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Effect Of Soil Amendments On The Germination And Early Growth Of (*Masonia Altissima*) Seedlings

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Abstract*—Poor seedling propagation rates can be attributed to inadequate knowledge of their requirements including appropriate growth media that can enhance their growth at the nursery. The objective of the study was to determine the effect of different soil amendments on seed germination and early seedling growth of Mansonia altissima. The experiment was laid out using Completely Randomized Design (CRD) with three replicates. Four treatments (soil amendments) - topsoil (S1) as control, topsoil and inorganic fertilizer (S2), topsoil and wood ash (S3), and topsoil and chicken manure (S4), were used. Observations on germination were made and recorded daily for 10 days. Germination percentage and germination emergence were calculated per treatment. Following germination, 24 Seedlings were transplanted into polybags filled with each of the treatments. Evaluation of early seedling growth was based on height, collar diameter and number of leaves. Results indicated that both germination percentage was significantly affected by soil amendments ($p \leq 0.05$). The highest germination percentage was observed in S1 (51.1%), followed by S2 (36.3%), S3 (34.1%), and S4 (29.6%). There was no significant difference ($p \geq 0.05$) in seedling height and leaf number at week 3 to 10 and in collar diameter at week 3 to 10, but there was significant difference ($p \leq 0.05$) in seedling height and number of leaves at week 2 and 4, and in collar diameter at week 1, 2 and 4. The highest mean seedling height at week 1 to 4, highest leaf number at months 1and 2 and highest collar diameter at months 3 and 4, were observed in S2. Topsoil and inorganic fertilizer (S2) and topsoil (S1) were recommended for the propagation of A. Mansonia altissima in the nursery.

Keywords— soil amendment, germination, mansonia altissima, early growth.

I. Introduction

Mansonia altissima (A. Chev.) A. Chev. var. altissima is a tree species which belongs to the family of Malvaceae. The tree species can be found in the Republic of Benin, the Democratic Republic of Congo, Cote d'Ivoire, Ghana, Guinea, Nigeria, Sudan, Togo, and Uganda where it is commonly called Mansonia, African black walnut, African walnut. Mansonia altissima is a valuable timber, commonly harvested from the wild and exported, especially to the USA and Europe, where it is being used as a substitute for walnut (Osunlaja, Olomola, Nwogwugwu, Afolabi, & Oloyede, 2017). The wood of Mansonia altissima is used for general and high-class joinery, cabinet work, furniture, turnery, decorative veneer, and handicrafts. It is also used in construction of doors and windows (Osunlaja et al., 2017). The products from the bark of Mansonia altissima have been used in the treatment of leprosy. Again, extracts from the bark have been shown to inhibit the growth of Mycobacterium tuberculosis (Fernandez-Villamil, Dubin, Galeffi, & Stoppani, 1990). A decoction of the twig bark is applied as a bath against yaws, scabies, and syphilis. Moreover, ethanolic extract of the wood has shown hepatotoxic and haematotoxic effects when administered orally. The bark contains a highly toxic compound known as mansonine, which is related to cardenolides from Digitalis purpurea and ouabain from Strophanthus preussii (Akinnagbe, Gailing, & Finkeldey, 2010; Fernandez-Villamil et al., 1990).

International Union for Conservation of Nature's (IUCN, 1998) red list of threatened species included Mansonia altissima (A. Chev.) A. Chev. var. altissima as one of the endangered valuable timber species (IUCN, 1998). The timber becomes endangered due to overexploitation for furniture, cabinet, and demands from foreign countries and inadequate of the seeds for germination because of its recalcitrant and dormancy nature (Wédjangnon, Houètchégnon, & Ouinsavi, 2016). These situations trigger depletion of the timber species in forest as demand for the species for wood production could no longer cope with their supply. Consequently, the species is moving towards extinction, reduction in biodiversity and decrease in primary productivity. With the immense importance of this timber species, there is a need to improve the germination techniques of the plant in vitro and in the field.

II*. Origin and geographic distribution*

Mansonia altissima occurs from Guinea and Côte d'Ivoire east to the Central African Republic and northern Congo. Mansonia altissima is an evergreen tree with a small, dense, ovoid, crown and branches that are almost horizontal at first, but later drooping; it can grow up to 45 metres tall. The cylindrical, generally straight bole can be branchless for up to 30 metres and up to 100cm, occasionally even 150cm, in diameter; it sometimes has narrow buttresses. A valuable wood, it is commonly harvested from the wild and exported, especially to the USA and Europe, where it is seen as a substitute for walnut The plant has been tried in plantations and in enrichment plantings, but no results are known. It is occasionally retained or grown in agroforestry systems.

III. Properties and Description

The heartwood is yellowish brown to dark grey-brown or even dark brown, often with purple, reddish or greyish green streaks, often in alternating light and dark bands. It fades on exposure to a somewhat dull brown. It is distinctly demarcated from the 2–4(–6) cm wide, white to pinkish sapwood. The grain is usually straight, texture fine. The wood is moderately lustrous.
The wood is of medium weight with a density at 12% moisture content of 590–720 kg/m³. It dries fairly rapidly with little distortion or degrade. In Congo it takes about 15 weeks to air dry boards 5.5–6 cm thick from 75% to 23% moisture content. Shrinkage from green to oven dry is (2.6–)4.1–5.7(–7.0)% radial and (5.2–)7.1–9.7% tangential. Movement in service is medium.
At 12% moisture content the modulus of rupture is (61–)114–177(–183) N/mm², modulus of elasticity 9320–12,800 N/mm², compression parallel to grain 43–68(–96) N/mm², shear 6–15 N/mm², cleavage 9–23 N/mm, Janka side hardness 5690–7470 N and Janka end hardness 5740–7470 N.
The wood is easy to work with hand and machine tools with little or only moderate blunting effect on cutting edges and no charring. The surface can be worked to a good finish. The wood holds nails and screws fairly well, but iron tends to corrode in contact with the wood. Gluing properties are good. The wood takes stain and polish well. The wood peels well, but requires softening beforehand; veneer is rather fragile. Steam-bending is easy unless knots are present.
The heartwood is very durable, being resistant to fungi, borers and termites; in logs the sapwood is susceptible to pinhole borer and longhorn beetle attacks.

A. Ecology of Mansonia altissima

Mansonia altissima is characteristic of the dense semi-deciduous forest in areas with about 1600 mm annual rainfall and a pronounced dry season. In Côte d'Ivoire the southern limit of its distribution area largely corresponds with the transition of semi-deciduous forest to evergreen forest; to the north its distribution extends to patches of dense forest in the savanna. Seedlings are most common on fertile soils on drier sites; they are fairly drought resistant. Seedlings planted in the wet forest zone died within a few years. In Ghana Mansonia altissima is most common in the semi-deciduous forest of the north-western part of the country, where it occurs mainly in exposed conditions. In southern Ghana seedlings up to 1 m tall are most common in disturbed forest, while smaller seedlings are more common in undisturbed forest. Adult trees are more common in logged or burnt forest than in undisturbed forest

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B. Propagation, planting and Management

The weight of 1000-seeds is about 330 g. Germination starts after about 10 days and may take one week, but a dormancy period of several months has also been observed. Dormancy caused little loss of seed viability. Germination occurs under both light and dark conditions but is strongly depressing in large gaps in the forest. During the first 2 years after germination slight shade stimulates growth and the formation of healthy leaves. Leaves are held vertically in exposed conditions, more horizontally in the shade. After 2 years *Mansonia altissima* requires full sunlight and it has been classified as a non-pioneer light demander.
Mansonia altissima has been tried in plantations and in enrichment plantings, but no results are known. In Cameroon 420 ha have been planted, and in Côte d'Ivoire 78 ha. It is occasionally retained or grown in agroforestry systems.

C. Growth and development

Seedlings attained a height of 1–2 m in 4 years in natural forest and 6 m in 4 years in logged areas. In Kumasi (Ghana) trees attained a bole diameter of 6.5–16 cm and a height of 8–15 m in 10 years. For plantations in Cameroon faster growth has been recorded, with trees growing 2 m in height per year after 2 years decreasing to 1.3 m per year after 10 years. In Côte d'Ivoire mean annual bole diameter growth of *Mansonia altissima* trees for all diameter classes was 2.5–7 mm. Mean growth for the diameter class 30–50 cm was 5.1 mm per year. An average tree would reach a bowl of 50 cm in 90 years. In Ghana flowering occurs from May to October with a peak in June and fruits ripen in July–April. The fruits are dispersed by wind at the end of the dry season.
ral raptor species readily occur in agricultural landscapes (Williams et al., 2000). However, few studies have directly assessed the effects of birds of prey as agricultural rodent-control agents, and the results are somewhat ambiguous. Although rodent-control measures (such as rodenticides and integrated pest management) are used widely, surprisingly few studies have assessed the effects of rodents on agricultural production (Brown et al., 2007). Nonetheless, there are examples of rodents having strong effects on crops (Brown et al., 2007), natural plant communities (Ostfeld & Canham1993; Cote et al., 2003; Lopez & Terborgh, 2007), and newly established synthetic prairie gardens (Howe & Brown 1999, 2001; Howe et al., 2002).

IV. Experimental Site

This study was carried out at the Forest Nursery of the Department of Forestry and Wildlife Management, in the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The nursery site lies at Latitude $7^0$10' 58"N and longitude $3^0$20' 37"E. It has a gentle undulating landscape and mild slope. This punctuated in parts by ridges isolated, residual hills, valleys and lowlands.

V. Procurement of materials

The materials that was used for this research work include

1. Forest topsoil at FUNAAB nursery

2. Black polythene bag (100)

3. Seed of *Nauclea diderrich* collected from Forest Research Institute Nigeria (FRIN)

Premises it is situated in Ibadan and lies on latitude 7^0 23'15" N to 7^0 24'00"E and longitude 3^0 51'00"N to 3^0 52'15"E of the Greenwich meridian premises.

4. Vermeer calipers to measure the collar diameter

5. Ruler for the measurement of seedling height

6. Watering can

7. Saw dust, wood ash and chicken droppings

8. Petri-dish

9. Nursery trays

A. Seed Collection, Processing and Seed Viability Test

Seeds were collected from mother trees at Forest Research Institute of Nigeria (FRIN) in Ibadan. The seeds were processed manually and mixed thoroughly to form a lot of seeds. The floatation method was used to test the viability of seeds before sowing. The seeds were soaked in cold water for 2 hours; the ones that float will be regarded as not viable and therefore discarded while the ones that sink were used for the study. (https://www.researchgate.net).

- NURSERY PROCEDURE

A total number of 96 randomly selected seeds was used for the experiment at 4 seeds per replicate per treatment. Seeds were sow in a germination tray measuring 17 cm x 13 cm x 3.5cm, fill with the different soil amendments. The trays was monitored and watered daily in the morning to maintain adequate moisture content. Seeds will germinate under 50% light shade. Soil amendment materials were mixed with topsoil at a ratio of 1:0.03 (i.e. 1kg of topsoil was mix with 0.03kg of inorganic fertilizer, wood ash and poultry droppings respectively while the control was 13kg of topsoil), for both the germination and early seedling growth aspects of the study.
Following germination, seedlings will then be transplant into polybags measuring 15.5cm x 20cm filled with the different soil amendments. Seedlings will be transplanted into each soil amendment with at the rate of one seedling per pot replicated 4 times with 26 experimental units. Seedlings was growing under 50% light shade in the nursery. Watering was done daily during the first and second months after seedling transplant. Weeding was carried out when required.

B. Experimental layout

- Table 1: experimental layout for *Mansonia Altissima*

Soil amendment	replicate					
S_1	R_2	R_3	R_4	R_5	R_1	R_6
S_2	R_3	R_1	R_6	R_4	R_5	R_2
S_3	R_2	R_4	R_5	R_6	R_3	R_1
S_4	R_1	R_5	R_3	R_2	R_4	R_6

S_1 = topsoil, S_2 = topsoil and inorganic fertilizer, S_3 = topsoil and wood ash, S_4 = top soil and chicken droppings.

C. Experimental Design

Experiment was laid out in a Completely Randomized Design (CRD) with six (6) replicates in each treatment. Seed germination was examined under four soil amendments (treatments) namely – topsoil (S1) as control, topsoil and organic fertilizer (S2), topsoil and ash (S3) and topsoil and poultry dung (S4), was used.

D. Data Collection

Observation on germination was made and recorded daily; this was terminated after sixty days.
Germination percentage was calculated according to Loha et al. (2006) using the formula below:

E. .Mathematical equation:

- Germination percentage (GP) = $\frac{Total\ germinated\ seeds}{Total\ \boldsymbol{seeds}\ sown} \times 100$
- Emergence (E) = Time of plumose appearance after sowing
- Initial measurement of shoot parameters was done on all seedlings immediately after transplanting. The seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule, stem; collar diameter was measure at the root collar using a vernier caliper, while leaf production was determined by directly counting the number of leaves. Data was collected forthrightly for the period of 10 weeks.

F. Statistical Analysis

Data that was collected on germination and early seedling growth parameters was analysed using the SPSS statistical software (SPSS version 18, SPSS Inc.) One way analysis of variance was used to determine variation. Significant means will be tested use at P<0.05. Duncan multiple range test (DMRT) was used to indicate levels of differences or compare means among soil amendments.

- Effect of soil amendments on collar diameter of *Mansonia Altissima* seedlings
- The result showed that different soil amendments have no significant effect on morphological parameters such as collar diameter, stem height and leaf area of *Mansonia Altissima* seedlings (p>0.05). The week with highest mean value for collar diameter (2.46) was observed in seedlings treated with Topsoil alone (S1) while the least mean value for collar diameter was observed in week 1 with value of (2.32).

Table 1: EFFECT OF SOIL AMENDMENTS ON COLLAR DIAMETER OF *Mansonia altissima* SEEDLINGS

Soil Amendment	CD (mm) Week2	CD (mm) Week4	CD (mm) Week6	CD (mm) Week8	CD (mm) Week10	CD (mm) Mean
S1	1.59[b]	1.98[ab]	2.36[a]	2.59[a]	3.19[a]	2.46[a]
S2	1.79[a]	2.02[a]	2.16[ab]	2.54[a]	3.07[a]	2.41[a]
S3	1.63[b]	1.87[b]	2.11[b]	2.44[a]	3.01[a]	2.38[a]
S4	1.60[b]	1.88[ab]	2.30[ab]	2.55[a]	3.01[a]	2.32[a]

- Means within a column with the same superscripts are not significantly different (*p>0.5*), LSD *p=0.5*
  - S_1 = topsoil,
  - S_2 = topsoil and inorganic fertilizer,
  - S_3 = topsoil and wood ash,
  - S_4 = topsoil and chicken droppings.

VII. Effect of soil amendments on plant height of *mansonia altissima* seedlings

- The result showed that different soil amendments have no significant effect on morphological parameters such as collar diameter, plant height and leaf area of mansonia altissima seedlings (p>0.05). The week with highest mean value for plant height (10.46) was observed in seedlings treated with Top Soil alone (S1) while the least mean value for plant height was observed with value of (8.78) top soil with wood ash (S3). (Table 2)

Table 2: Effect of soil amendments on plant height of *mansonia altissima* seedlings

Soil Amendment	PH (cm) Week2	PH (cm) Week4	PH (cm) Week6
S1	7.4[a]	9.78[a]	10.9[a]
S2	7.03[ab]	8.93[ab]	9.78[a]
S3	6.03[b]	8.08[b]	9.45[a]
S4	6.20[b]	8.57[ab]	9.87[a]

- Means within a column with the same superscripts are not significantly different (*p>0.05*), LSD *p=0.5*
  - S_1 = topsoil,
  - S_2 = topsoil and inorganic fertilizer,
  - S_3 = topsoil and wood ash,
  - S_4 = topsoil and chicken droppings.

DISCUSSION

Growth responses using morphological parameters were analyzed. It was observed that soil amendment not significantly affected the morphological parameters such as leaf numbers, collar diameter, plants height and leaf area of *Mansonia altissima*

Plants grow in height and diameter through the activity of meristematic tissues which could be made Possible or enhanced by nutrient availability (Kramer

and Kozlowski 1979). This could explain the insignificant difference observed among treatments on growth parameters during the 10weeks of growth. Also, the possible cause of differences on growth performance could be due to differences in the organic components in different soil amendments (Sa'id et al., 2015). The observed indifferences disagree with the report of Keyagha et al. (2016) who stated that that Irvingia wombolu responded to the different growing media for its growth and development.

Better growth in seedling height, collar diameter and leaf production observed in topsoil and Top soil/inorganic fertilizer mixture could be due to topsoil containing more of both micro and macro nutrients required by plants for their normal growth and developmental activities as seedlings after germination depend heavily on available nutrients in the soil (Agbogidi et al., 2007) and a high nitrogen, phosphate and potash content in inorganic fertilizer (Abou El-Magd et al., 2005). It may also be due to improved physical status of this combination (Osaigbovo et al., 2010) and high water retention capacity of topsoil (Fredrick et al., 2017a).This disagrees with the findings of Keyagha et al.(2016) who reported that seedlings of Irvingia wombulu planted in a mixture of topsoil, poultry manure and inorganic fertilizer had the highest seedling height, collar diameter and leaf number at weeks 4, 8 and 10 when compared with mixture of topsoil and sawdust and topsoil and wood ash; and also that of Okunomo et al.(2006) who noted that topsoil and poultry droppings mixture gave the best performance on plant height of G. albida when compared with other soil amendments used.

CONCLUSION

It is evident from this study that soil amendment does not have any effect on seedling growth of *Mansonia altissima*. The seedlings growth in soil amendment such as Topsoil, Topsoil and inorganic fertilizer, Topsoil and wood ash, Top soil and chicken manure have no significant effect on collar diameter, number of leaves, plants height and leaf area. It has been demonstrated that all the listed soil amendments can be used to grow *Mansonia altissima* seedlings.

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