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Effect of Watering Regimes on the Germination and Early Seedling Growth of *Annona muricata* Linn

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ABSTRACT

This study was carried out to determine the impact of different watering frequencies on germination and early growth of Annona muricata seeds and seedlings respectively. Three watering regimes (once in a week, twice in a week, and thrice in a week) were used. Evaluation of early seedling growth under the three watering regimes was based on height, collar diameter, and leaf number. Seed germination was significantly affected ($p \leq 0.05$) by the watering regimes. Seeds watered thrice weekly had the highest germination percentage (88.6%), followed by those watered twice weekly (58.6%) and those watered once weekly (53.34%). There were also significant differences ($p \leq 0.05$) in seedling height and collar diameter at all stages of growth (months 1, 2, 3 and 4) and in leaf number at months 1-3. Watering thrice a week gave the highest seedling height at months 2-4, highest seedling collar diameter at months 3-4 and highest leaf number at months 1-4 while the lowest seedling height, collar diameter and leaf number, were observed under once-in-a-week watering regime at months 1-4. These findings imply that A. muricata cannot be raised under some form of water stress condition since more frequent watering enhanced its germination and growth of seedlings.

INTRODUCTION

Annona muricata commonly called soursop and belonging to the family *Annonaceae* is a tropical fruit tree and one of the minor crops that is gaining popularity because of its economic and medicinal importance (Okoli *et al.,* 2016). It is a native of the warmest tropical area in South and North America and is widely distributed throughout tropical and sub-tropical parts of the world including India, Malaysia, and Nigeria (Moghadamtousi *et al.,* 2015). The species is small, slender, evergreen tree, and grows to height of 4-8m tall when mature (Pinto *et al.,* 2005). The fruit is large, heart shaped and green in colour, ranging in diameter between 15 to 20cm (Moghadamtousi *et al.,* 2015) and weighing up to 7kg (Orwa *et al.,* 2009). It is a multipurpose plant with acceptable nutritional value as food products, sources of medicinal and industrial products as well as contributing directly to food security and supplementary household income for small- and medium-scale farmers (Joseph-Adekunle, 2014).

Water is the physical basis of life in living organisms. It is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements (Isah *et al.,* 2012). Water requirement in plants is dependent on the botanical characteristics of the plants, its age of growth and the prevailing weather conditions of the region (Sale, 2015) Gbadamosi (2014) stated that plant species respond differently to water availability and that different plant parts adapt differently to varying water stress conditions. Insufficient moisture below the critical level is known to cause changes in cell structure leading to the death of plants (Shinkafi and Aduradola, 2009). Water has been recognised as a determinant factor for seed germination since it can affect germination parameters in plants (Shaban, 2013). According to Doescher *et al.* (1985) moisture stress is one of the parameters that can influence the adaptability and regeneration success of a species population.

Moisture stress causes reduction in general physiological activities and thus growth and development of plants (Shinkafi and Aduradola, 2009). Isah *et al.* (2012) also stated that too much water in excess of plants need may retard physiological processes in plant cell. Robert and Smith (1982) assessed survival and the growth of black oak under different watering regimes and found significant difference in the regimes. Mohammed *et al.* (2013) reported significant effect on the growth of tropical trees under different watering regimes.

This study aimed at ascertaining and recommending suitable watering regime for the germination and early seedling growth of *A. muricata*. It is expected that the findings will enhance the propagation and cultivation of *A. muricata* especially now that its nutritional and medicinal values are better appreciated.

MATERIALS AND METHODS

Study Area

This study was carried out at the Forest Nursery of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University Of Port Harcourt Nigeria between March to October 2017. The nursery site lies on Latitude 04^0 53' 38.3" N and longitude 00.6^0 54' 38" E.

Collection and Processing of Seeds

The fruits of *A. muricata* were collected from five trees at Edegberi Better-land Community in Rivers State. The seeds were processed manually and mixed properly to form a seed-lot. Seed viability test was done using the floatation method by soaking seeds in water for three hours. Seeds that sink were regarded as viable and used for the study, while the seeds that floated were discarded.

Experimental Design

The experiment was laid out in a completely randomized design involving 450 randomly selected seeds for the three (3) watering regimes (once in a week, twice in a week, and thrice in a week) i.e. 50 seeds x 3 replicates x 3 watering regime = 450 experimental units. Seeds were sown in germination trays measuring 17cm x 13cm x 35cm, filled with sharp sand and labelled appropriately. Seeds were germinated under a 50% light shade net. No fertilizers or bacterial and/or mycorrhizal inoculation were used. After one month of establishment, seedlings were transplanted into polypots.

Prior to transplanting, the polypots which were filled with topsoil were fully watered to field capacity to maintain the moisture content of the soil. At the two leaf stage, young seedlings were transplanted into polypots measuring 15cm x 15cm x 20cm when flat. All bags were watered daily after transplanting for one month until the seedlings were properly established (considered to be seedlings with new leaves). A completely randomized design was used. Ninety (90) seedlings equally divided among three watering regimes - once in a week, twice in a week, and thrice in a week (i.e. 10 seedlings x 3 watering regimes x 3 replicates = 90 experimental units) were used to determine the most appropriate watering regime for the early growth of *A. muricata*. Weeding was carried out regularly and when required throughout the period of the experiment.

Data Collection

Observation on germination was made and recorded daily for a period of sixty days. Germination percentage was calculated as:

$$\text{Germination percentage (GP)} = \frac{Total\ germinated\ seeds}{Total\ seeds\ sown} \text{x} \frac{100}{1}$$

Seedling height, stem collar diameter and number of leaves were measured immediately after

transplanting and monthly thereafter for four months. The seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a vernier caliper; while leaf production was determined by directly counting the number of leaves.

Data Analysis

Data collected on germination and early seedling growth were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). One way analysis of variance was used to determine variation and whether F value was significant at $p \leq 0.05$. Duncan Multiple Range Test (DMRT) was used to compare means and indicate levels of differences.

RESULTS

Germination Percentage of A. muricata seeds under different watering regime

Germination percentage (GP) of *A. muricata* seeds under different watering regimes is presented in Figure 1. There were significant differences ($p \leq 0.05$) in germination percentage between seeds watered thrice a week and those watered twice and once a week while there was no significant difference in GP between seeds watered once and those watered twice a week. Seeds watered thrice in a week had the highest mean germination percentage (88.66%), followed by seeds watered twice in a week (58.66%), while seeds watered once in a week had the lowest mean GP (53.34%).

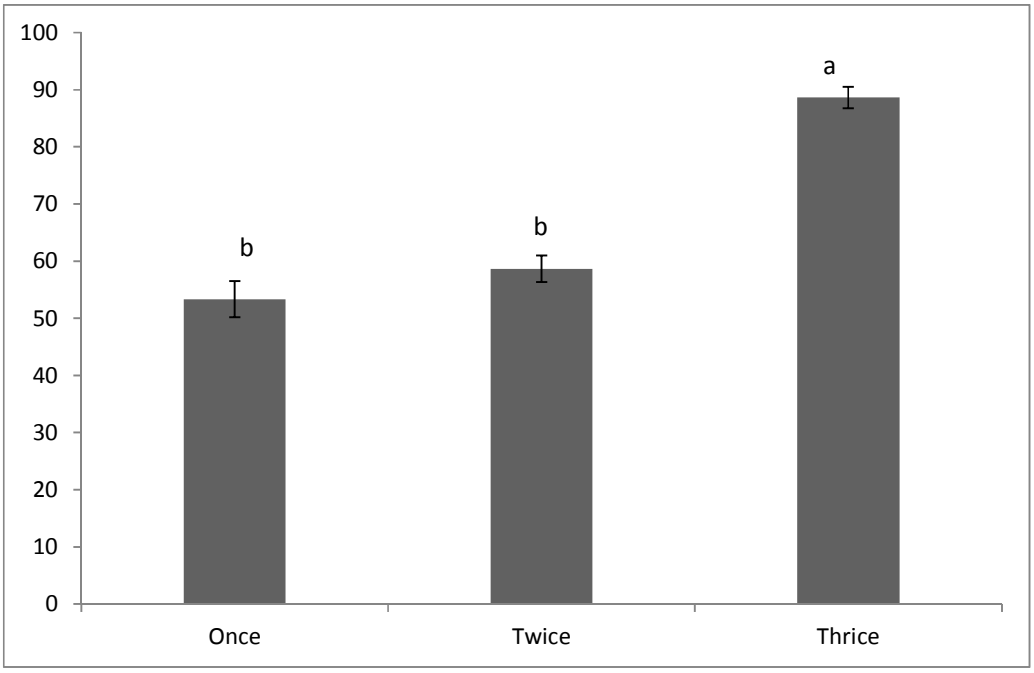

Figure 1. Effects of watering regimes on germination percentage (GP) of *Annona muticata* seeds.

Bars with the same letter are not significantly different ($p \geq 0.05$).

Growth indices of *A. muricata* seedlings under different watering regime

Seedling Height

The effect of different watering regimes on mean seedling height is shown in Table 1. Seedlings of *A. muricata* subjected to different watering regimes showed significant difference ($P \leq 0.05$) in height at month 1-4. At the first month, seedlings watered twice in a week had highest seedling height, followed by seedlings watered thrice, while seedlings watered once had the lowest seeding height. At months 2-4, highest seeding height was observed in the seedlings

watered thrice, followed by seedlings watered twice while seedlings watered once had the lowest seedling height.

Table 1. Effect of watering regimes on mean seedling height (cm) of *A. muricata*

Watering regime	Seedling Height (cm)			
	H_1	H_2	H_3	H_4
Once/week	10.53[b]	11.60[c]	13.10[c]	14.11[c]
Twice/week	11.49[a]	13.37[b]	15.27[b]	16.73[b]
Thrice/week	11.41[a]	15.14[a]	16.54[a]	17.66[a]
Mean	11.15	13.38	14.97	16.17
P-value	0.023	<0.001	<0.001	<0.001

Values in the same column with the same superscript do not differ significantly ($p \geq 0.05$).
H_1 to H_4= Mean seedling height at months 1 to 4.

Collar diameter

Seedlings of *Annona muricata* subjected to different watering regime showed significant differences ($P \leq 0.05$) in collar diameter (Table 2). At months 1 & 2, seedlings watered twice weekly had highest collar diameter, followed by seedlings watered thrice, while seedlings watered once had the lowest collar diameter. At month 3, average collar diameter was the same for seedlings watered twice and thrice, and lower for seedlings watered once weekly. At month 4 the highest collar diameter was observed in seedlings watered thrice weekly, followed by seedlings watered twice weekly, while seedlings watered once weekly had the lowest collar diameter.

Table 2. Effect of watering regimes on mean seedling collar diameter (cm) of *A. muricata* seeds

Watering regime	Seedling Collar Diameter (mm)			
	CD_1	CD_2	CD_3	CD_4
Once/week	1.22[c]	1.37[b]	1.48[b]	1.55[b]
Twice/week	1.52[a]	1.71[a]	1.80[a]	1.94[a]
Thrice/week	1.36[b]	1.68[a]	1.80[a]	1.95[a]
Mean	1.37	1.59	1.69	1.81
P-value	<0.001	<0.001	<0.001	<0.001

Values in the same column with the same superscript do not differ significantly ($p \geq 0.05$).
CD_1 to CD_4 = mean seedling collar diameter at months 1to 4.

Leaf number

The effect of watering regimes on mean seedling leaf number of *A. muricata* is shown in Table 3.There were significant difference ($P \leq 0.05$) in the number of leaves of seedlings of *A. muricata* subjected to different watering regimes in the number of leaves of seedlings of *Annona muricata* at months 1-3 and while no significant difference was observed amongst them at month 4. Seedlings watered thrice had highest leaf number at all periods of growth, followed by those watered twice weekly and those watered once weekly, respectively.

Table 3. Effect of watering regimes on mean seedling leaf number of *A. muricata* seeds

	Seedling Leaf Number			
Watering regime	LF_1	LF_2	LF_3	LF_4
Once/week	3.07^b	3.50^c	3.23^b	3.50^a
Twice/week	3.37^a	4.10^b	3.90^b	3.63^a
Thrice/week	3.47^a	5.00^a	4.83^a	4.33^a
Mean	3.30	4.20	3.99	3.87
P-value	0.005	<0.001	<0.001	0.074

Values in the same column with the same superscript do not differ significantly ($p \geq 0.05$).
LF_1 to LF_4 = mean seedling leaf number at months 1to 4.

DISCUSSION

The highest germination percentage observed in seedlings watered thrice weekly implies that *A. muricata* requires an appreciably high level of moisture for seed germination. Water is a determinant factor for seed germination since it can affect germination parameters in plants (Shaban 2013). Gbadamosi (2014) noted that water stress influences plant growth and limits production. The reduction in relative water contents affects physiological processes thereby reducing plant growth (Awodola, 1984). However, this finding is contrary to that of Doescher *et al.* (1985) who reported a decrease in both the amount and rate of germination following a decrease in water stress.

The significant difference in seedling height, collar diameter and leaf number of *A. muricata* due to different watering regimes agrees with Isah *et al.* (2012) who observed highly significant differences among *Acacia senegal* provenances under different watering regimes. The results of this study also agrees with those of other workers, for example, Mohamed *et al.* (2013) who observed significant difference in height and leaf number among different irrigation frequencies in five tropical species, Olajide *et al.* (2014) who reported a significant difference in *Dialium guineense* seedlings stem-collar diameters due to the application of different watering regimes, and Gbadamosi (2014) who reported significant difference in seedling height of *Picralima nitida* subjected to different watering regimes. Water stress causes significant variation in seedlings relative growth rate (Abdelbasit *et al*. 2012). However, Sale (2015) reported non-significant difference in seedling height and leaf number of *Parkia biglobosa* while Mohamed *et al.* (2013) and Gbadamosi (2014) observed non-significant difference in collar diameter of five tropical species and *Picralima nitida,* respectively due to the application of different watering regimes. Significant variation in both morphological and physiological adaptation to water stress in tree species has been reported by Cregg (1993).

Highest height and leaf number recorded for seedlings watered thrice weekly indicates that *Annona muricata* seedlings require enough water for proper growth and development. Water is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements (Sale, 2015). Various vital processes in plants including cell division, cell elongation, stem as well as leaf enlargement and chlorophyll formation depends on plant water availability (Price *et al.,* 1986). This explains why the once per week watering regime gave the poorest results. Vandoorne *et al.* (2012) reported that water stress drastically decreased leaf number in *Cichoriumintybus* (var: *sativum*).Water stress due to drought is the most significant abiotic factor limiting plant growth and development (Hartmann *et al.,* 2005;

Gbadamosi 2014).

Highest seedling collar diameter observed in seedlings watered twice weekly concurs with the findings of Olajide *et al.* (2014) who noted that seedlings subjected to watering once every three days in the morning (i.e. twice weekly) had the highest mean stem-collar diameter. This implies that growth in girth of *A. muricata* seedlings can be improved by moderate watering of seedling at the early growth stages.

CONCLUSION AND RECOMMENDATION

These findings imply that *A. muricata* cannot be raised under some form of water stress since more frequent watering enhanced the germination of *A. muricata* seeds and growth of its seedlings. Further investigation involving watering regimes with higher watering frequencies like four, five, six and seven times weekly, is recommended, to enable a conclusive decision on the best watering regime for optimum germination of *A. muricata* seeds and early growth of its seedlings.

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