EFFECTS OF TEMPERATURE ON THE EARLY GROWTH OF JATROPHA SEEDLINGS IN KANO, NIGERIA

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ABSTRACT

*This study examined the effects of Temperature on the early growth of Jatropha seedlings at the experimental site of the Forestry Research Institute of Nigeria (FRIN) Shelterbelt Research Station, Katsina Road, Dala LGA Kano, Nigeria. The experiment was conducted between April and July, 2014. Temperature values were recorded using Lascar EL- USB Data Logger attached to a pole at 1.2m above the ground. Early growth characteristics (*number of days to seedlings emergence, plant height, stem diameter, leaf area, number of leaves per plant, fresh weight per plant, dry weight per plant and crop growth rate (CGR) per plant*) of Jatropha seedlings were recorded at 2, 4, 6, 8, 10 and 12 weeks after sowing (WAS). Bar graphs were used to describe the mean temperature values and number of days to seedlings emergence. Table was used to show the early growth characteristics of Jatropha. Pearson's product moment correlation was used to test whether there is significant relationship between the Temperature and the early growth characteristics of Jatropha seedlings. The test was carried out at 0.05 significant levels. The correlation result showed that there is a significant relationship between temperature and the early growth characteristics of Jatropha seedlings nurtured in the sun. It is therefore recommended that Jatropha should not be grown in shaded areas as it grows better and faster in the open.*

Keywords: Jatropha curcas, Monoecious, Shelterbelt, Temperature

INTRODUCTION

Air temperature has a considerable influence on seedling growth and survival. Physiological processes such as photosynthesis and respiration involve biochemical reactions that are temperature-dependent. Physical processes such as transpiration are also temperature dependent. Growth rates are usually suboptimal when temperatures are below 15°C, optimal in the 15 to 25°C range, and increasingly suboptimal as temperatures rise above 30°C. Physical tissue damage and mortality can occur if temperatures exceed about 50°C. The degree and extent of damage, however, depends on the duration and intensity of high temperatures as well as on the type of tissue that is affected (Spittlehouse and Stathers, 1990). For survival and growth of young tree seedlings, for instance, favourable temperature, air humidity and soil moisture are crucial determinants, especially when the root system is sufficiently developed and other factors such as light conditions and nutrient availability become limiting (Wicklein, Christopher, Carter and Smith, 2012). Temperature affects rates of metabolism and growth and influences plant water demand. Similarly, soil temperature has been shown to influence root water uptake and thus transpiration rates (Mellander, Bishop and Lundmark, 2004).

Jatropha is a genus of 175 succulent perennial shrubs or small trees which can attain heights of more than 5 metres, depending on the growing conditions with spreading branches and stubby twigs, exuding milky or yellowish latex. Some of the species of Jatropha include: *J integerrima. J. elliptica, J. cuneata, J. macranth, J. pandurifolia, J. crdiophylla, J. podagrica, J. multifida, J. carthartica, J. macrorhiza, J. acanthophylla, J. excisa, J. nudicaulis, J. unicostata and J. curcas* to mention a few. *Jatropha curcas* the specie under study is deciduous specie from the family Euphorbiaceae. Their Seedlings generally form a central taproot, four lateral roots and many secondary roots. The leaves, arranged alternately on the stem, are shallowly lobed and vary from 6 to 15cm in length and width. The leaf size and shape can differ from one variety to another. As with other members of this family, the vascular tissues of the stems and branches contain white latex. The branches and stems are hollow and the soft wood is of little value.

Jatropha is monoecious, meaning it carries separate male and female flowers on the same plant. There are fewer female than male flowers and these are carried on the apex of the inflorescence, with the more numerous males borne lower down. The ratio of male to female flowers averages 29:1 but this is highly variable and may range from 25-93 male flowers to 1-5 female flowers produced on each inflorescence (Raju and Ezradanum, 2002 cited FAO, 2010). It also has been reported that the male-to-female flower ratio declines as the plant ages (Achten *et al.*, 2008), suggesting that fruiting capacity may increase with age. This research aimed at examining the effect of temperature on the early growth of Jatropha seedlings in Kano, Nigeria. Specifically it was set to assess the relationship between air temperature and Jatropha seed germination, its height, stem diameter, leaf count and area, growth rate and to estimate its fresh and dry weight.

STUDY AREA

The experimental site is the Forestry Research Institute of Nigeria (FRIN) Shelterbelt Research Station, Katsina Road, Kano. It is situated at Katsina road opposite Bukavu Army Barracks, Dala Local Government area of Kano State. The Station lies between latitude $12^0 1' 42.20''$ and $12^0 1' 43.65''$ north of the equator and between longitude $8^0 30' 19.06''$ and $8^0\ 30' 29.07''$ east of the prime meridian. It is bounded by Federal Department of Forestry to the east, Wood market to the west, Katsina road to the north and ancient Kano city wall to the south (See Figure 1)

The climate is the tropical wet and dry type coded as Aw based on the Koppen's classification of climate. Rainfall is a very critical element in this area because of its deficiency during the dry season. The wet season lasts for 4-5 months (May to September), with a mean annual rainfall of about 884mm. Temperature ranges from 21^{o}C in the coldest months (December/January) to 31^{o}C in the hottest months April/March). Four distinct seasons are experienced, which are the dry and cool, dry and hot, wet and warm, and dry and warm seasons (Olofin, 1987; Olofin, 2013).

The natural vegetation in the study area is the Sudan Savannah. (Olofin, 1987). The savannah woodland, which is the second largest zone, is typified by the Falgore Game Reserve. There are few forest plantations of exotic trees. Savannah vegetation is simply described as predominantly grassland with scattered woody trees with grasses under 1.2m tall. The vegetation has been largely cleared for cultivation to form cultivated parkland. Parkland has scattered protected trees at some distance apart in open cultivated land. Small trees and shrubs are more common on fallow land where regeneration may take place. About 75% of the land is cultivated parkland with average tree densities of less than 25 per hectare (Olofin, 1987).

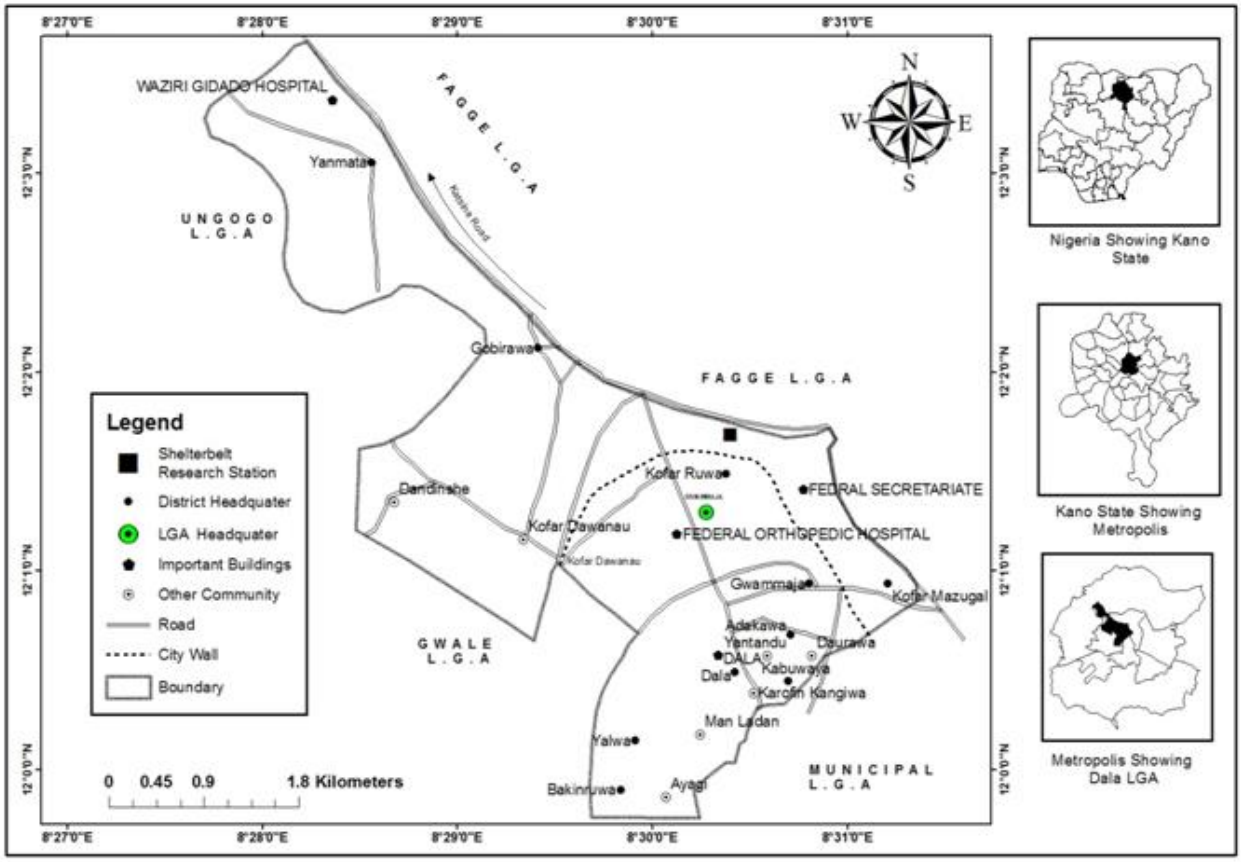

Fig. 1: Dala Local Government Area Showing the Experimental Site
Source: Adopted from Kano Urban Planning Development Agency (2005)

Gallery forest is found along floodplains of large river channels. Varieties of species such as *Parkia clappertoniana (Dorawa), Tamarindus indica (Tsamiya), Azadirachta indica (Darbejiya), Acacia albida (Gawo), Acacia seyal (Dushe)* are found in Kano. Other associated plant species include *Acacia nilotica (Bagaruwa), Acacia senegal (Dakwara), Balanites aegyptiaca (Aduwa), Ziziphus spina-christi (Kurna),* and *Anogeissus leiocarpus (Marke)* (Ahmed, 2011).

MATERIALS AND METHODS

The study covered a period of twelve (12) weeks (3 months) that is from 20 April to 14 June, 2014. The experiment was carried out in Shelterbelt Research Station, Kano. Data on the number of days to seedlings emergence, plant height, stem diameter, leaf area, number of leaves per plant, fresh weight per plant, dry weight per plant and crop growth rate (CGR) per plant were measured. Air temperature was monitored and recorded during the study period. There were 45 polythene pots placed in an open space (in the Sun). The experiment was laid out in a completely randomized design (CRD) with six repetitions at 2, 4, 6, 8, 10 and 12 weeks after sowing the *Jatropha curcas* seeds.

Lascar EL- USB Temperature/Relative Humidity Data Logger was programmed to sample air temperature at every six hours. The instrument was raised 1.2m above the ground. The instrument measures and records temperature readings using internal sensor or external thermocouple, and it has a direct USB connection, user programmable alarms for high and low thresholds. It also has software for setup, data download and analysis, and a frequency of 1 second to 12 hours sampling rate. The sensor has 94% accuracy (Equipment-professional, 2012).

Similarly, Fresh untreated *Jatropha curcas* seeds were collected from Shelterbelt Research Station, Kano. Two seeds per pot were sowed at 2cm depth directly in to 10 x 20cm polythene pots containing potting mixture of sand, soil and farm manure in the ratio of 1:1:2 by volume which were later thinned to one seedling at two weeks after sowing (2 WAS) as recommended by (Abubakar, 2010). The seedlings were irrigated in the morning on daily basis. The early growth characteristics (Number of days to seedlings emergence, plant height, stem diameter, leaf area, number of leaves per plant, fresh weight per plant, dry weight per plant and crop growth rate (CGR) per plant) were also measured as follows.

Number of days to seedling emergence was recorded from the date of sowing to when the final seedling emerged. Plant height was determined from five tagged plants at 2, 4, 6, 8, 10 and 12 weeks after sowing. Each plant was measured from its base to the terminal bud using a meter rule. Stem diameter was measured using digital vernier calipers. Each plant was measured at 2cm from its base. Leaf area was measured using leaf area meter. Number of leaves per plant was determined by counting the number of leaves of five tagged plants and dividing the total number by five at 2, 4, 6, 8, 10 and 12 weeks after sowing. Fresh weight per plant was determined by uprooting five sampled plants and weighed using an electronic weighing balance (ADP 3100L). The total weight was later divided by five to obtain the mean. Dry weight per plant was determined using an electronic weighing balance (ADP 3100L) after oven drying the five sampled plants at 70^0 C to a constant weight at 2, 4, 6, 8, 10 and 12 weeks each after sowing and the mean was recorded.

To determine the relationship between temperature and Jatropha growth characteristics: height, stem diameter, leaf count, leaf area, growth rate and fresh and dry weights, the Pearson's Product Moment Correlation Coefficient in the Statistical Package for the Social Scientist (SPSS) was used.

Crop growth rate (CGR) per plant was determined by Watson (1958) formula.

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \text{ (g/week)}$$

Where:

CGR = crop growth rate

$W_2 - W_1$ = differences in dry weight and

$T_2 - T_1$ = differences in times

RESULTS AND DISCUSSION

The mean temperature recorded during the period of the experiment is presented in Figure 2 where it can be observed from Fig 2 that the mean temperature values recorded was highest at 6 WAS with a value of 35.29^{o}C followed by 35.28^{o}C at 2 WAS while the lowest mean temperature recorded was at

12 WAS with a mean value of 29.85^{o}C. The difference between the highest and lowest mean temperature was 5.44^{o}C approximately 5^{o}C.

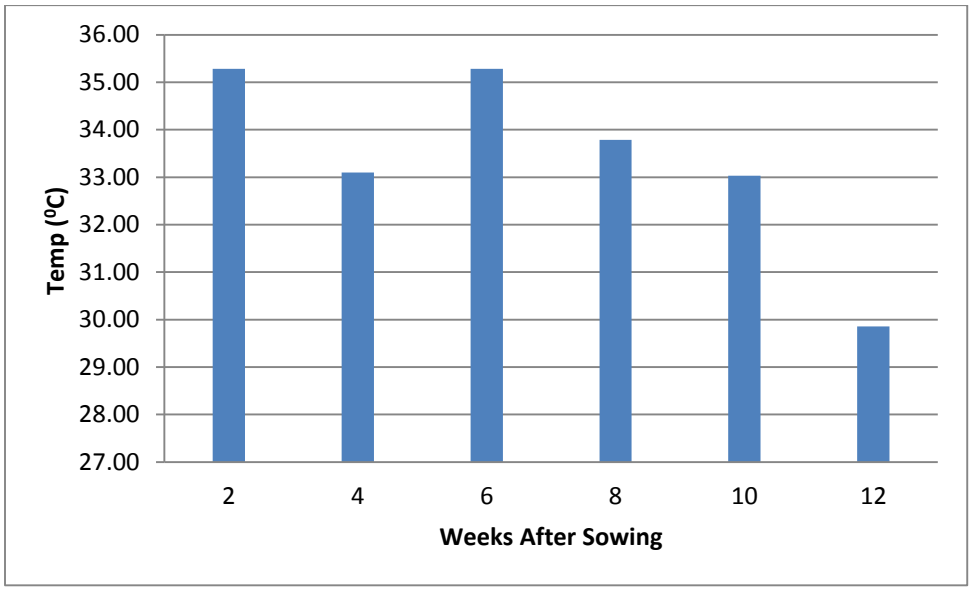

Fig. 2 Mean Temperature values

This result portrays Kano as having high temperature, typically that of tropical climate as observed by Olofin (1987). The mean monthly temperature of the area is between 31 and 21^{o}C in the hottest and coolest month of the year respectively.

The number of days taken by the seeds sown to emerge was examined here. The result is presented in Figure 3.

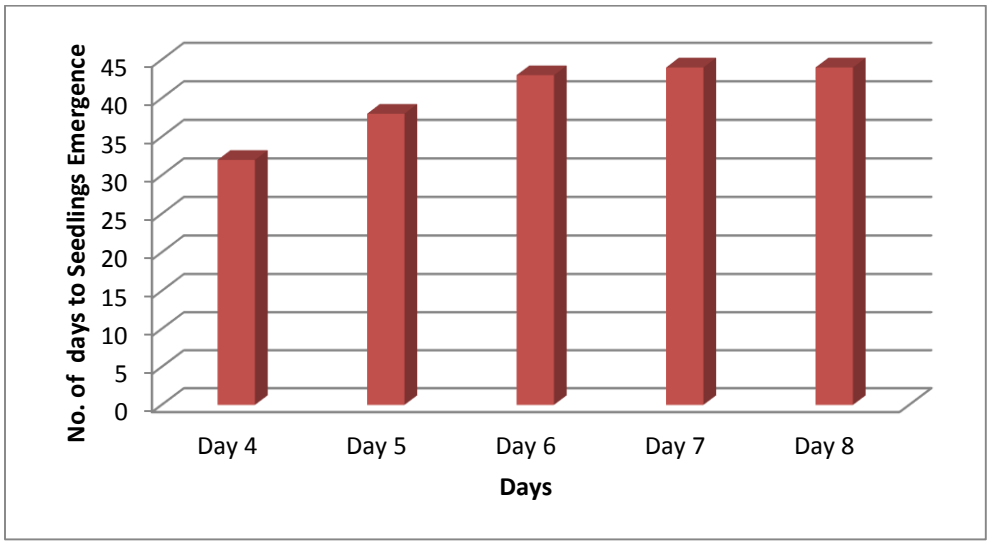

Fig. 3 Number of days to Seedlings Emergence

It can be observed from Fig. 3 that the seedlings emergence was first observed on the fourth day after sowing the seeds, where a total of 32 seedlings emerged followed by the fifth day where a total of 38 seedlings emerged. The trend continued like that up to the seventh and eighth day when a total and complete emergence was observed and 44 seedlings emerged. Therefore, the seeds sown gave 98% emergence. The remaining 2% did not emerge, they eventually died. The high number of seedlings emergence in the sun can be attributed to high temperature observed in the sun treatment.

Table 1 shows the early growth characteristics of *Jatropha curcas* seedlings recorded at 2, 4, 6, 8, 10 and 12 weeks after sowing the seeds.

Table 1 *Jatropha curcas* seedlings early growth characteristics

Week	Seedling Characteristics						
	Height (cm)	Stem Diameter (cm)	Leaf Area (cm2)	Leaf Count	Fresh Weight	Dry Weight	Crop Growth Rate
Two	12.7	0.5	21.8	3.4	4.9	0.4	2.5
Four	19	0.6	35.7	5.8	13.6	1.5	4.3
Six	27.9	0.7	42.1	11.4	28.6	3.9	7.5
Eight	39.1	1.2	45.5	15.8	71.1	10.9	21.2
Ten	51.7	1.4	48.8	21.4	136.4	31.9	32.7
Twelve	70.2	1.8	61.5	32.2	259.6	55.9	61.6

From Table 1, it can be observed that early growth characteristics of *Jatropha curcas* seedlings increase with increase in number of weeks, the plant height increased from 12.7cm at 2WAS to 70.2cm at 12WAS so also the other early growth parameters.

The result of the relationship between mean temperature and the early growth characteristics of *Jatropha curcas* seedlings is shown in Table 2.

Table 2 Relationship between Temperature and the Early Growth Characteristics of *Jatropha curcas* Seedlings

Jatropha Characteristics	Temp
Height (cm)	.833*
Stem Diameter (cm)	.829*
Leaf Area (cm2)	.797
Leaf Count	.831*
Fresh Weight	.896*
Dry Weight	.887*
Crop Growth Rate	.893*

*. Correlation is significant at the 0.05 level (2-tailed).

From Table 2, it can be observed that there is a significant relationship at 0.05 significance level between mean temperature and mean plant height, stem diameter, leaf count, fresh weight, dry weight and crop growth rate. These are all direct relationships, that is an increase in temperature leads to the increase in plant growth characteristics. However, there is no significant relationship between mean temperature and the mean leaf area although there is a strong positive relationship.

CONCLUSION

In conclusion, mean temperature of the study area affects *Jatropha curcas* seedlings' early growth characteristics by increasing the rate of growth, plant height, stem diameter, and leaf count. The findings revealed that there is a significant relationship between mean temperature and mean plant height, stem diameter, leaf count, fresh weight, dry weight and crop growth rate at 0.05 significant levels. However, even though there is a strong positive relationship between mean temperature and the leaf area, this relationship is not significant.

Since the result of this research indicated that temperature is very significant in the germination and early growth of Jatropha, it is therefore recommended that Jatropha as an important bio-fuel plant should not be cultivated in shaded areas as this will slow its germination and cause stunted growth.

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