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THE GROWTH OF *Balanites aegyptiaca* (L.) SEEDLINGS UNDER VARIED WATERING INTERVALS IN THE NURSERY

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ABSTRACT

Water stress has a strong influence on the physiological functions of tree crops which adversely affects the growth and yield of tree plants. Drought and soil fertility are the major factors that influence seedling survival and growth in arid areas, thus it is of paramount importance to establish optimum water requirements for tree seedlings in order to promote growth. In line with this, an investigation was carried out to assess early growth behaviours of Balanites aegyptiaca when exposed to varied watering intervals in the screen house. Two weeks old seedlings in polythene bag (2kg) containing the standard potting mixture as growing media were used for the experiments. Seedlings were exposed to 4 different watering intervals (once daily, once after 3, 7 and 14 days) and 200ml of water was administered per each seedling based on the watering frequency for 12 weeks. Ten seedlings were allocated per watering frequency and replicated 5 times in a completely randomized design. Data was collected on stem height, collar diameter, number of leaves and seedlings dry weights. Net assimilation rate, relative growth rate and absolute growth rate were also calculated. Data was analysed with analysis of variance and the significantly different means were separated with Duncan Multiple Range Tests ($p<0.05$). The result revealed a significant effect of water stress on seedlings growth of B. aegyptiaca where seedlings that received water once daily and once after 3 days produced highest growth in all the variables measured. Administering 200ml of water per seedling once after 3 days is therefore recommended for the improved growth of B. aegyptiaca in the nursery.

Key words: water stress, seedling growth, *B. aegyptiaca,* nursery, regeneration

INTRODUCTION

Water availability is the most important environmental factor known to have strong influence on tree species and distribution in the tropics (Bongers *et al*., 2004). The supply of water in an ecosystem is greatly influenced by the seasonality of its distribution and the length of dry period which may vary from a dry spell of a few days in humid wet forests to a dry season of up to 8 months in dry monsoon forests (Olajuyigbe *et al*., 2012). Plant water status strongly influences plant growth and biomass production particularly through its effects on leaf and root expansion. This implies that growth and biomass production is directly proportional to the supply and use of water (Mukhtar, 2016b). Water requirement of any tree depends on the botanical characteristics of the plant, its stage of growth and weather conditions (Mukhtar, 2016b). Water stress is said to affect the physiological functions of a tree crop, thereby influencing growth and yield (Simon *et al.,* 2011 and Sale, 2015). Drought and soil fertility are the major factors that influence seedling survival and growth in the dry land areas (Abraham, 2014; Obalum *et al*., 2017). In order to promote sustainable use of water in the nurseries, it is paramount to establish optimal water requirements for tree seedlings which will help in reducing the cost of planting stock production in commercial nurseries (Simon *et al.*, 2011).

A desert date in English and "Aduwa" in Hausa language, *Balanites aegyptiaca* belongs to *Balanataceae* family. It is widely spread in the drier regions of Africa from Mauritania to Nigeria (Manji *et al.,* 2013). It has about 25 known species distributed from tropical Africa to Burma. A savannah tree that can attain height of more than 6 metres with large spread of crown and simple spine of up to 5cm long (Manji *et al.,* 2013). The species is known to provide diverse goods and services such as food, fodder, fibre, timber, gum, lipid and medicines (Orwal *et al.,* 2009). It is also a good species for shade, shelter and used for boundary,

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barrier or support being a thorny tree species (Orwal *et al.,* 2009). Desert date is reported to be highly resistant to pest and insects attack, and for this reason, it is widely used for the production of different household utensils (Rabi'u *et al.,* 2013). The species holds great potentials and as such recommended for use in Agroforestry. A sustained propagation and utilization of *B. aegyptiaca* is paramount and in line with this, there is need to determine the extent to which the species will respond to drought at early stage for enhanced growth and development.

MATERIALS AND METHODS

The study was conducted in Aliero (latitude 12°16′42″N and Longitude 4°27′6″E) with tropical continental type of climate controlled by two air masses (tropical maritime and tropical continental) from the Atlantic Ocean and the Sahara desert which determined wet and dry seasons. The wet season lasts from May to September while the dry season lasts for the remaining period of the year. Aliero has mean annual rainfall of about 800mm and temperature of 26°C in Sudan savannah environment (Mukhtar, 2016a).

The experiment was carried out in the screen house where two weeks old seedlings in standard potting mixture (Table 1) were randomly selected and subjected to four different watering intervals (Once daily, once after 3, 7 and14 days) as done by Olajuyigbe *et al*. (2012). Ten seedlings were allocated per watering frequency and were replicated five times (making 50 seedlings each per watering frequency) in a completely randomized design and each seedling was given 200ml of water based on the watering frequency in the morning.

The growth variables measured were: seedling stem height, collar diameter and number of leaves. Metre rule was used to measure height, micro-meter screw gauge for collar diameter and number of leaves was counted fortnightly for twelve weeks. Seedlings dry weight was assessed at six weeks interval (6^{th} and 12^{th} weeks after emergence) through destructive method (Mukhtar, 2016a). Seedlings were sampled and separated into root, stem and leaves. Leaf area was measured by tracing the area covered on graph sheet. Fresh weight of root, stem and leaves were measured before they were oven dried at 80^{o}C to constant weight.

Table 1: Nutritional information of potting mixture

pH	% OC	% N	P	Ca	Mg	K	Na	CEC
			(mol/kg)					
7.6	0.26	0.091	1.01	1.15	1.10	1.23	0.91	8.38

The dry weight and leaf area were used to calculate the Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Absolute Growth Rate using the following formula by Mukhtar (2016):

$$NAR = \frac{w_2 - w_1 \; X \; LnA_2 - LnA_1}{A_2 - A_{12} \; X \; t_2 - t_1}$$

where w_1 and w_2 are biomass at time t_1 and t_2, respectively; A_1 and A_2 are leaf area at time t_1 and t_2, respectively; LnA_1 and LnA_2 are natural logarithm of leaf area at time t_1 and t_2, respectively.

$$RGR = \frac{Lnw_2 - Lnw_1}{t_2 - t_1}$$

where Lnw_2 and Lnw_1 are natural logarithm of biomass at time t_1 and t_2, respectively; and $t_2 - t_1$ is time interval between first and second harvest.

$$AGR = \frac{w_2 - w_1}{t_2 - t_1}$$

where, w_1 and w_2 are biomass at time t_1 and t_2, respectively; ; and $t_2 - t_1$ is time interval between first and second harvest.

RESULTS

Stem height

Watering frequency was found to have a significant ($p < 0.05$) effect on seedlings height and 37.75 cm was the highest height recorded in seedlings watered once daily, and this was significantly different with seedlings watered once after 14 days (20.66 cm) as shown in Table 1.

Stem diameter

There was a significant effect on seedlings diameter exposed to various watering frequencies. Table 2 shows the mean seedlings diameter where watering once daily recorded the highest diameter (3.63 mm) and was followed by seedlings that received water once after 3 days (3.59 mm) which were significantly different with seedlings that were watered once after 7 and 14 days (Table 2).

Number of leaves

A significant effect was observed in watering frequencies on seedlings leaf production (Table 2). Watering once daily had significantly ($p < 0.05$) higher number of leaves (69) and the least number of leaves (5) was recorded from seedlings that received water once after 14 days.

Table 2: Effect of watering frequency on seedlings growth of *B. aegyptiaca*

Treatment	Stem height (cm)		Stem diameter (mm)		Number of leaves	
	2WAE	12WAE	2WAE	12WAE	2WAE	12WAE
Once daily	18.99	37.75^{a}	1.70^{b}	3.63^{a}	28	69^{a}
Once after 3 days	17.98	37.10^{a}	1.94^{a}	3.59^{ab}	23	37^{b}
Once after 7 days	19.20	33.46^{a}	1.77^{ab}	3.27^{bc}	27	31^{b}
Once after 14 days	18.35	20.66^{b}	1.71^{b}	3.17^{c}	25	5^{c}
S.E.	0.308	1.847	0.034	0.679	0.660	5.714
Significance	*ns*	*	*	*	*ns*	*

Means followed by the same letter(s) within a column are not significantly different ($p > 0.05$); WAE: weeks after emergence

Leaves Dry Weight (LDW)
Table 3 shows the mean seedlings LDW where seedlings that were watered once daily gave the highest LDW (1.50 g) which was similar with seedlings that received watering once after 3 days (1.42 g) but differed significantly ($p < 0.05$) with seedlings that were exposed to watering once after 7 days (0.84 g).

Stem Dry Weight (SDW)
SDW was significantly ($p < 0.05$) influenced by watering frequency (Table 3). Seedlings that received watering once daily yielded significantly higher SDW (1.24 g) and those that received water once after 14 days had the least SDW (0.58 g) (Table 3).

Root Dry Weight (RDW)
There was a significant effect on seedlings' RDW (Table 3) with 2.50 g as the highest RDW recorded from seedlings watered once daily and significantly ($p < 0.05$) different from watering once after 14 days (0.86 g) (Table 3).

Total Dry Weight (TDW)
A significant effect was found in seedlings total dry weight exposed to different watering frequencies. Table 3 shows mean TDW where seedlings that received water once daily had significantly higher TDW (5.24 g) compared to seedlings that were exposed to watering once after 14 days (1.74 g) (Table 3).

Leaf area
Watering frequency had significant effect on leaf area with the highest leaf area (8.40cm^2) obtained from seedlings that received water once after 3 days which was followed by 7.30cm^2 from seedlings that received daily watering and both were significantly different ($p<0.05$) from seedlings exposed to watering once after 14 days (2.80) (Table 3).

Net Assimilation Rate (NAR)
A significant effect was found on seedlings NAR between 6th and 12th week after emergence (Table 4). Mean NAR of seedlings under various watering frequencies was higher (0.01017) for seedlings that received watering once daily.

Relative Growth Rate (RGR)
Watering frequency had significantly influenced seedlings RGR between 6th and 12th week after emergence (Table 4). The highest RGR (0.014314) was obtained in seedlings that received watering once daily and was similar with seedlings watered once after 3 days but differed ($p < 0.05$) from seedlings exposed to watering once after 14 days (0.01001) (Table 4).

Absolute Growth Rate (AGR)
The AGR was significantly ($p < 0.05$) influenced by watering frequency. Table 4 shows mean AGR of seedling between 6th and 12th week after emergence where seedlings watering once daily yielded the highest AGR of 0.05107 which was significantly ($p < 0.05$) different with watering once after 14 days (0.00964).

DISCUSSION

Seedlings growth was significantly improved by watering frequency where watering once daily and once after three days yielded higher growth than watering once after 7 and 14 days. Seedlings that received water once after seven days and those watered once after fourteen days had lower growth rate but the species was able to withstand the water stress. The lower growth obtained confirmed Mukhtar (2012) that plant water status has a strong influence on plant growth and biomass production through its effect on leaf and root expansion. This implies that growth and biomass production is directly proportional to the supply and use of water (Sale, 2015; Mukhtar, 2016^b).

Table 4: Effect of watering frequency on seedlings NAR, RGR and AGR of *B. aegyptiaca*

Treatment	NAR	RGR	AGR
Once daily	0.01017^a	0.01431^{ab}	0.05107^a
Once after 3 days	0.00866^a	0.01657^{ab}	0.04857^a
Once after 7 days	0.00963^a	0.02103^a	0.03892^a
Once after 14 days	0.00179^b	0.01001^b	0.00964^b
S.E	0.00129	0.001719	0.00505
Significance	*	*	*

Means followed by the same letter(s) within a column are not significantly different ($p > 0.05$)
NAR: Net assimilation rate, RGR: Relative growth rate, AGR: Absolute growth rate

Table 3: Effect of watering frequency on seedlings dry biomass of *B. aegyptiaca*

Treatment	LDW(g)	SDW(g)	RDW(g)	TDW(g)	LA (cm^2)
Once daily	1.50^a	1.24^a	2.50^a	5.24^a	7.30^a
Once after 3 days	1.42^a	0.94^{ab}	2.24^a	4.60^{ab}	8.40^a
Once after 7 days	0.84^b	0.92^{ab}	1.68^{ab}	3.44^b	6.00^a
Once after 14 days	0.30^c	0.58^b	0.86^b	1.74^c	2.80^b
S.E.	0.133	0.091	0.219	0.392	0.616
Significance	*	*	*	*	*

Means followed by the same letter(s) within a column are not significantly different ($p > 0.05$)
LDW: leave dry weight; SDW: stem dry weight; RDW: root dry weight; TDW: total dry weight; LA: leaf area

Deciduousness was observed in seedlings watered once after seven and fourteen days which is an important drought tolerant strategy which de-emphasize leaf production under low water supply (Cao, 2000 and Olajuyigbe *et al*. 2012). The result suggests that seedlings of *B. aegyptiaca* require average watering for enhanced growth. However, for reduced cost of production and optimum growth of *B. aegyptiaca,* seedlings should be given 200 ml of water once after three days in the nursery.

The good seedling growth obtained from watering once after three days confirmed Isah *et al*. (2013) on *Acacia senegal* seedlings. Their findings revealed high growth in seedlings watered once after three days over those watered once daily, twice a day and once after two days. The only difference being that seedlings of *B. aegyptiaca* watered once daily had the highest growth although was similar to once after three days. These findings partly disagreed with the result of Sale (2015) who recorded highest growth of *Parkia biglobosa* seedlings that were watered once in five days over seedlings watered once daily and once in three days. The species characteristics could be responsible for this variation.

The results, however, support the work of Akinyele (2007) where higher growth (stem height and collar diameter) was obtained from seedlings of *Buchholzia coreacea* that were watered once daily. Suberu (2014) and Oyun *et al*. (2010) reported high growth of seedlings of *Acacia senegal* that were watered once after fourteen days over the same seedlings watered once daily and weekly. This could be due to the species water requirement, environment, season of growth and state of the seedlings. The species is said to be tolerant to low water availability with respect to its ability to withstand long period of water stress inspite of the low growth recorded as confirmed by Cao (2000) that growth and biomass are said to be directly related to the supply and use of water.

CONCLUSION AND RECOMMENDATION

Although *Balanites aegyptiaca* is tolerant to water stress, highest growth in nursery could be achieved by watering the seedlings once after three days.

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