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

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ABSTRACT

A 2x2 factorial experiment was laid down in Completely Randomized Design with three replications to assess the effect of nutrient sources [NPK (30 g) and Poultry manure (30 g)] 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 Duncans Multiple Range Test. Sources of nutrients and light intensities significantly (P<0.05) enhanced the seedling growth. Taller plant (12.32 cm)., higher number of leaves (2.93)., wider leaf area (4.2 cm^2)., wider stem girth (1.01 cm)., higher leaf dry weight (0.27 g)., higher shoot dry weight (0.13 g) and higher total dry weight (0.52 g) were recorded from seedlings planted in soil influenced with poultry manure. Seedlings planted under 50 % light intensity gave higher value of leaf area (2.71 cm^2), root dry weight (0.13 g), leaf dry weight (0.25 g), total dry weight (0.53 g) and relative turgidity (74.82 %) compared to those subjected to 25 % light intensity. Widest leaf area (4.96 cm^2)., highest leaf dry weight (0.30 g)., highest shoot dry weight (0.16 g) and highest total dry weight (0.59 g) were recorded for seedlings planted in poultry manure soil 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 research therefore recommends planting of C. albidum seedlings in poultry manure soil under the 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). *Chrysophyllum albidum* is one of such endangered and indigenous fruit trees. *Chrysophyllum 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 languages, it is called "Udara" or "Udala" (Wole, 2013) and Agbaluba or Agbaluma (Adelani *et al.*, 2017).

Chrysophyllum albidum is used in the preparation of medicine for treatment of fibroids and female sterility (Egunyomi *et al.*, 2005). *Chrysophyllum albidum* fruit 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. 100 g of the fruit gives about 25 mg 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 *C. albidum* fruits 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). *Chrysophyllum 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 *C. 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 *C. albidum* to ascertain its nutrition and light requirement for healthy seedling growth.

MATERIALS AND METHODS

Study Area

The experimental site was 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 ^{o}N and 7 ^{o}55 $^{'}$N and longitude 3 ^{o}20 $^{'}$E and 3 ^{o}37 $^{'}$E. The Federal University of Agriculture, Abeokuta is located within the rain forest zone of South Western Nigeria (Amujoyegbe *et al.,* 2008). It is next to Ogun-Osun River Basin Development Authority (OORBDA), along Osiele-Abeokuta road, off Abeokuta-Ibadan road. It is in the North Eastern end of Abeokuta and lies approximately on latitude 7 ^{o}30 $^{'}$ N and longitude 3 ^{o} 54 $^{'}$ E. It lies within the humid lowland rain forest region with two distinctive seasons. The wet season extends from March to October while the dry season extends from November to February (Aiboni, 2001). The rainfall has a characteristic bimodal distribution with peaks in July and September and breaks in August. Generally, the rainfall could be heavy and erosive sometimes accompanied by lightning and thunderstorm at the beginning and end of rainy season.

Experimental Design

A 2x2 factorial experiment was laid down in Completely Randomized Design with three replications to assess the effect of nutrient sources [NPK (30 g) and Poultry manure (30 g)] 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 20x10x10 cm^3 dimensions at a depth of 15cm. Seedlings were established by first given 200 mL of water for a week. A rectangular cage of 2.5x1.5x1 m^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 planted under two layers of nets were conditioned 50 % light intensity; while that under four layers of nets were conditioned to 25 % light intensity. Eighteen seedlings under nutrient sources [NPK (30 g) and Poultry manure (30 g)] were exposed to 25 and 50 % light intensities respectively. 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).

$$LA = 0.74xLxW \quad \ldots\ldots 1$$

Where: LA = leaf Area
LxW = Product of linear dimension of the length and width at the broadest part of the leaf.

The mean of the growth parameters for period of experiment was used for tabulation. 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 6405 uv/vis Spectrophotometer, serial number 1364. The concentrations were calculated by adding 20.2 A 645, 8.02 A 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 663 nm.

$$\text{Concentration} = \frac{20.2\,A645 + 802\,A663}{(\text{Length of light path usually 1cm}) \times \text{Fresh Weight in grams} \times 1000}$$

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 ^{o}C for 72 hours (Umar and Gwaram, 2006).

Data Analysis

The data collected on the early seedling growth of *C. albidum* were subjected to One-way Analysis of Variance (ANOVA). Significant means on the early seedling growth of *C. albidum* were separated using Duncans Multiple Range Test (Duncans, 1955).

RESULT

Main Effect of Nutrient Sources on Seedling Vigour of *C. albidum*

Taller plant (12.32 cm)., higher number of leaves (2.93)., wider leaf area (4.2 cm^2)., wider stem girth (1.01 cm)., higher leaf dry weight (0.27 g)., higher shoot dry weight (0.13 g) and higher total dry weight (0.52 g) were recorded from seedlings planted in soil influenced with poultry manure (Table 1).

Table 1: Main Effect of Nutrient Sources on Seedling Vigour of *C. albidum*

Parameters	Nutrient Sources	
	NPK (30 g)	Poultry manure (30 g)
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 (2.71 cm^2), root dry weight (0.13 g), leaf dry weight (0.25 g), total dry weight (0.53 g) and relative turgidity (74.82 %) compared to those subjected to 25 % light intensity (Table 2).

Table 2: Effect of Light Intensities on Seedling Vigour of *C. albidum*

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 (g)	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 Nutrient Sources and Light Intensities on Seedling Vigour of *C. albidum*

Tallest plant (12.76 cm)., highest number of leaves (2.80) and widest collar girth (1.06 cm) were recorded for seedlings planted in poultry manure soil and subjected to 25 % light intensity. Widest leaf area (4.96 cm^2)., highest leaf dry weight (0.30 g)., highest shoot dry weight (0.16 g) and highest total dry weight (0.59 g) 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 Nutrient Sources and Light Intensities on Seedling Vigour of C. *albidum*

Parameters	Nutrient Sources			
	NPK (30 g)		PM (30 g)	
	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).

Key: NPK – NPK 15:15:15 Fertilizer; PM – Poultry manure

DISCUSSION

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 *et al.* (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.

One of the crucial environmental factors that affect plant growth and development is light intensity. The light intensity is vital for plant physiological and morphological growth. It can be deduced that higher growth parameters recorded for seedlings planted under higher light intensity in this experiment is as a result enhancement of their growth and development through better photosynthesis. This finding is corroborated with the reports of Liang (2000) and Yuncong *et al.* (2007) who stated that sun-light stimulates the plant growth and development; by photosynthesis process, plants use sun-light to convert H_2O and CO_2 into carbohydrate, photosynthetic pigments (Chl a, Chl b, and Chl a+b) play an important role in changing the solar energy to chemical energy.

Photosynthesis under higher light intensity enhances plant growth and development as well as biomass production. Similar observation has been made by Ologundudu *et al.* (2013) who stated that most variables analysed in their study showed that growth of *Corchorus olitorus, Amaranthus cruentus*, *Delonix regia*, *Abelmoschus esculentus* and *Celosia argentea* were greatly enhanced under higher light conditions as compared with its development under the shade. This is consonance with the reports of Liao *et al.* (2006); Zervoudakis *et al.* (2012) and Bhadmus and Onyekwelu (2014). Previously, researchers have found that biomass accumulation is directly associated with the availability of light intensity (Kiniry *et al.*, 2004) and reductions in light decreased the biomass production (Maddonni and Otegui, 2004).

The excellent performance in terms of growth parameters recorded for *C. albidum* seedlings planted under 50 % light intensity is traceable to its ability to adjust its morphology and physiology to changes brought about by higher light intensity better than that of lower light intensity. As light is the key resource for photosynthesis, plants acclimate to the light environment under which they are grown to maintain performance and fitness. Acclimation involves altering metabolic processes (including light harvesting and CO_2 capture) brought about by a range of mechanisms, from adjustments to leaf morphology to changes in photosynthetic apparatus stoichiometry (Terashima *et al.*, 2006; Athanasiou *et al.*, 2010; Kono and Terashima, 2014). Similar observations have been made by Zhang *et al.* (2003) and Fan *et al.* (2013).

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). Seedlings planted under lower light intensity gave higher height growth because they were able to maximize available light absorption for photosynthesis. Similar observation has been recorded by Steinger *et al.* (2003). The process of readjusting to environmental and biochemical changes brought by higher light intensity affected its physiology, limited the time and condition necessary for concentration of nutrient for height growth compared to that of seedlings planted under lower 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.

CONCLUSION

The *C. albidum* seedlings planted in poultry manure soil gave higher morphological and physiological parameters. 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 in poultry manure

soil under 50 % light intensity enhanced its seedling growth for agro-forestry systems.

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