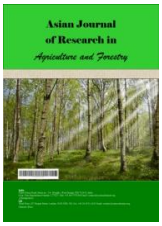

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Effects of Seed Size on the Germination and Early Growth of African Baobab (*Adansonia digitata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All the authors equally carried out the research with mutual understanding without conflict of interest. All authors read and approved the final manuscript.

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ABSTRACT

The effects of seed size on the germination and early growth of *A. digitata* were assessed. Seeds were sourced locally within the University of Ilorin Campus. One hundred viable seeds were selected from each of the size classes. The seed weight, length, breadth, and width were measured for all the selected seeds. Mean weight, length, breadth, and thickness were: 0.62 g, 9.16 mm, 7.45 mm, and 5.85 mm, respectively for small seeds. 0.41 g, 9.54 mm, 7.68 mm, and 6.03 mm, respectively for medium seeds; and 0.44 g, 9.92 mm, 7.89 mm, and 6.21 mm, respectively for large seeds. The experiment was laid out in a completely randomized design (CRD). Seed dormancy was broken through the acid scarification method by soaking in H_2SO_4 at 70% concentration for 20 minutes with constant stirring. Variables of interest include: leaves number, seedlings height, collar diameter and leaf area. Based on the results of this finding, medium and large seeds germinated in 7 days after sowing while small seeds germinated in 10 days after sowing. Large seeds had the highest germination percentage (55%), followed by medium seeds with 27%. The small seeds were the least in terms of germination rate (21%). There

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was no significant difference in mean seedling heights, collar diameters and number of leaves among the seed size classes (P>0.05). Mean leaf area significantly differed among the three size classes (P<0.05). The result showed that large seeds gave best germination at a shorter period than the medium and small seed sizes. Thus, large seeds of *A. digitata* are recommended in propagation activities involving the species.

Keywords: Adansonia digitata; germination; growth; seedling.

1. INTRODUCTION

Africa has an abundance of wild plants and cultivated native species with great agronomic and commercial potential as food crops [1]. In Nigeria and most developing countries where food insecurity is very pronounced, most rural communities rely on non-timber forest produce to supplement for food, health care and as a source of income. Rural people depend on natural resources and generate household income from marketing natural resources derivatives, most of which are plant materials.

The African baobab is among the most important trees that contribute significantly to the livelihoods of local people [2]. All parts of the baobab tree are useful and considered important for subsistence and commercial purposes. The fruit is considered as the most important of all as it is used for consumption and the seeds are used to make oil which is sold in the cosmetic industry.

Baobab is also reported to provide traditional medicine for both humans and livestock and plays a role in promoting biodiversity through the conservation of water and soil, therefore, enhancing the overall crop yield. The domestication and cultivation of the baobab tree is therefore important to protect its survival and provide income to the local people [2].

The seed phase is the most important stage in the lifecycle of higher plants as regards survival. There are many factors that influence seed germination in general, some of these factors are: seed germination mode, morphological and physiological constraints, and seed polymorphism [3].

Baobab species is facing a high risk of extinction because of its lack of natural regeneration. The seeds are known to stay in the soil for a long time before germination. Its survival is also threatened by bush fires, and grazing. Hence, practical ex-situ conservation measures are urgently needed to preserve the genetic diversity and maintain multiple specimens [4].

Due to dormancy factors (such as seed size, wrong time of seed collection and seeds storage), it is important to consider the morphological features of some seeds before sowing them in the field in order to reduce seeds loss and minimize cost of seeds procurement. There is the need for evaluation of the superiority of growth of different seed-lots; the effect of seed size in *A. digitata* on the germination and early growth becomes very necessary to be considered and evaluated.

2. METHODOLOGY

2.1 Study Area

Mature seeds of *Adansonia digitata* were collected within the University of Ilorin campus. The study was carried out at the university's central nursery. The university is located in Ilorin, the capital city of Kwara State, Nigeria. It is geographically situated on latitude 8°24'N and 8^{o} 36'N and longitude 4°10'E and 4°36'E (Fig. 1). Ilorin is located in transitional zone between the deciduous woodland of the south and dry savanna of north of Nigeria [5].

The climate of Ilorin is characterized by both wet and dry seasons. The temperature of Ilorin ranges from 33°C to 34°C from November to January while from February to April; the value ranges between 34°C to 35°C [6]. The total annual rainfall in the area is about 1200 mm [7]; with distinct wet and dry seasons of almost six months each. The average relative humidity is 77.50% and daily sunshine of 7.1 hrs daily. The mean monthly temperatures are very high, varying from 25°C to 28.9°C [6]. The soil is loamy sand with mean composition of 89%, 7% and 4% for sand, silt and clay, respectively. Sand, which is predominantly large particles, tends to drain quickly and have lower fertility. The pH range between 7.10 and 7.81, water holding capacity ranged between 0.28 ml/g and

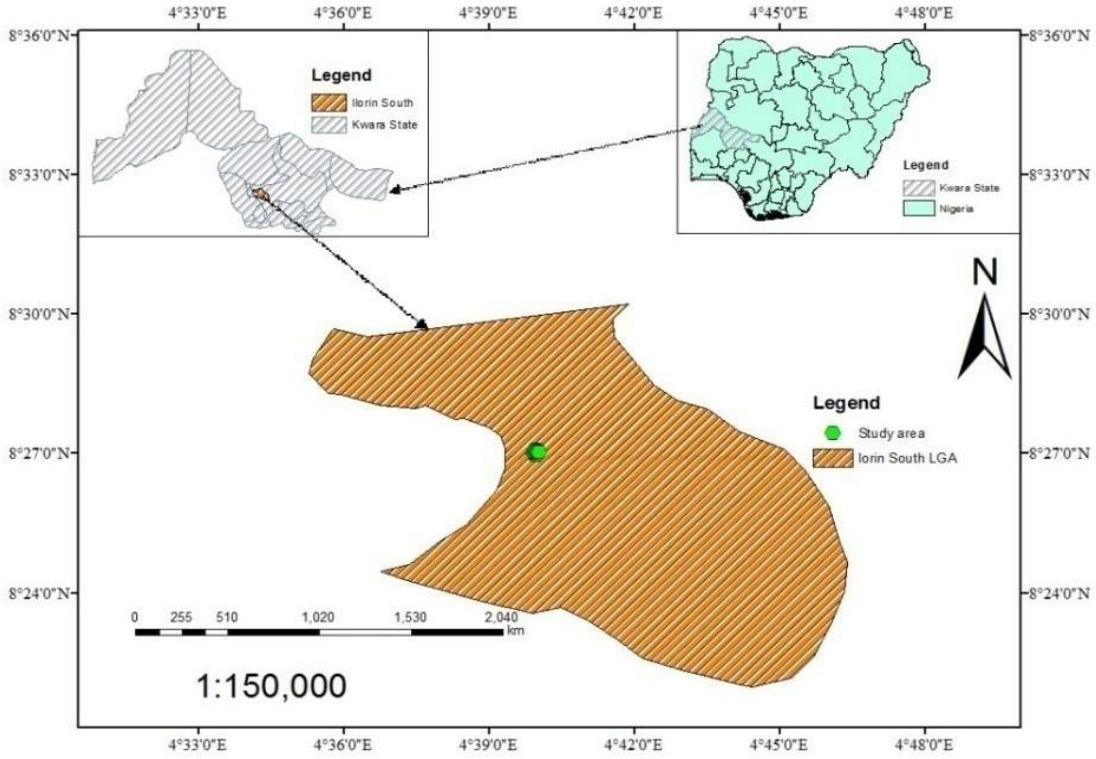

Fig. 1. Map of the Study site

0.53 ml/g, and the moisture content ranged from 2.10% to 5.23%. Generally, the vegetation of the area is savanna with occasional scattered trees. The trees in the area include *Parkia bigolobosa*, *Daniellia oliverii*, *Khaya senegalensis, Vitellaria paradoxa, Acacia senegal, Prosopis africana, Adansonia digitata, Blighia sapida,* and *Azadirachta indica.*

2.2 Sampling Design and Data Collection

Completely Randomized Design (CRD) was used for this study. The experimental units were classified according to seed size (weight) into large (≥36 cm and above), medium (26 to 35 cm), and small (≤25 cm) groups. Seeds viability was tested through the floatation method. Viable seeds were separated into three different classes based on their measured weight, length, breadth, and thickness, into large, medium and small sizes (A, B, C, respectively) until all the three hundred seeds were measured. The weight of the seeds was determined using sensitive electronic weighing balance calibrated in grams (g). The length, breadth, and thickness were determined using a digital vernier caliper calibrated in millimeters (mm). Based on these parameters, seeds were classified into A- large size group, B- medium size group, and C- small size group. The seeds dormancy was broken through the acid scarification method. Seeds were soaked in $H_2SO_4$of 70% concentration level for 20 minutes with constant stirring. Thereafter, they were rinsed under the tap for 5 minutes.

Hundred seeds from each group was afterwards selected and then sown in riverside sand. Watering was done once daily in the morning. The seeds were monitored closely for germination while watering continued, and readings were taken daily from the first day of germination until the last day of germination.

After attaining total germination, the seedlings were allowed to establish themselves for a period of two weeks after which they were transplanted. Thereafter, growth parameters were taken at a 5 days interval and were replicated four times.

2.3 Data Analysis

Data taken on both the germination and early growth variables were analyzed using descriptive and inferential statistics. The descriptive statistics

involved the use of frequency, tables and percentages. The inferential statistics involved the use of the one-way analysis of variance procedure at $p<0.05$. All the analysis was carried out using MINITAB (version 14), and Microsoft Excel (MS version 10).

3. RESULTS

3.1 Germination Rate of *Adansonia digitata* L. in Central Nursery, University of Ilorin, Nigeria

Number of days before germination commenced, mean number of seeds germinated daily and total number of seeds germinated were all observed and the results showed in Table 1. Large and medium seeds size germinated on the 7th day after planting while small seed size germinated on the 10th day after planting of *A. digitata.* Three (3) was the highest mean number of germinated seeds daily with one seed as the least mean number of germinated seeds daily in the study area. After 21 days of germination experiment in the study area, the mean total number of *A. digitata* seeds that germinated was observed to be 55, 29 and 21 seeds recorded from large seeds, medium seeds and small seeds size, respectively.

The large size seeds started germinating after 6 days of sowing with a mean germination percentage of 55% as the highest germination percentage, followed by medium size seeds started germination after 6 days of sowing with a mean germination percentage of 29% while the least germination percentage was observed from small size seeds which started germinating after 9 days of sowing with a germination percentage of 21% (Fig. 2).

3.2 Analysis of Seed Length

Small seeds had a mean of 9.1616; a range of 3.44, and a sum of 916.16 (Table 2). The medium sized seeds had a mean of 9.5409 cm; a range of 2.48 cm, and a sum of 954.09 cm. The large seeds had a mean of 9.9241 cm; a range of 2.88 cm, and a sum of 992.41cm. The small seeds class had the highest range followed by the large sized class and then the medium sized class. However, for the mean, the large size class had the highest, followed by the medium, and then the small size class.

3.3 Analysis of Seed Weight

Weights of varied seed size of *Adansonia digitata* were assessed and the result is presented on Table 3. Based on the result of this finding, the small, medium and large seeds had a mean weights of 0.2619 g, 0.4142 g and 0.4442 g, respectively; the seed sizes ranges from 0.11 – 0.40 g for small size seeds, 0.37 – 0.45 g for medium size seeds and 0.40 – 0.50 g for large size seeds.

3.4 Analysis of Seed Breadth

Adansonia digitata seeds size were assessed based on the seeds breadth at varied seed size, the result obtained is shown on Table 4. Small seeds had a mean breadth of 7.45 cm and a ranged of 3.31 cm. The medium sized seeds had a mean breadth of 7.67cmwith a range of 2.90cm. The large size seeds had a mean breadth to of 7.89 cm with a range of 2.87 cm. Also, the minimum and maximum of 6 cm and 8.87 cm was recorded from large size seeds of *A. digitata* in the study area, this was followed by medium size seeds which had 5.82 to 8.72 cm while small size seeds had the least seed breadth of 5.29 to 8.6 cm.

3.5 Analysis of Seed Thickness

Seed thickness of *A. digitata* was assessed and the result (Table 5) showed that, small, medium, and large size seeds had a mean thickness of 5.85 cm, 6.03 cm, and 6.21 cm, respectively. The seed thickness ranged between 4.09 to 6.84 cm for small size seeds, 4.86 – 7 cm for medium size seeds and 5.19 to 8.15 cm for large size seeds.

Table 1. Germination rate on varied seed size of *Adansonia digitata* L. in the study area

Seed size	No. of days before 1st germination	Mean no. of seeds germinated daily	Total no. of seeds germinated	Total germination %
Small	10	1	21	21%
Medium	7	1	29	29%
Large	7	3	55	55%

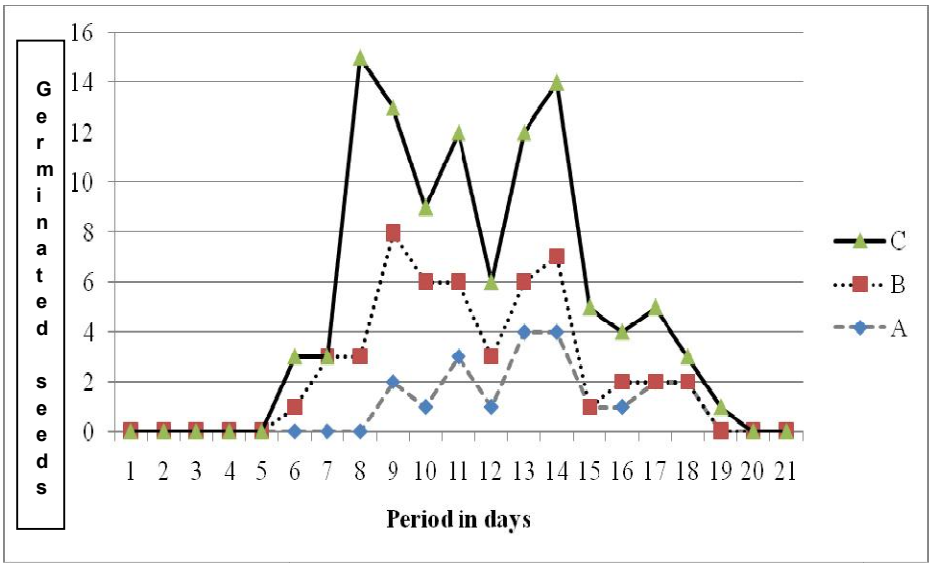

Fig. 2. Germination percentage on varied seed size of *Adansonia digitata* L. in the study area
Where: A=, small size seed; B= medium size seed and C= large size seeds.

Table 2. Length of varied seed size of *Adansonia digitata* L. in the study area

Parameters	Small (cm)	Medium (cm)	Large (cm)
Mean	9.16	9.54	9.92
Variance	0.30	0.15	0.22
Range	3.44	2.48	2.88
Sum	916.16	954.09	992.41

Table 3. Weights of varied seed size of *Adansonia digitata* L. in the study area

Parameters	Small (g)	Medium(g)	Large(g)
Mean	0.26	0.41	0.44
Range	30.89	0.08	0.10
Minimum	0.11	0.37	0.40
Maximum	0.40	0.45	0.50
Sum	31.5	41.42	44.42

Table 4. Breadths of varied seed size of *Adansonia digitata* L. in the study area

Parameters	Small	Medium	Large
Mean	7.45	7.67	7.89
Range	3.31	2.90	2.87
Minimum	5.29	5.82	6.00
Maximum	8.60	8.72	8.87
Sum	745.22	767.85	789.09

Table 5. Thickness of varied seed size of *Adansonia digitata* L. in the study area

Parameters	Small	Medium	Large
Mean	5.85	6.03	6.21
Range	2.75	2.14	2.96
Minimum	4.09	4.86	5.19
Maximum	6.84	7.00	8.15
Sum	585.00	603.30	620.72

3.6 Analysis of Growth Variables

The comparative effects of seed size on the growth variables of *A. digitata* are shown on Table 6. Based on the ANOVA result from this finding, there were no significant differences in mean seedling heights, collar diameters and number of leaves among the seed sizes (P>0.05). Mean leaf areas significantly differed among the three seed size categories (P<0.05).

The highest mean height of 13.53 cm recorded from large size seeds, this was followed by medium size seeds which had a mean height of 12.44 cm while the least mean height of 10.73 cm was recorded from seeds with small size. The collar diameter of the seed sizes was assessed and the result showed that there was no variation between the seed sizes but large size seeds had the highest mean collar diameter of 2.34 cm, followed by medium size seeds which had 2.33 cm and 2.64 cm recorded from small size seeds which was the lowest collar diameter obtained from this study in the area. Leaf area was determined using graph sheet of $5cm^2$, based on the result, large size seed had the highest mean leaf area of 16.5 cm, followed by medium size seeds which had 11.58 cm while the small size seeds had the lowest leaf area of 10.58 cm.

4. DISCUSSION

The results showed that large and medium sized seeds germinated faster and with highest germination rates than the small seeds. Moreover, large seeds had highest daily germination within the period. This could be attributed to the larger food reservoirs in large seeds compared to medium and small seeds. This enhanced their viability, hence, earliest and highest germination percentage of large seeds. Seeds with large dimension are likely to have large embryos, which enhance good germination and early growth [8]. Similar results were reported by Owoh et al. [9], having highest germination percentage in large seeds of *Gmelina arborea*. In this respect it is normal that one should expect some variations in the rates of germination and early growth within the three size groups.

The result of this finding is not in line with Padonou et al. [10], who reported lower germination rate in large seeds for *Jatropha curcas* in Benin. They reported highest germination in small seeds. This was attributed to the genetic variation of the seeds because environmental variation at the experimental site was negligible and the experimental design reduced any residual variation that could persist on site.

There was no significant effect of seed size on the seedling height, collar diameter and number of leaves. The leaf area was significantly affected by seed size. Large seeds had the highest mean leaf area. They had larger and vigorous leaves compared to other seed groups. According to Ahlrichs and Baue [11] leaf area index predicts the photosynthetic capacity of a crop and serves as a reference tool for crop growth and development. An increase in leaf area index results in an increase in light interception. Thus, the higher the leaf area index, the higher the photosynthetic activity and the higher the growth.

Tsialtas and Maslaris [12] observed that leaf area index influences plants to capture photon to increase photosynthetic rate and this enhances assimilate partitioning resulting in high growth and grain yield. On the other hand, the low germination percentage of the small seeds could be attributed to relatively lower food reserve in a small-sized seeds, the stage of maturity, and size of cotyledon and genetic factors. This finding agrees with the report of Faluyi [13], who noted better growth in cashew from large nuts than small nuts. Bada [14] reported that seeds size can be used as a parameter for predicting germination and seedling growth rate both in the nursery and the brief period following establishment. One can therefore predict that large seeds will have faster growth and larger yield at maturity than small and medium sized seeds since they had the highest germination percentage and leaf area.

Table 6. Comparative effects of seed size on growth variables of *A. digitata* in the study area

Growth variable	Seed size			*p*-value
	Small	Medium	Large	
Height (cm)	10.73 ± 4.1^a	12.44 ± 3.1^a	13.53 ± 2.3^a	0.071
Collar diameter (cm)	2.64 ± 0.6^a	2.33 ± 0.7^a	2.34 ± 0.5^a	0.292
Leaf number	4.73 ± 1.3^a	5.40 ± 1.4^a	5.73 ± 1.3^a	0.121
Leaf area (cm)	10.58 ± 3.0^a	11.58 ± 2.9^a	16.50 ± 2.6^b	0.000

Means with the same alphabets as superscripts under the same row are not significantly different.

5. CONCLUSION

This finding showed that large seeds germinated best at a shorter period of time than the medium and small seed sizes; they also had the highest leaf area. The ability of large seeds in *A. digitata* to germinate and grow better indicates that germination and seedling vigour could be selected directly from the seed collection stage of this tree species. In order to obtain better stands of *A. digitata*, it is recommended that large seeds should be used to raise seedlings for plantation establishment and further regeneration of *A. digitata*. They will promote faster growth and greater yield at harvest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Gebauer J, El-Siddig K, Ebert G. Baobab (*Adansonia digitata* L.): A review on a multipurpose treewith promising future in the Sudan. Gartenbauwissenschaft. 2002; 67(4):155–160.
2. Sanchez AC. The status of baobab tree populations in Southern Malawi: Implications for furt her exploitation. Forests, Trees and Livelihoods. 2011;20: 17.
3. Schmidt L. Guide to handling of tropical and sub-tropical forest seeds. Danida Forest Seed Center, Humlebaek, Denmark. 2000;511.
4. Assogbadjo AE, Gle`le` R, Kakaı, Edon S, Kyndt T, Sinsin B. Natural variation in fruit characteristics, seed germination and seedling growth of *Adansonia digitata* L. in Benin; New Forests, Sprnge. 2010;13.
5. Jimoh HI. Erosion tolerance range of landuse surface: Implication on land resource use and management techniques in Ilorin, Nigeria, Intern. Journal on Environmental Studies. 2003;60(5):445-452.
6. Ajadi BS, Adeniyi Adedapo, Afolabi Monisola Tunde. Impact of climate on urban agriculture: Case Study of Ilorin City, Nigeria. Global Journal of Human Social Science. 2011;11(1):25-29.
7. Olaniran OJ. Rainfall anomalies in Nigeria: The contemporary understanding" 55th Inaugural Lecture, University Press, Ilorin. 2002;66.
8. Offiong MO. Variation in growth and physiological characteristic of *Xylopia aethopica* (DUNAL). A rich from Akwa-Ibom and Cross River States. Unpublished Ph.D Thesis. Department of Forest Resources Management. University of Ibadan, Ibadan. 2008;255.
9. Owoh PW, Offiong MO, Udofia SI, Ekanem VU. Effects of seed size on germination and early morphorlogical and physiological characteristics of *Gmelina Arborea*, Roxb. An International Multidisciplinary Journal. Ethiopia. 2011;5(6):422-433.
10. Padonou EA, Kassa B, Assogbadjo AE, Fandohan B Chakeredza S, Glèlè Kaka S, Sinsin B. Natural variation in fruit characteristics and seed germination of *Jatropha curcas* in Benin, West Africa. Journal of Horticultural Science & Biotechnology. 2014;89(1):69–73.
11. Ahlrichs JS, Baue ME. Relation of agronomic and multispectral reflectance characteristics of spring wheat canopies. Agronomy Journal. 1983;75:987-993.
12. Tsialtas JT, Maslaris N. Evaluation of a leaf area prediction model proposed for sunflower. Photosynthetica. 2008;46:294-297.
13. Faluyi MA. Investigations of seedlings vigour in cashew (*Anacardium occidentale*). Plant Breeding. 1986;97:237-245.
14. Bada SO. Effects of seed size on seedling vigour in Idigbo (*Terminalia ivorensis*). Journal of Tropical Forest Science. 1992; 4(3):215-224.

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