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Seedling emergence and growth of *Blighia sapida* K.D. Konig using different watering frequencies

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ABSTRACT

Rainfall fluctuations affect regeneration of tropical tree species. Response of sown seeds and seedlings of *Blighia sapida*, commonly called Ackee, to different watering frequencies was investigated using completely randomized design with three replicates. One hundred and twenty seeds from mature fruits of Ackee from Itapa-Ekiti (Latitude 7^{o}49'0"N and Longitude 5^{o}23'0"E) were used. Watering frequencies adopted were: Daily, Every two days, Every three days and Every five days watering represented as T1, T2, T3, and T4 respectively. The seeds subjected to T4 germinated 8 days after sowing (DAS) giving 80 % germination percentage (GP), T3 on 5 DAS with 86.7 % GP, T2 on 22 DAS with 6.7 % GP and T1 on 14 DAS with 66.7 % GP. Seedlings were then assessed fortnightly for collar diameter, seedling height, leaf number and number of branches for twelve weeks. Mean collar diameter did not indicate significant difference throughout assessment period. However, highest diameter value of 0.62 cm was obtained at 12 weeks under T4 while T1 gave the least value of 0.33 cm at 2 weeks. Analysis of variance revealed significant differences in seedling height across assessment period. Highest seedling height value of 28.39 cm was obtained under T4 while T3 produced least value of 11.44 cm. Highest mean leaf number of 13.11 was obtained under T4 while T1 gave least value of 4.22. Highest mean number of branches of 5.56 was recorded under T4 while T1 gave least value of 2.22. *B. Sapida* seeds can germinate and its seedlings raised with every five days and every three days watering.

Keywords: *Blighia sapida*, germination, seedling growth, watering frequencies, drought stress

INTRODUCTION

Forest products are of two categories, namely; wood products and non-wood products. Wood products are further categorized into timber products and non-timber products. Osemeobo and Ujor (1999) defined non-timber forest products (NTFPs) as forest materials derived from soil minerals, water, fauna and flora resources other than sawn wood. Whether termed Non-Timber Forest Products (NTFPs) or designated as Agroforestry Tree Products (AFTPs) to differentiate between wild and domesticated products (Simons et al., 2004), many plant species are essential for the livelihoods of millions of poor farmers in tropical developing countries (Ekué et al., 2010) . *Blighia sapida* can be categorized as a NTFP considering the fact that it is more popular for its fruits being used as food than its other uses. *B. sapida* commonly called ackee apple or ackee is a wild food plant and a soap berry plant that belongs to the family Sapindaceae. Many plants species are essential for the livelihoods of millions of poor farmers in tropical developing countries. Throughout history, man has turned nature into various substances such as medicines, food and domestic aids (Atolani, Olatunji and Fabiyi, 2009). *Blighia sapida* is an inhere tree crop of

West Africa, prevalent in tropical and subtropical environments. The ripe arils of the ackee fruit, yellow to cream colour are nutty-flavoured and edible (Oyeleke et al., 2013). The arils are the major component of the Jamaican national dish; ackee and saltfish. The ripe fruit arils are eaten fresh, dried, fried, roasted or made into sauce or soup in some parts of West Africa (Ekue et al., 2010). Seeds and capsules of the fruits are used for soap-making and for fishing, and all parts of the tree have medicinal properties. The plant has been reported to be effective against cold and pain when applied whereas it is also said to be acaricidal and insecticidal (Mitchell and Ahmad, 2006). Furthermore, good quality charcoal is produced from *Blighia sapida* and the timber produced from the tree is used in making furniture. *Blighia sapida* roots protect soil from water erosion and it is a shade tree useful in homes, parks and gardens (Orwa et al., 2009). Also, it has been found that soil under the *Blighia sapida* canopy has high organic matter and potassium contents (Muoghalu and Awokunle, 1994) and this benefit can be explored in agroforestry. In order to enjoy the benefits derivable from *B. sapida* in perpetuity, there is need to evaluate its silvical requirements most especially, because, it is usually referred to as a neglected and underutilized species. Dansi et al. (2012) categorized *B. sapida* as a neglected and underutilized species of priority in Benin, a country in West Africa. Although, data may not be readily available for some other developing countries in West Africa, it can be deduced that a very similar condition exists in Nigeria because the fruit is not very popular again to so many people.

Seeds are usually the starting materials for investigating silvical requirements of most indigenous tree species. The basic requirements of seeds to aid germination are warmth, moisture and air. When these three factors are present in the right amounts, the seed will swell and the embryo will begin to grow. Moisture and warmth aid in softening the seed coat. Water is an important natural resource that supports life and growth of plants. Initial growth of seedlings largely depends on stored food reserves contained in the cotyledons and also availability of soil moisture. However, after depletion of food reserves, seedlings rely on photosynthesis for their continued growth and survival (Bargali and Tewari, 2004). Soil moisture plays a key role in this process and also for nutrient uptake from growing media to support plant growth (Shao et al., 2008). According to Bargali and Tewari (2004), the small size, shallow roots and little food store make seedlings less tolerant to harsh environments. Such harsh conditions could be as a result of water deficiency in the soil consequent upon unprecedented drought conditions. The role of water as one of the requirements for germination and continued existence of any plant is crucial. Water is essential in plants for many reasons and these include enzyme activation, breakdown of soil minerals for easy uptake by roots, translocation and it is a medium for many chemical reactions.

Water use requirement of any plant depends on the species, growth stage and time of the year and hence, it is necessary to establish this for each tree species as there are differences in growth rates (Simon et al., 2011). Insufficient water in plants below a critical level is usually demonstrated by changes in all structures leading to eventual death of the plants whereas too much water in excess of plant's need may retard physiological processes in such a plant (Levy and Krikum, 1983). Germination and early seedling growth are highly susceptible to changes in climatic conditions such as temperature and water availability (Dalling and Hubbell, 2002). A lack of soil moisture is often a major reason for seedling mortality (Lamont, Witkowski and Enright, 1993). In a seasonal tropical forest, species have adapted to ever wet conditions which may make these species sensitive to changes in the rainfall regime (Gibbons and Newbery, 2002) consequent upon climate change. It therefore becomes imperative to evaluate the influence of different watering frequencies on *B. sapida* seeds and seedlings as this will aid its proper domestication as well as likely success of its natural regeneration in response to changing rainfall pattern as a result of climate change.

MATERIALS AND METHOD

Mature fruits of *Blighia sapida* were obtained from Itapa-Ekiti, Ekiti State (Latitude 7^{o}49'0"N and Longitude 5^{o}23'0"E). Seeds were extracted from the fruits and carefully depulped to avoid damage to the seeds. Seeds of similar size were selected and soaked in water at room temperature for 24 hours following Olayode and Osuji (2015). These were air-dried for one hour before they were sown. There were four watering frequencies adopted for this study making four treatments in all. They are daily watering, every two days watering, every three days watering and every five days watering represented as T1, T2, T3 and T4 respectively. Seeds under each treatment were sown in polythene pots filled with topsoil and laid out in three replicates under each treatment. Watering was done at the different watering routines and soil was watered to field capacity on each occasion. Cumulative germination count was done daily until no further germination was observed for about seven days. Germination was taken to have occurred when the plumule emerged above the soil surface.

Germination percentage (GP) was calculated with the following formula:

$$GP = \frac{Number\ of\ germinated\ seeds}{Total\ number\ of\ sown\ seeds} \times 100$$

Uniformly growing seedlings from each treatment were separated to continue into the phase of seedling growth assessment. However, T2 could not continue into this phase because it did not produce sufficient seedlings. Also, seedlings were sprayed with insecticide every 21days to control insect infestation. An earlier study by Osuji (2014) already proposed that *Blighia sapida* seedlings are prone to aphid infestation at the nursery (Plate 1) and should be controlled. Seedlings were assessed fortnightly for twelve weeks. The variables assessed were seedling height measured with the aid of metre rule, seedling collar diameter obtained with vernier caliper while number of leaves and number of branches were counted on each seedling. Data were then subjected to one-way Analysis of Variance (ANOVA). Duncan's Multiple Range Test was used to separate the means that were significant ($p \leq 0.05$).

Plate 1: Insect-infested seedlings of *Blighia sapida* subjected to daily watering

RESULTS

Germination of *B. sapida* seeds under watering frequencies

Germination percentages and rates of *B. sapida* seeds under the various watering frequencies are shown in Table 1. Germination percentage of 66.7 % was recorded as germination began on the 14th day after sowing (DAS) for the daily watering (T1) and was completed on the 26th DAS. Germination percentage of 6.7 % was also recorded as germination started on the 22nd DAS for T2 and was completed on the same day because no other germination was later observed. Germination percentage of 86.7 % was equally recorded as germination of seeds began on the 15th DAS for T3 and was completed on the 22nd DAS. Germination percentage of 80.0 % was obtained as germination started on the 8th DAS and it was completed on the 20th DAS for seeds subjected to T4 treatment.

Table 1: Mean germination percentage of *Blighia sapida* seeds subjected to different watering frequencies

Watering frequencies	Germination percentage (%)	Start of Germination (DAS)	End of Germination (DAS)
T1	66.7	14	26
T2	6.7	22	22
T3	86.7	15	22
T4	80.0	8	20

*DAS = Days After Sowing

Germination rate of *Blighia sapida* under different watering frequencies

Germination rate of *Blighia sapida* done every other day from the commencement of germination to its completion revealed significance ($p \leq 0.05$) at 10 DAS, 12 DAS, 14 DAS, 20 DAS, 22 DAS, 24 DAS and 26 DAS among the watering frequencies. However, no significance ($p > 0.05$) was observed at 8 DAS, 16 DAS and 18 DAS. Furthermore, when Duncan's Multiple Range Test (DMRT) was used to separate the means of germination rate of the watering frequencies that were significantly different, it revealed that at 10 DAS, 12 DAS and 14 DAS, T1, T2 and T3 were not significantly different from one another but they were different from that of T4. Also, at 20 DAS, 22 DAS, 24 DAS and 26 DAS, T1, T3 and T4 were not significantly different from one another but they were different from T2 (Table2).

Table 2: Mean germination rate of *Blighia sapida* seeds under different watering frequencies

DAS	T1	T2	T3	T4
10	0.00^b	0.00^b	0.00^b	0.67^a
12	0.00^b	0.00^b	0.00^b	0.69^a
14	0.33^b	0.00^b	0.00^b	2.00^a
20	2.67^a	0.00^b	3.67^a	4.00^a
22	2.67^a	0.33^b	4.33^a	4.00^a
24	3.00^a	0.33^b	4.33^a	4.00^a
26	3.33^a	0.33^b	4.33^a	4.00^a

Means with the same letter in each row are not significantly different ($p > 0.05$).

Seedling collar diameter

Seedling collar diameter revealed no significant difference ($p > 0.05$) throughout the assessment period; that is from 2 to 12 weeks after sowing (WAS). Nevertheless, the highest mean collar diameter was obtained from T4 at 12 WAS with a value of 0.62 cm, closely followed by 0.61 cm also obtained at 12 WAS for T3, while, the least value of 0.33 cm was obtained at 2 WAS under T1 (Table 3).

Table 3: Mean diameter increment of *Blighia sapida* seedlings under the watering frequencies

Assessment Period (WAS)	T1 (cm)	T3 (cm)	T4 (cm)
2	0.33	0.34	0.40
4	0.42	0.42	0.45
6	0.49	0.47	0.48
8	0.52	0.51	0.55
10	0.54	0.59	0.59
12	0.56	0.61	0.62

WAS: Weeks after sowing

Seedling height

Seedling height showed significant differences ($p \leq 0.05$) across the assessment period (2-12 WAS) among watering frequencies. However, when DMRT was used to separate the mean height values for the watering frequencies, it revealed that at 2 weeks, 10 weeks and 12 weeks, T1 and T3 were not significantly different from each other but different from T4. Also at 4 weeks, T3 and T4 were not significantly different from each other. Similarly, T1 and T3 were not significantly different from each other whereas T1 and T4 were different. Moreover, at 6 weeks and 8 weeks, T1, T3 and T4 were significantly different from one another. The highest mean height recorded was obtained at 12 weeks under T4 with a value of 28.39 cm followed by 25.00 cm at 12 weeks under T3 while the least value was obtained at 2 weeks under T3 with a value of 11.44 cm (Table 4).

Table 4: Mean seedling height of *Blighia sapida* seedlings under the watering frequencies

Assessment Period (WAS)	T1 (cm)	T3 (cm)	T4 (cm)
2	14.11[b]	11.44[b]	19.50[a]
4	17.39[b]	19.94[ab]	22.44[a]
6	19.64[c]	21.78[b]	24.31[a]
8	20.53[c]	23.16[b]	20.06[a]
10	23.28[b]	23.83[b]	27.06[a]
12	24.22[b]	25.00[b]	28.39[a]

NOTE: Means with the same letter in each row are not significantly different ($p > 0.05$).

Number of leaves

Mean number of leaves for the watering frequencies was comparable but not significantly different from one another across the period of assessment. The highest mean number of leaves recorded was obtained at 12 weeks under T4 with a value of 13.11 followed by a value of 11.56 at 12 weeks under T3 and the least value was obtained at 2 weeks for T1 with a value of 4.22 (Table 5).

Table 5: Mean number of leaves of *Blighia sapida* under the watering frequencies

Assessment Period (WAS)	T1	T3	T4
2	4.22[b]	7.00[a]	8.11[a]
4	5.44[b]	9.78[a]	9.22[a]
6	6.67	10.44	10.33
8	7.44	12.00	10.89
10	8.39	12.00	11.56
12	9.22	11.56	13.11

Means with the same letter in each row are not significantly different ($p > 0.05$).
Row without superscripts did not indicate significant difference ($p > 0.05$).

Number of branches

Mean number of branches was comparable but not significantly different from one another from 6-12 WAS among the watering frequencies. Meanwhile, when DMRT was used to separate the mean branch number for the period that indicated significance, it revealed that at 2 weeks, T3 and T4 did not differ from each other, T1 and T3 did not also differ from each other whereas T1 and T4 were significantly different. Also at 4 weeks, there was no significant difference between T3 and T4 but they were both different from T1. Nevertheless, the highest mean branch number value of 5.56 was recorded at 12 weeks under T4 followed by 5.45 at 12 weeks for T3 and the least mean value of 2.22 was recorded at 2 weeks under T1 (Table 6).

Table 6: Mean number of branches for the watering frequencies across assessment period

Assessment Period (WAS)	T1	T3	T4
2	2.22[b]	2.78[ab]	3.55[a]
4	2.78[b]	4.11[a]	4.11[a]
6	3.39	4.66	5.00
8	3.39	5.22	4.66
10	4.11	5.00	5.33
12	4.33	5.45	5.56

Means with the same letter in each row are not significantly different (p > 0.05).
Row without superscripts did not indicate significance (p > 0.05).

Correlation analysis for the growth variables at 12 weeks after sowing (WAS)

Correlation analysis was carried out to determine relationship among growth variables at 12 WAS (Table 7). There is direct relationship between the seedling height and the collar diameter, seedling height and number of leaves as well as seedling height and number of branches since the correlation coefficient r, was greater than zero for all the possible combinations. The result showed significance ($p \leq 0.05$) for relationship between seedling height and number of leaves, diameter and number of leaves as well as collar diameter and number of branches with a value of 0.6 for all the relationships. Also, the relationship between number of leaves and number of branches indicated significance ($p \leq 0.01$) giving a value of 0.9 which indicated a very strong positive relationship between them.

Table 7: Correlation analysis for the growth parameters at 12weeks

	Seedling height	Collar diameter	Number of leaves	Number of branches
Seedling height	1			
Collardiameter	0.5	1		
Number of leaves	0.6*	0.6*	1	
Number of branches	0.4	0.6*	0.9**	1

*indicates significance ($p \leq 0.05$) **indicates significance $p \leq 0.01$

DISCUSSION

The result of germination experiment for *Blighia sapida* seeds under the watering frequencies did not follow any particular trend. It revealed that germination rate was highest under every five days watering (8 DAS), followed by daily watering (14 DAS), then every three days watering (15 DAS) which was very close to that of daily watering and lastly every two days watering (22 DAS). However, every three days watering produced the highest germination percentage (86.7 %), closely followed by every five days watering (80 %) while the least value for germination percentage was obtained in every two days watering (6.7 %). It can therefore be inferred that appreciable germination percentage well over 60 % can be obtained under the different watering frequencies except for every two days watering. The reason for the very low germination obtained in every two days watering could not be substantiated. O'Brien et al. (2013) tested the role of watering frequency intervals (from daily to six-day watering on the germination and the early growth of Dipterocarpaceae seedlings, and discovered that cumulative germination declined for all species when plants were watered at six-day intervals, and days to germination increased by 76.7 % on average for all species from daily to six-day intervals. However, reverse is the case in this study because it can be said that germination rate increased with increasing watering interval while germination was also completed faster as watering interval increased.

Some of the variables assessed for seedling growth of *B. sapida* indicated significance for the watering frequencies either across the assessment period or at certain times within the assessment period. However, seedling collar diameter did not indicate significance under the different watering frequencies throughout the assessment period. This means that watering frequencies did not influence seedling collar diameter significantly. Moreover when the mean values for the various growth variables were considered, watering every five days produced the highest mean values for all the variables followed by every three days watering while the least values were obtained under daily watering for the various variables. Longer watering intervals such as every three days watering and every five days watering have favoured vegetative growth in *B. sapida* seedlings. The result of this study is also an indication that watering seedlings of *B. sapida* at longer intervals will not predispose them to water stress. Similarly, Sale (2015) discovered that watering once in five days produced the highest plant height in *Parkia biglobosa* seedlings in comparison with watering once daily and watering once in three days.

The fact that the performance of seedlings that were watered daily in this study was low in comparison with other watering frequencies is in consonance with that of Jimoh et al. (1999) who reported that frequent watering of seedlings of some tropical rainforest tree species reduced their growth rates and encouraged damping-off. Furthermore, the low performance of seedlings under daily watering may be due to the fact that frequent watering of the seedlings can impair good aeration of the seedlings' roots, and therefore reduce their growth rate. Another observation in *Blighia sapida* seedlings subjected to daily watering was infestation by insects which kept defoliating the leaves in comparison with those under the other watering frequencies (Plate 1). Also, it can be deduced from this study that *B. sapida* can survive in areas with low rainfall judging by the better response of *B. sapida* seedlings under every three days and every five days watering in comparison with those subjected to daily watering.

CONCLUSION

Natural regeneration of *Blighia sapida* seeds would not likely be impaired by occasional water unavailability considering the fact that its seeds were able to produce good germination under the various watering frequencies. Moreover, the good response of *B. sapida* seedlings to different watering frequencies especially the ones with wide intervals such as every five days watering and every three days watering showed that the species will likely adapt to changing rainfall patterns in response to climate change which is gradually permeating the tropics. Daily watering should be avoided in the nursery for *B. sapida* seedlings for it favoured defoliation of its leaves by aphids. Therefore, *B. sapida* seedlings can be successfully watered at every five days and every three days in the nursery. The capability of *B. Sapida* to cope with drought stress has been revealed by this study.

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