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SILVICULTURAL IMPLICATIONS OF SEED SIZE ON GERMINATION AND EARLY GROWTH OF CASHEW (*Anacardium occidentale* L.)

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Abstract
The study investigated the effects of seed size on germination and early growth of Anacardium occidentale. The study was carried out at the screen house of the Federal College of Forestry, Ibadan. Seeds of A. occidentale were categorized into three size classes length, breadth and weight as small (2.0 - 2.5 cm, 1.0 - 1.5 cm and 2.5 - 5.0 g), medium (2.6 - 3.0 cm, 1.6 - 2.0 cm and 5.1 - 7.5 g) and large (3.1 - 3.5 cm, 2.1 - 2.5 cm and 7.6 – 10.0 g). Seeds were sown for each class into the germination baskets filled with sterilized river sand. The seeds were watered daily and monitored for germination with daily record of new sprouts. The seedlings were transplanted into polythene pots filled with topsoil. The experiment was laid in Completely Randomized Design (CRD) with three treatments and ten replicates. The parameters assessed include seedling height (cm), collar diameter (mm), leaf production and leaf area (cm^2). The data collected were subjected to Analysis of Variance and means were separated by Least Significant Difference at 5% level of probability. Germination results showed cumulative percentages of 60.43%, 73.78% and 77.33%. The result from growth parameters showed a direct association with the sizes of the seeds. The large, medium and small-sized seeds had 26.17 cm, 22.55 cm and 17.93 cm in seedling height with 7.14 mm, 6.59 mm and 6.26 mm in collar diameter respectively. Large seeds of A. occidentale should be adopted for quick germination and fast growth to establish its orchard.

Key Words: *Anacardium occidentale, seed size, growth, germination*

Introduction

Cashew (*Anacardium occidentale* L.) is indigenous to Brazil and an evergreen nut-bearing tropical plant (Adeigbe *et al*., 2015). It has a height of 5-10 m, but in clay, land can reach up to 20 m. It has a crooked trunk of 25-40 cm in diameter. The leaves are oval, obovate, leathery, glabrous; rosy when young; it has vináceas flowers, arranged in terminal panicles (Lorenzi, 2008). *A. occidentale* belongs to the family Anacardiaceae which covers over 70 genera in which more than 600 species are distributed in tropical, sub-tropical and temperate regions in the world (Engels *et al.,* 2012). The family is rich in important secondary metabolites with varieties of interesting biological activities (Abu-Reidah *et al.*, 2015). The cashew tree is found between latitudes 27º N in Southern Florida and 28º S of South Africa; also prevalent in low

latitude regions, between 15º N and 15º S, in coastal areas, typically tropical South America, Africa and Asia (Gomes, 2010). The cashew tree is common among the Northeastern states such as Ceará, Piauí and Rio Grande do Norte (Lubi and Thachil, 2000). World's total area under the cultivation of cashew is around 35,100 km^2 with India sharing 20 and 16 per cent respectively of cashew area and production globally (Mog *et al*., 2017).

In Nigeria, commercial cultivation of cashew dates back to more than 60 years while research and development into its production, processing and marketing started in 1972. Cashew trading and exports are worth 24 billion naira ($160 million) and over one million people depend on the industry (Adeigbe *et al*., 2015). About 5000-7000 tonnes are produced annually and mainly as an export crop (Aremu *et al.,* 2006; Akos *et al*., 2017). It was introduced into Nigeria between 15^{th} and 16^{th} centuries by the Portuguese explorers purposefully for erosion control and afforestation schemes of defunct Eastern Nigeria (Ventakaramah, 1976; Togun, 1977; Hammed *et al*., 2008).

The cashew apple is a valuable source of raw materials for the manufacture of both soft and alcoholic drinks and as livestock feed ingredient after the extraction of the juice. The roots and young leaves are used as herbal remedies in the treatment of malaria, while the sap from the bark provides indelible ink and the exudates are useful as an adhesive (Udoh *et al.,* 2005; Oyewole, 2010).

Consideration for superior seed morphological traits is of paramount importance in domestication programme (Aderounmu, 2019a). High germination and vigorous seedlings are major important factors in the establishment of good cashew orchard (Anjusha *et al*., 2015). Therefore, variation in seed morphological traits underscores the significance of picking suitable seed quality before initiating conservation programme (Aderounmu, 2019a). This study, therefore, investigated the effect of seed size on the germination and growth of *Anacardium occidentale*

Methods

The experiment was carried out at the screen house of Federal College of Forestry Ibadan (latitude 7° 90′N and longitude 3° 58′ E). The climate of the area is tropically dominated with an annual rainfall of 1250 mm and an average temperature of 37.2ºC (FRIN, 2016). Mature seeds of *A. occidentale* were collected from its orchard at Haston Farms in Ogbomoso, Oyo State, Nigeria with the selection of five (5) mother trees. The seed lots were thoroughly hand-mixed for even distribution of the sizes before the seed lots were categorized into three size classes (2.0-2.5 cm, 1.0-1.5 cm and 2.5-5.0 g), medium (2.6-3.0 cm, 1.6-2.0 cm and 5.1-7.5 g) and large (3.1- 3.5 cm, 2.1-2.5 cm and 7.6-10 g) (Table 1). Seventy-five (75) seeds per size class were sown into germination trays (30cm x 30cm) filled with sterilized river sand and replicated three (3) times. These were watered daily and monitored for three weeks with a daily record of new sprouts taken and from which mean daily germination (MDG), germination percentage (GP), mean germination time (MGT), rate of germination (RT), germination index (GI) and seed vigour index (SVI) were calculated.

After three (3) weeks of sowing, the seedlings were transplanted into polythene pots filled with topsoil and watered once daily. One week after

transplanting, 30 uniformly growing seedlings from each size class were randomly selected for the growth study. The experiments were arranged in a Completely Randomized Design. The growth data collected include plant height (cm), stem diameter (mm), leaf production and leaf area (cm^2) were subjected to Analysis of Variance (ANOVA) while the significant means separated using the Least Significant Difference (LSD) at 5% level of probability.

Table 1: Categorization of *Anacardium occidentale* Seed

Seed Size	Length (cm)	Breadth (cm)	Weight (g)
Small	2.0 – 2.5	1.0 – 1.5	2.5 - 5.0
Medium	2.6 -3.0	1.6 – 2.0	5.1 – 7.5
Large	3.1 -3.5	2.1 – 2.5	7.6 – 10

Results and Discussion

Table 1 showed the parameters (length (cm), breadth (cm) and weight (g)) used in categorizing seeds of *Anacardium occidentale* into three classes. Ajeesh *et al*. (2014) confirm the benefits of grading of seeds based on size and weight which in turn has a regulative influence on seed germination and growth of the seedling in many plant species.

The results from germination study showed that the highest cumulative germination percentage was recorded for large seed sizes with 77.33%, followed by the medium seed size with 73.78% while small seed size had the least with 60.43% (Table 2). The trend of germination on the first day (12^{th} day after sowing (DAS)) when germination was observed showed that large seeds had highest with 12.89% and also had overall highest daily germination percentage on the 13^{th} and 14^{th} consecutive (DAS) (27.56%). This was followed by small (16.44%) and medium (16.00%). By the 19^{th} DAS, the medium had 1.78%, while small and large had 0.44 each. However, from the 16^{th} to the 19^{th} DAS, medium-sized seeds germinated more than the others (Table 2).

For mean daily germination (MDG)) of cashew, large and medium seeds had 20.67 and 13.67 on the 13^{th} DAS while MDG for small seeds (12.33) was recorded on the 15^{th} DAS. Small and large seed classes had MDG of 0.33 each while 1.33 for medium on the 19^{th} DAS (Table 3). The seeds had mean germination time (MGT) of 9.00, 8.93 and 8.26; and rates of germination of 0.11, 0.12 and 0.11 for large small and medium-sized seeds (Table 4). The germination index for large medium and small were 8.59, 8.20 and 6.71 respectively (Table 5). The result revealed that large seeds size had the best germination index with a value of 8.59 meaning that large seed size gave the highest germination percentage as well as the speed of germination. Table 6 shows the seed vigour index (SVI) of different seed sizes of *A. occidentale*. It was evident from the table that large seed size had the highest germination percentage (77.33%), seedling shoot length (26.17 cm) and seed vigour index of 2,023.73. Small seed size gave the least performance in terms of germination percentage (60.43%), seedling shoot length (17.93cm) and seed vigour index of 1,091.76.

These are indications that cashew seeds had the peak germination percentage between the 13^{th} and 15^{th} DAS and large seeds possess the ability to sprout earlier than smaller seeds. The result revealed that large seed size germinated was more and

faster when compared with small and medium seeds sizes. On the other hand, the highest rate of germination was experienced from the medium seed size as compared to small and large seeds sizes. Variations in seed size also have a strong influence on germination time as experienced by Murali (1997); Mog *et al*. (2017) in their studies confirming that large seeds had higher germination rate than the smaller sized seeds. In terms of the viability of the seeds, large seeds were found to be more viable (77.33%) than the smaller sized seeds. This observation has been attributed to the presence of large food reserve and advanced embryological development in large seeds. This corroborates the study of Aderounmu (2019b) who reported that large seeds of *Tetracarpidium conophorum* had better germination percentage compared to medium and small-sized seeds. Kadu *et al*. (2006); Mkwezalamba *et al.* (2015) and Aderounmu (2019a) confirmed collection preference of larger seeds for early seedling growth and development. Colombo *et al.* (2015) also stated that seeds with bigger mass present better germination capacity, standardization and seedling emergence. Adio *et al*. (2008) reported higher germination value from large seeds of *Gmelina arborea* than smaller seeds. Large-sized seeds could specify better genetic potential for quality germination of seeds (Abideen *et al*., 1993; Alptekin *et al*., 2002; Aderounmu, 2019b).

The results for early growth revealed that there were significant differences in the height of *A. occidentale* seedlings concerning the seed sizes. The large seeds significantly produced seedlings with the highest height at the end of the study with a mean value of 26.17 cm while the small seeds produced the lowest mean value of 17.93 cm (Table 7). This is an indication that larger seeds produced more vigorous seedlings compared with smaller seeds (Yanlong *et al.*, 2007). There were no significant differences in the collar diameter of *A. occidentale* as influenced by the seed sizes. The collar diameter of *A. occidentale* range between 6.26 and 7.14 mm at the end of the growth study revealed that the sizes of the seeds were directly proportional to mean collar diameter (Table 8). The mean number of leaves at the end of the growth study ranged between 9.5 and 11.9 with the mean values being directly proportional to the mean number of leaves recorded (Table 9). There were no significant differences in the seed sizes on leaf production of *A. occidentale* at the end of growth study. In terms of leaf area of *A. occidentale* seedlings, the results revealed that there were significant differences concerning the seed sizes with the larger seed sizes recording the highest mean value (379.21 cm^2), followed by the medium (343.89 cm^2) and the smallest seed sizes had the lowest mean values (136.51 cm^2) (Table 10).

The result of this study agrees with Cicek and Tilki (2007) who reported that large-sized seeds of *Castanea sativa* had the highest seedling height which was not significantly different from the medium and small-sized seeds. Aderounmu (2019a) also reported similar result with *Vitellaria paradoxa* seedlings that there were no significant differences in the seed sizes except on the height. In the growth study of *Afzelia africana,* Aderounmu *et al*. (2019) reported a direct association between seed sizes and growth rate. In another study by Aderounmu and Adegeye (2018), small-sized seeds of *Vitellaria paradoxa* exhibited higher performance in stem diameter, leaf production and leaf area than other sizes.

Table 2: Germination Percentage of *A. occidentale* Seeds

Days after sowing	Small %	Medium %	Large %
12	7.56	6.22	12.89
13	11.11	18.22	27.56
14	13.78	16.00	18.22
15	16.44	13.78	10.22
16	7.55	8.00	4.00
17	2.22	5.78	2.67
18	1.33	4.00	1.33
19	0.44	1.78	0.44
20	0	0	0
Total/Cumulative	60.43	73.78	77.33

Table 3: Mean Daily Germination of *A. occidentale* Seeds

	Days After Sowing (DAS)								
Treatments	12	13	14	15	16	17	18	19	20
Small	5.67	8.33	10.33	12.33	5.67	1.67	1.00	0.33	0
Medium	4.67	13.67	12.00	10.33	6.00	4.33	3.00	1.33	0
Large	9.67	20.67	13.67	7.67	3.00	2.00	1.00	0.33	0

Table 4: Mean Germination Time (MGT) and Rate of Germination (RG) of *A. occidentale* Seeds

Treatments	MGT	RG
Small	8.93	0.11
Medium	8.26	0.12
Large	9.00	0.11

Table 5: Germination Index (GI) of *A. occidentale* Seeds

Treatments	GI
Small	6.71
Medium	8.20
Large	8.59

Table 6: Seed Vigour Index (SVI) of *A. occidentale* Seeds

Treatments	% Germination	Seedling Shoot Length (cm)	Vigour Index
Small	60.43	17.93	1,091.76
Medium	73.78	22.55	1,668.74
Large	77.33	26.17	2,023.73

Table 7: Seedling Height (cm) of *A. occidentale* Seedlings from Seed Classes

	Weeks after Transplanting											
	1	2	3	4	5	6	7	8	9	10	11	12
Small	14.68	14.90	16.32	16.36	16.70	17.35	17.43	17.50	17.60	17.66	17.80	17.93
Medium	18.98	19.45	19.75	20.34	20.74	21.34	21.54	21.64	21.80	22.04	22.28	22.55
Large	21.25	21.95	22.47	23.31	23.69	24.25	24.47	24.65	25.31	25.45	25.75	26.17
LSD (0.05)	2.80	2.60	3.80	3.40	3.02	3.01	2.99	3.10	3.20	3.00	3.14	3.41

Table 8: Collar diameter (mm) of *A. occidentale* Seedlings from Seed Classes

	Weeks after Transplanting											
	1	2	3	4	5	6	7	8	9	10	11	12
Small	6.04	6.07	6.11	6.14	6.16	6.19	6.19	6.20	6.20	6.22	6.23	6.26
Medium	6.18	6.27	6.33	6.36	6.42	6.47	6.47	6.50	6.50	6.53	6.54	6.59
Large	6.49	6.60	6.71	6.77	6.84	6.90	6.90	6.95	6.98	7.03	7.05	7.14
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

ns - not significant (p<0.05)

Table 9: Leaf Production of *A. occidentale* Seedlings from Seed Classes

	Weeks after Transplanting											
	1	2	3	4	5	6	7	8	9	10	11	12
Small	6.60	7.50	7.60	7.90	8.30	8.90	8.40	8.70	8.60	8.80	9.10	9.50
Medium	8.40	9.10	9.50	10.30	11.00	11.60	9.30	9.30	9.90	10.30	10.90	11.40
Large	8.90	9.80	10.10	10.90	11.70	12.60	9.90	9.50	9.70	10.50	11.20	11.90
LSD (0.05)	1.60	2.15	2.00	1.80	1.20	ns	ns	ns	ns	ns	ns	ns

ns - not significant (p<0.05)

Table 10: Leaf Area (cm^2) of *A. occidentale* Seedlings from Seed Classes

	Weeks after Transplanting					
	2	4	6	8	10	12
Small	7.65	17.51	33.58	69.72	95.78	136.51
Medium	16.37	53.86	80.03	149.43	202.64	343.89
Large	35.50	91.92	171.95	277.21	317.83	379.21
LSD (0.05)	6.87	35.40	42.96	78.44	98.66	34.41

Conclusion and Recommendation

Germination performance and the early growth of *A. occidentale* were significantly influenced by the seed sizes with the large seed sizes producing higher germination rates and vigorous growth. This is an indication that seed size is a crucial seed quality trait which influences germination, growth and development of seedlings. For the production of vigorous seedlings of *A. occidentale*, larger sized seeds should be given higher priority in the selection of seed germplasm.

References

Abideen, M.Z., Gopikumar, K. and Jamaludheen, V. (1993). Effect of Seed Character and its Nutrient Content on Vigour of Seedlings in *Pongamiapinnata* and *Tamarindus indica. My Forest.* 29:225-230.

Abu-Reidah, I.M., Ali-Shtayeh, M.S., Jamous, R.M., Arraez-Roman, D. and Segura-Carretero, A. (2015).

HPLC-DAD-ESI-MS/MS Screening of Bioactive Components from *Rhus coriaria* L. (Sumac) Fruits. *Food Chem*. 166:179-191.

Adeigbe, O.O., Olasupo, F.O. Adewale, B.D. and Muyiwa, A.A. (2015). A Review on Cashew Research and Production in Nigeria in the Last Four Decades. *Scientific Research and Essays,* 10(5): 196-209.

Aderounmu, A.F. (2019a). Variation in Morphometric Characters of *Vitellaria paradoxa* (C. F Gaertn) Seeds in relation to Germination and Seedling Biomass. *Ethiopian Journal of Environmental Studies and Management,* 12(4): 441-451.

Aderounmu, A.F. (2019b). Evaluation of Growth Media, Seed-Sizes and Microclimate on Sproutability of *Tetracarpidium conophorum* (African walnut). *International Journal of Organic Agriculture Research and Development*, Vol. 15.

Aderounmu, A.F. and Adegeye, A.O. (2018). Effect of Seed Size on Germination and Early Seedling Development of *Vitellaria paradoxa* (C.F. Gaertn) Hepper. *Journal of Tropical Forest Resource,* 25(1):1-7.

Aderounmu, A.F., Asinwa, I.O. and Adetunji, A. O. (2019). Effects of Seed Weights and Sowing Media on Germination and Early Growth of *Afzelia africana* Smith ex Pers. *Journal of Agriculture and Ecology Research International,* 19(3):1-11.

Adio, A.F., Oyeleye, B. and Oduwaye, E.A. (2008). Effects of Seed Source and Size on Germination and Early Growth of *Ceiba pentandra* (Linn) Gaertn. *Journal of Forestry Research and Management.* 5, 1-8.

Ajeesh, R., Jijeesh, C.M., Vidyasagran, K. and Vikas K. (2014). Impact of Seed Weight on Germination Parameters of *Calophyllum inophyllum* L.: A Potential Biodiesel Tree Species of Coastal Region. *The Bioscan,* 9(3): 1087-1091.

Akos, I.S., Tagwai, M.Y. and Dabo, J. (2017). Effect of Interaction between Seed Size and Sowing Depth of Cashew *Anacardium occidentale* (L) on Seedlings Emergence and Height under Treatment with Organic and Inorganic Fertilizer in Gidin-Waya, Southern Guinea Savanna, Nigeria. *Science World Journal* Vol. 12 (No. 2).

Alptekin, C. and Tilki, F. (2002). Effects of Stratification and Pericarp Removal on Germination of *Quercuslibani* Acorns. *Silva Bale*. 2:21-28.

Anjusha, J. R., Vidyasagaran, K., Kumar, K. and Ajeesh, R. (2015). Effect of Seed Weight on Germination and Seedling Characters of *Anacardium occidentale* L.: An Important Plantation Crop of India. *Plant Archives,* 15(1):595-601.

Aremu, M.O., Olonisakin, A., Bako, D.A. and Madu, P.C. (2006). Compositional studies and physico-chemical characteristics of cashew nut (*Anacardium occidentale*) flour. *Pakistan Journal of Nutrition*, 5(4):328-333.

Aremu, M.O., Olonisakin, A., Bako, D.A. and Madu, P.C. (2006). Compositional Studies and Physico-Chemical Characteristics of Cashew Nut (*Anacardium occidentale*) Flour. *Pakistan Journal of Nutrition* 5(4):328-333.

Cicek, E. and Tilki, F. (2007). Seed Size Effects on Germination, Survival and Seedling Growth of *Castanea sativa* Mill. *Journal of Biological Sciences*, 7:438-441.

Colombo, R.C., Favetta, V., Yamamoto, L.Y., Alves, G.A.C., Abati, J., Takahashi, L.S.A. and Faria, R.T. (2015). Biometric Description of Fruits and Seeds, Germination and Imbibition Pattern of Desert Rose [*Adenium obesum* (Forssk.), Roem. &Schult.]. *Journal of Seed Science*, 35(3): 368-373.

FRIN (2016). Annual Meteorological Report of Forestry Research Institute of Nigeria.

Hammed, L.A., Anikwe, J.C. and Adedeji, A.R. (2008). Cashew Nuts and Production Development in Nigeria. *American-Eurasian Journal of Scientific Research,* 3(1): 54-61.

Kadu, C.A.C., Imbuga, M., Jamnadass, R. and Dawson, I.K. (2006). Genetic Management of Indigenous Fruit Trees in Southern Africa: A Case Study of *Sclerocarya birrea* Based on Nuclear and Chloroplast Variation. *South African Journal of Botany* 72(3): 421-427.

Lorenzi, H. (2008). Brazilian Trees: Manual for Identification and Cultivation of Native Tree Plants in Brazil. 5th Ed. Sao Paulo: *Instituto Plantarum de Estudos da Flora*.

Lubi, M.C. and Thachil, E.T. (2000). Cashew Nut Shell Liquid (CNSL) - A Versatile Monomer for Polymer Synthesis. *Designed Monomers and Polymers,* 3:123-153.

Mkwezalamba, I., Munthali, C.R.Y. and Missanjo, E. (2015). Phenotypic Variation in Fruit Morphology among Provenances of *Sclerocary abirrea* (A. Rich.) Hochst. *International Journal of Forestry Research*, http://dx.doi.org/10.1155/2015/735418

Mog, B., Adiga, J.D. Nayak, M.G. and Mohana, G.S. (2017). Germination and Seedling Establishment in Cashew (*Anacardium occidentale* L.): An Interaction between Seed Size, Relative Growth Rate and Seedling Biomass. *Journal of Plantation Crops,* 45(2): 110-120.

Murali, K.S. (1997). Pattern of Seed Size, Germination and Seed Viability of Tropical Tree Species in Southern India. *Biotropica,* 29: 271- 279.

Oyewole, C.I. and Koffa, K.J. (2010). Effect of Storage, Size of Nut and Soaking Length on Sprout Emergence in Cashew. *Thai Journal of Agricultural Science,* 43(1): 39-45.

Togun, A. (1977). A Review of the Prospect of Cashew Industry, pp 39

Udoh, D.J., Ndoh, B.A., Asuquo, P.E. and Ndaeyo, N.U. (2005). Crop Production Techniques for the Tropics. Concept Publication (Nig.) Ltd.

Ventakaramah, T.M. (1976). Cashew Nut Production and Processing: Nigeria Agronomic Aspect of Cashew Nut Production. Unpublished Paper Submitted to Cocoa Research Institute of Nigeria, pp 39.

Yanlong, H., Mantang, W., Shujun, W., Yanhui, Z., Tao, M. and Guozhen, D. (2007). Seed Size Effect on Seedling Growth under Different Light Conditions in the Clonal Herb *Ligularia virgaurea* in Qinghai-Tibet Plateau. *Acta Ecologica Sinica,* 27: 3091-3108.