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Effects of Seed Weights and Sowing Media on Germination and Early Growth of *Afzelia africana* Smith ex Pers

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Authors' contributions

This work was carried out in collaboration among all authors. Author IOA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AFA and AOA managed the analyses of the study. Author AFA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Seed weight is essential in assessing seed quality traits, while sowing medium has significant role in seed germination. This study therefore assessed effect of seed weights and sowing media on germination of *Afzelia africana* seeds to enhancing sustainable production of the species.
Seeds of different sizes were collected, weighed and grouped into small (120), medium (120) and large (120) seeds. Each seed group was sown in three sowing media (washed river sand, decomposed sawdust, and forest top soil) replicated 4 times and arranged in Completely Randomized Design. The growth assessment comprised of 3 treatments which included seedlings from small, medium and large seeds and replicated 4 times. Plant height, leaf production and stem diameter were assessed fortnightly for twelve weeks. Biomass assessment was carried out twice (second week and twelfth week). Mean Daily Germination, Germination Percentage, Germination

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Energy, Peak Value, Germination value, Net Assimilation Rate and Relative Growth Rate were estimated. Data were subjected to analysis of variance (ANOVA).
Mean Daily Germination showed that large seeds sown in river sand large seed size sown in saw dust (T_4 and T_7) had highest value of 3.47 and 3.29 respectively with GV of 12.83.
There was significant difference ($p < 0.05$) in the effects of different sowing media and seed weights on the germination of *A. africana.* Saw dust gave the highest mean value with 52.777±0.28 while mean value of large sized seeds was highest (57.539±0.6). There was significant difference ($p<0.05$) in the effects of different seed weight on the height, collar diameter and leaf production.
Germination percentage of *A. africana* improved significantly with the sowing media and seed weight especially sawdust, river sand, and large seed size. It therefore suggested that *A. africana* seedling should be raised at nursery stage with river sand and Large seed size in order to increase the growth of plant and have more vigorous seedlings for plantation establishment.

Keywords: Sowing media; biomass; net assimilation rate; relative growth rate.

1. INTRODUCTION

Afzelia africana also known as African mahogany belongs to the family Ceasalpiniaceae. It is a multipurpose tropical African tree used as as agroforestry tree species. It is mostly recognized as vulnerable in some parts of Africa while it is categorized as endangered in Nigeria because of its high-grade timber for various wood constructions and furniture works [1,2]. It is a common commercial timber in Africa, and every part are good potential livestock fodders; flowers and oil from seeds are used for cooking [3]. *A. africana* can be recognized by its open crown, several branches and black fruits. It is a N-fixing tree, thus improves soil fertility through N and mineral –rich fallen leaves which mulch and provide nutrient and soil cover which protects the soil from erosion. In the eastern part of Nigeria, seeds of the species are processed for, while leaves serve as fodder for livestock. Roots of the species are used to treat several ailments such as billorzia, eye problems, gonorrhea, chest pains, kidney problems and snake bites [2].

The regeneration or mass production of many plants depends on seed and characteristic features. An immature diploid sporophyte that developed from zygote surrounding by nutritive tissue and covered by a seed coat is called a seed [4]. Viable seeds are living entities. They must contain living, healthy embryonic tissue in order to germinate. Developed seed consists of an embryo with food reserves, enclosed in a seed coat. Moisture and temperature are key environmental factors that enhance germination of seeds and contribute to the growth of the germinants [5].

The life cycle of plants is dependent on germination and population dynamics often depend on it [6]. In flowering plants, Environmental factors play crucial roles in both germination percentage and germination phenology in flowering plants [7,8,9,10,11].

Factors such as photoperiod and temperature have been found to affect seed maturation and seed germination of many plant species [6,10]. Sizes of the seeds, as well which have greater impact on the emergence, timing and success of sown seeds and within species, the mass of seeds is influenced by probability or time of germination [12,13]. This is very essential because of the fact that it has been shown that seeds with more weights have an advantage over smaller ones as a higher proportion of bigger seeds will germinate and give rise to more vigorous seedlings [14]. However, there is dearth of information on how environmental factor and seed weight affect the germination of seed.

Seed physiological properties affect germination, seedling growth and plant development [15]. Plant seeds are characterized with different weights and this is could be ascribed to the size of the endosperm within the seed and it has been found to influence germination and consequently productivity of species [15,16]. Seed size is a crucial seed quality trait, which influence growth and development of seedlings [17]. The nutrient content of seed is function of sizes of seeds and species [18].

A growing substrate is a solid medium that replaces the natural soil on which seedlings grow regularly by absorbing moisture and nutrients for growth and development [19]. Several materials can aspire to be used for growing media preparation; however, the final choice depends the ability of the media to sustain plant growth [20]. This study therefore assessed effect of seed weights and sowing media on germination of *A. africana* seeds with a few to enhancing sustainable production of the species.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was carried out at Silviculture Nursery of Forestry Research Institute of Nigeria (FRIN) situated at Jericho Hill in Ibadan Nigeria which lies between latitude 7°23'N and longitude 3°51' E. The climatic condition of the area is tropically dominated by rainfall pattern from 1400 mm-1500 mm with average temperature of about 31.2°C. The area experiences two distinct seasons dry and rainy seasons; the former starting from April to October and the latter commencing from November to March [21].

Seeds of *A. africana* were collected from scattered mother trees at Olokemeji Forest Reserve in Ogun State, Nigeria and were processed. Based on weights measured with sensitive weighing balance (Plate 1), seeds were grouped into small (120) medium (120) and large (120) classes. Ten (10) seeds per treatment and replicated four (4) times were sown into three different germination media namely: washed river sand, decomposed sawdust, and forest top soil. Altogether, 360 seeds were used. Thirty-six (36) germination trays were filled with three different media and arranged in Completely Randomized Design in the screen house. Watering was done once daily and germination counts were taken daily for 28 days.

For the assessment of early growth of the species, uniform germinant from the three seed weights (Plate 2) were pricked and transplanted into polythene pots filled with 1 kg top soil. The physiochemical properties of the experimental top soil was analysed at Soil Laboratory of Bioscience Department in Forestry Research institute of Nigeria (FRIN). The growth assessment comprised of three treatments which included seedlings from small medium and large seeds. Four (4) seedlings were made up of a treatment and replicated 4 times making a total of forty-eight seedlings. Watering of the seedlings was done daily and plant height, leaf production and collar diameter were assessed fortnightly for twelve weeks. Heights were measured from the root collar to apical bud using a graduated ruler while the numbers of leaves were counted and stem diameter was measured at about 2cm above the root collar with the use of digital caliper.

Biomass assessment was done twice; the first assessment was carried out at the end of the first two weeks after transplanting and the second biomass determination was at the end of the experiment (twelfth week). The same selected seedlings whose growths were assessed were subjected to destructive experiment (Plate 3).

The combined weight of the leaves, stems and roots of each specie accounted for the total weight. Leaves, stem and root of the experimental samples were excised with a sharp razor blade to separate the leaves, stems and roots. Fresh weights were determined using a Sensitive Weighing Balance and then oven dried to constant weight for twenty-four hours at 70°C. The net assimilation rate (NAR) and relative growth rate (RGR) were calculated.

Plate 1. Measuring of seed weight with sensitive weighing balance

Plate 2. Seedlings from the three seed weights *A. africana*

Plate 3. Selected seedlings for biomass assessment

2.2 Data Analysis

Germination Percentage (GP), Germination Energy (GE), Mean Daily Germination (MDG), Peak Value (PV) and Germination value (GV) were determined with the use of the following equations according to [22].

1. Germination Percentage (%) = $\frac{total\ seeds\ germinated}{Total\ sseds\ sown}$ (1)

2. Germination Energy (GE) is the percentage total of highest germination counts from the day it begins till when it starts diminishing divided by total seed sown.

$$GE = \frac{......x+y+z}{Total\ sseds\ sown} \times 100 \quad (2)$$

Where: x = the first highest germination count, y = higher germination count, z = high germination count

3. Mean Daily Germination percentage (MDG): This is cumulative total percentage of germinated seeds divided by exact germination day.

$$MDG(\%) = \frac{Cumulative\ Total\ Percentage\ of\ seed\ sown}{X} \quad (3)$$

Where: x = Exact germination day

4. Peak Value (PV) is the highest value calculated as MDG
5. Germination Value (GV) is the product of the last day MDG and PV

GV = Last *day MDG X PV* (4)

Data were subjected to analysis of variance (ANOVA) and where there were significant differences; post-hoc analysis was carried out with Duncan Multiple Range Test (DMRT) in order to separate the means. The experimental design was a 3 x 3 factorial with three (3) sowing media and three (3) seed weights. There were 9 treatment combinations replicated 4 times.

A1B1 = T_1, A1B2 = T_2, A1B3 = T_3, A2B1 = T_4, A2B2 = T_5, A2B3 = T_6, A3B1 = T_7, A3B2 = T_8, A3B3 = T_9

Where,

A– Sowing media: A1 –Top soil, A2 – River sand, A3 – Saw dust
B – Seed weights: B1 – Large, B2 – Medium, B3 – Small

3. RESULTS

3.1 Germination Percentage (%), Germination Energy, Peak Values, Mean Daily Germination and Germination Values of *A. africana* Seeds

Table 1 shows the result of the effects of seed weights on germination of *A. africana* seeds. The Mean daily germination (MDG) shows that the treatment with saw dust and large seed weight and river sand and large seed weight (T_7 and T_4) had highest value of 3.29 and 3.47 with the same Germination Value (GV) of 12.83 and 12.28. This was closely followed by Medium seed weight and Saw dust (T_8) with the MDG of 2.95 and GV of 12.27 respectively. The treatment with top soil and small weight (T_3) had the least value with MDG of 2.61 and GV of 7.07 (Table 1).

3.2 Effects of Sowing Media and Seed Weights on the Germination of *A. africana* Seeds

There was significant difference ($p < 0.05$) in the effects of different sowing media, seed weights and interaction between sowing media and seed weights on the germination of *A. africana* (Table 2). However, mean value showed that seeds sown in saw dust gave the highest mean value with 52.777±0.28 while the seeds sown in top soil gave the lowest mean value with 42.399±0.24 (Table 2). Mean value of different sown seed weights were highest in large weight (57.539±0.6) while small seeds gave the lowest value 39.521±0.09 (Table 2).

3.3 Effects of Different Seed Weights on the Mean Height Growth of *A. africana* Seedlings

The result of Analysis of Variance (ANOVA) revealed that there was significant difference ($p<0.05$) in the effects of different seed weight on the height of *A. africana* seedlings (Table 3). Mean value shows that T_3 had the highest growth height of 71.438±0.61 cm while T_1 gave the least growth height of 35.218±0.45 cm (Table 3 and Fig.1).

3.4 Effects of Different Seed Weights on the Mean Collar Diameter of *A. africana* Seedlings

There was significant difference ($p< 0.05$) in the effects of different seed weights on the collar diameter of *A. africana* seedlings within the period of study. (Table 3). The mean separation test shows that T_3 had the highest collar diameter of the seedlings 5.963±0.22 mm while T_1 had the least collar diameter of 5.363±0.13mm (Table 3 and Fig. 2).

3.5 Effects of Different Seed Weights on Leaf Production of *A. africana* Seedlings

The result of ANOVA indicated that there was significant difference ($p< 0.05$) in the effect of different seed weights on the mean leaf production of *A. africana* seedlings (Table 3). Post-hoc test shows that T_3 had the highest mean leaf production of 8 leaves while T_1 gave the least mean leaf production Table 3 and Fig. 3.

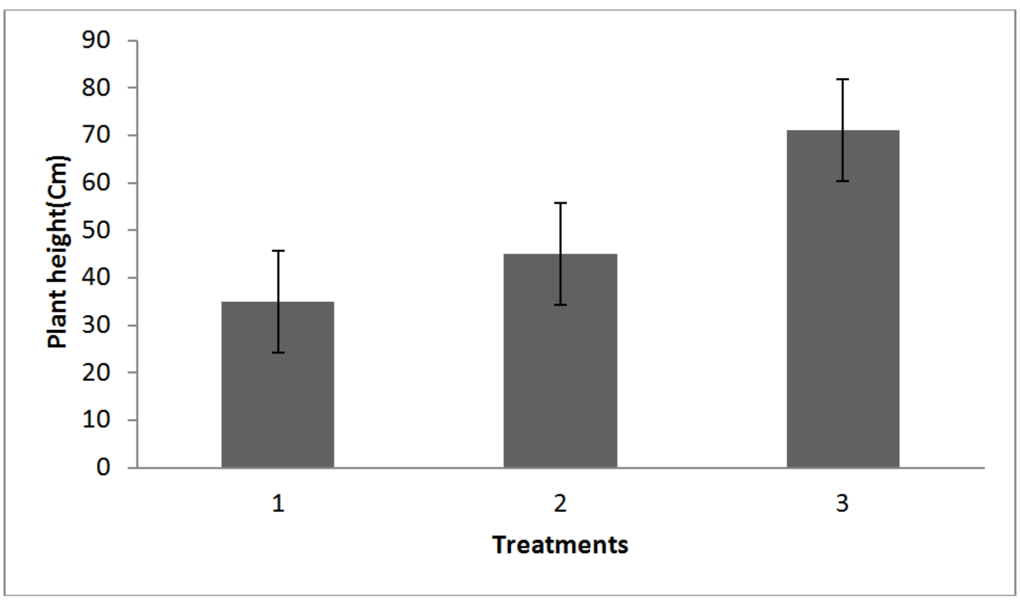

Fig. 1. Growth pattern showing the mean height (cm) of *A. Africana* within 12 weeks

Table 1. Germination values of *A. africana* seeds under different sowing media treatments

Treatment	Germination %	Germination energy	Peak value	Mdg final	Germination value
T_1	46.88	28	2.88	2.6	7.49
T_2	40.6	25	2.9	2.9	8.41
T_3	46.9	25	2.71	2.61	7.07
T_4	62.5	31.25	3.54	3.47	12.28
T_5	50	41	3.65	2.79	10.15
T_6	37.5	37.5	3.13	3.13	9.8
T_7	62.5	37.5	3.9	3.29	12.83
T_8	53.13	34	4.16	2.95	12.27
T_9	43.75	28	2.87	2.43	6.97

Table 2. Analysis of variance for the influence of sowing media and seed weights on the germination of *A. africana* seeds

SV	Df	SS	MS	F-cal	P-value
Sowing Media	2	511.693	255.847	234.684	.000*
Seed Sizes	2	1463.849	731.925	671.381	.000*
Sowing Media* Seed Size	4	131.094	32.773	30.063	.000*
Error	18	19.623	1.090		
Total	26	2126.260			
Treatments		Post-hoc (means)			
Top Soil		42.399±0.24a			
River Sand		49.711±0.30b			
Saw dust		52.777±0.28c			
Treatments		Post-hoc (means)			
Small Size		39.521±0.09a			
Medium Size		47.827±0.29b			
Big Size		57.539±0.16c			

***=*significant at P<0.05; Means with the same letters are not significantly different (p> 0.05)*

Table 3. Analysis of variance (ANOVA) for shoot height (cm), collar diameter (mm) and leaf production of different seed weights of *A. africana* within 12 weeks

Parameters	SV	Df	SS	MS	F-cal	P-value
Shoot Height	Treatments	2	11108.97	5554.49	46.600	.000*
	Errors	45	5363.78	119.20		
	Total	47	16472.75			
Collar Diameter	Treatments	2	3.746	1.873	3.351	.044*
	Errors	45	25.149	.559		
	Total	47	28.896			
Leaf Production	Treatments	2	66.292	33.146	12.011	.000*
	Errors	45	124.188	2.760		
	Total	47	190.479			
Shoot Height		Post-hoc (means)				
T_1		35.218±0.45a				
T_2		45.738±0.52b				
T_3		71.438±0.61c				
Collar Diameter		Post-hoc (means)				
T_1		5.363±0.13a				
T_2		5.377±0.11a				
T_3		5.963±0.22b				
Leaf Production		Post-hoc (means)				
T_1		5.375±0.14a				
T_2		6.688±0.17b				
T_3		8.025±0.11c				

***=*significant at P<0.05; Means with the same letters are not significantly different (p> 0.05)*

3.6 Biomass Accumulation of *A. africana* at 2nd and 12th Week of Study

The result of biomass accumulation at 2nd and 12th week of study as influenced by seed weights is shown in Tables 4 and 5. At both 2nd and 12th week, the large seed weight (T_3) had the highest biomass accumulation of 5.83 g and 18.59 g respectively while the least biomass accumulation were recorded for small seed weight (T_1) at 2nd week (1.94 g) and 12th week (6.13 g) . Considering root, leaves and stem ratio, biomass accumulation of leaves were highest at 2nd week (3.25 g) and at 12th week (8.45 g). The biomass accumulation of stem at both 2nd and 12th week were the least (0.4 g) and (1.47 g) respectively.

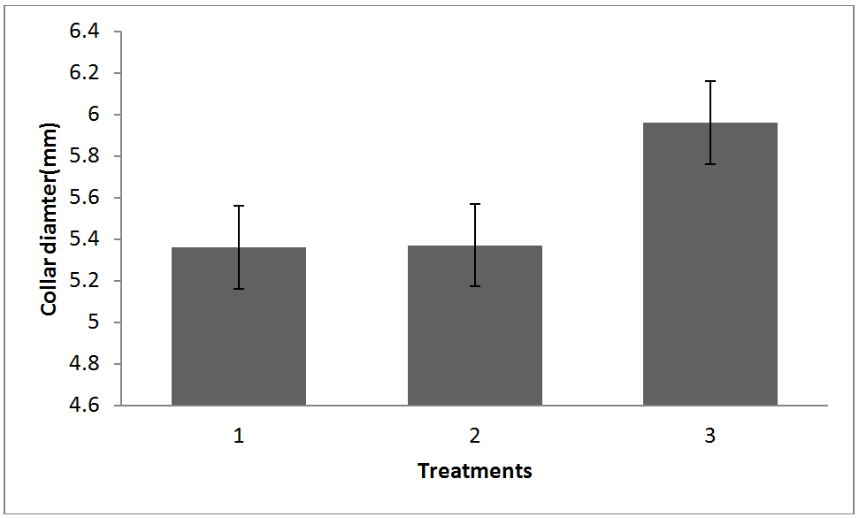

Fig. 2. Growth pattern showing the mean stem diameter (mm) of *A. africana* within 12 week of study

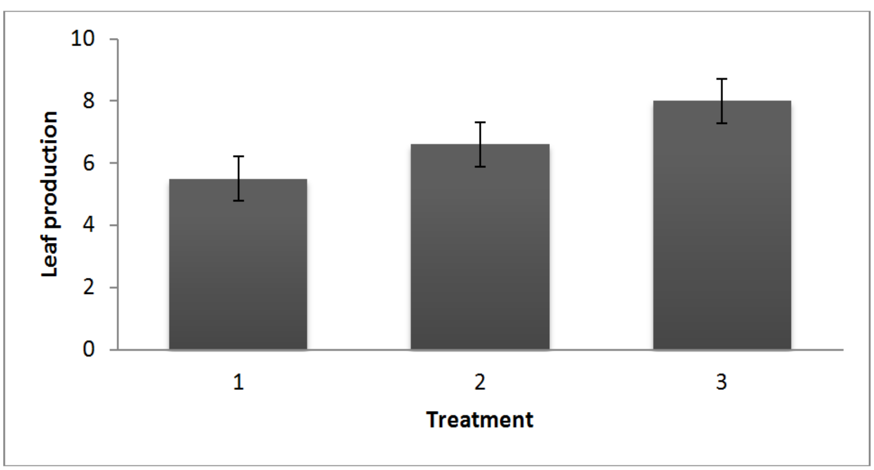

Fig. 3. Growth pattern showing the mean leaf production of *A. africana* within 12 week of study

Table 4. Biomass accumulation of *A. africana* at 2nd week

Treatments	Root (g)	Leaves (g)	Stem (g)	Total (g)
T_1	0.55	0.99	0.4	1.94
T_2	0.79	1.99	0.44	3.22
T_3	1.06	3.25	1.52	5.83

Table 5. Biomass accumulation of *A. africana* at 12th week

Treatments	Root (g)	Leaves (g)	Stem (g)	Total (g)
T_1	1.92	3.72	1.47	6.13
T_2	2.49	6.15	2.73	11.37
T_3	3.54	8.45	6.6	18.59

Table 6. Net assimilation rate (NAR) and relative growth rate (RGR) for *A. africana*

	Treatments	Root (g/wk)	Leaves (g/wk)	Stem (g/wk)	Total (g/wk)
NAR	T_1	0.036	0.008	0.036	0.08
	T_2	0.036	0.01	0.058	0.10
	T_3	0.039	0.014	0.066	0.12
RGR	T_1	0.077	0.028	0.071	0.18
	T_2	0.078	0.41	0.12	0.61
	T_3	0.082	0.78	0.13	0.99

3.7 Net Assimilation Rate (NAR) and Relative Growth Rate (RGR) for *A. africana*

Table 6 shows effects of seed weights on NAR and RGR of *A. africana* seedlings within 12 weeks of study. Large seed weight (T_3) had highest NAR (0.12 g/wk) and RGR (0.99 g/wk) while T_1 had the least of NAR (0.08 g/wk) and RGR (0.18 g/wk).

4. DISCUSSION

Seed weights and sowing media significantly affected the germination potentials of the seed of *A. africana* within the period of study. The highest values for large seeds on MDG, GP, GV and GE over medium and small seed weights depicts the importance of seed size on germination of the seeds. According to [23], seed size is one of the components of seed quality which affects the germination ability of plant seeds. [24] expressed that seed weight and/or seed size is a widely accepted measure of seed quality and large seeds have high germinability, survival, seedling growth and establishment. The highest germination values of large seed size which could be ascribed to stored energy in the cotyledons of the seeds agreed with the finding of [25] who reported that the germination parameters were significantly related by seed weight. [26] reported that large seed size of *Caesalpinia bonduc* as influenced by sowing media performed significantly better than the medium and small seed size in terms of seedling emergence, mean daily germination, germination percentage and germination value. Higher and quicker germination in larger sized seeds could also be attributed to the presence of higher amount of carbohydrates and other nutrients than in medium and small sized seeds [24].

Different seeds of indigenous tree species require various techniques and several factors for successful germination. One of important prerequisites is sowing media. After appropriate seed procurement, handling and processing for sowing, optimum germination of such seeds will be the function of suitable sowing media [27].

The influence of sowing media was significant in the germination of *A. africana* with more germination potentials obtained from large seed size sown in sawdust when compared to other sowing media. The highest PV which is the function of MDG recorded for large seed size in river sand and saw dust could be attributed to aeration and absorption capability of the two media. The significance of interaction between sowing media and seed weight implies that appropriate sowing media couple with seed sizes is very essential to be considered when tropical seeds are being raised in the nursery. According to [18] moisture and aeration play key roles in germination of seed as they enhance metabolic activities in the seed. The high germination percentage in river sand also agrees with the finding of [28], who reported high germination percentage from seeds of *Irvingia wombolu* sown in river sand. The least germination potentials obtained from top soil in this study contrasted sharply with the findings of [29, 30] who obtained a higher germination percentage in topsoil with *Dacryodes edulis and Persia americana* respectively. The least impact of top soil on the germination of different seed size disagrees with the findings of [31] who observed higher germination percentage in topsoil with *Parkia bicolor*. It also contradicts [32] who reported highest germination percentage of *Terminalia ivorensis*; a tropical tree species in topsoil. This thereby implies that *A. africana* requires relatively more aeration and water percolation as evident in saw dust and river sand in comparison to top soil.

Plant growth and development are characterized by high degree of co-ordination and phasing. The growth of one part is closely related with the activities in other part of the plant which is enhanced and maintained by amount of reserved food [33].

The result obtained on height, diameter and leaf production of *A. africana* from different seed weight agreed with work of [34] that observed highest shoot height, leaf production and collar diameter from large sized seeds followed by medium compared to small seeds in sun flower seedlings. The differences in growth parameters of seedlings raised from various sizes therefore implies that initial stored food in the seeds play crucial roles in growth and development of the plant [32,35].

The increase in plant dry mass per unit leaf area within period of study depicts biomass accumulation, NAR and RGR is influenced by efficiency of food production between plants of different sizes. It could be inferred that seed size significantly constitute to the germination and growth of seedlings in *A. africana*. Moreover, Seedlings from large sized seeds with highest growth parameters and highest biomass in term of root, stem and leaves conforms to the general assertion that the amount of reserves contained in the cotyledon (a correlate of seed size) is positively related with plant's growth potentials [36].

5. CONCLUSION

The study has shown that the germination percentage of *A. africana* improved significantly with the sowing media and seed weight especially river sand, sawdust, and large seed weight. The increase in all parameters assessed within twelve weeks of study indicated that quantitative changes had occurred. This was also confirmed by the biomass yield assessment. It is therefore recommended that *A. africana* seedling should be raised at nursery stage on river sand medium using large weighted seed for vigorous seedlings with rapid growth for plantation establishment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bonou W, Glèlè Kakai R, Assogbadjo AE, Fonton H, Sinsin NB. Characterisation of *Afzelia africana* Sm. habitat in the Lama Forest reserve of Benin; 2009.
2. Hutchings A, Scott AH, Lewis G, Cunningham A. Zulu medicinal: An inventory. University of Natal press, Pietermaritzburg; 1996.
3. Ejikeme CM, Chukwuma SE Qualitative and quantitative determination of photochemical contents of indigenous Nigerian softwoods Hindawi. Publishing Corporation New Journal of Science. 2001;20:9.
   [Article ID 5601327]
   Available:http://dx.doi.org/10.1155/2016/5601327
4. Cendán C, Sampedro L, Zas R. The maternal environment determines the timing of germination in *Pinus pinaster*. Environ. Exp. Bot. 2013;94:66-72.
5. Miles A, Brown M. Teaching organic farming and gardening: Resources for instructors. Santa Cruz: University of California Farm and Garden; 2007.
6. Boyko A, Blevins T, Yao Y, Golubov A, Bilichak A, Ilnytskyy Y. Trans generational adaptation of Arabidopsis to stress requires DNA Methylation and the function of Dicer-like: Proteins. 2010;34.
7. Li ZQ, Yu DT UMA, SH. Seed germination of three species of *Vallisneria* (Hydro charitaceae), and the effects of freshwater microalgae. Hydro Biological. 2005;544:11–18.
8. Lacey EP. A growth chamber experiment to examine pre- and postzygotic temperature effects. Evolution. Plantago Lanceolata. 1996;50:865–878. [PubMed]
9. Donohue K. Completing the cycle: Maternal effects as the missing link in plant life histories. Phil. Trans. R. Soc. B. 2009;364:1059–1074.
10. Figueroa R, Herms DA, Cardina J, Doohan D. Maternal environment effects on common groundsel (*Senecio vulgaris*) seed dormancy. Weed Sci. 2010;58:160–166.
11. Tielbörger K, Petrü M. An experimental test for effects of the maternal environment on delayed germination. Journal of Ecology. 2010;98:1216–1223.
12. Castro J. Short delay in timing of emergence determines establishment success in *Pinus sylvestris* across

microhabitats. Ann. Bot; 2006;98:1233–1240.

13. Hendrix SD. Variation in seed weight and its effects on germination in *Pastinaca sativa* L. (*Umbelli ferae*) American. Journal of Botany. 1984;71:795–802.
14. Baskin CC, Baskin JM. Seeds: Ecology, biogeography and evolution of dormancy and germination. San Diego: Academic Press; 1998.
15. Dutta AC. Botany for degree students Revised. Edition 6th edition Oxford University Press. Delhi. Bombay, Madras. 1995;90-103.
16. Houssard C, Escarre J. The effect of seed weight on growth and competitive ability *Rumex acetosella* from two successional old fields. Oecologia. 1991;86:236-242.
17. Adebisi MA, Kehinde TO, Salau AW, Okesola LA, Porbeni JBO, Esuruoso AO, Oyekale KO. Influence of different seed size fractions on seed germination, seedling emergence and seed yield characters in tropical soybean (*Glycine max* L.Merrill). International Journal of Agricultural Research. 2013;8:26-33.
18. Arunachalam A, Khan MI, Singh ND. Germination growth and biomass accumulation as influenced by seed size in *Mesua ferra* L. Turkish Journal of Botany. 2003;27:343-348.
19. Douglass JF, Thomas LD. Tara Growing media. In: Dumroese R, Kasten, Luna, Tara; Landis, Thomas D., editors. Nursery manual for native plants: A guide for tribal nurseries - Nursery management. Agriculture Handbook 730. Washington, D.C.: U.S. Department of Agriculture. Forest Service. 2009;1:77-93.
20. Parente A, Serio F, Montesano, FF, Mininni C, Santamaria P. The compost of *Posidonia residues*: A short review on a new component for soilless growing media. Acta Hortic. 2000;1034:291–298.
21. FRIN. Annual Metrological Report of Forestry Research Institute of Nigeria. 2017;9.
22. Schelin M, Tigabu M, Eriksson I, Sawadogo L. Effect of scarification, gibberellic acid and dry heat treatments on the germination of *Balantiesa egyptica* seeds from the Sudanian savanna in Burkina Faso. Seed Science and Technology. 2003;31:605-617.
23. Adebisi MA, Kehinde TO, Ajala MO, Olowu EF, Rasaki S. Assessment of seed quality and potential on gevityinelite tropical soybean (*Glycine max* L.) Merrill grown in South western Nigeria. Nigeria. Agric .Journal. 2011;42:94-103.
24. Forest Ecology and Management. 2009;258:1084-1092.
25. Gunaga R, Doddabasava P, Vasudeva R. Influence of seed size on germination and seedling growth in *Mammea suriga*. Karnataka Journal of Agricultural Science. 2011;24:415-416.
26. Hojjat SS. Effect of seed size on the germination and seedling growth of some lentil genotypes. International Journal of Agricultural Crop Science. 2011;3.
27. Kazeem-Ibrahim F. Effects of plant growth regulators on rooting potentials of *Caesalpinia bonduc* (L) Roxb. Cuttings. JWHSD. 2019;5:3-11.
Available:http://www.hsdni.org/jwhsd/articles/
28. Asinwa IO, Kazeem-Ibrahim F, Olaifa KA, Asabia LO. Storage potentials and influence of moisture contents on the germination of *Vitellaria paradoxa* C.F. Gaertn. Journal of Research in Forestry, Wildlife & Environment. 2019;11(2).
29. Dickens D. Effect of propagation media on the germination and seed performance of *Irvingia wombolu* (Vermoesen). American Journal Biotechnology and Molecular Sciences. 2011;21593701.
[ISSN print: 21503698]
DOI:10525/ajbms.2011.1.2.51.56 ©science Hu,
Available:http://www.scihub.org/AJBMS2011
30. Okunomo KU, Ureigho N, Opute HO. The effect of soil amendment on the performance of *Gambaya albida* seedlings. European Jounal of Science Research. 2000;13:24415.
31. Okunomo K, Orji EC. Agroforestry technology: An environmental-friendly initiative. Nigerian Journal of Research Production. 2004;4:38-47.
32. Okunomo K. Germination and seedling growth of *Parkia bicolor* (A. Cheu) as influenced by nursery techniques. African Journal of General Agriculture. 2010;6(4).
33. Agboola PA, Adedire MO. Response of treated dormant seeds of tropical tree species of germination promoters. Nigerian Journal of Botany. 2001;11:103110.
34. Bawa KS, Krugman SL. Reproductive biology and genetics of tropical trees in relation to conservation and management. In Rainforest Regeneration and

Management. Man and the Biosphere Series (eds) Gompez-pompa, A; Whitmore, T.C and Hadley. 1991;119-136.

35. Nagaraju S. Influence of seed size and treatments on seed yield and seed quality of sun flower morden. M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka, India. 2001;87.

36. Hall JS, Mark P, Astone S. Graeme P. Seedling performance of four sympatric *Entandrophragma* species (Meliaceae) under simulated fertility and moisture regimes of a Central African Rainforest. Journal Tropical Ecology. 2003;19:55-66.

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