STUDIES ON GERMINATION AND SEEDLING GROWTH RATE OF *BLIGHIA SAPIDA* KOENIG.--A CANDIDATE FOR REFORESTATION.

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ABSTRACT

This study investigated the germination and seedling growth rate of *B. sapida* (Sapindaceace) with a view to determining the germination potential and its growth performance. The germination study was carried out in the laboratory; the seeds were sown in a plastic germination box (12cm×22cm×5cm) lined with moistened filter paper, replicated four times for both scarified and control seeds after which they were incubated at 25±2^{0}C in light. The control seeds readily germinated with a percentage germination of 96.7%±1.11 after 18 days, a percentage germination attained by scarified seeds after 10 days. Five seedlings were grown per bowl in five replicates and arranged in a completely randomized layout. The shoot height, leaf area, root length, fresh and dry weight of both roots and shoots of the seedlings were determined. *B. sapida* seedlings exhibited a slow growth rate attaining a shoot height of 22±1.58 cm and root length of 22.5±3.77 cm after 14 weeks of sowing. The leaves increased in number from an average of 2±0.00 in week 4 to 4.4±0.40 in week 12, with correspondingly total leaf area of 133.39±12.24 cm^2 and 542.72± 102.12cm^2, respectively. Both fresh and dry weights of shoots and roots increased significantly during the period of growth assessment. The assessed growth parameters are discussed together with the suitability of *Blighia sapida* plant for reforestation projects. .

Keywords: Growth Rate, Seedling, Reforestation.

INTRODUCTION

Vegetation constitutes the energy fixer of the entire ecosystem, a function which is made possible through the process of photosynthesis, exclusive to plants and a few bacteria. Plants also play vital roles in the global cycles which provide favourable environment for the entire living matter aside from playing significant roles in conservation and utilization of bio-resources. Plants, therefore, are the most indispensable component of the environment. It is in the light of these that studies on plant growth are of great interest. Mbaekwe (2008) succinctly expressed the view that studies of plant growth and biomass accumulation could be invaluable in the analyses of an ecosystem in terms of flow of energy, recycling process and organic matter production. Growth and development studies constitute the basic criteria for evaluating the success of any forest reestablishment effort (Pitto *et al.,* 2004).

Blighia sapida is a multi-purpose medicinal plant which belongs to the family Sapindaceae. It has its origin in West Africa (Okigbo, 2008) and it is widely cultivated in India, West Indies and tropical America (Gledhill, 1972). The tree is evergreen and it has a straight bole which is branchless for at least 15m. The plant is planted for its ornamental qualities and shade. The fruits (its mature aril) which is a major food in Jamaica is known for its high protein and fat content (Ashurt, 1971). The seeds and capsule contain high oil content and potash respectively and so are burnt into ashes for making soap in some parts of West Africa (Irvin, 1961).

The wood of *B. sapida* is termite-resistant and is very useful in light construction, furniture, and charcoal production (Asamoah *et al.*, 2010). The aqueous extract of the seed is claimed to be capable of expelling parasites while combinations of various extracts of seeds, bark, capsule, root and leaves have been used in the treatment of diverse ailments such as dysentery, epilepsy, yellow fever (Kean & Hare, 1980) and diabetics (Gbolade, 2009).

The seeds of *B. sapida* are not dormant but they are recalcitrant (Janick *et al,* 2008; Ekue *et al.,* 2009). Furthermore, there is no known *ex situ* conservation of the plant (Ekue *et al.,* 2011).

The objective of this research, therefore, is to evaluate as well as improve on the germinability of the seeds of *B. sapida* and to assess seedling growth rate with a view to justifying its use for mass propagation in reforestation programmes.

MATERIALS AND METHODS

Fruit Collection / Seed Extraction

Matured fruits of *B. sapida* were collected during mid-rainy season (July and August, 2012) from the secondary forest flanking the Department of Botany, Obafemi Awolowo University, Ile-Ife (Longitude :04^0 $33^{'}$E & Latitude: $08^0 28^{'}$N). The seeds of *B. sapida* were obtained by removing the aril from the capsule.

Germination Experiments

Viability test of seeds was carried out using the floating method (Agboola *et al.,* 2004). The viable seeds were divided into two lots. Thirty seeds of the first lot were surface- sterilized for 5 minutes, rinsed several times with distilled water and planted in plastic germination box. This box comprised of two units, a basal unit and another unit serving as a cover, each of dimension (12×22×5) cm. The basal unit contained a tabular plastic frame carrying a plastic mesh over which blotting paper was laid. The two long parallel sides of the blotting paper hanged down into the distilled water in the basal unit. The cover unit has two holes (each 2cm in diameter) to allow for aeration. The control seeds were planted on the moistened blotting paper and covered with the lid. The second lot of seeds was scarified using sand-paper, sterilized and washed as the first lot of seeds. Thirty seeds of each lot were planted and each had 3 replicates. The seeds were all incubated at 25 ± 2^0C in the light. Seeds were observed for germination in an interval of 2 days for 18 days. Visible breaking of the seed coat by the radicle was taken as the criterion for germination.

Seedling Growth and Measurement

Five 2- week old seedlings of *B. sapida* (radical length about 2cm) were transferred to humus top soil in a small plastic bowl (diameter 12cm depth of 11cm) with perforation at the bottom to allow for drainage after which the bowls were placed under shade for 1 week to establish properly. The bowls (6 replicates) were then moved to the open to receive direct sunlight, beginning from the 4^{th} week after sowing (Plate 1) and fortnightly until 14 weeks after sowing. Five randomly selected plants, one from each bowl were harvested and several growth parameters were assessed, calculating the mean value and standard error of each.

Shoot Height and Root Length

Shoot height was measured for each plant as the distance between the scar of the cotyledon and the tip of the terminal bud using a thread and meter rule prior to harvesting. The root length was measured as the distance between the scar of the cotyledon and the terminal end of the tap root also using a thread and meter rule.

Fresh and Dry Weight of Shoot and Root

The fresh shoot and the washed roots mopped dry with blotting paper were weighed using Mettler Toledo Balance. The shoot and roots were dried to constant weight in an oven at 80^0C for about 24 - 48hrs for dry matter determination.

Leaf Area

Leaf area of each plant was determined using modified Hoyt & Bradfield (1962) formula:

$$\text{Leaf Area} = L \times W \times 0.81.$$

where L is leaf length measured as the distance between the base of the leaf and the leaf apex; W is the width of the most expanded portion of the leaf (both measurements were taken with metre rule); 0.81 is the correction factor (C.F), determined as follows: fifty leaves were taken randomly from a few stands of *B. sapida* saplings and the areas measured using graph paper glued to a glass plate. The mean of the ratios of the leaf area determined using graph paper to that obtained by the product of L and W alone were then obtained. The leaf areas calculated by using the C.F were strongly positively correlated with the areas of the leaves obtained by the graph method (r = 0.994).

Number of Leaves

The number of leaves was also counted fortnightly.

The various data obtained were analyzed using SPSS package and the Duncan Multiple Range data test was used to separate the means found to be different significantly.

RESULTS

Germination Experiments

The percentage germination of *B. sapida* over time is shown in Table 1. The control seeds started germinating on the eighth day after sowing with 6.7% germination and by the sixteenth day, 80% of the seeds had germinated. The maximum percentage germination (96.7%) obtained on day 18 was not significantly ($p>0.05$) different from 80% germination obtained on day 16. The physically-scarified seeds started germinating on the second day with 16.7% germination and by the 10th day of sowing, 100% of the seeds had germinated and this was significantly ($p< 0.05$) different from the percentage germination (23.3 ± 2.93) of the control seeds on day 10.

Plate 1 - Four Week - Old Young Potted Seedlings of *B. sapida*

Seedling Growth Rate

There is significant difference ($p< 0.05$) among all the parameters measured from week 4, (time of seedling transplant) to week 14 (time of last measurement). The means of shoot height; root length and the number of leaves from week 4 to week 14 are shown in Table 2. The mean shoot height at week 14 was significantly ($p< 0.05$) higher than the mean shoot height in week 4. There was no significant ($p< 0.05$) difference in the root length from the fourth week after sowing to twelve weeks after sowing.

The results show significant ($p<0.05$) increase in number of leaves from week 4 to week 8. The variation in the mean leaf area of *B. sapida* from the fourth week after sowing to the fourteenth week after sowing is shown in Table 3. There was significant ($p> 0.05$) increase in the leaf area between week 4 and 8 and also between week 8 and week 14. Table 4 shows the means of shoot and root fresh weights of seedlings of *B. sapida* from week 4 after sowing to week 14 after sowing. No significant ($p< 0.05$) change was observed in the shoot and root fresh weights from week 4 to week 8 while significant ($p< 0.05$) increase in these plant parts were shown by the analyses between week 8 and week 14.

In the case of the shoot dry weight, no

significant ($p < 0.05$) increase was observed also from week 4 to week 8 whereas significant change ($p > 0.05$) in the dry weight (of the shoot) occurred from week 8 to week 10; from week 10 to 12 and from week 12 to 14. With the root dry weight, a similar trend was observed as that of shoots where a significant ($p < 0.05$) increase occurred at the 10th week after sowing (Table 5).

Table 1: Mean Percentage Germination of *Blighia sapida* Seeds from Day 0 to Day 18

Days	Control *B. sapida*	Scarified *B. sapida*
0	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
2	0.00 ± 0.00^{a}	16.7 ± 1.11^{b}
4	0.00 ± 0.00^{a}	46.7 ± 1.11^{c}
6	0.00 ± 0.00^{a}	70.0 ± 1.93^{d}
8	6.7 ± 2.22^{ab}	96.7 ± 1.11^{e}
10	23.3 ± 2.93^{b}	100.0 ± 0.00^{e}
12	43.3 ± 4.00^{c}	-
14	66.7 ± 1.11^{d}	-
16	80.0 ± 1.93^{de}	-
18	96.7 ± 1.11^{e}	-

Values with the same superscript along the column are not significantly different from each other at $p < 0.05$

Table 2: Mean Shoot Height, Mean Root Length and Mean Number of Leaves of *B.sapida* from Week 4 to Week 14

Weeks	Mean Shoot Height (cm)	Mean Root Length (cm)	Mean Number of Leaves
Week 4	$15.42 \pm .82^{a}$	14.20 ± 1.99^{a}	2 ± 0.00^{a}
Week 6	17.66 ± 1.20^{ab}	18.44 ± 1.69^{ab}	3 ± 0.32^{b}
Week 8	19.36 ± 1.33^{bc}	16.56 ± 1.12^{ab}	3.6 ± 0.24^{bc}
Week 10	$20.00 \pm .93^{bc}$	20.48 ± 2.43^{ab}	4.2 ± 0.49^{c}
Week 12	19.00 ± 1.39^{abc}	22.47 ± 2.076^{b}	4.4 ± 0.40^{c}
Week 14	22.00 ± 1.58^{c}	22.50 ± 3.772^{b}	-

Values with the same superscript along the column are not significantly different from each other at $p < 0.05$.

Table 3: Mean Leaf Area (cm^2) of *Blighia sapida* Seedlings from Week 4 to 14.

T R	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14
1	88.40	134.85	314.64	384.86	572.69	392.91
2	157.95	391.94	281.87	160.11	730.10	497.41
3	133.75	353.07	386.00	500.34	486.79	737.84
4	134.2	185.13	281.50	219.39	478.88	_
5	152.63	268.22	286.20	399.47	278.64	_
Mean±S.E	133.39 ± 12.24^{a}	266.64 ± 48.57^{ab}	310.04 ± 19.96^{b}	332.83 ± 62.41^{b}	509.42 ± 73.29^{c}	542.72 ± 102.12^{c}

Mean values with the same superscript in the row are not significantly different from each other at $p < 0.05$.

T: Time in Weeks

R: Replicate

Table 4: Mean of Shoot and Root Fresh Weights (G) of *B. Sapida* Seedlings from Week 4 to 14

	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14
MSFW ± S.E	5.73 ± 0.25[a]	7.49 ± 0.61[abc]	6.66 ± 0.57[ab]	8.51 ± 0.73[bc]	9.71 ± 0.89[c]	12.37 ± 1.84[d]
MRFW± S.E	0.63 ± 0.10[a]	0.83 ± 0.08[a]	1.24 ± 0.23[ab]	2.06 ± 0.34[bc]	2.33 ± 0.26[c]	4.57 ± 1.00[d]

Mean values with the same superscript in the row are not significantly different from each other at $p < 0.05$.
MSFW: Mean shoots fresh weight.
MRFW: Mean roots fresh weight.

Table 5: Means of Shoot and Root Dry Weights (g) of *B. sapida* Seedlings from Week 4 to Week 14

	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14
MSDW ± S.E	1.66 ± 0.14[a]	1.78 ± 0.14[a]	2.12 ± 0.15[a]	3.00 ± 0.28[b]	3.92 ± 0.33[c]	5.27 ± 0.72[d]
MRDW ± S.E	0.14 ± 0.01[a]	0.30 ± 0.02[a]	0.38 ± 0.05[a]	1.28 ± 0.00[b]	1.01 ± 0.09[b]	1.66 ± 0.42[c]

Mean values with the same superscript in the row are not significantly different from each other at $p < 0.05$.
MSDW: Mean shoot fresh weight.
MRDW: Mean roots dry weight.

DISCUSSION AND CONCLUSION

The high percentage germination observed with the control seeds is an indication that the *B. sapida* seeds do not exhibit dormancy. The rate of germination can, however, be improved by physical scarification. By day 18, *B. sapida* seeds showed 96.7% germination. Asamaoh et al., (2010) reported that germination starts after 2-4 weeks with a percentage germination of 80%. In our study, physical scarification of the coat produced 100% germination within 10 days which is significantly ($p<0.05$) different from the percentage germination (23.3%) obtained for the control seeds for the same period of incubation. Physical scarification hastens the rate of imbibition and it is known that the rate of water penetration into the seeds is critical to the success of germination (Bewly and Blade, 1994).

The seeds used in this study were freshly harvested from "open capsule" and obtained from the tree stands in Obafemi Awolowo University, Ile - Ife, Osun State, Nigeria (7.55^{0}N 4.5^{0}E) where two prominent seasons and an annual temperature range of 27-34^{0}C prevail. Those seeds collected in the early fruiting season presumably had a high moisture content (fresh weight of 3.5g), and showed a high percentage germination (100%) because of the prevailing high humidity while those collected late in the dry season, most likely, with low moisture content (fresh weight of 2.7g) showed a percentage germination of less than 30% due to the prevailing dry weather (Personal Observation). These observations support the view of Janick *et al.* (2008) that *B. sapida* seeds may be recalcitrant since their viability decreased in drier conditions due to desiccation.

The observed increase in the number and area of leaves (seedling growth) at the 8th week after sowing must have resulted into the significant increase in the root length and weights of shoots and roots in the 10th week after sowing. This pattern of seedling growth can be explained by two complementary effects: large cotyledon of the seeds and increased leaf area of seedlings. The large cotyledon of the seeds brought about early increase in shoot height with increase in numbers of leaves and leaf area. Seed and seedling size are normally correlated (Sorenson and Campbell, 1993). Similarly, Agboola (1996) reported that the seedlings emerging from large seeds may enjoy a lot of food supply from the large cotyledons of their seeds than those of small seeds. The larger the total leaf area, the greater the surface exposed to light and so more energy will be captured for photosynthesis (Muramoto *et al.,* 1965) leading to increased food production which is necessary for growth. The significantly increased root length in the 10th week allows the early acquisition of nutrients and/or water , a feature that makes *B. sapida* species to thrive in relatively dry and resource- poor soils

In conclusion, *B. sapida* seeds are probably recalcitrant and their germination can be enhanced by physical scarification. The successful establishment of the seedlings on the field can be ensured by its fast seedling growth rate, a quality of interest in the consideration of economic trees for reforestation projects.

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