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Legume Seed Sizes and Their Consequential Growth Performance

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ABSTRACT
Background and Objective: Selection of appropriate seed size has become a huge challenge considering the anticipation of bumper harvest. The study evaluated the effect of seed sizes on the growth and development of three legumes (*Vigna unguiculata* (L.) Walp., *Arachis hypogaea* L. and *Glycine max* (L.) Merrill) grown in Nigeria. **Materials and Methods:** The seeds of *V. unguiculata*, *A. hypogea* and *G. max* were sorted according to their sizes (length×breath) and grouped into 'big-size', 'medium-size' and 'small-size', respectively: *V. unguiculata* (1.08×0.62 cm, 0.65×0.44 cm, and 0.48×0.16 cm), *A. hypogea* (1.59×0.72 cm, 1.10×0.65 cm and 0.62×0.19 cm) and *G. max* (0.51×0.42 cm, 0.40×0.38 cm and 0.30×0.28 cm). After planting, the parameters investigated were plant height, stem girth, number of leaves and leaf area while the chlorophyll content, biomass and dry matter of the plants were determined 8 weeks after planting. **Results:** The study showed that big-size seeds of *V. unguiculata*, *A. hypogea* and *G. max* enhanced the plant height, stem girth, number of leaves, leaf area, biomass and dry matter when compared to other seed sizes while small-size seeds recorded the least values for plant height. However, the chlorophyll a and b content of *V. unguiculata* was high with medium-size seeds and least with small-size seeds. Again, for *A. hypogea* and *G. max*, the small-size seed had the highest chlorophyll a and b content while the big-size seed recorded the least values. **Conclusion:** The study, therefore, recommends the use of big-size seeds of *V. unguiculata*, *A. hypogea* and *G. max* for planting because of the presence of more endosperm that supports early growth.

KEYWORDS
Development, growth, propagule, seed, sizes

INTRODUCTION

Farmers are consistently faced with the task of selecting a batch of seeds or propagules for the cultivation of their gardens and farms. Hence, the selection of appropriate seed size becomes a huge challenge considering the anticipation of a bumper harvest. Seed size is widely accepted as a measure of seed quality, which can affect germination percentage, seedling vigour, plant competition with the competing weed species, grain yield, grain quality and general performance of the crop[1-3]. It was reported that large seeds have high seedling survival growth and establishment[4,5]. According to Ambika *et al.*[6], larger seed size germinates quickly and is stronger in the seedling establishment stage with better root weight and higher yield than small seeds. Seed size is an important physical indicator of seed quality that affects the

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emergence, plant growth and performance of the crop in the field[7]. Seed size is positively correlated with seed vigour with larger seeds producing more vigorous seedlings in ryegrass[8]. Researchers[5,9] have shown that seed size in a range of plants affects germination rate, emergence rate, the success of establishment and growth. Sowing of the mixed seed of a species may result in a non-uniform density of seedlings, which may lead to heterogeneity in the vigour and size of the seedlings[10-12].

Dar *et al.*[13] have mentioned that in some multi-purpose tree species, small seeds to medium-sized ones produced better germination and seedling vigour than those of bigger ones. Peksen and Artik[14] showed that cultivars with a low 100 seed weight had a higher germination percentage than larger seed ones in pea (*Pisum sativum* L.). Under optimal conditions, seeds from different sources may result in similarly high levels of germination. However, these same seeds under the more stressful conditions experienced in the field may have vastly contrasting abilities to establish plants due to differences in their vigour[15]. The initial stage of growth may be due to the intrinsic nutrient resource pool of the seeds. After this stage, growth establishment is shifted to the extrinsic nutrient resource pool available in the immediate environment of the seedlings. They also noted that although smaller propagules may initially exhibit delayed growth, their seedlings eventually become comparable to those from larger propagules. Nerson[16] showed that small muskmelon seeds had the lowest percentage of germination, emergence and the lowest seedling growth demonstrating that there is an association between seed physical parameters and seed quality. Distinct seed sizes have different levels of starch and other energy reserves which may be an important factor to improve the expression of germination and initial growth of seedlings[17]. Germination depends on the ability of the seed to use reserves more efficiently[18], by mobilization of seed reserves for the germination traits[19]. Khurana and Singh[20] noted that seed size variations affected leaf area and large seeds had more leaf area in *Albizia procera*. Cicek and Tilki[21] reported based on the study of tree seedlings in 8 species in the Guyanese tropical rainforest, that size of the seed has a strong influence on germination as well as growth and biomass increment of a plant.

It has been severally established that the seed sizes of certain crops affect their overall performance in the field, but there is no certain trend as to which crop or group of crops are most likely to be positively influenced or otherwise by their varying seed sizes. While some researchers have established that larger seed sizes improve crop performance on some species of plants, other researchers have also established that varying seed sizes do not have any significant effect on the performance of the crop(s) investigated. These findings present a dilemma for the farmer(s) who will have to determine which crops are affected by varying seed sizes and also choose which seed size is the best for maximal crop performance. The study, therefore, seeks to assess the effect of seed sizes on the growth and development of three legumes [Cowpea, *Vigna unguiculata* (L.) Walp., Groundnut, *Arachis hypogea* L. and Soybean, *Glycine max* (L.) Merrill] grown in Nigeria.

MATERIALS AND METHODS

Study area and duration: The study was carried out in February, through July, 2021 at the Ecological Centre of Plant Science and Biotechnology Department University of Port Harcourt.

Source of materials: The seeds of *V. unguiculata*, *G. max* and *A. hypogea* were obtained from The Rivers State Agricultural Development Programme (ADP) Headquarters in Port-Harcourt. The varieties obtained were *V. unguiculata* [Sampea-9 (IT90K-277-2)], *G. max* [G. soja (TGx1465-1D)] and *A. hypogea* [Sammrt-23/24].

Grouping of seeds: The seeds of *V. unguiculata*, *G. max* and *A. hypogea* were sorted according to their sizes (length×breath) and grouped into ‘big-size’, ‘medium-size’ and ‘small-size’, respectively: *V. unguiculata* (1.08×0.62 cm, 0.65×0.44 cm and 0.48×0.16 cm), *A. hypogea* (1.59×0.72 cm, 1.10×0.65 cm and 0.62×0.19 cm) and *G. max* (0.51×0.42 cm, 0.40×0.38 cm and 0.30×0.28 cm).

Experimental site and design: The potted experiment was conducted at the Center for Ecological Studies in the Department of Plant Science and Biotechnology, University of Port-Harcourt, Rivers State, Nigeria. It is on geographical coordinates: Latitude 4°52'N and 4°55'N longitudes 6°54'E and 6°56'E in Obio/Akpor Local Government Area Rivers State. It is situated in the Niger Delta wetland of Southern Nigeria. The climatic weather condition of the area is characterized by a tropical monsoon climate with a mean annual temperature of 25-28°C and annual rainfall of over 3000 mm. The relative humidity is very high with an annual mean of 85% while the soil is usually sandy or sandy loam underlain by a layer of impervious pan. The experiment was conducted by adopting a Completely Randomized Design (CRD) with six replicates for each treatment.

Seed viability test: A viability test was carried out to ensure the seeds were viable, after which 90% germination was observed, showing the viability of the seeds.

Planting of seeds and measurement of parameters: Two seeds each of the big-size, medium-size and small-size *V. unguiculata*, *G. max* and *A. hypogea* were planted in planting bags filled with 4 kg of loam soil. The plants were allowed to grow normally for 8 weeks with intermittent measuring of the requisite parameters bi-weekly. The parameters investigated were plant height, stem girth, number of leaves and leaf area. The chlorophyll content, biomass and dry matter of the plants were determined 8 weeks after planting.

Statistical analysis: Data were analyzed with Analysis of Variance using LibreOffice Calc. and the means were separated using Tukey's HSD at a 5% level of probability.

RESULTS

Plant height: The height of the plants (*V. unguiculata*, *A. hypogea* and *G. max*) obtained from different seed sizes increased from week 2-8 after planting in Fig. 1. At 8 WAP for *V. unguiculata*, the medium-size seed had the highest plant height of 43.75 cm while the small-size seed showed the least plant height of 32.25 cm. For *A. hypogea* and *G. max*, the big-size seed had the highest plant height and the small-size seed recorded the least value. However, the difference among the seed sizes is not statistically different at $p \leq 0.05$.

Stem girth: The stem girth of *V. unguiculata*, *A. hypogea* and *G. max* raised from different sizes of seeds from 2-8 WAP are presented in Fig. 2. The plants raised with bigger seeds had higher stem girth across the test plants while small-size seeds produced plants with lower stem girth. These differences amongst plants were shown to be statistically significant at $p \leq 0.05$. Also, the stem girth of plants is a function of the seed size that produced them concerning the test plants.

Number of leaves: The number of leaves of *V. unguiculata*, *A. hypogea* and *G. max* raised from different sizes of seeds from 2-8 WAP are presented in Fig. 3. At 8 WAP, the plants raised with bigger seeds had a higher number of leaves across the test plants while small-size seeds produced plants with the lower number of leaves for *V. unguiculata* and *G. max*. For the *A. hypogea* plant, the medium-size seed had the least number of leaves when compared with other sizes. These differences amongst plants were shown to be statistically significant at $p \leq 0.05$.

Leaf area: The plant leaf area monitored 6-8 WAP showed an increase in leaf area across *V. unguiculata*, *A. hypogea* and *G. max*. At 8 WAP for *V. unguiculata* plant, the medium-size seeds had the highest leaf area of 29.44 cm^2 followed by the small-size seeds (23.53 cm^2) while the big-size seed had the least leaf area at 22.32 cm^2. This difference was not statistically different at $p \leq 0.05$. The big-size seeds gave rise to the highest leaf area (12.64 and 23.1 cm^2) for *A. hypogea* and *G. max*, respectively, while the small-size seeds had the least values (3.17 and 6.67 cm^2), in that order. This difference is statistically different at $p \leq 0.05$. The medium-size seed produced plant leaf areas of 5.72 and 10.13 cm^2 for *A. hypogea* and *G. max*, respectively.

Chlorophyll content: The chlorophyll a and b content of the plants raised from different seed sizes are presented in Fig. 4. The plants raised with small-size seeds had the highest chlorophyll content while the big-size seeds had the least values for *A. hypogea* and *G. max*, respectively. However, for *V. unguiculata*, the medium-size seeds gave rise to the highest chlorophyll a and b content while the small-size seeds had the least value. The difference in chlorophyll a and b content is statistically different at $p \leq 0.05$.

Biomass and dry matter: The biomass and dry matter of the plants at 8 WAP are presented in Fig. 5. The big-size seeds had the highest biomass of 14.15, 10.03 and 4.36 g for *V. unguiculata*, *A. hypogea* and *G. max*, respectively, while small-size seeds recorded the least value (6.79, 4.6 and 1.27 g) for *V. unguiculata, A. hypogea* and *G. max,* in that order. However, the difference among the seed sizes is statistically different at $p \leq 0.05$. Also, the dry matter of plants showed a similar trend to the biomass.

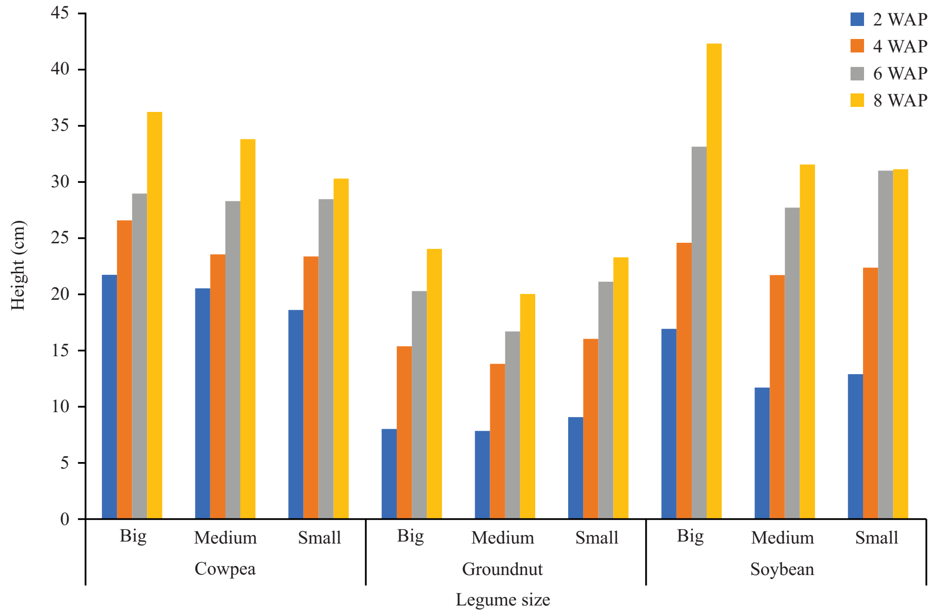

Fig. 1: Effect of seed size on plant height over a period of 8 weeks

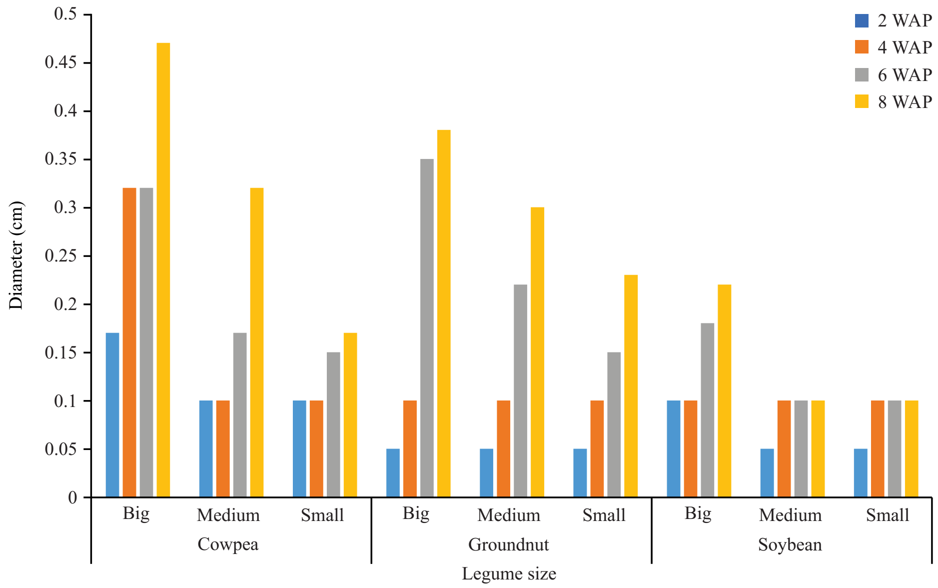

Fig. 2: Effect of seed size on the stem diameter of three legumes 8 weeks after planting

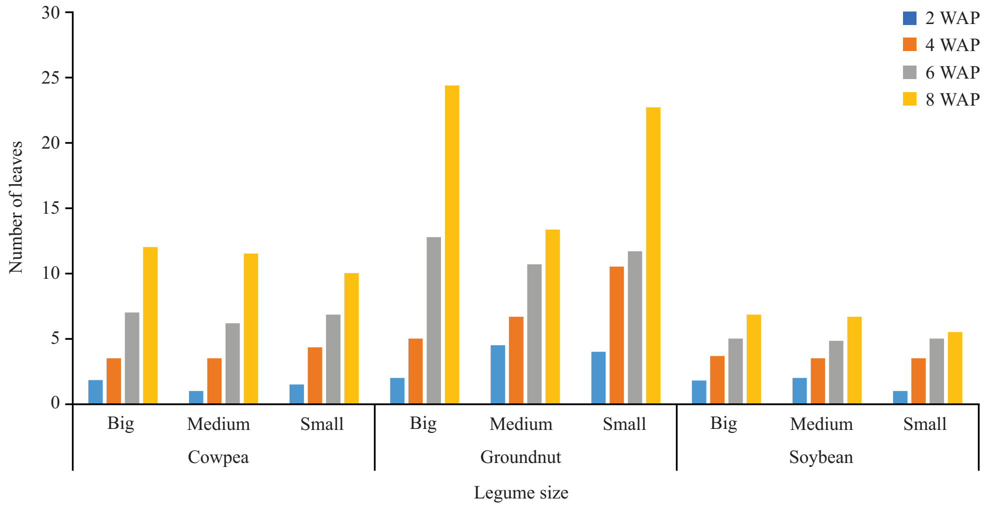

Fig. 3: Effect of seed size on the number of leaves of three legumes 8 weeks after planting

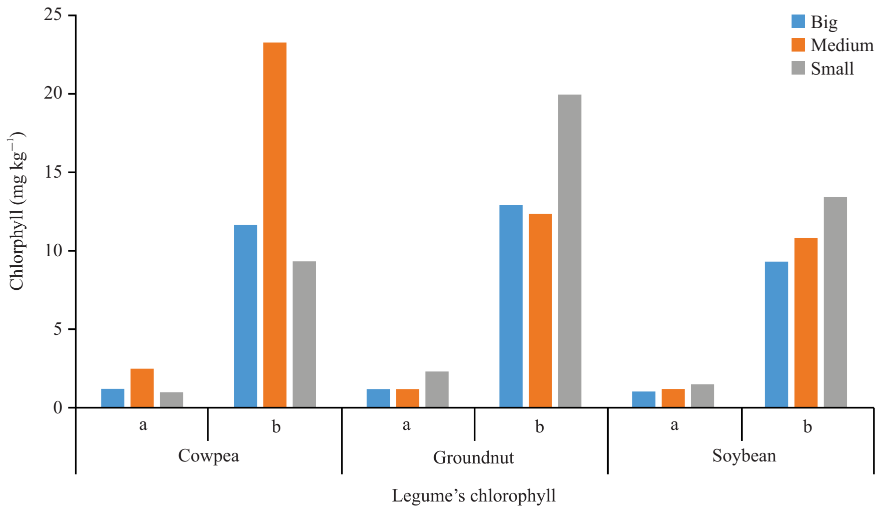

Fig. 4: Effect of seed size on the chlorophyll a and b content of three legumes after 8 weeks of planting

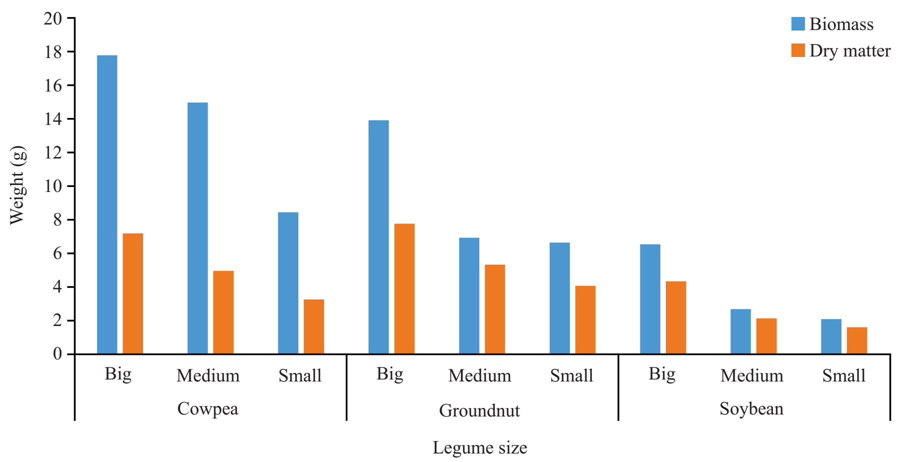

Fig. 5: Effect of seed size on the biomass and dry matter of three legumes 8 weeks after planting

DISCUSSION

The results obtained from the investigation showed that, for *V. unguiculata*, the big-size seeds had the highest number of leaves, stem diameter and biomass. This is followed by the medium-size seeds which accounted for the plant height, leaf area and chlorophyll content. This is in line with the findings of Ehoniyotan and Olorunmaiye[22], who investigated the influence of seed size on the germination and seedling development of cowpea using four local varieties of cowpea-oloyin, drum, ifebrown and local white and reported that germination efficiency was similar in both big and small seeds of the drum, oloyin and ifebrown but not in small seeds of local white, weights of 100 seeds from big seeds were much heavier than those of small seeds. These workers reported that the number of leaves, leaf length, leaf breadth, leaf area, stem height and dry weight, were consistently higher in cowpea plants for big seeds than the small seeds of all the varieties. They documented that the seedlings emerging from big seeds of all the cowpea varieties performed better in all the parameters studied than those emerging from smaller seeds. This suggests that the big-size seeds are most appropriate for planting.

For *A. hypogea*, the big-size seeds had the highest plant height, number of leaves, stem diameter, leaf area and biomass. The highest chlorophyll content and number of leaves were observed for the small-size seeds. This is in partial agreement with the findings of Oyewole and Aminu[23], who evaluated the influence of seed size on plant performance concerning seedling emergence, seedling growth, development and yield components of *A. hypogea* and reported that there was no significant effect of seed size on *A. hypogea* canopy height, leaf number, leaf area, stem girth, days to the first flower, number of pods/plant, pod weight and shelling percentage, but significantly influenced mean days to seedling emergence, days to 50 percent flowering, 100-seed weight and taproot length. The significant effect of seed size on days to seedling emergence, days to 50 percent flowering, 100-seed weight and taproot length could therefore significantly influence farmers' opinion in the choice of seeds used in planting a field, as this could determine crop maturity, grain yield/ha. Though seedling emergence was not investigated in this study, it may also be passed that the seeming better performance of the big-size seeds on *A. hypogea* could be attributed to the improved rate of seedling emergence and root length. Kaydan and Yagmur[5] reported that increased seed size gave rise to higher germination and emergence in pearl millet and triticale. Also, Larsen and Andreasen[24] earlier documented a reduction in the median germination time in forage plants with increased seed size.

For *G. max*, the big-size seeds had the highest plant height, number of leaves, stem diameter, leaf area and biomass. Khurana and Singh[20] noted that seed size variations affected leaf area and large seeds had more leaf area in *Albizia procera*. Cicek and Tilki[21] reported based on the study of tree seedlings in 8 species in the Guyanese tropical rainforest, that size of the seed has a strong influence on germination as well as growth and biomass increment of a plant. Large seeded seedlings were found to have 2-3 times more dry weight of seedlings than that small seed[21]. However, the highest chlorophyll content was observed for the small-seed size of *G. max*. These workers advised that the effects of seed size and density on viability and vigour do not appear to be of sufficient magnitude to allow for significant seed lot improvement through conditioning unless clean-out percentages are prohibitively high. This study has shown that the best-performed seed size was the big-size seeds.

It is worthy to note that, though the big-size seeds showed the best performance with the morphological growth parameters, the same cannot be said of the chlorophyll content, as the small-size seeds and the medium-size seeds had higher chlorophyll content than the big-size seeds in that aspect across the test plants, *V. unguiculata*, *A. hypogea* and *G. max*. Several researchers[1-3] have reported that seed size is one of the components of seed quality which affects the performance of the crop.

CONCLUSION

Investigations of the effect of differences in seed size on the growth parameters of *V. unguiculata*, *A. hypogea* and *G. max* have shown that the big-size seeds have the best performance on most of the growth parameters studied for all three plants, albeit insignificantly so in certain parameters. This, therefore, suggests that the yield of all three test plants may be directly or indirectly linked to the size of the seed used during cultivation, as a bigger seed size is bound to have a better yield. This study, therefore, recommends the use of big-size seeds of *V. unguiculata*, *A. hypogea* and *G. max* during cultivation in a bid to improve crop yield by farmers.

SIGNIFICANCE STATEMENT

Investigations of the effect of differences in seed size on the growth parameters of *V. unguiculata*, *A. hypogea* and *G. max* have shown that the big-size seeds have the best performance on most of the growth parameters studied for all three plants. This therefore suggests that the yield of all three test plants may be directly or indirectly linked to the size of the seed used during cultivation, as a bigger seed size is bound to have a better yield. This study therefore, recommends the use of big-size seeds of *V. unguiculata*, *A. hypogea* and *G. max* during cultivation in a bid to improve crop yield by farmers and encourage researchers to explore the effect of other seed sizes on performance of crops.

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