Journal of Forestry Research and Management. Vol. 18(4).137-146; 2021, ISSN 0189-8418

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Effects of Different Textural Classes of Soil and Light Intensity on *Daniellia oliveri* Hutch & Dalz Seedlings

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ABSTRACT

Daniellia oliveri is an indigenous timber tree species that is fast disappearing from the forest due to over exploitation and its regeneration has not been encouraged. This study therefore investigated the influence of light intensities and different textural classes of soil on seedlings growth and development of *D. oliveri*. Two hundred seedlings with good vigour and relatively uniform growth were randomly selected from the germination box, transplanted into medium sized polythene pots and monitored under four light intensities (25%, 50%, 75% and 100%) and five textural classes of soil (sand, loamy sand, sandy loam, loam and clay). Completely randomized design (CRD) was used with twenty treatments (T1 to T20) and replicated five times. The following parameters were assessed; seedlings height, collar diameter, leaf production and biomass accumulation. Result from the study revealed that there were significant differences ($p<0.05$) in plant height, leaf production, stem dry matter and root dry matter on the seedlings raised under the influence of different light intensities and textural classes of soil. It was observed that loam soil with 100% light intensity had the highest value for shoot height of 31.40 cm while clay soil under 75% light intensity had the least value of 19.40 cm, sand soil under 50% light intensity gave the highest value for leaf production with 9.0 and clay soil under 100% light intensity still had the least value of 7.0. *D. oliveri* will strive under any variation of light intensity and loam textural classes of soil.

Keywords: indigenous, over-exploitation, regeneration, light intensity, soil textural, *D oliveri*

Introduction

Tree species differ in their requirements for light and respond differently to environmental conditions associated with canopy gaps of different sizes (Vincent, 2006). Sunlight is a source of energy and a source of formation for green plants (Agbo-Adediran, 2014). One of the requirement for successful plantation programme is adequate knowledge of nutrient relations of tree species which can be influenced by soil texture particularly at seedling stage (Rom, 1991). This is because the success of any plantation establishment depends on the successful production of adequate number of seedlings of right quality at the right time (El-Kassaby, 2000). These seedlings should be properly raised so as to improve on the quality of planting stock used for the establishment of the plantation.

Light is one of the most important environmental factors affecting plant survival, growth, reproduction and distribution (Rom, 1991). Light intensity influences plant growth and development in several ways depending on its intensity and spectral quality, therefore, understanding the optimum light intensity for any plant species is essential for a complete understanding of the process of dry matter production and its role in photosynthesis, leaf and shoot development, flower initiation and fruit set and its importance to fruit development and quality (Rom, 1991).

El-Kassaby (2000), describe the domestication of forest tree species as the process whereby plants are taken from the wild (natural), undomesticated state through a series sampling and selection stages, with each stage curtailing the genetic variation and ultimately resulting in the production of somewhat genetically uniform plantation. In recent times, mature fruiting trees of indigenous hard wood species are rare in the forest thereby limiting seed supply to foresters *D. oliveri* is among the most highly priced timber species in local and international market (FAO, 2005).

Daniellia oliveri is a medium sized, deciduous tree growing to a height of 25m or more, it has sometimes twisted trunk up to 200cm in diameter and abroad, flat topped crown, *D. oliveri* is found in tropical west and central Africa, the wood is used for flooring, joinery, furniture, boatbuilding, but the timber exudes too much gum for high quality joinery and carving (Keay *et al.*, 1989). *D. oliveri* is been threatened in several West and Central African countries because of high demand for its timbers, considering its importance, appropriate strategies should be developed to promote its sustainability. Little or no work has been reported on the effect of light intensity and textural classes of soil on *Daniellia oliveri* seedlings therefore necessitated this study.

Materials and Methods

Five different textural classes of soil namely sand, loamy sand, sandy loam, loam and clay were prepared using soil textural triangle of Foth (1984). Loamy sand comprise of 80% sand, 10% silt and 10% clay, sandy loam contains 65% sand, 20% silt, 15% clay while loam has 50% sand, 28% silt and 22% clay (Table 1). Two hundred seedlings with good vigour and relatively uniform growth were randomly selected from the germination box and transplanted into medium sized poly pot (16 x 7 x 0.005 cm^3) filled with different soil textural class which were subjected to different light intensities, 100%, 75%, 50% and 25% of full day light. The light screening chambers used for this experiment was made of wood of 5cm X 5cm in thickness with internal dimensions of each light screening chamber being 1.8 x 1.2 x 1.3m.

The wooden frames were covered on all sides with single, double or triple layers of synthetic green 1mm mesh net to achieve varying levels of light reduction. Seedlings put under light screening chambers with one layer of mesh net is for 75% of light intensity and those under cages with double layers of mesh net stand for 50% light intensity, those under light screening chambers with triple layers stand for 25% light intensity while those in the open field exposed to 100% light intensity (Akinyele, 2007). Light intensity within and outside the light screening chambers were measured with a light meter. Growth variables assessment commenced at two weeks after transplanting. Growth variables assessed were plant height (cm), collar diameter (mm) and number of leaves, which was done on fortnight basis for 16 weeks, also leaves dry weight (LDW), stem dry weight (SDW) and root dry weight (RDW) were taken at the end of experiment and the data were subjected to analysis of variance. Duncan Multiple Range Test was used for the follow up test.

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Table 1: Compositions of different textural classes of soil

Textural Class	Composition	Percentage (%)
Loamysand	Sand	80
	Silt	10
	Clay	10
Sandyloam	Sand	65
	Silt	20
	Clay	15
Loam	Sand	50
	Silt	28
	Clay	22

Source: Foth, 1984

Experimental Design

The experimental design used for this study was Completely Randomized Design (CRD). With twenty treatments replicated 5 times. The treatments consists of light intensities and textural classes of soil and their interactions from the setting out of the experiment

Table 2 : Experimental Layout/Treatment combination

	S	**LS**	**SL**	**L**	**C**
L1	L1 S{T1)	L1 LS(T2)	L1 SL (T3)	L1 L (T4)	L1 C(T5)
L2	L2 S(T6)	L2 LS (T7)	L2 SL(T8)	L2 L (T9)	L2 C(T10)
L3	L3 S(T11)	L3 LS (T12)	L3 SL(T13)	L3 L (T14)	L3 C(T15)
L4	L4 S(T16)	L4 LS (T17)	L4 SL (T18)	L4 L (T19)	L4 C (T20)

Where L_1= 100% S – Sand soil C – Clay
L_2= 75% LS – loamy sand
L_3 = 50% SL – Sandy soil
L_4 = 25% L – loam

Results

Effect of textural classes of soil and light intensity on the growth and development of *Daniela oliveri* seedlings.

There were significant differences ($p<0.05$) in the stem height among the treatments within period of study with respect to effects of light intensity and textural classes of soil (Table 3). It was shown in table 4 that there was variation in the mean stem height which was between 31.40cm and 19.40cm. The highest mean value was observed in T4 (31.40cm) while T10 (19.40cm) has the least value (Table 4).

The analysis of variance shows that there were no significant differences ($p > 0.05$) in collar diameter when seedlings of *D. oliveri* seedlings were subjected to effect of textural classes of soil and light intensity (Table 3).

Mean separation result for leaf production increased with increase in age of the seedlings, leaf production ranged between 9.60 and 7.00 with seedlings under 50% light intensity with sandy soil had the highest (T11) while the seedlings subjected to 100% light intensity with clay soil (T5) had the least value (Table 5) ANOVA revealed that there were significant differences among the treatments with respect to leaf production (Table 3).

Table 3: Analysis of Variant (ANOVA) for the Effect of light intensities and textural classes of soil on the growth of *Daniellia oliveri* seedlings

		Sum of Squares	df	Mean Square	F
Stem Height	Treatment	1267.347	19	66.702	13.45*
	Error	396.600	80	4.958	
	Total	1663.947	99		
Collar Diameter	Treatment	164.408	19	8.653	1.153ns
	Error	600.193	80	7.502	
	Total	764.601	99		
No of Leaves	Treatment	32.560	19	1.714	1.617*
	Error	84.800	80	1.060	
	Total	117.360	99		

ns = Not significant and * = Significant at 5% probability level

Table 4: Post- hoc Test effect of different textural classes of soil and light intensity on the Stem Height

Treatment	**Mean**
T1	30.8000^{a}
T2	20.4000^{de}
T3	31.1000^{a}
T4	$31..4000^{a}$
T5	20.7000^{de}
T6	22.2000^{bcde}
T7	21.4000^{bcde}
T8	20.8000^{de}
T9	20.4000^{de}
T10	19.4000^{e}

T11	23.1000^{bcd}
T12	21.3000^{cde}
T13	24.7000^{b}
T14	22.2000^{bcde}
T15	21.8000^{bcde}
T16	20.6000^{de}
T17	23.1000^{bcd}
T18	22.8000^{bcd}
T19	22.0000^{bcde}
T20	22.3000^{bcde}

Means with the same superscript alphabets are not significantly different at 5% probability level

Table 5: Post- hoc Test effect of different textural classes of soil and light intensity on the leaf production

Treatment	Mean
T1	8.4000^{abcd}
T2	8.2000^{abcd}
T3	8.8000^{ab}
T4	8.8000^{ab}
T5	7.0000^{d}
T6	7.8000^{abcd}
T7	7.2000^{cd}
T8	7.6000^{abcd}
T9	7.4000^{bcd}
T10	7.2000^{cd}
T11	9.6000^{a}
T12	8.0000^{abcd}
T13	8.6000^{abc}
T14	8.8000^{ab}
T15	8.2000^{abcd}
T16	7.8000^{abcd}
T17	8.2000^{abcd}
T18	8.4000^{abcd}
T19	8.0000^{abcd}
T20	8.2000^{abcd}

Mean with the same superscript alphabets are not significantly different at 5% probability level

Effect of different textural classes of soil and light intensity on the biomas accumulation of *Daniellia oliveri* seedlings.

The effect of textural classes of soil and light intensity revealed that seedlings subjected to with 100% light intensity with loamy soil (T4) had the highest mean value of 1.98g in stem dry weight while seedlings under 25% light intensity with sandy soil (T16) had the least value of 1.01g stem dry weight, (Table 6). There were significant differences ($p<0.05$) in the stem dry matter among the treatments (Table 7).

The analysis of variance shows that there were no significant differences ($p > 0.05$) in leaves dry weight when seedlings of *D. oliveri* seedlings were subjected to effect of textural classes of soil and light intensity (Table 7).

Table 6: Post- hoc Test effect of different textural classes of soil and light intensity on the Stem Dry Matter

Treatment	Mean
T1	1.1850^{c}
T2	1.0650^{c}
T3	1.5600^{b}
T4	1.9800^{a}
T5	1.0850^{c}
T6	1.0200^{c}
T7	1.0500^{c}
T8	1.2700^{c}
T9	1.2250^{c}
T10	1.0800^{c}
T11	1.2150^{c}
T12	1.1100^{c}
T13	1.6400^{b}
T14	1.2050^{c}
T15	1.1700^{c}
T16	1.0150^{c}
T17	1.1250^{c}
T18	1.2200^{c}
T19	1.1600^{c}
T20	1.0600^{c}

Mean with the same superscript alphabets are not significantly different at 5% probability level

Table 7: Analysis of Variant (ANOVA) for the Effect of light intensities and textural classes of soil on the biomass accumulation of *Daniellia oliveri* seedlings

		Sum of Squares	Df	Mean Square	F-tab
Stem Dry Matter	Treatment	2.198	19	0.116	23.2*
	Error	0.381	80	0.005	
	Total	2.579	99		
Leaves Dry Matter	Treatment	.815	19	.043	7.167^{ns}
	Error	.491	80	.006	
	Total	1.306	99		
Root Dry Matter	Treatment	2.522	19	.133	66.5*
	Error	.132	80	.002	
	Total	2.653	99		

ns = Not significant and * = Significant at 5% probability level

The highest mean value was observed in seedlings under 100% light intensity with loamy soil (T4) 2.08g with respect to root dry matter while the least value was observed in T16 with 1.21g (Table 8). Analysis of Variance revealed that there was significant difference in root dry matter (Table 7).

Table 8: Post- hoc Test effect of different textural classes of soil and light intensity on the Root Dry Matter

Treatment	Mean
T1	1.5750^{b}
T2	1.3400^{c}
T3	1.9500^{a}
T4	2.0800^{a}
T5	1.2900^{c}
T6	1.2400^{c}
T7	1.3200^{c}
T8	1.2800^{c}
T9	1.3550^{c}
T10	1.3150^{c}
T11	1.5600^{b}

T12	1.3100[c]
T13	1.9550[a]
T14	1.3000[c]
T15	1.3400[c]
T16	1.2150[c]
T17	1.3200[c]
T18	1.2650[c]
T19	1.3500[c]
T20	1.3500[c]

Mean with the same superscript alphabets are not significantly different at 5% probability level

Discussion

Variation in growth parameters of *D. oliveri* within period of study established the relevant of soil texture in the growth and development of plant as affirmed by Niranjan *et al*. (2010) who described Soil texture as an important soil characteristic that influences storm water infiltration rates that in turn affect plant growth. The seedlings of *D. oliveri* thrived in all textural classes of soil, but the best growth and development given by the loamy sand compared to other textural classes of soil could be ascribed to the fact that which water drains through a saturated soil such as loamy sand which allows water to move more freely through it, than it does through clayey soils (Ogunwande, 2014). Seedlings on loamy sand with the highest value in terms of height followed by sandy loam and the least with seedlings with clay soil can be as a result of loamy sand and sandy loam which are well drained and typically have good soil aeration meaning that the soil contains air that is similar to atmospheric air, which is conducive to healthy root growth, and thus a healthy seedlings. Low erodibility of these textural classes can also be a factor because a soil with a high percentage of silt and clay particles has a greater erodibility than a sandy loam or loamy sand soil under the same conditions (Tisdale *et al*., 2003).

Differences in soil texture also impacts organic matter levels; organic matter breaks down faster in sandy soils than in fine-textured soils, given similar environmental conditions, tillage and fertility management, because of a higher amount of oxygen available for decomposition in the light-textured sandy soils (Tisdale *et al*., 2003). The cation exchange capacity of the soil increases with percent clay and organic matter and the pH buffering capacity of a soil (its ability to resist pH change upon lime addition), is also largely based on clay and organic matter content (Niranjan *et al*., 2010). More so, sandy loam gave the best result in terms of collar diameter. This corroborates the work of Kareem *et al.* (2019), Ogunwande (2014) and Niranjan *et al*. (2010) that found that plant can be cultivated on a wide range of soil from loam with moderate fertility. Then, it was further shown that soil texture affects soil behavior in particular its retention capacity for nutrient and water plasticity, rigidity, permeability, ease of tillage, fertility and productivity may be closely related to the textural classes of soil in a given geo-graphical region (Tisdel *et al*., 2003).

The significant difference in stem height and leaf production with respect to light intensity is in agreement with findings of Akinyele, (2007), Ogunwande, (2014), Agbo-Adediran, (2014), and Kareem *et al*, (2019) that found that different light intensities influenced growth parameters on *Buchholzia coriacea, Andrographis paniculata, Entradrophragma angolense* and *Mansonia altissima* respectively If plants do not receive enough light, they will not grow at their maximum rate or reach their maximum potential, regardless of how much of any other variable; water, growth medium or fertilizer, this could be why seedlings under 100% light intensity had the tallest plant height, while those place under 50% light intensity had the highest mean value in leaf production.

Understanding the effect of light intensity on plant development is essential for a good knowledge of the process of dry matter production and its partitioning (Schopfer, 1990 and Akinyele, 2007). Result revealed that there was no significant difference in the effect of textural classes of soil and light intensity on leaves dry weight and collar diameter but there were significant differences in the stem height, leaves production, stem dry weight and root dry weight. Light intensity and textural classes of soil are important factors affecting the growth and development of plant especially at a tender stage. However *D. oliveri* seedlings has a way of adjusting to these important factors as no shock was experienced in the seedlings throughout the study period.

Conclusion and Recommendation

Light and soil texture type is an important factor in forest regeneration and growth. Tropical tree species are unique in vegetation and habitat and therefore light affect the shade tolerant species both morphologically and physiologically. This study revealed hat light intensity and textural classes of soil had significant effect on growth and development of *D. oliveri* seedlings with loam sand performed best in terms of growth parameters assessed except for the collar diameter in which it was sandy loam that gave the highest mean value, while for the variation in light intensities it was observed that it was seedlings under 100% light intensity that performed best in term of plant height. The result of this study can be applied in the nursery to raise healthy seedlings of *D. oliveri* for possible plantation establishment

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