation Rate	Relative Growth rate	Absolute Growth rate
S1L1	W	W	W	W	W
S1L2	1.123[a]	40.124[a]	0.002102[a]	0.03474[a]	0.0800[a]
S1L3	1.088[a]	37.720[a]	-0.00473[a]	-0.00326[a]	-0.00750[a]
S2L1	W	W	W	W	W
S2L2	1.109[a]	34.794[a]-	0.000097[a]	0.00977[a]	0.02250[a]
S2L3	1.108[a]	39.446[a]	0.000190[a]	0.01086[a]	0.02500[a]
S3L1	W	W	W	W	W
S3L2	1.117[a]	39.114[a]	-0.001698[a]	0.03366[a]	0.07750[a]
S3L3	1.092[a]	38.610[a]	-0.000886[a]	0.00189[a]	0.00250[a]

Mean values with the same subscripts in each column are not significantly different ($p > 0.05$)
W-Wilted before the commencement of measurement.
S1L1-Sandy soil under 100% Light intensity, S1L2- Sandy soil under 50% Light intensity, S1L3-sandy soil under 25% light intensity, S2L1- Loamy soil under 100% Light intensity, S2L2- Loamy soil under 50% Light intensity, S2L3- Loamy soil under 25% Light intensity, S3L1- Sandy loam soil under 100% Light intensity, S3L2- Sandy loam soil under 50% Light intensity, S3L3- Sandy loam soil under 25% Light intensity.

Discussion

From the experiment, it was observed that the morphological parameters responded differently to the various soil treatments used. In particular, stem height, leaf number, leaf area, and the seedling height showed a considerable increase on the sandy soil, appearing to be more suitable than the other two soil types. Meanwhile sandy loam soil was more effective in enhancing the collar diameter of the seedlings. This further corroborates other studies where for example, *Moringa oleifera* seedlings in sandy soil had the highest total plant dry matter (Hegazi, 2015). This similar trend was observed for the physiological parameters as well.

Seedlings that were exposed to 100% direct sunlight showed an early increase only in height but had lower values for the leaf number and collar diameter. Seedling under shade with light intensity of 25% favorably enhanced the leaf number. 50% light intensity showed more increase in collar diameter. While growing, it was observed that the seedlings under the direct sunlight began to change in their color of leaves from green to yellow and then to brown, resulting to the final death of the seedlings. The other two treatment on light however survived till the end of the experiment and it was also revealed that 50% light intensity had greater values for the chlorophyll content, net assimilation rate, relative growth rate and the absolute growth rate. Whereas 25% light had higher value for relative turgidity. Study shows that leaf responses to different light environments vary widely within and among species. In general, within species, shade-growing leaves are thinner, have lower mass per unit area and have higher mass-based chlorophyll content than do sun-growing leaves (Bongers et al, 2014).
With respect to interaction between sowing media and light intensity, seedlings planted on sandy soil under 100% light intensity (S1L1) showed a rapid increase for a short time but then died back at the same rate. They had the highest values for almost all the morphological parameters except the leaf number but towards the end of the 12 weeks, they all wilted. The other treatments had a slow but steady increase, which made them survived till the end of the experiment. Seedling raised on loamy soil under 100% light intensity(S2L1) had the least result in almost all the morphological parameters except in collar diameter where sandy loam soil and 25% (S3L3) gave the least value. Seedling raised with sandy soil under 50% light intensity (S1L2) gave the best result for all the physiological parameters that were measured which was not the case while considering the morphological parameters.

Conclusions

The study shows that sandy soil is more suitable for raising Iroko seedlings at the early stage of growth, but also yield a good result when sandy loam soil is used. There is only a little difference in their effect on both the morphological and physiological parameters of the seedlings. Hence, both soil types are equally good for raising Miliciaexcelsa seedlings.

With respect to light, seedlings of Miliciaexcelsa cannot withstand prolonged exposure to light especially at the early stage of growth. This makes them a shade loving plant.
A combination of sandy loam soil, mixed in the right proportion with adequate shade is effective in raising Miliciaexcelsa seedlings.

Recommendation

Sandy and sandy loam soils are recommended for raising Miliciaexcelsaseedlings. Light intensity of 50% is best suitable for their growth and therefore recommended for raising their seedlings before they are transferred to the field.

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