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EFFECTS OF VARYING LIGHT INTENSITIES ON CHLOROPHYLL CONTENTS AND SEEDLING GROWTH OF *Moringa oleifera* Lam.

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ABSTRACT

Light plays significant roles in the growth and development of tree seedlings. However, climate change has led to the disruption of growth and development of many plant species. This study therefore investigated effects of varying light intensities on chlorophyll contents and seedling growth of *Moringa oleifera* lam. *Moringa oleifera* seeds were sown in a germination box filled with washed and sterilized river sand. After germination, seedlings were transplanted into polythene pots (15cm by 8cm) filled with top soil. At second week of transplanting, potted seedlings were subjected to different levels of light intensities under light chambers constructed to modify the intensity of light. The light chambers had varying light intensities representing four treatments (T0 = 100%, T1 = 75%, T2 = 50%, T3 = 25%) with five replicates. The experimental design was Completely Randomised Design (CRD). Plant height, leaf production, stem girth were assessed fortnightly while chlorophyll contents and biomass accumulation were assessed at end of the experiment. The data collected were subjected to analysis of variance (ANOVA) and descriptive analysis at 0.05 level of probability. There were no significant differences among the treatments on all the parameter assessed. T2 had the highest mean plant height of 25.08cm, mean stem girth (0.67mm) and mean leaf production of leaves (14). This was followed by T1 with the mean plant height of 23.73cm, stem girth (0.64) and number of leaves (13). The T0 had the least values with mean plant height of 19.97 cm, stem girth of 0.51mm and leave production of 9. The chlorophyll contents increased with decrease in light intensity. The T3 had highest chlorophyll contents (13.40 msPU) followed by T2 (12.70 msPU) and T1 (11.50 msPU) while T0 had the least (7.42 msPU). The T2 had the highest biomass accumulation (71.61g) followed by T1 (57.58g) and T3 (43.94) while T0 had the least biomass of 38.78g. The optimum growth and development of *M. oleifera* seedlings was obtained with 50% light intensity

Keywords: Chlorophyll contents, Biomass, Climate change, Climatic factors, *Moringa oleifera*.

Introduction

The rapid change in climatic factors like light, temperature, relative humidity, irrational precipitation has led to the disruption of growth and development destruction of many plant species which makes them threatened while many more are heading to extinction. Unless urgent action is taken to conserve and domesticate some of these endangered species so as to meet the need and demand for large scale plantation establishment, they will eventually be extinct (World Bank, 2002). Hence it is very important at this period of climate change to examine the response of some of the useful species to some of these climatic factors like light intensity (Perera, 2005). Light plays major and the most significant roles in the growth and development of tree seedlings. This is due to the fact that it is the process through which green plant manufactures their food, that is, photosynthesis and other physiological process like chlorophyll formation and opening of stomata. In addition, light intensity exerts many stimulating effects on different tissues and organ of the trees (Stone, 1999). It also controls the overall growth and development of the tree through photoperiodic reaction. (Adedoyin, 2005).

Moringa oleifera is one of the many useful plants that needs to be protected against extinction as a result of climatic change. It is one of the notable members of Moringaceae family. In Yoruba, it is known as *Ewe Igbale*, Hausa language as *Zongalla gandi* and Igbo as *Okwe-oyibo*, (Adio *et al*., 2008). It is a perennial evergreen tree that grows up to 6.1 meter in height. With a straight trunk with corky, whitish bark. It has tuberous tap root and brittle stem. The leaves are pale green, compound tri-pinnate, 30 – 60cm (11.8 – 23.6 in) in length with small leaflets. The fruit pods are pendulous, greenish-brown which contain about 10 – 20 seeds embedded in the flesh pith. The seeds are dark brown and contain main constituent of palmatic and stearic acid, saponnis, gum, protein, vitamin; A, B1, B2, B3, C minerals; calcium, iron, phosphorus, magnesium (Troup, 2000). Leaves are pounded up and used for scrubbing utensils and for cleaning wall. Seeds yield 38 – 40% of non-drying oil known as Ben oils used for lubricating watches and other delicate machinery. Oil is clear, sweet and colourless, never becoming varied. Consequently, it is edible and useful in manufacturing of perfumes and hair dressing cosmetics. It can serve as shade, fibres and water purifiers (FAO, 1999).

It is commonly planted in Africa as living fence. Its wood yield blue dye and young branches are relished by livestock.. Bark can serve for tannin. It also yields a coarse fiber (Rajangam, 2001). Other advantages of this underutilized species are its high protein, nitrogen content in the foliage, rapid growth in turn to produce high biomass. It can be easily established (D' scuza and Kularin, 1993).

Much have been learnt about *M. Oleifera* seedlings; its medicinal, environmental and economic benefits. However, there is dearth of information on the effect of varying light intensity on *M. Oleifera* seedlings. This study was therefore carried out to fill this identified gap in knowledge to enhance the effort of Silviculturists, nursery workers and *M. Oleifera* farmers and in raising healthy and climate change adapted species of *M. Oleifera* at the nursery stage. Findings will be used as yardstick to justify the probable negative and positive effect of exposing *M. Oleifera* seedlings to high or low light intensity as importantly bordered on chlorophyll formation.

Materials and Methods

The experiment was carried out at the Federal College of Forestry premises, Jericho, Ibadan. The College is located on latitude 07º23' 18"N to 07º 23' 40"N and longitude 03º 36' 20"E to 03º32' 41"E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9ºC, minimum 24.2ºC while the mean daily relative humidity is about 71.9% (FRIN, 2015).

Moringa oleifera seeds were sown in a germination box filled with washed and sterilized river sand on which daily watering was carried to facilitate seedling emergence. After germination, seedlings were transplanted into polythene pots (15cm by 8cm) filled with top soil. At second week of transplanting, potted seedlings were subjected to different levels of light intensities under light chambers constructed to modify the intensity of light. The light chambers were made up of one (1), two (2) and three (3) layers of wire mesh with varying light intensities of 75% (T1), 50% (T2), 25% (T3) while that of control was 100% (T0) (full exposure to sunlight). The light intensity of different chambers was determined with the use of photometer (Lux).

Estimation of chlorophyll

The chlorophylls a and b were measured, as described by (Arnon, 1949). Fresh leaves (0.2 g) were ground in a mortar with a small amount of quartz sand and calcium carbonate powder and 2–3 ml 95% ethanol. Absorbance of the supernatant was measured at 665, 649, and 470 nm using a spectrophotometer (Hitachi-U2001; Hitachi, Japan) and concentrations of chlorophylls a (C_a) and b (C_b) were calculated using the following formulae:

$$\mathrm{C_a} = 13.95A_{i\,665} - 6.88A_{649}\ x\frac{VW}{1000}\ldots\ldots 1$$

$$\mathrm{C_b} = 24.96A_{i\,649} - 24.96A_{665}\ x\frac{VW}{1000}\ldots 2$$

Where: A_i indicates absorption at wavelength i, V is the volume of the extract, and W is the weight of fresh leaf tissue (g).

Assessment of growth variables

Heights were measured from the root collar to apical bud using a graduated ruler**.** The numbers of leaves were counted while the stem girth was measured at about 2cm above the root collar with the use of digital caliper.

Biomass Assessment

Biomass assessment was carried out at the end of the experiment where leaves, stem and root of the selected seedlings of the species were excised with a sharp razor blade. The leaves of the species were separately gathered so also the stems and roots. Their fresh weights were determined using a Sensitive Weighing Balance for Biomass estimation of

M. oleifera and then oven dried to constant weight for twenty-four hours at 70^{o}C. The combined weight of leaves, stems and roots accounted for the total dry weight.

Data were collected fortnightly for twelve (12) weeks. The experimental design was a Completely Randomized Design with five replicates. Descriptive statistics and Analysis of Variance (ANOVA) were used to analyze the data at 5% probability level.

Results and Discussion

Effects of varying light intensities on Mean Plant Height (cm), Stem girth (mm) and Number of leaves at 12 weeks is presented in table 1. It shows that T2 (50% exposure to light intensity) had the highest mean plant height of 25.08cm, mean stem girth (0.67mm) and mean number of leaves (14). This was followed by T1 (75% exposure to light intensity) with the mean plant height of 23.73cm, stem girth (0.64) and number of leaves (13). The T3 (25% exposure to light intensity) had 23.03cm, 0.54mm and 11 for mean plant height, stem girth and number of leaves, respectively. The least values in all the growth parameter assessed were recorded for

(100% exposure to light intensity, that is, control) with mean plant height of 19.97 cm, stem girth of 0.51mm and leave production of 9. According to Zhang *et al*., (2003), radiation of sun light is an important environmental factor that plays most significant role in regulating green plant photosynthesis, and consequently plant survival, growth and adaptation. As a result of temporary variation in light intensity on plant habitat, different plant species develop acclimation and plasticity to cope with the varying light regimes (Zhang *et al*., 2003). Differences in growth variables of *M. oleifera* imply that majority of plant species have the ability to develop anatomical, morphological, physiological and biochemical alterations in response to different light intensities (Czeczuga 1987; Muraoka *et al*., 2002).

Several studies have revealed that the biomass of roots, stems, leaves and whole plant as well as the photosynthetic rate, the transpiration and the stomatal conductance of water vapour decreased under low light (Zhang *et al*., 2003; An and Shangguan 2009; Wang *et al*., 2009; Mielke and Schaffer 2010). In contrary to the above and as it was observed in the present study, Yang *et al*., (2007) and Wang *et al*., (2009) found that plant height increased at low light intensity. Besides, plant leaves under high light intensity have lower photosynthetic pigments contents than leaves under low light intensity (Czeczuga 1987; Adamson *et al*., 1991; Yang *et al*., 2007; Mielke and Schaffer 2010).

Table 1: Effect of Varying Light Intensities on Mean Plant Height (cm), Stem girth (mm) and Number of leaves at 12th week

Treatments	Plant height (cm)	Stem girth (mm)	Leaf count
T0	19.97	0.51	9
T1	23.73	0.64	13
T2	25.08	0.67	14
T3	23.03	0.54	11

Tables 2, 3 and 4 show that there were no significant differences among the treatments at 5% level of significance. This implies that the species can relatively withstand different levels of light intensity for growth and development. Though, 50% light intensities had better influence on the growth variables compared to other treatments. This confirms that moderate light intensity is required for proper growth and development of plant as too much exposure can have negative effects on the plant. This corroborates the findings of Wang *et al*., (2009) that the intermediate light conditions were more adequate for some species to grow appropriately. According to, Bastchauer, (1999) light intensities should be regulated for some species

Table 2: Analysis of Variance (ANOVA) on effect of varying light intensities on seedlings plant height (cm) of *M. oleifera*

SV	df	SS	MS	F-Cal	F-tab	Remark
Treatments	3	678.84	226.28	0.27	3.20	ns
Error	16	13463.51	841.47			
Total	19	14142.35				

Table 3: Analysis of Variance (ANOVA) on effect of varying light intensities on seedlings girth (mm) of *M. oleifera*

SV	df	SS	MS	F-Cal	F-tab	Remark
Treatments	3	0.83	0.28	0.25	3.20	ns
Error	16	17.58	1.10			
Total	19	18.41				

Table 4: Analysis of Variance (ANOVA) on effect of varying light intensities on leaf production of *M. oleifera* seedlings number

SV	df	SS	MS	F-Cal	F-tab	Remark
Treatments	3	524.63	174.88	0.41	3.20	ns
Error	16	6774.31	423.39			
Total	19	7298.94				

Figure 1 reveal the relationships among varying light intensities biomass accumulation and chlorophyll contents on seedlings of *M. oleifera*,. The chlorophyll contents increased with decrease in light intensity. The T3 had highest chlorophyll contents (13.40 msPU) followed by T2 (12.70 msPU) and T1 (11.50 msPU) while T0 had the least (7.42 msPU).

This implies that exposure of the seedlings of *M. oleifera* to 100% light intensity reduces the chlorophyll contents in the plant leaves. This is in accordance with the findings of (Czeczuga 1987; Adamson *et al*., 1991; Muraoka *et al*., 2002; Mielke and Schaffer 2010) that the photosynthetic pigments in the shaded plants tended to be higher when compared with the plant exposed to full sunlight. Specifically, it was found that at 25% light intensity, chlorophylls a, b and their sum were doubled in comparison with the plants grown at 100% light intensity (Adamson *et al*., 1991). In contrary, the chlorophyll contents of *Tradescantia pallida* were increased under full sunlight (Sousa-Paiva *et al*., 2003).

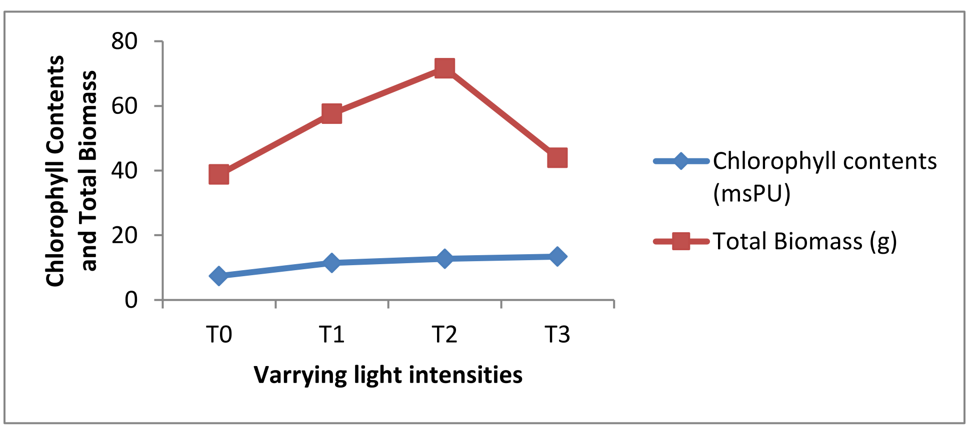

Figure 1: Relationship between Chlorophyll contents and biomass accumulation as influenced by varying light intensities

The total biomass accumulation of *M. oleifera* as influenced by light intensity is presented in table 5. The T2 had the highest biomass accumulation (71.61g) followed by T1 (57.58g) and T3 (43.94) while T0 had the least biomass of 38.78g. This is an indication that higher light intensity produces lower biomass (Mielke and Schaffer 2010). The estimated biomass of leaves, stems and roots were highest in T2 with 21.56g, 17.41g and 32.64g, respectively. The T0 had the least with leaves (12.22g), stems (9.05g) and roots (17.51g). These findings supported Stone, (1999) which stated that different part of plant response differently to varying light intensities. It also supported Folta, (2001) findings which revealed that plant initiated under different set of light condition often face quite different challenges during growth and development.

Table 5: Effects of Varying Light Intensities on chlorophyll content and Biomass Accumulation of leaves, stem roots of *M. oleifera* as at termination stage (12weeks) of experiment

Treatments	Chlorophyll (msPU)	Leaf (g)	Stem (g)	Root (g)	Total (g)
T0	7.42	12.22	9.05	17.51	38.78
T1	11.50	15.17	13.91	28.50	57.58
T2	12.70	21.56	17.41	32.64	71.61
T3	13.40	14.33	10.29	19,32	43.94

Conclusion and Recommendations

The effect of light on the growth of plant is complex. This is as a result of the fact that in nature, increase in light intensity is usually accompanied by an increase in respiration and transpiration rates. When the level of light intensity is high, respiration will be affected. This effect is clearly seen and observed in the seedlings exposed to 100% light intensity (control). Hence, high light intensity often cause increase rate of transpiration, thus causing water stress condition much earlier than at other treatments levels of lower light intensities.

Therefore, from the result of this study, it is clearly shown that the optimum light intensity for the best performance of *M. Oleifera* seedlings was achieved with 50% light intensity. Therefore, *Moringa oleifera* seedlings do not require high light intensity. Hence, seedlings of *M. Oleifera* should be raised at 50% light intensity so as to enhance its optimum growth and development. It is therefore recommended that moderate light intensity should be used in raising *M. oleifera* seedlings in the nursery.

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