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# BIOMASS ACCUMULATED BY *Mansonia altissima* A Chev. SEEDLINGS UNDER DIFFERENT LIGHT INTENSITIES AND TEXTURAL CLASSES OF SOIL

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## ABTRACT

*Mansonia altissima* is an indigenous timber tree species that is fast disappearing due to deforestation and degradation, its regeneration has not been encouraged. This study investigated the influence of textural classes of soil and light intensities on the biomass accumulation of *M. altissima* seedlings. Seedlings were monitored under five textural classes of soil (sand, loamy sand, sandy loam, loam and clay) and four light intensities (25%, 50%, 75% and 100%). The study was conducted in 4 x 5 factorial experiments in Completely Randomized Design (CRD) and subjected to ANOVA. It was observed that seedlings leaf dry weight (LDW) ranged from 1.13 to 1.42g, Stem dry weight (SDW) ranged from 0.53 to 0.82g, Root dry weight (RDW) ranged from 0.66 to 0.89g, and Total dry weight (TDW) ranged from 2.01 to 2.99g respectively after 16 weeks depending on light intensity. Seedlings LDW, SDW, RDW and TDW under textural classes of soil were significantly affected at ($p > 0.05$). Seedlings LDW ranged from 0.33 to 2.09g, SDW ranged from 0.25 to 1.20g, RDW ranged from 0.37 to 1.24g and TDW ranged from 0.94 to 4.52g respectively after 16 weeks depending on textural classes of soil. The biomass accumulated by *M. altissima* under 25% light intensity and sandy loam textural classes of soil was higher compared to other light intensity and textural classes of soil. This implies that *M. altissima* preferred low light intensity and sandy loam textural classes of soil for optimum biomass production.

**Keywords:** Deforestation, biomass accumulation, light intensities, soil textural classes and *Mansonia altissima*

## INTRODUCTION

Light plays a critical role in plant growth and development in both quantity and qualities, as well as direction of light, are perceived by photo sensory systems which, collectively, regulate plant development, presumably to maintain photosynthetic efficiency. Seedlings and saplings under forest canopy environment are often characterized by reduced light conditions for growth. Tree species differ in their requirement for textural classes of soil, light and respond differently to environmental conditions associated with canopy gaps of different sizes (Vincent, 2006). Light demanding species are more flexible in both morphology and biomass allocation in response to light change than shade tolerant species (Lortie and Aarssen, 1996; Vallarares, 2000).

*Mansonia altissima* belongs to the family sterculiaceae. The genus consists of two species namely: *Mansonia altissima* and *M. kamerunica* . *Mansonia altissima* occurs in the drier areas of lowland rainforest in Nigeria while *M. kamerunica* occurs in Cameroons (Keay, 1989). *Mansonia* is a multipurpose species being used for furniture, door and general construction works. It is known as “ofun” in Yoruba language and bears the trade name “mansonia”. It is a hard wood species with cylindrical boles that usually reach up to 30m in height and 2.4m girth (Keay, 1989).

The wood of *Mansonia altissima* is characterized by an excellent stability with little susceptibility to variation in humidity, small shrinkage rates during drying and a good natural durability. The wood is durable and treatment with preservative is unnecessary, even for usage in permanent humid condition or localities where wood attacking insects are abundant (Oteng-Amoako, 2006). This means it is an excellent wood for use in pleasure-crafts, especially for keels stems and panels for bridges, as well as interior fittings.

Roots, bark, leaves and fruits are used in traditional medicine, various preparations of the plant are used for the treatment or condition such as diabetes, curbing the incidence of diet related disease like non-chronic communicable diseases (Onyeachi *et al.,* 2013). Considering its importance, appropriate strategies should be developed to promote its sustainable use. This study therefore investigated the effect of different light intensities and textural classes of soil on biomass accumulated of *M. altissima*.

## MATERIALS AND METHODS

### Experimental site

The study was carried out in the Tree improvement nursery of Forestry Research Institute of Nigeria Headquarters, 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 1000 mm and 14500 mm, 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 season (April - October) (FRIN).

### Experimental design and treatments

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 comprises 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. The experimental design used for the study was 4 x 5 factional experiment in a completely randomized design (CRD). Factor A is 4 light intensities and factor B is 5 textural classes of soil which constituted the treatments. Each textural classes of soil were replicated 10 times. Two hundred seedlings with good vigour and relatively uniform growth were randomly selected from the germination box and transplanted into polythene pots (16 x 7 x 0.005 cm$^3$) filled with top soil; these were exposed 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 5 cm x 5 cm in thickness with internal dimensions of each light screening chamber being 1.8 x 1.2 x 1.3 m. 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.

*M. altissima* seedlings under each treatment were used to examine biomass accumulation. The experiment was monitored for the period of 24 weeks. For biomass estimation, mean height of the seedlings under each light intensities and textural classes of soil was calculated and three seedlings with heights closest to the mean height were selected for destructive sampling. The selected seedlings from each treatment was carefully uprooted by separating the seedlings from the soil, washed and sectioned into root, stem and leaves. A sensitive weighing balance was used to obtain the initial (fresh) weight of leaves, stem and root.

After taking the fresh weight, seedling components (leaves, stem and root) were taken to the analytical laboratory of the Bio- sciences Department, FRIN and placed in the oven and dried at 70$^{o}$C for 24 hours until a constant weight was obtained. Since 100% of each component was taken as their biomass. Seedling total biomass was then obtained by summing the biomass of the various components.

### Data collection and analysis

Leaf dry weight (LDW), stem dry weight (SDW), root dry weight (RDW), and total dry weight (TDW) were taken after 16 weeks. The data were then subjected to analysis of variance to compare the effect of different light intensities and textural classes of soil on the biomass accumulated by *M. altissima* seedlings.

## RESULTS

### Effects of light intensities on seedlings biomass of *Mansonia altissima*

The highest mean leaf dry weight under light intensities was observed with seedlings under 100% light intensity while the lowest was at 75% intensity value of 1.42 g and 1.13 g respectively (Table 1). There was no significant difference in LDW among the varying light intensity, similar trend was found in RDW ($p>0.05$). However, SDW showed a significant difference in 25% light intensity (0.82g) ($p < 0.05$), with no significant difference in other light intensities ($p > 0.05$).

The result of the TDW presented in Table 1 showed that after four months, the seedlings raised under 25% light intensity had the highest mean value of 2.99 g, although no significant difference was recorded when compared with 50% light intensity. In addition, TDW was not significantly different between 75% and 100% ($p > 0.05$). ANOVA revealed that there was significant difference in SDW and TDW among the light intensities at ($P < 0.05$) (Table 4).

**Table 1: Effect of Light Intensities on the Biomass Accumulation of *M. altissima* Seedlings after 16 weeks**

| Light Intensity | LDW( g) | SDW( g) | RDW( g) | TDW( g) |
|---|---|---|---|---|
| 100% | $1.42 \pm 0.21^{a}$ | $0.53 \pm 0.15^{b}$ | $0.66 \pm 0.19^{a}$ | $2.01 \pm 0.22^{b}$ |
| 75% | $1.13 \pm 0.34^{a}$ | $0.67 \pm 0.08^{b}$ | $0.83 \pm 0.10^{a}$ | $2.63 \pm 0.24^{ab}$ |
| 50% | $1.29 \pm 0.41^{a}$ | $0.65 \pm 0.04^{b}$ | $0.89 \pm 0.07^{a}$ | $2.83 \pm 0.11^{a}$ |
| 25% | $1.38 \pm 0.16^{a}$ | $0.82 \pm 0.25^{a}$ | $0.78 \pm 0.22^{a}$ | $2.99 \pm 0.12^{a}$ |

*Means with same superscripts in columns are not significantly different from each other (p>0.05)*

**Effect of textural classes of soil on seedlings biomass of *Mansonia altissima***

The highest mean value of leaf dry weight observed in seedlings raised with sandy loam and least in clay textural classes of soil were 2.09 g and 0.33 g respectively (Table 2). Leaves dry weight in sandy loam and loamy sand are not significantly different from each other with 2.09 g and 2.00 g respectively (p>0.05). Biomass of seedlings from clay and sandy soils are not significantly different from each other with 0.33 g and 0.82 g respectively in LDW. However, Sandy loam textural class of soil had the highest mean stem dry weight of 1.20 g while clay soil had the lowest 0.25 g (Table 2). Mean separation revealed that seedling biomass from loamy sand, sandy and loamy were not significantly difference from each other. Seedlings raised in sandy loam textural class of soil had the highest mean RDW value of 1.24 g while clay soil had the lowest mean value of 0.37 g (Table 2). Mean separation revealed that biomass production of *M. altissima* from loamy sand, sandy and loamy were not significantly difference from each other. Also, TDW under textural classes of soil had the highest mean value of 4.52 g with sandy loam soils while the least is 0 .94 g with clay soil.

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**Table 2: Effect of Soil Textural Classes on the Biomass Accumulation of *M. altissima* Seedlings**

| Soil | LDW (g) | SDW (g) | RDW (g) | TDW (g) |
|---|---|---|---|---|
| Clay | $0.33 \pm 0.07^{b}$ | $0.25 \pm 0.03^{c}$ | $0.37 \pm 0.07^{c}$ | $0.94 \pm 0.13^{c}$ |
| Sandy loam | $2.09 \pm 0.30^{a}$ | $1.20 \pm 0.12^{a}$ | $1.24 \pm 0.14^{a}$ | $4.52 \pm 0.47^{a}$ |
| Loamy sand | $2.00 \pm 0.70^{a}$ | $0.61 \pm 0.06^{b}$ | $0.74 \pm 0.07^{b}$ | $2.59 \pm 0.21^{b}$ |
| Sandy | $0.82 \pm 0.10^{b}$ | $0.60 \pm 0.07^{b}$ | $0.72 \pm 0.10^{b}$ | $2.14 \pm 0.25^{b}$ |
| Loamy | $1.28 \pm 0.11^{ab}$ | $0.69 \pm 0.04^{b}$ | $0.90 \pm 0.10^{b}$ | $2.86 \pm 0.21^{b}$ |

*Means with same superscripts in columns are not significantly different from each other ($p>0.05$)*

**Interaction Effect of light intensities and Soil textural classes on the stem dry weight of *M. altissima* Seedlings**

The interaction between light intensities and soil on stem dry weight revealed that seedlings raised under 25% light intensity in sandy loam soil had the highest value (1.65 g) and the least value was recorded under 75% light intensity with clay soil (0.19 g) (Table 3).

**Table 3: Mean Separation for the Interaction Effect of light intensities and Soil on the stem dry weight of *M. altissima* Seedlings**

| Light Intensity | Soil | SDW (g) |
|---|---|---|
| 100% | Clay | $0.21 \pm 0.21^{c}$ |
| | Sandy loam | $0.91 \pm 0.16^{a}$ |
| | Loamy sand | $0.64 \pm 0.10^{ab}$ |
| | Sandy | $0.29 \pm 0.21^{c}$ |
| | Loamy | $0.59 \pm 0.12^{b}$ |
| 75% | Clay | $0.19 \pm 0.11^{a}$ |
| | Sandyloam | $1.03 \pm 0.10^{a}$ |
| | Loamysand | $0.79 \pm 0.18^{a}$ |
| | Sandy | $0.66 \pm 0.09^{ab}$ |
| | Loamy | $0.69 \pm 0.21^{ab}$ |
| 50% | Clay | $0.31 \pm 0.14^{c}$ |

| | | |
|---|---|---|
| | Sandyloam | 1.20 ± 0.13[a] |
| | Loamysand | 0.34 ± 0.21[c] |
| | Sandy | 0.60 ± 0.22[ab] |
| | Loamy | 0.81 ± 0.15[a] |
| 25% | Clay | 0.27 ± 0.10[a] |
| | Sandyloam | 1.65 ± 0.08[a] |
| | Loamysand | 0.67 ± 0.01[ab] |
| | Sandy | 0.85 ± 0.12[a] |
| | Loamy | 0.67 ± 0.11[ab] |

*Means with same superscripts in columns are not significantly different from each other (p>0.05)*

**TABLE 4: ANOVA result for effect of light intensity and textural classes of soil on biomass accumulation**

| Variable | SV | Df | SS | MS | F | Sig |
|---|---|---|---|---|---|---|
| Leaves Dry Weight (g) | Li | 3 | 0.76 | 0.25 | 0.17 | 0.29[ns] |
| | S | 4 | 27.22 | 6.81 | 4.59 | 0.00* |
| | Li*s | 12 | 19.22 | 1.60 | 1.08 | 0.40[ns] |
| | Error | 40 | 59.25 | 1.48 | | |
| | Total | 59 | 106.45 | | | |
| Stem Dry Weight (g) | Li | 3 | 0.65 | 0.22 | 5.85 | 0.00* |
| | S | 4 | 5.60 | 1.40 | 37.87 | 0.00* |
| | Li*s | 12 | 1.18 | 0.10 | 2.66 | 0.01* |
| | Error | 40 | 1.48 | 0.04 | | |
| | Total | 59 | 8.91 | | | |
| Root Dry Weight (g) | Li | 3 | 0.42 | 0.14 | 1.21 | 0.32[ns] |
| | S | 4 | 4.76 | 1.19 | 10.37 | 0.00* |
| | Li*s | 12 | 1.36 | 0.11 | 0.99 | 0.48[ns] |
| | Error | 40 | 4.59 | 0.12 | | |
| | Total | 59 | 11.14 | | | |
| Root Dry Weight (g) | Li | 3 | 8.17 | 2.72 | 3.72 | 0.02* |
| | S | 4 | 80.57 | 20.14 | 27.54 | 0.00* |
| | Li*s | 12 | 13.88 | 1.16 | 1.58 | 0.14[ns] |
| | Error | 40 | 29.25 | 0.73 | | |
| | Total | 59 | 131.86 | | | |

*ns – not significant (p>0.05)*significant at (p=0.05)*

## DISCUSSION

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). This corroborates the work of Niranjan *et al.*, (2010) and Ogunwande

(2014) that the plant can be cultivated on a wide range of soil from loam to laterite soils with moderate fertility, the lower dry matter accumulation of *Mansonia altissima* seedling exposed to full sunlight was probably due to increase leave temperatures, transpiration and respiration. This is in agreement with the findings of Bolanle-Ojo *et al. (*2015) reported that *Garcinia kola* needs a dense shade with little amount of light for its optimum growth in the early stage. Soil texture is one of the factors that influence crop growth and yield, tissue nutrient concentrations and crop response to treatment (Vandamme, 1978, Mengel and Kirkby, 2001, Tisdale *et al.*, 2003.) It also affects soil behaviour in particular its retention capacity for nutrients and water, plasticity, rigidity, permeability, ease of tillage, fertility and productivity may be closely related to the textural classes of soil in a given geographical region (Tisdale *et al.*, 2003). However, this species has a way of adjusting to these important factors as no shock was observed in the seedlings throughout the study period.

## CONCLUSION AND RECOMMENDATIONS

Light intensity and textural classes of soil are important factors in forest regeneration and growth. Tropical tree species are unique in vegetation and habitat and therefore light affect the shade tolerant species both morphological and physiological. This study revealed that

*M. altissima* preferred low light intensity and sandy loam textural classes of soil for optimum biomass accumulation. The result of this study can be useful in the nursery to raise healthy seedlings of *M .altissima* for plantation establishment.

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