EVALUATION OF WATERING REGIMES AND DIFFERENT POT SIZES IN THE GROWTH OF *PARKIA BIGLOBOSA* (JACQ) BENTH SEEDLINGS UNDER NURSERY CONDITION

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Abstract

The study was carried out to investigate the effect of watering regimes and pot size on the growth of potted seedlings of Parkia biglobosa (JACQ) Benth. The experiment was set up using 3 x 4 Factorial experiment in Completely Randomized Design (CRD). Four different watering regimes were used: watering once daily, watering once in three days, watering once in five days and the control that was not watered. Three different pot sizes were used: the small size, medium and the large size. The parameters measured were subjected to Analysis of Variance (ANOVA). The means were separated by Least Significant Difference (LSD; $P \leq 0.05$). The results showed that the best performance of Parkia biglobosa in terms of pot size was Medium Pot size (P_2) which had 246.20 cm at the 10th week after transplanting, the poorest growth was recorded in the small pot size with the height of 16.55 cm in the 10th weeks after transplanting. Also the result showed that watering once in five days (W_3) had the highest height of 19.96 cm followed by watering once daily (W_1) with the height of 18.72 cm while the control (W_0) had the least height of 16.21 cm.

Keywords: Watering regimes, Pot sizes, Parkia biglobosa, Nursery Condition.

Introduction

Parkia biglobosa (Jacq.) Benth also known as dawadawa (Hausa), African locust beans (English), Iru (Yoruba), Nere (Bambara) have been known to be a native of Africa and is an important multipurpose tree of West African Savannah land and one of the most common species of the parkland agroforestry system (Sacande and Clethero, 2007). More attention have been given to the economically important species of tree plants especially *Parkia* *biglobosa* in recent years to a sustainable use and integrated management due to an increasing recognition of its contribution to fulfil basic needs of people, household economics, food security and conservation of natural resources (Joshi and Joshi, 2009). *Parkia biglobosa* as a common species of the parkland agroforestry, plays important roles such as food and wood production, supply of timber, firewood, pulp and fibre through fodder, gum, drugs, and dyes as well as restoration of fertility (Popoola and Maishanu,1995). In most of these agrarian communities, Nigeria inclusive, forest foods are essential dietary supplements especially during lean agricultural production periods or times of emergency. The Nigerian Study/Action Team (NEST, 1991) submitted that leaves, fruits, nuts and oils obtained from wild plants have provided food for humans, livestock and wildlife in many parts of the country. Latiff *et al* (2002) reported that forest resources directly contributed up to 80% of the livelihoods of the people in that country living in extreme poverty.

The roots, barks, leaves, stems, flowers, fruits and seeds of *Parkia biglobosa* are all used medicinally to treat a range of ailments including diarrhea, ulcers, pneumonia, burns, coughs, jaundice etc (Sacande and Clethero, 2007). The pulp contains higher cellulose and sucrose but less ascorbic acid than the cotyledons. The pulp also contains simple sugars except maltose (Alabi *et al.*, 2005). The seeds of *Parkia biglobosa* on fermentation are used in cooking stew and soup. The sweet yellow pulp contains 60% sugar when ripe and the seeds contain 30% protein as well as vitamins and minerals (Sacande and Clethero, 2007). The fruit pods are used to produce an insecticide powder for treating crops.

Locust bean seeds were rich in proteins (30-40%). They also provided significant amounts of carbohydrates (10-15%), fats (15-20%), minerals (4%) and vitamins mainly from Group B (Diawara and Diasso, 2004).

Effect of Watering Regime

Water requirements of a crop are dependent on the botanical characters of the crop, its stage of growth and the prevailing weather conditions. Different criteria based on soil, plant and metrological factor were used for estimation of crop water needs. The effect of water deficit on yield (total or economic) yield is the integral of its effects on the growth and other physiological process (Farah, 1996). During vegetative growth, phyllochron decreases under water stress (McMaster and Smike, 1988) and leaves become smaller, which results in low leaf area index, as well as low shoot dry weight (Abo El-Kheir, 2000). Detection of crop water stress is critical for efficient irrigation water management, especially in the semi-arid regions. On the other hand, Irrigation water is becoming increasingly scarce;

this highlights the importance of the effective and efficient use of this resource.

Poor yield of the species in the semi arid region of Nigeria may be attributed to inadequate physiological and silvicultural information regarding the species. Hence to adequately integrate *Parkia biglobosa* with the other semiarid trees for the control of desertification and for the production of its very valuable and high-quality yield, there is an urgent need to delineate its required physiological and silvicultural characteristics. Water is a significant factor in dry land forestry and it is critical to tree growth and development in the tropics (Awodola and Nwoboshi, 1993). Water is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements. Various vital processes in plants such as cell division, cell elongation, stem as well as leaf enlargement and chlorophyll formation depends on plant water availability (Price *et al.,* 1986). As noted by (Levy and Krikum, 1983), insufficient water in plants below a critical level is usually demonstrated by changes in all structures leading to the death of the plants. According to Miller *et al.* (1999), for each ton of vegetative growth, hundreds of tons of water may be consumed by the growing plant particularly in dry climates. As observed by (Awodola, 1984), the reduction in relative water contents affects physiological processes and hence plant growth. Similarly, too much water in excess of plant need may retard physiological processes in plants. In particular, stomata conductance which is a numerical measure of the maximum rate of passage of either water vapour or carbon dioxide through the stomata and the xylem pressure potential which is the component of water potential due to hydrostatic pressure that is exerted on water in a cell are influenced by the soil-water balance (Komer *et al.,* 1999). Huang *et al.,* (1985) reported that root to shoot ratio to be 3.5 times higher in water stressed plants.

Effect Of Pot Sizes On Growth

Container volume is a very important factor for seedlings production. On one side, big containers increase substrates consumption and space demand in nursery, influencing directly the costs of production and transport. But on the other hand, small containers can limit seedlings growth and reduce its quality (Lima *et al*., 2006).

Low quality seedlings result in plantations of reduced stand and yield. Successful greenhouse and nursery production of container-grown plants is largely dependent on the chemical and physical properties of the growing media. An ideal potting medium should be free of weeds and diseases, heavy enough to avoid frequent tipping over and yet light enough to facilitate handling and shipping. The media should also be well drained and yet retain sufficient water to reduce the frequency of watering. Other parameters to consider include cost, availability, consistency between batches and stability in the media overtime. Selection of the proper media components is critical to the successful production of plants (James and Michael, 2009).

Materials And Methods

The pot experiment was carried out at the green house of the Department of Crop Production, Kogi State University, Anyigba. Located in the Southern Guinea Savanna of the agro ecological zones . with Latitude 7^0 6^1N and Longitude 7^0 43^1E. Kogi State has a bimodal rainfall with the peak pattern occurring in July and September. The mean annual rainfall ranges from 1,560mm at Kabba in West to 1,808mm at Anyigba in the East (Amhakhian *et al*., 2012). The temperature shows some variation throughout the years. Average monthly temperature varies from 17°C to 36.2°C. Relative humidity is moderately high and varies from an average of 65-85% throughout the year (Amhakhian *et al*., 2012).

The seeds of *Parkia biglobosa* were procured from Agricultural Development Project (ADP) office, Anyigba branch, Kogi State, while the top soil was collected from the nursery site of the Crop Production Department, Kogi State University, Anyigba.

The seed of *Parkia biglobosa* was soaked overnight to hasten the germination process. The seeds were then broadcasted into four (4) germination boxes and stored under room temperature to speed up the germination of the seeds. Three (3) weeks after the seed have germinated fully, the seedlings were transplanted into black polytene pot in the three different pot sizes containing sieved topsoil.

Different watering regimes were carried out accordingly. The first set was watered once daily, the second set was watered once in three days, while the third set was watered once in five days and the fourth set was the control.

Experimental Design

There were twelve treatments combinations with three replications. The experimental design is 3 x 4 factorial experiment in Complete Randomized Design (CRD).

Table 1: Experimental Layout

RI	R2	R3
P_1W_0	P_3W_1	P_2W_1
P_3W_1	P_1W_0	P_1W_2
P_1W_3	P_3W_2	P_3W_2
P_2W_1	P_1W_1	P_1W_3
P_3W_2	P_2W_3	P_1W_0
P_2W_3	P_1W_2	P_3W_1

P_3W_0	P_2W_0	P_2W_2
P_1W_1	P_3W_3	P_3W_3
P_3W_3	P_2W_2	P_1W_1
P_2W_2	P_3W_0	P_3W_0
P_2W_0	P_2W_1	P_1W_3
P_1W_2	P_1W_3	P_2W_0

Where:
R – Replicate
P1 = Small size pot 15cm x 17cm
P2 = Medium size pot 20cm x 22cm
P3 = Large size pot 23cm x 24cm
W0 = Control (No Water application)
W1 = Water regime 1 (watered once daily)
W2 = Water regime II (Watered once in three days)
W3 = Water regime III (Watered once in five days).

Data Collection

Data were collected once every week and the experiment lasted for 10 weeks. Parameters measured are:

i. Days to emergence
ii. Number of leaves
iii. Height of plant (cm)
iv. Stem diameter (cm)
v. Fresh weight of shoot and root
vi. Leaf biomass

Statistical Analysis

The data collected from the various pot sizes were subjected to Analysis of Variance (ANOVA) procedure for Completely Randomized Design (CRD) and the means were then subjected to Fishers Least Significant Difference (F-LSD).

Results And Discussion

At two weeks after planting, the plant hight was found not to be statistically significant ($P \geq 0.05$). However, P_2 gave the tallest plant height (7.33) while P_3 recorded the shortest plant height (6.75) showing the influence of pot size on the plant height. On the influence of the watering regime on the plant height, W_3 recorded the tallest plant height (7.79) while W_0 recorded the shortest plant height (5.79) (Table 2).

The influence of pot size on the plant height at four weeks after sowing, P_2 gave the tallest plant height (9.63), P_3 recorded the shortest plant height (8.45). Whereas, on the influence of watering regime on the plant height, W_3 recorded the tallest plant height (9.82), closely followed by W_1 (9.60), while the least was W_0 with 7.40. However, this was not significantly different ($P \geq 0.05$) (Table 2).

At six weeks after planting, the influence of pot size and watering regime on the plant height was not significantly different ($P \geq 0.05$). However, P_2 influence was recorded to give the tallest plant height (14.79) while P_1 recorded the shortest plant height (12.67). Furthermore, the influence of W_1 gave the tallest plant height (14.68) while W_0 gave the shortest plant height (10.99) (Table 2).

At eight weeks after planting, the effect of the Pot size on the plant height recorded its tallest height by P_2 with 17.53 while the shortest was P_1 with 14.21. While the highest influence of watering regime on the plant height was recorded by W_3 with 17.33 and W_0 with 13.25 being the shortest. This however, was not significantly different ($P \geq 0.05$) (Table 2).

At ten weeks after planting, the effect of pot size on the plant height recorded the highest with the treatment P_2 recording 246.20 while P_1 was the shortest with 16.55 this was however, highly significantly different ($P \geq 0.05$). Similarly, the effect of the watering regime on the plant height recorded the highest with W_3 recording 19.96 while W_1 recorded the shortest plant height with 16.21. This was however not significantly different ($P \geq 0.05$) (Table 2).

Number of Leaves

The number of leaves was found out not to be significantly different ($P \geq 0.05$) at two weeks after planting. However, treatment, P_1 gave the highest number of leaves (103.25) and the least was P_3 (88.75) on the effect of the pot size. While W_2 gave the highest number of leaves (99.11) and the least was recorded by W_0 (88.44) on the effect of the watering regime. The interaction between the two treatments was equally not significant (Table 3).

At four weeks after planting, P_2 gave the highest number of leaves (152.08), while P_3 gave the least number of leaves (137.00) on the effect of plant response to pot size. Treatment W_2 gave the highest number of leaves (158.33) while W_0 recorded the least (124.44) on the response of the plant to the different watering regime. However, these and the interaction between them were not significantly different ($P \geq 0.05$) (Table 3).

The number of leaves per plant was found to be highly significant ($P \leq 0.05$) at six weeks after planting. P_1 gave the highest number of leaves (231.83), while P_3 recorded the least number of leaves (165.33) on the effect of pot size on growth of plant. While on the effect of watering regime on the growth of plant, W_2 recorded the highest number of leaves per plant (239.44) while W_0 gave the least number of leaves (186.89). Similarly, the interaction among them was statistically not significant (Table 3).

The number of leaves per plant at eight weeks after planting was found not to be significantly different ($P \geq 0.05$). However, P_1 gave the highest number of leaves (286.59), while P_3 recorded the lowest number of leaves (271.00) for the influence of pot size on the growth of the plant. Similarly, W_3 gave the highest number of leaves per plant (300.44) and this was closely followed by W2 with 293.89, while W_0 recorded the least number of leaves (245.00) for the influence of watering regime on the growth of the plant. The interaction among the treatments was however, not significantly different ($P \geq 0.05$) (Table 3).

At ten weeks after planting, the number of leaves was found to be significant ($P \geq 0.05$). P_2 recorded the highest number of leaves (323.58), while P_1 gave the least number of leaves (98.00) for the influence of pot size on the growth of the plant. Also, W_3 gave the highest number of leaves (345.87) closely followed by W_2 (345.67), while W_0 recorded the least number of leaves (261.44) for the influence of watering regime on the growth of the plant (Table 3).

Stem Diameter Per Plant

Table 4 shows the summary table showing the influence of pot size and water regime on the stem diameter of *Parkia biglobosa*.At two weeks after planting, the stem diameter was found not to be statistically significant ($P \geq 0.05$). However, P_2 gave the highest stem diameter (0.021) while P1 recorded the least stem diameter (0.014) showing the influence of pot size on the stem diameter. On the influence of the watering regime on the stem diameter, W_1 recorded the highest stem diameter (0.021) while W0 recorded the least stem diameter (Table 4).

The influence of pot size on the stem diameter at four weeks after sowing, P_2 gave the highest stem diameter (0.110), P_1 recorded the least stem diameter (0.07). Whereas, on the influence of watering regime on the stem diameter, W_1 recorded the highest stem diameter (0.131), closely followed by W_3 (0.093), while the least was W_0 with 0.059. However, this was not significantly different ($P \geq 0.05$) (Table 4).

At six weeks after planting, the influence of pot size and watering regime on the diameter of the plant was not significantly different ($P \geq 0.05$). However, P_2 influence was recorded to give the highest stem diameter (1.140) while P_1 and P_3 both recorded the least stem diameter (1.080). Furthermore, the influence of W_0 gave the highest stem diameter (1.120) while W_3 gave the least stem diameter (1.063) (Table 4).

At eight weeks after planting, the effect of the Pot size on stem diameter was highest by P_2 with 1.2 while the least was P_1 with 1.14. While the highest influence of watering regime on the stem diameter was recorded by both W_2 and W_3 both with 1.188 and W_0 with 1.155 being the least. This however, was not significantly different (P≥0.05) (Table 4).

At ten weeks after planting, the effect of pot size on the stem diameter of the plant recorded the highest with the treatment P_1 and P_3 both recording 1.230 while P_2 was the least with 1.220 this was however, not significantly different (P≥0.05). Similarly, the effect of the watering regime on the stem diameter recorded the highest with W_3 recording 1.250 while W_2 recorded the least with 1.200. This was however significant (P≥0.05) (Table 4).

Fresh and Dry Plant Weight

The fresh plant weight was found not be significantly different (P≥0.05). However, the treatment P_2 recorded the highest plant weight (3.82) while P_1 gave the least (2.20) on the influence of pot size on the fresh plant weight. While on the influence of the watering regime on the fresh plant weight, W_3 recorded the highest effect (3.72) followed by W_2 (3.76), whereas, W_1 recorded the least effect (1.83) (Table 5).

The dry plant weight was found not be significantly different (P≥0.05). However, the treatment P_2 recorded the highest plant weight (1.57) while P_1 gave the least (0.77) on the influence of pot size on the fresh plant weight. While on the influence of the watering regime on the fresh plant weight, W_2 recorded the highest effect (1.53) followed by W_0 (1.39), whereas, W_1 recorded the least effect (0.86) (Table 5).

Table 2: Effect Of Watering Regime And Pot Sizes On Plant Height Per Plant At 2, 4, 6, 8 And 10 Weeks After Planting

Treatment	2	4	6	8	10
Watering regime					
W_0	5.79	7.40[a]	10.99	13.25	16.21
W_1	7.66	9.60[a]	14.68	16.05	18.72
W_2	6.77	8.65[a]	13.59	15.49	17.89
W_3	7.94	9.82[a]	14.33	17.33	19.96
Significance	NS	*	NS	NS	NS
LSD (5%)	--	2.81	--	--	--
Pot Size					
P_1	7.06	8.54	12.67	14.21[a]	16.55[c]
P_2	7.33	9.63	14.79	17.53[a]	246.20[a]
P_3	6.75	8.45	12.77	14.88[a]	210.50[b]
Significance	NS	NS	NS	*	**
LSD (5%)	--	--	--	5.03	4.78
Interaction (PxW)	NS	NS	NS	NS	NS
LSD (5%)	--	--	--	--	--
CV (%)	29.93	18.82	26.34	19.25	15.61

Means followed by same letter(s) in the same column are not significantly different at 5% level of probability.

Table 3: Effect Of Watering Regime And Pot Sizes On The Number Of Leaves Per Plant At 2, 4, 6, 8 And 10 Weeks After Planting.

Treatment	2	4	6	8	10
Watering regime					
W_0	88.44	124.44	186.89	245.00[a]	261.44[a]
W_1	98.22	152.00	241.11	285.55[a]	295.00[a]
W_2	99.11	158.33	239.44	293.89[a]	345.67[a]
W_3	96.33	149.55	237.55	300.44	345.89[a]
Significance	NS	NS	NS	NS	*
LSD (5%)	--	--	--	--	98.61
Pot Size					
P_1	103.25	149.16	231.83	286.58	298.00
P_2	94.58	152.08	226.92	285.17	323.58
P_3	88.75	137.00	219.92	271.92	314.42
Significance	NS	NS	NS	NS	NS
LSD (5%)	--	--	--	--	--
Interaction					
(PxW)	NS	NS	NS	NS	NS
LSD (5%)	--	--	--	--	--
CV (%)	29.5	18.15	11.34	19.68	25.86

Means followed by same letter(s) in the same column are not significantly different at 5% level of probability

Table 4: Effect Of Watering Regime And Pot Sizes On Stem Diameter Per Plant For 2, 4, 6, 8 And 10 Weeks After Planting

Treatment	2	4	6	8	10
Watering regime					
W_0	0.013	0.059	1.120	1.155	1.220[a]
W_1	0.021	0.131	1.116	1.166	1.210[a]
W_2	0.015	0.033	1.096	1.177	1.200[a]
W_3	0.015	0.093	1.063	1.177	1.250[a]
Significance	NS	NS	NS	NS	*
LSD (5%)	--	--	--	--	0.084
Pot Size					
P_1	0.014	0.070	1.080[a]	1.140[a]	1.230
P_2	0.021	0.110	1.140[a]	1.200[a]	1.220
P_3	0.015	0.080	1.080[a]	1.170[a]	1.230
Significance	NS	NS	*	*	NS
LSD (5%)	--	--	0.1	0.084	--
Interaction					
(PxW)	NS	NS	NS	NS	NS
LSD (5%)	--	--	--	--	--
CV (%)	58.04	88.67	5.67	4.27	4.16

Means followed by same letter(s) in the same column are not significantly different at 5% level of probability

Table 5: Effect Of Watering Regime And Pot Sizes On Fresh Plant Weight And Dry Plant Weight

Treatment	FRESH PLANT WEIGHT	DRY PLANT WEIGHT
Watering regime		
W_0	2.55	1.39
W_1	1.83	0.86
W_2	3.65	1.53
W_3	3.72	1.21
Significance	NS	NS
LSD (5%)	--	--
Pot Size		
P_1	2.20[a]	0.77
P_2	3.82[a]	1.52
P_3	2.79[a]	1.47
Significance	NS	NS
LSD (5%)	--	--
Interaction		
(PxW)	NS	**
LSD (5%)	--	1.63
CV(%)	72.95	77.56

Means followed by same letter(s) in the same column are not significantly different at 5% level of probability

Conclusion

From the present investigation *Parkia biglobosa* is a slow growing species like it had been reported for several indigenous tree species in Nigeria and West Africa (*Dialum guineensis* and *Vitellaria paradoxa* (Oni, 2002; Odebiyi *et al*., 2004). This problem makes the various treatments effect not to be fully expressed even at the expiration of the study.

It was however observed that plants watered once in three days or once in five days yielded the highest number of leaves and pot size 15 cm x 17 cm and 20 cm x 22 cm gave the highest number of leaves. Similarly, plants water once daily and once in three days gave the highest stem diameter and pot size 20 cm x 22 cm gave the highest stem diameter. Furthermore, plants watered once in five days yielded the tallest height and pot size 20 cm x 22 cm gave the tallest plant height.

It was equally observed that plants watered once in five days gave the highest fresh weight of the plant and pot size 20 cm x 22 cm was found to give the highest weight of the fresh plant. Similarly, plants watered once in three days and pot size 20 cm x 22 cm gave the highest dry plant weight. A similar work carried out on *Acacia senegal* by Isah *et al* (2013) indicated that, *Acacia Senegal* performed better when watered once in three days and this reflects the capability of this species to cope with drought stress.

Generally, the bigger the soil volume the more the expected growth for most plants (Oni and Caspa, 2002), however it has been observed that this may not bring about significant effect on overall plant growth as observed in the present study. It was observed that optimum seedlings performance for both total plant height and number of leaves were obtained in medium pot size compared with other pot sizes. Pot size had no significant effect on other growth parameters. Oni, (2013) pointed out that, small to medium pot sizes are likely to have more positive effects on early seedling growth in the species.

Recommendation

From the study, the raising of *Parkia biglobosa* can be raised using pot size 20 cm x 22 cm and should be watered once in three days.

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