EFFECT OF NUTRIENT SOURCES AND LIGHT INTENSITIES ON THE SEEDLING VIGOUR OF AFRICAN STAR APPLE (*CHRYSOPHYLLUM ALBIDUM* G.DON)

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Abstract
The inadequacy of research-based information on nutrient sources and light intensity on the growth of Chrysophyllum albidum seedlings has been limiting its afforestation as well as reforestation programmes for increased biodiversity conservation. In this light, A 2 x 2 factorial experiment was laid down in Completely Randomized Design with three replications to assess the effect of nutrient sources [NPK (30g) and Poultry manure (30g)] and light intensities (25 and 50%) on seedling vigour of Chrysophyllum albidum. Data collected on seedling growth experiment was subjected to One-way Analysis of Variance (ANOVA). Significant means were separated using Duncan's Multiple Range Test. Sources of nutrients and light intensities significantly (P<0.05) enhanced the seedling growth. Taller plant (12.32cm)., higher number of leaves (2.93)., wider leaf area (4.2cm^2)., wider stem girth (1.01cm)., higher leaf dry weight (0.27g)., higher shoot dry weight (0.13g) and higher total dry weight(0.52g) were recorded from seedlings planted in soil influenced with poultry manure. Seedlings planted under 50 % light intensity gave higher value of leaf area (2.71cm^2), root dry weight (0.13g), leaf dry weight (0.25g), total dry weight (0.53g) and relative turgidity (74.82%) compare to those subjected to 25% light intensity. Widest leaf area (4.96cm^2)., highest leaf dry weight (0.30g)., highest shoot dry weight (0.16g) and highest total dry weight (0.59g) were recorded for the seedlings planted in soil with poultry manure and subjected to 50% light intensity. Planting of C. albidum seedlings in poultry manure soil under 50% light intensity enhanced its seedling growth for agro-forestry systems. The study therefore recommended the planting of C. albidum in soils with poultry manure under 50% light intensity.

Key words*: Biodiversity conservation, Seedling growth, Nutrient sources, Light intensity, Afforestation*

Introduction

Tropical forests contain many socio-economically important tree species, most of which are currently endangered and with edible parts (Liao *et al.,* 2006). The developing nations including Nigeria are endowed with many indigenous fruits that are of great importance to the rural communities (Okunlola and Akinyele, 2017). *C. albidum* is one of such endangered and indigenous fruit trees. *C. albidum* is a climax tree species of tropical rainforest that belongs to the family Sapotaceae (Olaoluwa *et al.,* 2012; Wole, 2013) which has up to 800 species and make up almost half of the order (Ehiagbonare *et al.,* 2008). The Yoruba name is "Osan Agbalumo" (Rahaman, 2012) while in Igbo and Hausa langua ges, it is called "Udara" or "Udala" (Wole, 2013) and Agbaluba or Agbaluma (Adelani *et al.,* 2017).

It is used in the preparation of medicine for treatment of fibroids and female sterility (Egunyomi *et al.,* 2005). *C.albidum* helps in prevention of mouth gum disease, treatment of toothache as well as sore throat (Adaobi, 2019). Adaobi (2019) stated that studies have shown that milky juice from a *C. albidum* fruit contains just 67 calories; thus making it a good option for people who want to lose weight as they get fewer calories intake in the process of consuming it. Its fruit milky juice contains a high Vitamin C content i.e. 100g of the fruit gives about 25mg of vitamin C. This helps in boosting the immune system (Agustin, 2018, Adaobi, 2019). This also helps to protect the body against immune system deficiencies, cardiovascular disease, prenatal health problems, eye disease, and even skin wrinkling (Adaobi , 2019).

Agustin (2018) stated that the post-birth diagnosed for diabetic disease for pregnant women can be prevented by consuming *C. albidum* fruits because it contains compounds that are hypoglycemic that serves to lower blood sugar levels. The high water content in star apple can prevent dehydration in pregnant women (Agustin, 2018). Agustin (2018) stated that a slightly sour taste in *C. albidum* fruit taste helps pregnant women to overcome nausea that is preventing them from having appetites for food. The diverse nutritional content of *C. albidum* fruit is very good for the digestive system and nutrient consumption of the pregnant mother and fetus (Agustin, 2018). The consumption of *C. albidum* fruit is highly recommended because it is rich in fiber that helps pregnant women to overcome constipation problems (Agustin, 2018). Consumption of *C. albidum* fruits is very helpful for pregnant women to prevent malaria because of its abundant nutritional content and ability to leach out malaria parasite in blood stream (Agustin, 2018). *C. albidum* has been noted to be of great medicinal, nutritional (Adisa, 2000; Onyekwelu and Stimm, 2011) and economical values (Oboh *et al.,* 2009).

In spite of enormous potentials of *C. albidum,* it has been greatly neglected particularly with respect to its regeneration (Adelani *et al.,* 2016, Adelani *et al.,* 2017). There is dearth of quantified information on the seedling nutritional and light requirement for propagation of *Chrysophyllum albidum*. The adequate knowledge of the roles of element of fertilizer is essential for appropriate application to ensure healthy seedling growth of the tropical forest trees in time to meet the current population demand (Adelani *et al.,* 2014a). Adelani *et al.* (2014b) stated that one of the major concerns in forest nurseries in the tropics is the lack of adequate information on light intensity for healthy seedling growth of particular tree species. Light is one of the most important environmental factors affecting plant survival, growth, reproduction and distribution (Liao *et al.,* 2006). In this light, investigation was conducted on nutrition and intensity of light required by *Chrysophyllum albidum* to ascertain its nutrition and light requirement for healthy seedling growth.

Materials and Method

Experimental Site Description
This study was carried out at the forest nursery of the Federal University of Agriculture, Abeokuta. It is situated along Alabata Road, North-East of Abeokuta. It is located within latitude 7°N and 7°55'N and longitude 3°20'E and 3°37'E. It is characterized with disturbed savanna. The soil is well drained, moderate water holding capacity and highly responsive to inputs of fertilizer.

Effect of Nutrient Source and Light Intensity on Seedling Vigour of *Chrysophyllum albidum*
A 2x2 factorial experiment was laid down in completely randomized design with three replications to assess the effect of nutrient sources [NPK (30g) and Poultry manure (30g)] and light intensities (25 and 50%) on seedling vigour of *Chrysophyllum albidum*. A-month old *C. albidum* seedlings were transplanted into top soil filled in the polythene pots of 20x10x10cm^3 dimensions at a depth of 15cm. Seedlings were established by first given 200ml of water for a week. A rectangular cage of 2.5x1.5x1m^3 was constructed and covered with a mosquito net of different layers. The cage was partitioned into two. The first partitioned was covered with two layers of nets, while the second partition was covered with four layers of nets. Digital light meter was used to take the quantity of light intensity under four layers and two layers of nets, respectively.

Seedlings under 50% light intensity were conditioned to two layers of nets; while that of 25% light intensity was conditioned to four layers of nets. Eighteen seedlings under each nutrient source [NPK (30g) and Poultry manure (30g)] were exposed to 25 and 50% light intensities. Growth parameters were monitored every two weeks for 12weeks. Growth parameters assessed include; Seedling height (using meter rule); girth (using venier caliper); the number of leaves were counted manually and Leaf area was obtained by linear measurement of leaf length and leaf width as described by Clifton-Brown and Lewandowski (2000).
LA = 0.74xLxW,
where: LA = leaf Area and LW = Product of linear dimension of the length and width at the broadest part of the leaf.

The means of the growth variables for period of experiment were tabulated. Relative turgidity was determined by method of Awodola (1998). Measurements of Chlorophyll were made by direct determinations of the absorbance at different wavelengths, using Model 6405uv/vis Spectrophotometer, serial number 1364. The concentrations were calculated by adding 20.2A 645, 8.02 663 and divided by length of light path in cell (usually 1cm), fresh weight in grams and 1000.The result was multiplied by the volume of chlorophyll solution in ml. A645 and A663 is the absorbance at 645 and 663nm. The dry weight of the *C. albidum* seedlings were determined, by the use of Mettler Top Loading Weighing Balance (Model-Mettler PM 11-K), after oven dried at 70°C for 72hours (Umar and Gwaram, 2006).

DataAnalysis
The data collected on the early seedling growth of *C. albidum* was subjected to one-way analysis of variance (ANOVA). Significant means were separated using Duncans Multiple Range Test (Duncans, 1955).

Result and Discussion

Main Effect of Fertilizer Types on Seedling Vigour of *C. albidum*
Taller plant (12.32cm)., higher number of leaves (2.93)., wider leaf area (4.2cm^2)., wider stem girth (1.01cm)., higher leaf dry weight (0.27g)., higher shoot dry weight (0.13g) and higher total dry weight(0.52g) were recorded from seedlings planted in soil influenced with poultry manure (Table 1). The excellent growth parameters recorded in seedlings planted in soil mixed with poultry manure is an indication that poultry manure gave steady supply of rich nutrient to the seedlings compared to NPK fertilizer. Various authors as Onyema (2009) on *Cissus striata* and Adelani *et al.* (2014c) on *Chrysophyllum albidum* had reported the efficacy of appropriate rich organic manure in enhancing the growth of tree seedlings.

Table 1: Main Effect of Fertilizer Types on Seedling Vigour of *C. albidum*

Parameters	Fertilizer types	
	NPK (30g)	**Poultry manure (30g)**
Height (cm)	11.55[b]	12.32[a]
Leaf No	2.38[b]	2.93[a]
Leaf area (cm^2)	3.75[a]	4.20[a]
Collar girth (cm)	0.89[b]	1.01[a]
Root dry weight (g)	0.12[a]	0.12[a]
Leaf dry weight (g)	0.19[b]	0.27[a]
Shoot dry weight (g)	0.12[a]	0.13[a]
Total dry weight (g)	0.43[b]	0.52[a]
Chlorophyll content (Mg/g)	4.30[a]	3.03[a]
Relative turgidity (%)	68.89[a]	62.59[b]
SE	0.35	0.35

ab Means on the same row having different superscripts are significantly different (P<0.05).

Effect of Light Intensity on the Seedling Vigour of *C. albidum*

Seedlings planted under 50 % light intensity gave higher value of leaf area (2.71cm^2), root dry weight (0.13g), leaf dry weight (0.25g), total dry weight (0.53g) and relative turgidity (74.82%) compare to those subjected to 25% light intensity (Table 2). Higher morphological and physiological parameters recorded by seedlings planted in the sunlight (50% intensity) are an indication that average sunlight intensity enhances the growth of *C. albidum* seedlings. Similar observation has been reported by Onyekwelu *et al.* (2012). This result is in consonance with the reports of Wardiana and Herman (2011) who recorded better growth parameters for *Parkia biglobosa* seedlings under reduced light environment (65% light intensity) than full light (100% light intensity). Contrary to the result of this experiment, Adeoye and Onyekwelu (2014) stated that *Parkia biglobosa* seedlings planted under full light intensity (100%) recorded highest growth parameters compared to other light intensities. Of the light investigated, higher light intensity gave better growth parameters. The growth of *C. albidum* seedling is correlated to the light intensity. Bhadmus and Onyekwelu (2014) stated that both the intensity and duration (length) of light may have different and characteristic effects upon plant growth and development. This is consonance with the reports of Liao *et al.* (2006) and Zervoudakis *et al.* (2012).

Table 2: Effect of Light Intensities on Seedling Vigour of *Chrysophyllum albidum* Seedlings

Parameters	Light intensities	
	25%	**50%**
Height (cm)	12.26[a]	11.61[b]
Number of leaves	2.59[b]	2.71[a]
Leaf area cm^2	3.98[a]	3.98[a]
Collar girth (cm)	0.99[a]	0.91[b]
Root dry weight(g)	0.11[a]	0.13[a]
Leaf dry weight(g)	0.24[a]	0.25[a]
Shoot dry weight	0.10[b]	0.15[a]
Total dry weight(g)	0.45[b]	0.53[a]
Chlorophyll content (Mg/g)	4.14[a]	3.19[b]
Relative turgidity (%)	56.66[a]	74.82[a]
SE	0.35	0.35

ab means on the same row having different superscripts are significantly different (P<0.05).

Interactive Effect of Fertilizer Types and Light Intensities on Seedling vigour of C. *albidum*

Tallest plant (12.76cm)., highest number of leaves (2.80) and widest collar girth (1.06cm) were recorded for seedlings planted in poultry manure soil and subjected to 25% light intensity. Widest leaf area (4.96cm^2)., highest leaf dry weight (0.30g), highest shoot dry weight (0.16g) and highest total dry weight (0.59g) were recorded for seedlings planted in poultry manure soil and subjected to 50% light intensity. Highest chlorophyll content (4.35 Mg/g) and highest relative turgidity (82.65%) were recorded for seedlings planted in NPK and subjected to 25 and 50% light intensities.

Table 3: Interactive Effect of Fertilizer Types and Light Intensities on Seedling Vigour of C. *albidum*

Parameters	Fertilizer types			
	NPK (30g)		PM (30g)	
	25%	50%	25%	50%
Height (cm)	11.76^{b}	11.34^{b}	12.76^{a}	11.89^{b}
Leaf No	2.38^{b}	2.38^{b}	2.80^{a}	2.05^{c}
Leaf area (cm^2)	4.51^{a}	2.99^{b}	3.44^{ab}	4.96^{a}
Collar girth (cm)	0.93^{b}	0.86^{c}	1.06^{a}	0.97^{b}
Root dry weight (g)	0.11^{a}	0.13^{a}	0.10^{a}	0.13^{a}
Leaf dry weight (g)	0.18^{b}	0.20^{b}	0.23^{b}	0.30^{a}
Shoot dry weight (g)	0.08^{b}	0.14^{ab}	0.11^{ab}	0.16^{a}
Total dry weight (g)	0.35^{b}	0.48^{ab}	0.44^{b}	0.59^{a}
Chlorophyll content (Mg/ g)	4.35^{a}	4.26^{a}	3.93^{a}	2.12^{b}
Relative turgidity (%)	55.12^{c}	82.65^{a}	58.19^{bc}	67.00^{b}
SE	0.50	0.50	0.50	0.50

ab Means on the same row having different superscripts are significantly different (P<0.05).

Conclusion

Human activities deplete the population of *C. albidum* tree species that is currently facing extinction. To meet the demand of the ever-increasing human population, more of this indigenous tree species needs to be propagated. Inadequate knowledge of appropriate light intensity limits the growth and development of *C. albidum*. Investigation conducted into light intensity of *C. albidum* revealed that seedlings planted under average light intensity gave higher morphological and physiological parameters. Planting of *C. albidum* seedlings under average light intensity enhances its growth.

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