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EFFECTS OF HUMIDITY AND DEW ON THE EARLY GROWTH OF JATROPHA (*Jatropha curcas* (Linn) SEEDLINGS IN KANO, NIGERIA

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ABSTRACT

This study examined the effects of Humidity and Dew on the early growth of Jatropha curcas seedlings in Kano, Nigeria. The experiment was conducted between 20 April, 2014 and 14 July, 2014. Humidity and Dew values were recorded using two Lascar EL- USB data loggers one at each of the two treatments (shade and sun). Early growth characteristics of Jatropha curcas seedlings were recorded at 2, 4, 6, 8, 10 and 12 weeks after sowing (WAS). Line graphs were used to describe the mean humidity and dew values. Table was used to show the early growth characteristics of Jatropha curcas. Pearson's Product Moment Correlation was used to test whether there is significant relationship between the Humidity and Dew and the early growth characteristics of Jatropha curcas seedlings. The test was carried out at 0.05 significant levels. The Correlation results showed that there is a significant relationship between the Humidity and Dew and the early growth characteristics of Jatropha curcas seedlings in the sun treatment and also between Dew and seedlings emergence in both shade and sun treatments however; it showed that there is no significant relationship between the Humidity and Dew and the early growth characteristics of Jatropha curcas seedlings in the shade treatment. Jatropha curcas seedlings nurtured in the sun grows faster than their shade counterparts due to the vital role played by sunlight during photosynthesis and other growth processes. Finally, it is concluded that there is a significant relationship between Humidity and Dew and the early growth characteristics of Jatropha curcas seedlings nurtured in the sun.

Key words: Dew, Early growth, Humidity, and Jatropha curcas

INTRODUCTION

Relative humidity influences a plant's loss of water due to transpiration to fix a certain amount of carbon dioxide (CO_2). The water vapour content of the air (the vapour pressure or vapour density) directly affects the atmospheric evaporative demand on seedlings and therefore, the seedling transpiration rate. Prolonged high evaporative demand for moisture can cause seedling water stress and a subsequent reduction of growth (Von Arx, Dobbertin & Rebetez, 2012).

Seedling transpiration rates are influenced by the vapour pressure deficit which is the difference between the vapour pressure in the leaf (which depends on needle temperature) and the vapour pressure of the air adjacent to the leaf. Vapour pressure deficits usually reach a maximum in the mid-afternoon when air and needle temperatures are highest. The relative humidity of the air is the ratio of the actual vapour pressure to the saturation vapour pressure. Increasing the vapour pressure deficit (decreasing the relative humidity) of the air increases the evaporative demand, and increases the potential for plant water stress. Winter desiccation often occurs when needles are exposed to air with a low relative humidity (Spittlehouse & Stathers, 1990).

Jatropha curcas is a small tree or shrubs with smooth gray bark which extrudes whitish coloured watery latex when cut. It is commonly refered to as physic nut or American purging nut. In Nigeria, it is called *Bini da Zugu* in Hausa," *odo- ala*" in Igbo, " *Lapalapa or Botuje*" in Yoruba and "*Ujara*" in Edo (Adeoye, *et al.*, 2011). It belongs to the family of *Euphorbiaceae* which normally grows in the tropics. It can grow almost anywhere and it is a drought resistant and perennial crop. It is easy to establish, grows relatively quickly and lives for 40-50years. Its productive life is from 30- 40 years. The hardy *Jatropha curcas* is resistant to drought and produce seeds containing 32-40 % oil. When the seeds are crushed and processed, the resulting oil can be refined to diesel engine, while the residue can also be processed into biomass to power electricity plants and organic fertilizer and it is one of the best plants for future bio-diesel production (FACT Foundation, 2010).

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. cardiophylla, J. podagrica, J. multifida, J. cathartica, J. macrorhiza, J. acanthophylla, J. excise J. nudicaulis, J. unicostata* and *J. curcas* to mention a few.

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 (Raju & Ezradanum, 2002 cited FAO, 2010).

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 & Ezradanum, 2002 cited FAO, 2010). It has also 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.

MATERIALS AND METHODS

The Study Area

The experimental site is 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 $12^{o}1' 42.20''$ and $12^{o}1' 43.65''$ north of the equator and between longitude $8^{o}30' 19.06''$ and $8^{o} 30' 29.07''$ 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 (Olofin, 1987). 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 is the Sudan Savannah type, which is gradually being replaced by cultural vegetation in the form of cultivated fields known as farmed parkland (Olofin, 1987), dotted with patches of shrub savannah. The savannah woodland, which is the second largest zone, is typified by the Falgore Game Reserve. There are few forest plantations of exotic trees.

Study Period, Experimental Design and Detailed Field/ Nursery Work

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. Humidity and dew were monitored and recorded during the study period. There were 90 polyethene pots all together, 45 placed in the shade and another 45 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.

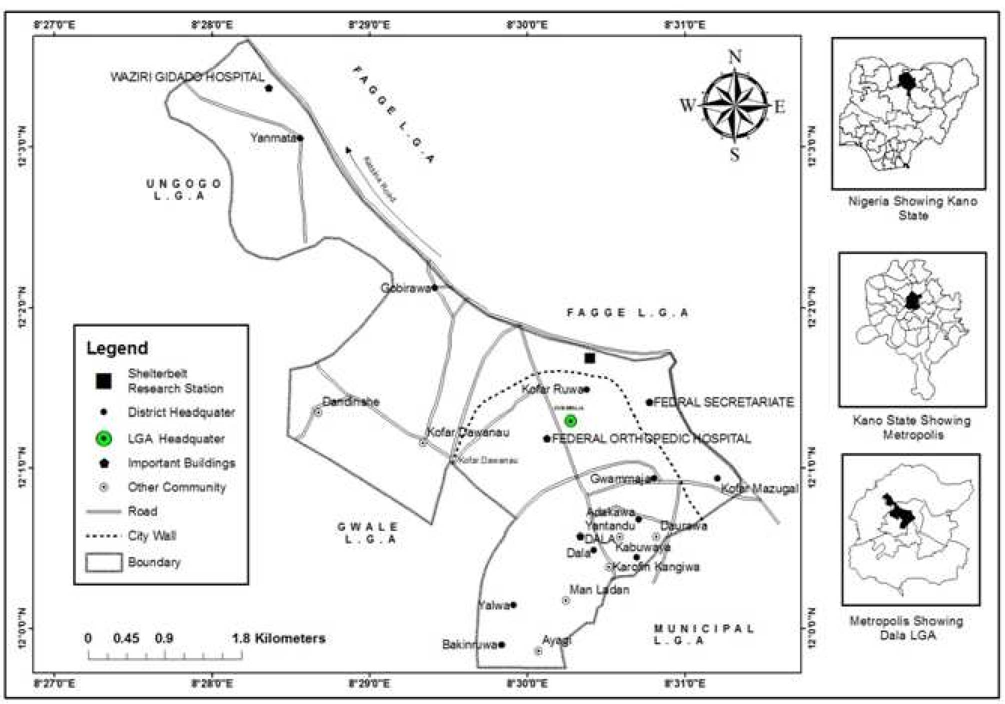

Figure 1: Dala Local Government Area Showing the Experimental Site

Source: Adopted from Kano Urban Planning Development Agency (2005)

Two Lascar EL- USB Temperature/Relative Humidity Data Loggers, one at each treatment (shade and sun) were programmed to sample Humidity and dew at every six hours. The instruments were raised 1.2m above the ground at each treatment. The instrument measures and records humidity and dew 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 a digital vernier caliper. 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 above five sampled plants at 70^{o} C to a constant weight at 2, 4, 6, 8, 10 and 12 weeks after sowing and the mean was recorded (Nnka, 2011; Adamu, 2014; & Mustapha, 2014). Crop growth rate (CGR) per plant was determined by using Watson (1958) formula as follows:

$$\mathrm{CGR} = \frac{W2 - W1\left(\frac{g}{week}\right)}{T2 - T1}$$

Where: $W_2 - W_1$ = differences in dry weight and $T_2 - T_1$ = differences in times

RESULTS AND DISCUSSION

The mean relative humidity recorded during the period of this experiment at the two treatments is presented in Figure 2

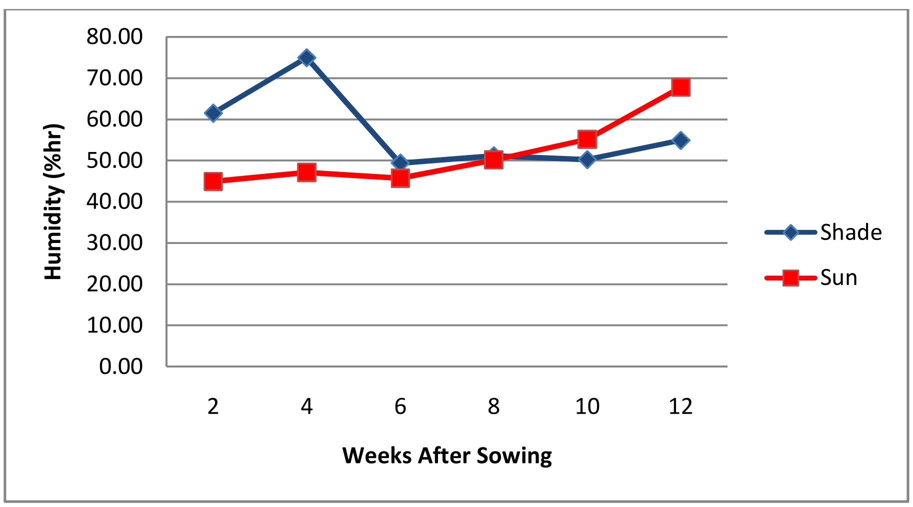

Figure 2. Mean Relative Humidity in the Shade and Sun Treatments

Figure 2 revealed that the mean relative humidity was higher in the shade at 2, 4, 6, 8 Weeks After Sowing (WAS). It was highest at 4 WAS with a mean value of 74.89% while the lowest was in the sun at 2 WAS with a mean value of 44.87%. However, the mean relative humidity was higher in the sun at 10 and 12 WAS with a mean values of 55.09% and 67.72% respectively, as against that of shade 50.16% and 54.84% respectively.

Figure 3 shows the mean dew recorded during the period of the experiment at both shade and sun treatment.

From the figure, it can be observed that the mean dew recorded in the sun was higher at 8, 10 and 12 WAS with mean values of 20.48, 21.09 and 22.02 respectively while there was a slight difference of 0.51 at 6 WAS between the shade and sun with the sun treatment being higher than.

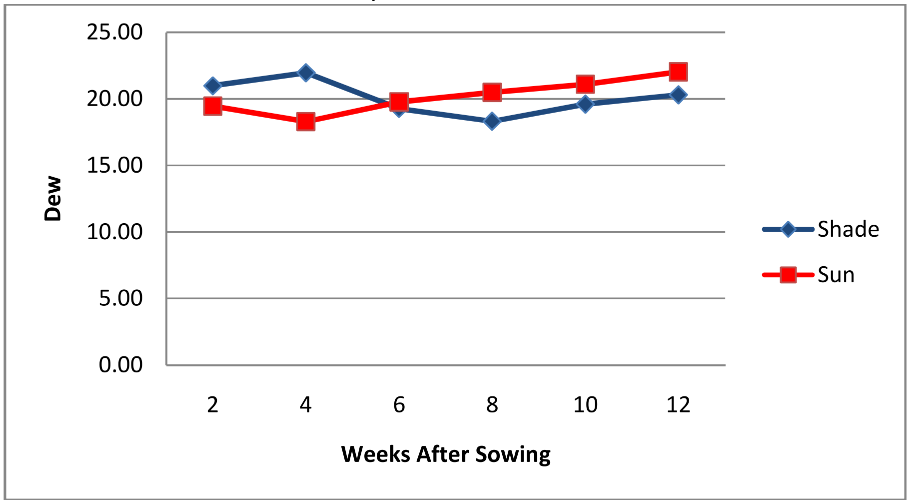

Figure 3. Mean Dew in the Shade and Sun Treatment

its shade counterpart. However, the mean dew in the shade was higher at 2 and 4 WAS with a mean value of 20.98 and 21.96 respectively.

Table 1. Shade and Sun Mean Early Growth Characteristics of *Jatropha curcas* Seedlings' Data

Characters	Treatments	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS	12 WAS
HT(cm)	Shade	13.5	16.7	20	24.1	27.1	38.3
HT(cm)	Sun	12.7	19	27.9	39.1	51.7	70.2
SD(cm)	Shade	0.5	0.5	0.6	0.7	0.8	1.1
SD(cm)	Sun	0.5	0.6	0.7	1.2	1.4	1.8
LA(cm^2)	Shade	28.4	34.8	38.8	39.9	41.7	43.2
LA (cm^2)	Sun	21.8	35.7	42.1	45.5	48.8	61.5
LC	Shade	3.2	5.2	8.4	10.6	13.4	18.2
LC	Sun	3.4	5.8	11.4	15.8	21.4	32.2
FW (g)	Shade	4.9	7.9	14.2	23	30	69.7
FW(g)	Sun	4.9	13.6	28.6	71.1	136.4	259.6
DW(g)	Shade	0.4	0.8	1.8	3.1	6.5	13.8
DW(g)	Sun	0.4	1.5	3.9	10.9	31.9	55.9
CGR(g/wk)	Shade	0.2	0.2	0.5	0.7	1.7	3.7
CGR (g/wk)	Sun	0.2	0.6	1.2	3.5	10.5	12

From Table 1, it can be observed that early growth characteristics of *Jatropha curcas* seedlings increased with increase in number of weeks, the plant height increases from 13.5cm in the shade and 12.7cm in the sun at 2WAS to 38.3cm in the shade and 70.2cm in the sun treatment at 12WAS so also the other early growth parameters.

The result of the relationship between mean humidity and dew and seedlings emergence of *Jatropha curcas* seedlings in the shade is shown in table 2.

Table 2 Relationship between Microclimatic Conditions and Number of Days to Seedlings Emergence in the Shade Treatment

	Humidity	Dew
Seedling Emergence	-0.705	- 0.888*

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

**. Correlation is significant at the 0.01 level (2-tailed).

It can be deduced that there is a significant relationship between dew and number of days to seedlings emergence ('r' value = - 0.888*) at 0.05 significant level (Table 2). On the other hand, there is no significant relationship between the temperature and relative humidity and the number of days to seedlings emergence at both 0.05 and 0.01 significant levels. This result implies that there is an inverse relationship between the dew and seedlings emergence that is as the dew increases, the number of seedlings emergence decreases.

The result of the relationships between humidity and dew and the early growth characteristics of *Jatropha curcas* seedlings in the shade treatment are presented in Table 3.

There is no significant relationship between humidity and dew and the early growth characteristics of *Jatropha curcas* seedlings in the shade treatment at both 0.05 and 0.01 significant level (Table 3)

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Table 3: Relationship between Microclimatic Conditions and the Early Growth Characteristics of *Jatropha curcas* Seedlings in the Shade Treatment

Jatropha Characteristics	Humidity	Dew
Height	*-0.458*	*-0.321*
Stem Diameter	*-0.467*	*-0.293*
Leaf Area	*-0.575*	*-0.548*
Leaf Count	*-0.548*	*-0.413*
Fresh Weight	*-0.367*	*-0.196*
Dry Weight	*-0.354*	*-0.146*
Crop Growth Rate	*-0.921*	*-0.115*

**. Correlation is significant at the 0.01 level (2-tailed).

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

The relationship between humidity and dew and the seedlings emergence in the sun treatment is given in Table 4.

Table 4. Relationship between Microclimatic Conditions and Number of Days to Seedlings Emergence in the Sun Treatment

	Humidity	Dew
Seedling Emergence	-0.718	- 0.943*

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

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 shows that there is a significant relationship between dew and number of days to seedlings emergence ('r' value = - 0.943*) at 0.05 significant level. On the other hand, there is no significant relationship between the humidity and the number of days to seedlings emergence at both 0.05 and 0.01 significant levels. This result implies that there is an inverse relationship between the dew and seedlings emergence as observed in the shade treatment.

The result of the relationship between humidity and dew and the early growth characteristics of *Jatropha curcas* seedlings in the sun treatment is shown in table 5.

Table 5. Relationship between Microclimatic Conditions and the Early Growth Characteristics of *Jatropha curcas* Seedlings in the Sun Treatment

Jatropha Characteristics	Humidity	Dew
Height	*0.946***	*0.926***
Stem Diameter	*0.935***	*0.928***
Leaf Area	*0.861**	*0.800*
Leaf Count	*0.951***	*0.931***
Fresh Weight	*0.992***	*0.904**
Dry Weight	*0.986***	*0.896**
Crop Growth Rate	*0.921***	*0.897**

**. Correlation is significant at the 0.01 level (2-tailed).

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

From Table 5, it can be observed that there is significant relationship between humidity and dew and plant height. The relationship is significant between mean plant height and humidity ('r' value = *0.946***) and dew ('r' value = *0.926***) at both 0.01 and 0.05 significant levels.

The mean stem diameter also have a significant relationship with the humidity ('r' value = *0.935***) and dew ('r' value = *0.928***) the relationship is significant at both 0.05 and 0.01 significant levels.

The relationship between plant height and humidity and dew and that of also between stem diameter and humidity and dew is a direct relationship, meaning an increase in one variable leads to an increase in the other and is significant at both 0.05 and 0.01 significant levels.

There is a significant relationship between humidity and leaf area ('r' value = *0.861***)* in the sun treatment at 0.05 significant levels. On the other hand, there is no significant relationship between dew and leaf area ('r' value = *0.800)* at both 0.05 and 0.01 significant levels.

The plant height and the stem diameter and the leaf count also have a significant relationship with humidity and dew, the relationship is significant between leaf count and humidity ('r' value = *0.951****)* and dew ('r' value =*0.931****)* at both 0.05 and 0.01 significant levels.

There is also a significant relationship between fresh weight and humidity and dew. The relationship is however, more significant between humidity and fresh weight ('r' value = *0.992****)* than between dew and fresh weight ('r' value = *0.904***)* because the relationship between fresh weight and dew is significant at only 0.05 significant level while the relationship between humidity and fresh weight is significant at both 0.05 and 0.01 significant level.

There is also a significant relationship between dry weight and humidity and dew. The relationship is however, more significant between humidity and dry weight ('r' value = *0.986***) than between dew and dry weight ('r' value = *0.896**). This is because the relationship between dew and dry weight is significant at only 0.05 significant levels but the relationship between relative humidity and dry weight is significant at both 0.05 and 0.01 significant levels.

There is a significant relationship between crop growth rate and humidity and dew but the relationship is more significant between humidity and crop growth rate ('r' value = *0.921****)* than between dew and crop growth rate ('r' value = *0.897***)* because the relationship between humidity and crop growth rate is significant at both 0.05 and 0.01 significant levels while the relationship between dew and crop growth rate is only significant at 0.05 significant level.

The results of the correlation (Table 2-5) revealed that there is a significant relationship between humidity and dew and the early growth characteristics of *Jatropha curcas* seedlings in the sun treatment and there is no significant relationship between humidity and dew and the early growth characteristics of *Jatropha curcas* seedlings in the shade treatment except between dew and number of days to seedlings emergence. The mean early growth characteristics of *Jatropha curcas* seedlings' values recorded in the sun were higher than those recorded in the shade. This indicates that nurturing seedlings in the sun gives better growth results. This might be as a result of the role played by sun light and temperature during the process of photosynthesis. Microclimatic elements such as temperature, humidity and dew play an important role in the successful establishment of seedlings because they influence many of the important physical and physiological processes that affect seedling survival and growth (Spittlehouse & Stathers, 1990).

This study corroborates with the findings of Spittlehouse and Stathers (1990) as they also found out that there is a significant relationship between microclimatic elements and seedlings establishments. The result is also similar to that of Wicklein, Christopher, Carter and Smith (2012) who reported that favourable temperature, air humidity and soil moisture are crucial determinants for a survival and growth of young tree seedlings. The study also corroborate the findings of Geiger, 1927; Geiger, Aron and Todhunter (2009) that canopy and tree stems partly shield near ground areas from solar radiation and reduce mixing of air. As a consequence, below-canopy microclimate may substantially differ from comparable open areas; hence this might be the cause of the difference in early growth characteristics of *Jatropha curcas* between the seedlings in the shade and those in the sun treatment.

The results on early growth characteristics of *Jatropha curcas* (Table 1) corroborates that of Adeoye *et al.* (2011) in Ibadan Southern Nigeria, their findings revealed that *Jatropha curcas* seedlings gave the best performance in terms of plant height in the sun. It also gave a better performance in terms of mean plant height when compared with a mean plant height of 24.3cm at three month old obtained by Ndiaye *et al.* (2008) in Senegal because this study obtained a mean plant height of 38.3cm and 70.2cm at 12 WAS that is at three month old in the shade and sun treatments respectively. Stem diameter recorded shows that seedlings in the sun gave better results. However, it contradicts the findings of Adeoye *et al.* (2011) who found out that *Jatropha curcas* seedlings placed under *Bambussa vulgaris* canopy gave better performance in terms of stem diameter than their sun treatment counterparts. Leaves count recorded shows that seedlings in the sun have more leaves compared to their shade counterpart. However, it also contradicts the findings of Adeoye, *et al.* (2011) who revealed that *Jatropha curcas* seedlings placed under *Bambussa vulgaris* canopy gave better performance in terms of leaf count than those in the sun treatment. These findings emphasized the importance of Sun light on plants generally; specifically, the results have revealed that *Jatropha curcas* plant is well adapted to high light intensity conditions and is unsuited to growing in shade. The findings are also not far from the findings of Baumgaart, (2007), cited Jongschaap, *et al,* (2007).

CONCLUSION

In conclusion, humidity and dew affects seedlings' early growth characteristics by increasing the rate of growth, plant height, stem diameter, and leaf count. *Jatropha curcas* seedlings nurtured in the sun grows faster than their shade counterparts due to the vital role played by sunlight during photosynthesis and other growth processes. The findings also revealed that there is a significant relationship between humidity and dew and plant height, stem diameter, leaf count, fresh weight, dry weight and crop growth rate at both 0.01 and 0.05 significant levels in the sun and there is no significant relationship between humidity and dew and the early growth characteristics in the shade. Farmers and Entrepreneurs should be encouraged to raise *Jatropha curcas* seedlings in an open space to avoid shading effect. This will allow the seedlings to absorb more sunlight for photosynthesis. Research like this one could be useful to farmers and entrepreneurs in producing large scale *Jatropha curcas* seedlings for bio diesel, chemical synthesis and other uses.

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