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SEEDLINGS GROWTH PERFORMANCE OF *Nauclea diderrichii* (MERR) AS INFLUENCED BY DIFFERENT LIGHT INTENSITY

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ABSTRACT

Light is an essential factor in plant growth. The rate at which plant grows and remains active is dependent on the amount of light received. This study was carried out to investigate seedlings growth performance of *Nauclea diderrichii* (MERR) as influenced by different light intensity. There were 5 (five) treatments (direct sunlight, one layer mash net, two layer mesh net, three layer mesh net and under forest canopy) replicated five (5) times laid in a Complete Randomized Design (CRD). The variables assessed were plant height, number of leaves, stem diameter and chlorophyll assessment. The data collected were subjected to analysis of variance (ANOVA) in CRD. The result showed that there was significant difference among the treatment at 5% level of probability. Seedling under tree canopy had the highest mean height of 84.8cm and the stem diameter of 1.76mm and the highest mean for the number of leaves (30.05). However, control had the lowest 20.75 and the height was 50.19cm, the chlorophyll test showed that treatment five under tree canopy had the highest chlorophyll content of 16.08ng/m followed by treatment four with three layered wire mesh of 13.95ng/m, while treatment one in direct sunlight had the least of 8.54ng/m. The one under tree canopy is therefore recommended for raising seedling of *Nauclea diderrichii* at the nursery stage.

Keywords: *Nauclea diderrichii, Seedlings, wire mesh, Light intensity, Canopy, Treatments*

Introduction

Environment has a major role to play in the growth and development of forest trees. The total environment of trees is a complex integration of biological and physical elements. The physical elements are climate, soil, precipitation, radiation, movement and composition of air. Environmental condition affects photosynthetic rate and thus, the responses of *Nauclea diderrichii* to environmental factor is part of the success of silviculture (FAO, 2005).

Light intensity controls the growth and development of tree through photoperiodic reaction, when in-turn influence growth diameter and its existence (Adedoyin, 2005). Visible light that is part of electro- magnetic spectrum with the wavelength in the range of about 400-760 mills microns phis ultraviolent and infrared light affect the growth of trees in several distinct ways. The role of light as a source of energy for growth in photosynthesis is commonly known, but its role in regulating growth is subtle (Adedoyin, 2005). Light intensity influences plant food manufacturing, , leaf colour and flowering. Plant can also be classified according to their light needs such as high, medium and low light requirement. The light intensity received by an indoor plant depends on the nearness of the light source to the plant (Adedoyin, 2005).

Generally, plant grown in low length tends to be spindly with light greens leaves. Similar plant grown in very bright light tends to be shorter, better branches and have large dark green leaves (Nwoboshi, 1982). Light intensity rapidly decreases as the distance from the light source increases. Reflective light coloured surface inside the home or office tends to increase light intensity (Nwoboshi, 1982).

Nauclea diderrichii is commonly known as “Opepe” and it belongs to the Rubiaceae family. It is an indigenous species found in tropical rainforest of West Africa and one of the timbers in the rainforest zone, considering the economic importance of the tree with increases in population and living standards (Keay, 1964). The tree has diverse utility to man and animals. The wood is yellow and slightly dark when exposed to light. It is semi-heavy and of medium hardness, its shrinkage and nerrosity are average (Dupuy and Mille, 1993). *Nauclea diderrichii* species spreads throughout the humid lowland forests of West Africa countries, extending from SierraLeone to Congo, Uganda and part of East Africa countries (Burkill, 1985). Because of the good mechanical properties and natural durability of *Nauclea diderrichii*, it can be enhanced by preservative treatment, it is sought after as a timber for out-door uses (harbor works, railway sleepers) in building and constructions (Dupuy and Mille, 1993).

In Nigeria, the species bears different local names relatives to the immediate environment where it is formed. The Igbos named the species “Uburu” Yorubas call it “Opepe” while Bini calls it “Obiache” (Keay, 1964). It is spread throughout the humid

lowland forests of West African countries, extending from Sierra Leone to Congo, Uganda and part of East African countries (Burkill, 1985). The trees have diverse utility to man and animals. Generally, the medicinal uses of the leaves are for treatment of diarrhea in SierraLeone and for treatment of fever like those of *Nauclea latifolia* (Irvine, 1961). The steeped boiled bark of *Nauclea diderrichii*, is useful in French Equatorial in the treatment of gonorrhea (Abbe, 1953). The bark decoction is boiled and drunk by women for stomach pains because the bark contains alkaloids (Irvine, 1961).

In Nigeria the leaves are fed to livestock. The root, bark and wood are used for making a yellow dye. *Nauclea diderrichii* is a good shade tree, used for crops as well as other timber trees. *Nauclea diderrichii* is widely used in local traditional medicine. The roots are credited with diuretic properties and used for the treatment of anaemia. Bark decoctions are taken in Sierra Leone and Ghana against stomach-ache and malaria, and as a foot wash after long walks. InCôte d'Ivoire Sierra , Gabon, Congo and Nigeria, leaf decoctions are drunk against diarrhea,Cough, treatment of measles, Hepatitis, fever, stomach problems, gonorrhea and menstruation problems and also used as appetizer and diuretic(Mustafa *et al.,* 2000). *Nauclea diderichii* is heavily exploited for its timber, which is used in general construction work (ARW, 1998). Regeneration is good in large canopy gaps but the species is outcompeted by other pioneer after clear- felling (IUCN, 1998). This study will investigate the best light intensity for the mass production of *Nauclea diderichii* seedlings for plantation establishment to ensure a continuous availability of the species.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Forestry department nursery, within the premises of Federal College of Forestry, Ibadan. The College is situated at Jericho Quarters under Ibadan North-West Local Government Area of Oyo state. The area has an annual rainfall pattern ranging from 1300mm to 1500mm. The average temperature is about 37.2^0C and relative humidity is about 80 – 85% (FRIN, 2014)

The experiment was carried out in the dry season, and the light intensity chambers were constructed using mesh net.

Three wooden chambers were constructed using wooding frames of 60 by 60 by 90cm in dimension. Each chamber was covered on all sides by different layers of 1 mm-size green mesh except the side touching the ground. Treatment one (1) (control) was left in open place without shade to receive full sunlight (100% light intensity), Treatment 2 was constructed with one layer of mesh net (75% light intensity), Treatment 3 was constructed with two layers of mesh net (50% light intensity), Treatment 4 was covered with three layers of mesh net

(25% light intensity) to further reduce the amount of light intensities and Treatment 5 was under forest canopy (Akinyele, 2007; Aderounmu, 2010). The available light intensity under each chamber was confirmed by using light meter. Each treatment were replicated five (5) times and the total numbers of seedlings were twenty-five

The top soils were sieved using 2mm sieve size in order to remove the debris and stones present. It was then filtered into polythene pot. Seeds of *Nauclea diderichii* were sown in a germination box filled with top soil. The seeds were watered daily. After the germination, the seedlings were gently pricked out into each polythene pot containing the top soil and then subjected to various treatments, the prepared mesh net of three different levels.

The seedlings were watered daily (early in the morning) using watering can and weeding was done when necessary. The seedlings were observed and assessed weekly for a period of two months. The variables assessed were plant height, numbers of leaves, plant girth and Biomass. For biomass estimation, mean height of the seedlings of each potting media was calculated and one seedling whose height is closest to the mean height was selected for destructive sampling at the beginning and end of the experiment. The selected seedling from each treatment was carefully uprooted by separating the seedling from the soil, washed and sectioned into root, stem and leaves. Estimations of the stem length and root length of each seedling was obtained using meter tape and sensitive weighing balance was used to obtain the initial (fresh) weight of leaves, stem and root.

After taken the fresh weight, seedling components (leave, stem and root) was taken to the analytical laboratory of the Department of Sustainable Forest Management, FRIN and placed in the oven and dried in a gallenkamp drier at 70^0c until a constant weight was obtained. Since 100% of each component was dried in the oven, the dry weight of each component will be taken as their biomass. Seedling total biomass will be obtained by summing the biomass of the various components.

The chlorophyll content of the plant (*Nauclea diderrichii*) was determined, the sample was concentrated by filtration. During the filtration 0.2ml of $MgCO_3$ solution was added before the sample was placed in the grinder. It sample was covered with 3 to 4ml of aqueous acetone solution. The sample was macerated and later transferred into a centrifuge tube. The volume was increased by 5ml of acetone solution and left overnight at 4^oc in the dark. The extract was centrifuge for about 20minutes at 500gm.

It was later decanted into a clear 15ml centrifuge tube before the extracts volume was measured. The extract was then put into the curette before determine the optical density at 663nM and 750nM before and after adding 0.02ml of IN HCL/ml of extract. The 750nM optical density value was then subtracted from the 663nM reading to calculate the optical density at $663_b/663_a$ ratio and concentrated of chlorophyll in sample according to the formula.

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$$\text{Chlorophyll (mg/m}^3) = \frac{26.73\,(663_b - 663_a)\,XV_1}{V_2}$$

Where 663_b and 663_a = n OD of the 90% acetone before and after acidification respectively when a 1cm light path is used.

V_1 = volume of extract.

V_2 = sample volume (m^3).

Data Analysis

The data collected was subjected to statistical analysis using analysis of variance (ANOVA) in a Completely Randomized Design (CRD). Means found to be differing from each other was subjected to follow up test procedure using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Table 1: Mean number of leaves of *Nauclea diderichii* subjected to different light intensities.

Week	1	2	3	4	5	6	7	8	9	10
T_1	19	17	19	18	16	18	20	22	28	30
T_2	19	19	21	21	23	25	27	30	35	38
T_3	19	19	20	20	21	24	26	32	34	35
T_4	19	21	22	22	24	28	31	31	37	39
T_5	22	22	23	27	28	29	34	38	40	42

Table 2: ANOVA table for the leaf number

Source	DF	SS	MS	F-cal
Treatment	4	1791.68	447.92	31.72*
Error	45	635.6	14.12	
Total	49	2427.28		

*Significance at 5% probability level

From Table 1 above, the maximum number of leaves was obtained from treatment 5 (seedlings under forest shade) with 30.5, followed by treatment 4 (seedlings under 3 layers mesh net) with 27.4, followed by T_2 (seedling under 1 layer mesh net) with 25.8, followed by T_3 (seedling under 2 layer mesh net) with 25.0 while the seedling in treatment 1 which is direct sunlight had the lowest leaf number with 20.7. There was significant different among the treatment (Table 2). The result observed here was in accordance with the findings of Hawthorne and Jongkind (2006) that seedlings grown under shade grow faster and develops better at nursery stage.

Table 3: Mean plant height of *Nauclea diderrichii* to different light intensities.

Week	1	2	3	4	5	6	7	8	9	10
T_1	44.1	43.4	46.7	47.3	45.7	49.2	51.6	53.6	59.1	61.2
T_2	48.8	52.2	59.6	60.0	61.8	67.0	71.2	75.2	82.8	87.3
T_3	43.0	48.4	53.5	55.1	55.9	60.2	66.7	72.4	78.8	81.8
T_4	51.0	57.3	62.7	65.8	65.7	69.7	74.9	74.9	88.2	91.6
T_5	60.0	70.2	77.1	82.5	87.2	92.4	97.7	106.7	112.6	115.6

Table 4: ANOVA table for plant height

Source	DF	SS	MS	F-cal
Treatment	4	23987.83	5996.96	69.55*
Error	45	-3879.69	86.23	
Total	49	20108.19		

*Significance at 5% probability level

Table 3 shows the mean value of plant height. It indicates that treatment 5 (seedlings under forest shade) had the highest height of 84.8cm followed by treatment 4 (seedling under 3 layer mesh net) with 70.18cm, followed by T_3 (seedling under 2 layer mesh net) with 61.5cm while the least was from treatment 1 with mean value of (50.19cm). There is significant difference among the treatment (Table 4). This is in accordance with the findings of Voorhoeve (1979) that there is a 20% increase in volume and 40% increase in height of seedlings raised under shade at nursery stage.

Table 5: Mean stem diameter of *Nauclea diderrichii* subjected to different light intensities.

Week	1	2	3	4	5	6	7	8	9	10	Total
T_1	1.07	1.09	1.12	1.12	1.18	1.25	0.98	1.25	1.37	1.46	11.89
T_2	1.42	1.42	1.46	1.50	1.57	1.60	1.43	1.58	1.73	2.01	15.72
T_3	1.10	1.12	1.14	1.18	1.21	1.34	1.33	1.55	1.75	1.96	13.68
T_4	1.22	1.26	1.29	1.31	1.33	1.41	1.30	1.63	1.83	1.98	14.52
T_5	1.48	1.51	1.55	1.58	1.61	1.68	1.64	1.86	2.24	2.43	17.58

Table 6: ANOVA table for plant diameter

Source	DF	SS	MS	F-cal
Treatment	4	5.92	1.48	134.55*
Error	45	-0.49	0.011	
Total	49	5.43		

*Significance at 5% probability level

From Table 5, treatment 5 (seedlings under forest shade) had the highest mean stem diameter of 1.76, followed by treatment 2 (seedling under 1 layer mesh net) with 1.46, followed by T_4 (seedling under 3 layer mesh net) with 1.46, followed by T_3 (seedling under 2 layer mesh net) with 1.37. Shade had well on effect while treatment 1 had the lowest mean value of 1.19.
This is in accordance with the findings of Onyekwelu (2007) that shading has the greatest ability to enhance plant growth and development at nursery stage. There is significant difference among the treatment (Table 6).

Table 7: Chlorophyll analysis of *Nauclea diderrichii* subjected to different light intensities

Treatment	Chlorophyll (g/m)
T_1	8.54
T_2	11.39
T_3	13.84
T_4	13.95
T_5	16.08

The chlorophyll content of the treatment decreased as the level of light intensities increased (Table 7). The observation was highly conspicuous in the case of seedling in T1 (control), treatment 5 had no problem and all plant was green. Therefore, the seedlings under treatment 5 had the highest chlorophyll content. It is evident that the photosynthetic potential of the plant increased with decrease light intensities. It is observed that treatment 5 had lush green leaves.

Table 8: Biomass weight of replicate in each treatment

Treatment	Leaves weight	Stem weight	Root weight	Total
T_1	8.50g	5.80g	16.76g	31.06g
T_2	14.71g	8.87g	21.39g	44.95g
T_3	11.22g	10.33g	22.52g	47.07g
T_4	15.78g	9.46g	36.74g	61.98g

T_5	15.34g	12.32g	40.98g	68.23g

From the Table 8, treatment 5 has the highest value in the reading with 34.80g in wet weight and 11.92g in dry which indicate that seedling in treatment 5 is a good commodity for the society and influence the medical value. The Physical observation of the treatment reveals that there is 100% survival in the shade but only 40% survival in the direct sunlight at tenth week of the experiment. In the forest shade, there was high leaf development and uniform leaves were produced.

Normal percentage of light enhanced growth better than full sunlight. The different in growth terms of plant height, number of leaves and plant diameter was significant as from the third week. There was no appreciable growth under full exposure to sunlight while there was great increase in plant height and diameter under shaded screen house. Under full exposure to sunlight the seedlings in T_1 shows a yellowish colour, continual exposure to sunlight eventually result to leave burn. It was observed in the course of the study that the seedling under 100% direct sunlight suffered insect defoliation, spot infestation and leaf fall that affect the leaf number. This shows that *Nauclea diderrichii* seedlings will not do well under the influence of direct sunlight.

CONCLUSSION AND RECOMMENDATION

Nauclea diderrichii under reduced light intensity seedlings under shade has the fastest growth and full survival. It is also clear from the result that the seedling is best cultivated in the shade under reduce sunlight. Shaded light enhanced growth in the experiment whereas seedlings under direct sunlight had the least, due to the full sunlight attack and reduced the growth. The leaves, stem and root weight of treatment five (5) gain much from the reduce sunlight. Despite the amount of light absorbed it had great value of the use of the community.

The species at the nursery stage needs some shade (dense) for optimum performance. Hence, silviculturist, horticulturist or nursery attendant should provide and raise the seedling under shade before being taken to the field. Further studies should be carried out on the effect of light intensity in raising our indigenous tree species in the nursery to really ascertain its influence and how it can be adopted in our forest nurseries.

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