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Influence of different light intensity on early growth of *Jatropha curcas* L. seedlings

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This study investigated the influence of different light intensities on the early growth of *Jatropha curcas* seedlings. Forty (40) seedlings were randomly selected from the germinated seedlings in the nursery and arrayed under four different treatments (0, 20, 40 and 60% light intensity). The amount of light being received by each of the seedlings was regulated, using constructed wooden box covered with wire gauze (1 mm in size) and measured with photometer. The results on seedlings germination under different light intensity revealed that, the highest mean height (29.2±1.94 cm) was observed in seedlings covered with 60% wire gauze, while the least mean height (27.0±1.24 cm) was observed in the seedlings placed under control treatment (0% wire gauze). Also the highest mean seedlings girth (2.69 ± 0.15 mm) was observed in seedlings not restricted with light intensity (0% wire gauze), while, the least mean girth (2.27±0.08 mm) was found in seedlings restricted with 60% light intensity. The average number of leaves in the four treatments ranges between 6 and 7. The result on analysis of variance (ANOVA) conducted shows a significant effects (P<0.05) of light intensity on *J. curcas* seedlings girth and number of leaves, while, the seedlings height shows no significant difference (P>0.05). Conclusively, the finding has shown that, *J. curcas* seedlings required light for its survival, but at varying intensity, and it was noticed that the thicker the light regulator (wire gauze), the lower the amount of light being absorbed by the seedlings.

Key words: *Jatropha* seedling, light intensity, wire gauze, influence survival.

INTRODUCTION

Seed germination and plant growth are greatly influenced by external conditions such as the intensity and duration of light and temperature. Aside from its effect through photosynthesis, light influences the growth of individual organs or of the entire plant in less direct ways. The most striking effect can be seen between a plant grown in normal light and the same kind of plant grown in partial darkness or total darkness. The plant grown in the partial dark or total dark will have a tall and spindling stem. According to Dennis (2009), the leaves of plant deficient in light fails to expand in both length and width, lacking chlorophyll and are always pale yellow colour, as such a plant is said to be etiolated.

Light intensity and its duration (length) may have different and characteristic effects upon plant growth and development. It has been found that the length of the day

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light period may have a striking effect upon vegetative growth and reproductive activities of plants. The reaction of plants in relation to the length of the day is called photo-periodism (Dennis, 2009). Despite the economic, nutritional, cultural and social importance of *Jatropha curcas*, especially to rural dwellers that depend on them, it has been greatly neglected, especially with respect to their regeneration. Due to lack of care and old age, a lot of trees have died or are in the process of doing so, thus the species is classified among the endangered tree species (Turner et al., 2011), with a high possibility of going into extinction in the near future except something is done to increase its population.

Allowing the species to go into extinction will endanger the livelihood of millions of rural dwellers in Nigeria and reduce the rich biological diversity of the ecosystem. Artificial regeneration and subsequent improvement (domestication) appears to be a very viable option of saving the species from extinction and ensuring that its products are supplied on sustained basis. The need to rapidly domesticate tropical forest food tree species has been stressed and is now one of the three pillars of the International Centre for Research in Agroforestry (ICRAF) program (Leakey and Simons, 1998).

Early growth of forest seedlings is affected by some factors such as light intensity, air, temperature, water, soil condition, etc. Except these factors or their combinations are provided at the right time and in good quantity, seed germination and growth of seedlings may be adversely affected. Till date, research work on the effect of light intensity on the early growth of *Jatropha curcas* seedlings is scanty, which is the focus of this study.

Research on domestication of forest food tree species is still at a preliminary stage. Specifically, efforts on domestication of *J. curcas* only covers seed storage and germination, vegetative propagation, germplasm collection, priority setting exercise, integration into agro forestry, economic and nutritional importance, selection of multiple traits for potential cultivars (Leakey et al., 2003).

Presently, much work have not been done on the influence of light intensity on the early growth rate of *J. curcas* seedlings and thus necessitated this research to investigate the influence of different light intensities on the early growth of *J. curcas* seedlings.

MATERIALS AND METHODS

Study site

The study was conducted in the Department of Forestry and Wildlife Management Nursery Unit, Modibbo Adama University of Technology, Yola (MAUTECH) Adamawa State. The study area lies between Latitude 9° 35′ N and 10° 25’ N and Longitude 12° 55′ E and 14° 35’ E at an altitude of 158.8 m (Figure 1). It covers an area of about 54 ha. The soils of the study area as classified by USDA are Alfisol and Inceptisols. It ranges from sandy loam underlined by salty clay, deep loam underlined by salty clay to sandy loam. Soil pH is acidic (6.5-6.9) whereas total nitrogen and phosphorus is low. Generally, the area is semi-arid and is of low fertility (Musa, 2006). The rainfall starts in April and becomes more intense in August and September and periods of no rainfall exist between January and March. Temperature varies between 26.9°C and 27.8°C mean annually while the minimum temperature can be as low as 18°C between December and January and maximum temperature about 40°C, depending on the season of the year. The relative humidity of the study area varies between 30 - 80% depending on the particular period of the year (Adebayo and Zemba, 2020).

Procedure

The seeds of *J. curcas* were procured from Jos seed bank and were sown in polythene pot at the Departmental nursery. The seeds were subjected to a pre-germination test for 3 days before planting. Two weeks after planting, the seedlings were arranged under different light intensities. The amount of light falling on the seedlings was reduced by 20, 40 and 60%, using constructed wooden box made up of single, double and triple wire gauze, 1 mm in size. The amount of light (Candela) received by each treatment was measured, using, photometer.

Experimental design

Completely randomized design was used for this study, in which thirty (30) seedlings (10 replicate) were randomly selected out of the germinated seedlings and arranged under each of the constructed wooden box labelled T_1, T_2 and T_3 respectively for assessment. Another ten (10) seedlings were also set aside under direct sunlight, which serves as control (T_0) making a total number of forty (40) seedlings used for this study.

Parameters assessed

The following parameters were assessed for 42 days (6 weeks) under each of the randomized treatments (T) and recorded.

i) Height (cm): The height of the seedlings was assessed, using a calibrated ruler.
ii) Leave count: This was carried out by counting the number of leaves per plant.
iii) Girth (mm): The girth or collar diameter of the seedlings was measured using veneer caliper.

Data analysis

Descriptive and inferential statistics was used for data analyses, using, Microsoft Excel statistical tools, 2007 Version. The descriptive statistics was used to estimate the measured variables, while, one-way analysis of variance was used to check the variation among the light intensity absorbed by the seedlings, under each treatment. Fisher’s Least Significant Difference (LSD) was used for mean separation.

RESULTS AND DISCUSSION

Germination potential of *Jatropha curcas* seedlings under different light intensity

The result (Table 1) revealed that, the highest mean height (29.2 ± 1.94 cm) was observed in seedlings

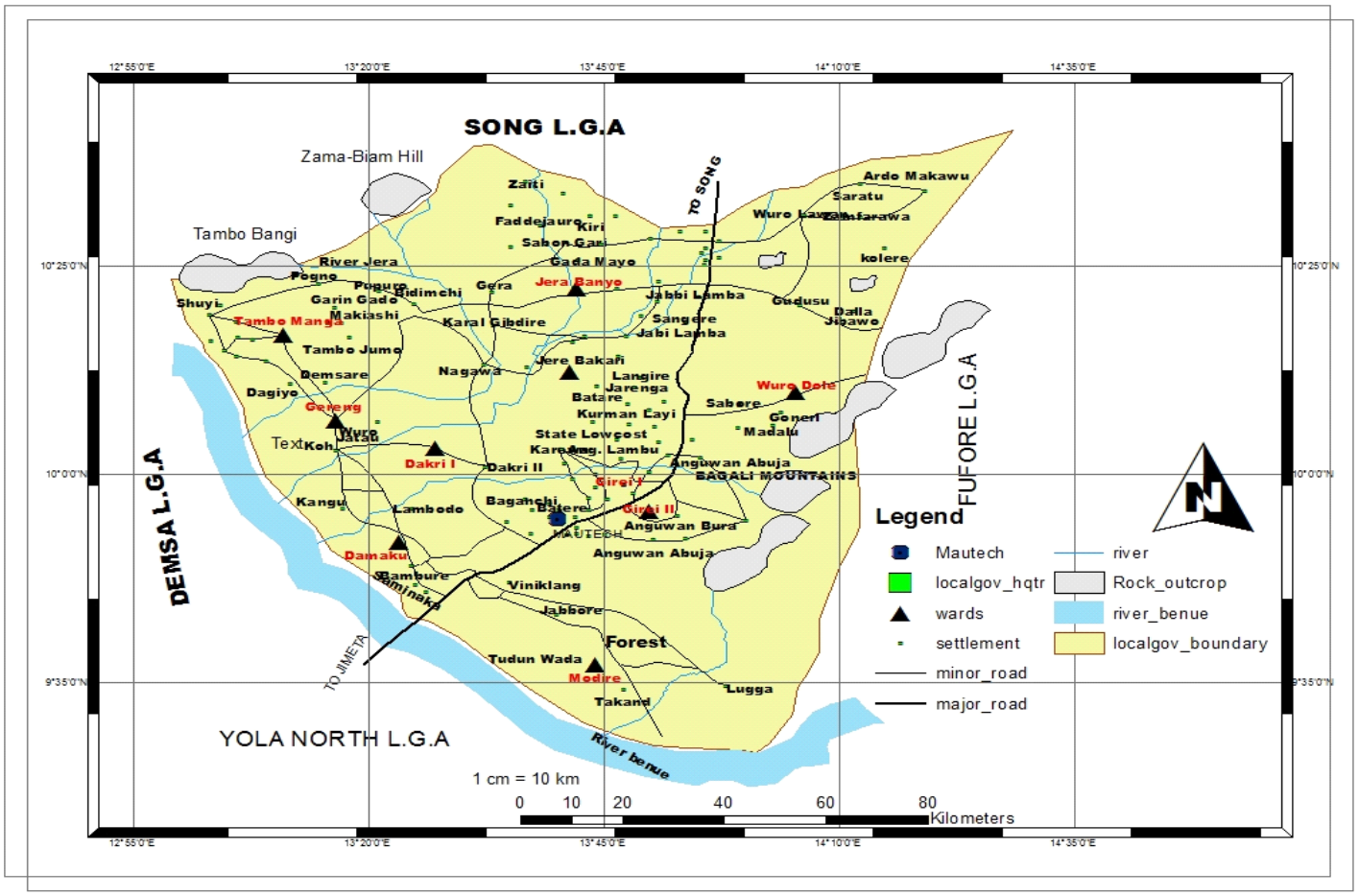

Figure 1. Map of Girei showing the study area.
Source: Department of Geography, Geographical Information System (GIS) Unit, MAUTECH. Yola (2017).

Table 1. Germination potential of *J. curcas* seedlings under different light intensity.

Treatment	Light Intensity (cd)	Mean Seedling Parameters		
		Height (cm)	Girth (mm)	Number of Leaves
0	456.6 ± 53.7^{a}	27.0 ± 1.24	2.69 ± 0.15^{a}	7 ± 0.43^{a}
20	287.5 ± 56.1^{b}	27.7 ± 2.39	2.45 ± 0.16^{b}	7 ± 0.52^{ab}
40	187.5 ± 36.9^{cd}	29.1 ± 2.06	2.31 ± 0.11^{bc}	6 ± 0.24^{b}
60	150.8 ± 33.6^{d}	29.2 ± 1.94	2.27 ± 0.08^{c}	6 ± 0.58^{bc}
LSD Value	53.099	-	0.161	0.605

covered with 60% wire gauze; this was followed by seedlings covered with 40% wire gauze (29.1 ± 2.06 cm), while the lowest mean height (27.0 ± 1.24 cm) was observed in the seedlings without light intensity restriction (0% wire gauze). The analysis of variance (Table 2) conducted revealed that there was no significant difference among the four treatments. This implies that light intensity has no effect on *J. curcas* seedling height at their early germination stage (P > 0.05). However, Droppelmann et al. (2000) observed that under conditions of shading, evapo-transpiration is reduced, which favours moisture conservation for use by the plant thus, light of a lower intensity required for seedling establishment.

The result (Table 1) on the mean seedlings girth shows that the highest mean girth (2.69 ± 0.15 mm) was observed in seedlings without light intensity restriction (0% wire gauze), this was followed by seedlings covered

Table 2. ANOVA for germination potential for *J. curcas* seedlings under different light intensity.

Source of Variation	SS	df	MS	F cal	P-value	F crit
Height						
Treatment	34.29339	3	11.43113	1.531854	0.222891	2.866266$^{n.s}$
Error	268.6423	36	7.462285			
Total	302.9357	39				
Girth						
Treatment	1.10891	3	0.369637	11.68783	1.7E-05	2.866266*
Error	1.138528	36	0.031626			
Total	2.247438	39				
Number of Leaves						
Treatment	5.405556	3	1.801852	4.005489	0.014708	2.866266*
Error	16.19444	36	0.449846			
Total	21.6	39				

n.s = Not significant; * = Significant.

with 20% wire gauze with mean girth (2.45 ± 0.16 mm), while the lowest mean girth (2.27 ± 0.08 mm) was found in seedlings covered with 40 and 60% wire gauze respectively. The analysis of variance (Table 2) conducted shows that light intensity significantly affects *J. curcas* seedling girth at their early stage of germination. This implies that the collar diameter or girth of *J. curcas* seedling is significantly affected by light intensity ($P < 0.05$).

The result (Table 1) revealed that, the highest mean number of leaves (7 ± 0.52) was observed in seedlings without light intensity restriction (0% wire gauze), this was followed by seedlings covered with 40% (7 ± 0.43) and 60% (6 ± 0.58) wire gauze. The analysis of variance (Table 2) shows a significant effect of light intensity on *J. curcas* seedlings leaves ($P < 0.05$).

The result on the amount of light received by each of the treatment shows that the control treatment-T_0 (0% wire gauze) has the highest light intensity (456.6 cd); this was followed by T_2 (20%) and T_3 (40% wire gauze) with 287.5cd and 187.5cd respectively, while the least amount of light intensity (150.8cd) was observed on T_4 with triple wire gauze (60%). This indicated that the thicker the intensity restriction barrier, the less the amount of light being received by the seedlings. Generally, plants use light to perform the process of photosynthesis which uses light energy to combine carbon-dioxide with water to make sugars and oxygen. The higher the intensity, the more rapid this process of photosynthesis takes place. The result is in line with that of Lajzerowicz et al. (2004) and Nwoboshi (1982) in their respective work that light intensity aids in adapting plants to specific niches in the environment and often interacting with temperature. The amount of solar energy available for these processes depends upon the intensity and quality, especially beneath the forest canopy and it also influences the establishment of tree seedlings.

Conclusion

Conclusively, the finding has shown that, *J. curcas* seedlings required light for its survival, but at varying intensity. It was noticed that the thicker the light regulator (wire gauze), the lower the amount of light being absorbed by the seedlings. The finding also showed that light intensity has most significant effect on *J. curcas* stem girth and number of leaves as compared to seedlings height. It is believed that light is an absolute requirement for plant growth and development, and has been considered as one of the most important physical factor affecting tree growth, especially at the early seedling stage.

RECOMMENDATIONS

This study has shown that there was no variation among height, girth and number of leaves *J. curcas*, whereas there was significant difference in the light intensity as well as biomass estimation. However, the following recommendations are made:

i) Plantations of *J. curcas* seedlings should be established at the departmental level for commercial purpose as its seeds are used to produce bio-diesel.
ii) Further research should be conducted into the stem cutting aspect of *J. curcas* in the Northern part of the country.
iii) Further research should also be conducted on the

process of extracting bio-diesel from *J. curcas* seeds in the Northern part of the country.
iv) Light meter (either analog or digital) should be purchased, to enable more research on light intensity among students of the department.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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