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Effects of seed size and nursery media on the germination and seedling growth of *Plukenetia conophora*

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Abstract

Research on the effects of seed size, soil-based and soilless media to determine the best condition for increased seedling production of African walnut was carried out at the green house of Department of Crop Science and Technology, Federal University of Technology, Owerri. Seed size was categorized into 10.23 to 10.31g (for large seeds) and below 10.23g (for small seeds). Soil-based nursery medium was sawdust mixed with topsoil volume by volume (v/v) 1:1, while soilless was sawdust alone. The experiment was a 2×3 factorial in a complete randomized design with 6 replications. Data were collected on number of days to emergence, plant height at 4, 8, and 12 weeks after planting (WAP), and number of leaves at 4, 8, and 12 WAP. Data collected were tested with analysis of variance (ANOVA), and treatment means were separated with Fishers least significant difference at 5% level of probability. Result showed that large seeds planted on soil-based media performed best in all the assessed traits. The inference is that high quality seedlings of African walnut can be produced by planting large seeds in soil-based media.

INTRODUCTION

Until recently, most vegetables and floriculture crops are grown by sowing seed directly in the field. In some crops, this traditional practice is giving way to planting of seedlings for some reasons. Growing seedlings instead of seeds offer many advantages to farmers. It ensures early establishment of crops, which invariably decrease the time taken to produce the crops. Uniformity in growth and yield can be achieved by growing seedlings. Also, growing seedlings minimizes wastage as it allows farmers to grow what they need. High-quality young plants are produced by growing seedlings. Concisely growing seedlings offer farmers the advantage of having control over the varieties of crop to grow, their quantities and time of production.

Success in growing of seedling can only be achieved when the appropriate knowledge on ideal conditions for germination and seedling development is applied. In addition, requirements for success in growing seedlings require appropriate equipment and materials. The basic cultural requirement for germination and seedling development differs for crops. Therefore, it is necessary to set up the materials and equipment required for each crop to achieve optimal germination percentage. Soil mixes and containers should be structured or composed to ensure that the required most favorable temperature, moisture, aeration, light and fertility are provided for optimal seed germination and seedling development. According to Brown and Foley (2020), soil and air temperature between 75–78 °F is the best condition for germination of some warm season crops like cucumbers, tomatoes, eggplant and pepper.

The domestication of forest tree crops, especially non-timber producing forest tree crops, has gained attention among workers. This new initiative in

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agroforestry seeks to incorporate indigenous forest trees of high-value products into tropical farming systems. African walnut is a very important non-timber producing forest tree crop. This crop naturally grows in the forest, but its domestication is in progress (Ayoola et al., 2011; Agbo et al., 2014). Smallholders' farmers seek to integrate this crop into agroforestry due to outstanding nutritional and medicinal properties of both seed and other parts of this crop. Unfortunately, unavailability of planting materials was reported to be a major hinderance in the production of African walnut (World Agroforestry, 2013), necessitating other workers to make efforts to grow this crop vegetatively (Agbo et al., 2014). In order to ensure the availability of planting materials to enhance the production of African walnut, this study was therefore set up to evaluate the effect of seed size and nursery media in African walnut seedling production.

MATERIALS AND METHODS

The study was conducted in the green house, Department of Crop Science and Technology, Federal University of Technology, Owerri (FUTO). The project site is located between latitude of 5^{o} 25'N and longitude of 7^{o} 0'E. at an elevation of 55 m above sea level The mean annual rainfall is 2000 mm, with an annual relative humidity of between 89–93%.

Materials used for this project work were African walnut seeds, topsoil, sawdust, plastic buckets: medium size (22 cm × 18 cm), watering can, paper masking tape and meter rule. Seeds of African walnut used for the study were randomly selected. The weight of the seeds was used to classify the seeds into large and small. Seeds that weighed from 10.23 g to 10.31 g were tagged large seeds, while those that weighed below 10.23 g were tagged small seeds (Sanderson et al, 2002). A total of 120 seeds were used for the experiment, comprising 60 large seeds and 60 small seeds. These seeds were planted in plastic buckets. Two-third of each plastic bucket was filled with equal volume of the nursery media used for the experiment. Soil (topsoil collected from the research farm), soil-based (topsoil mixed with sawdust volume by volume 1:1), and soilless (sawdust alone). One seed was sown per bucket at a depth of 2 cm. Watering was carried out at intervals of three days and sanitary practices were regularly done as to keep the experimental site free from weeds and contaminants.

The experiment was a 2×3 factorial in a complete randomized design with 6 replications. Factor A consisted of two seed sizes (large and small) observed among the seeds acquired for the study, while factor B was three different nursery media (soil, soil-based and soilless) evaluated. Data collected included the number of days to emergence. The days to emergence for each plant were counted and recorded. A plant was said to have emerged when the plume is visible 1 cm to 2cm above ground. The formula stated below was used to determine the percentage of the seeds that germinated.

$$\text{Germination percentage} = \frac{\text{Total number of seeds planted}}{\text{Number of germinated seedlings}} \times 100 \quad \ldots\ldots(1)$$

Plant height was measured and recorded at 4, 8 and 12 WAP with a meter rule. It was measured from the base of the plant from the soil to the leaf tip. Number of leaves were counted and recorded at 4,8, and 12 WAP for each plant stand used for data collection. Collected data were analyzed with analysis of variance (ANOVA). Treatment means were compared at 5% level of probability with fisher's least significance difference.

RESULTS AND DISCUSSION

The results obtained on the effect of seed size and growing media on the germination and seedling growth of African walnut are presented in Tables 1 to 4.

There was no significant effect on days to emergence. However, the least mean value on number of days to emergence of 14.66, approximately 15 days, was recorded for large seeds planted on topsoil mixed with sawdust (v/v 1:1), while the highest mean value on number of days to emergence of 19.4, approximately 20 days, was recorded for small seeds planted on topsoil.

Germination rate result recorded the highest germination rate of 72% for large seeds planted on topsoil mixed with sawdust (v/v 1:1). On the other hand, the least germination rate of 40% was recorded for small seed planted on sawdust.

There was significant effect on the plant height (Table 3) at 4 and 8 WAP. However, there was no significant difference on plant height at 12 weeks WAP. Similar to the result on the days to emergence, large seed planted on topsoil mixed with saw dust (v/v 1:1) had highest plant height mean value of

Table 1. Result on days to emergence of African walnut

Treatments	Days to emergence (mean)
Sawdust/small seed	18.80
Sawdust/large seed	17.60
Topsoil + sawdust/small seed	17.33
Topsoil + sawdust/large seed	14.66
Topsoil/small seed	19.40
Topsoil/ large seed	18.75
LSD (0.05)	Not significant

Table 2. Results on the germination rate

Treatments	Germination rate (percentage)
Sawdust/small seed	40
Sawdust/large seed	45
Topsoil + sawdust/small seed	60
Topsoil + sawdust/large seed	72
Topsoil/ large seed	60

Table 3. Results on the plant height at 4, 8, and 12 WAP

Treatment	4 WAP	8 WAP	12 WAP
Sawdust/small seed	15.62	62.62	91.20
Sawdust/large seed	17.72	50.72	86.08
Topsoil + sawdust/small seed	19.75	87.45	109.80
Topsoil + sawdust/large seed	23.56	104.08	123.28
Topsoil/small seed	15.53	52.00	98.40
Topsoil/ large seed	16.92	43.03	87.30
LSD (0.05) seed size	5.92	26.44	NS
LSD (0.05) media type	NS	NS	NS
LSD (0.05) size and media	NS	NS	NS

Remarks: NS = Not significant.

Table 4. Results on the number of leaves at 4, 8, and 12 WAP

Treatment	4 WAP	8 WAP	12 WAP
Sawdust/small seed	4.20	13.20	19.40
Sawdust/large seed	4.80	12.60	21.40
Topsoil + sawdust/small seed	4.50	13.17	19.00
Topsoil + sawdust/large seed	5.60	14.33	22.83
Topsoil/small seed	4.00	10.25	21.00
Topsoil/ large seed	4.80	12.10	18.75
LSD (0.05) seed size	1.75	4.66	NS
LSD (0.05) media type	NS	NS	NS
LSD (0.05) size and media	NS	NS	NS

Remarks: NS = Not significant.

23.56, 104.08 and 123.28 at 4, 8, and 12 WAP, respectively, while the least value of 16.92, 43.03 and 87.30 at 4, 8, and 12 WAP was recorded for small seeds planted on topsoil. Seed size (factor A) showed significant effect, while media type (factor B) and interaction between seed size and media type (interaction of factor A and B) did not show any significant effect.

Significant effects were observed at 4 and 8 WAP on the number of leaves (Table 4), but not at 12 WAP. The highest mean value of 5.6, 14.33 and 22.83 at 4, 8 and 12 WAP, respectively, was recorded

for large seed planted on topsoil mixed with sawdust (v/v 1:1), while the least mean value of 4.00, 10.25 and 21.00 was obtained for small seeds planted on topsoil. Factor A (seed size) showed significant effect, while media type (factor B) and interaction between seed size and media type (interaction of factor A and B) did not show any significant effect.

Discussion

In seedling production, seed germination is the first step, which involves series of stages starting from imbibition (absorption of water) and ends in the growth of tiny roots downwards and shoot upwards. Seed size may affect seed germination. Similarly, the physical and chemical properties of the planting media may affect seedling germination and growth. In addition, both seed size and the properties of the media may have an interaction effect on seedlings production. In this study, the effects of seed size and nursery media composition on seed germination and seedling growth were observed.

The result on the number of days to emergence showed that large seeds planted on topsoil mixed with sawdust (v/v 1:1) had the least number of days to emergence of approximately 15 days. A detailed analysis of the result on emergence showed that large seed consistently had the least number of days to emergence in all the nursery media combination used in the study. Further, large seed size had the best performance in percentage germination. The best performance obtained for large seed on speed and percentage germination may be due to its large surface area that is better exposed to conditions necessary for germination than small seeds. Previous studies have reported that large seeds outgrow small seeds in seedling production; they produce seedlings that emerge faster and bigger in size in crops like Gmelina arborea (Owoh et al., 2011), Peanut (Steiner et al., 2019), Hairy vetch (Ekpo, 2004), Swietenea macrophylla (Pramono et al., 2019), and Afzelia quanzensis (Mtambalika et al, 2014). However, this result slightly varied with the report of Souza and Fagundes (2014) on Copaitera langsdorffi, which observed that while large seed had higher percentage germination and vigorous seedlings, small seed emerged faster. The obtained result is also comparable with reports from other workers on early emergence of 13 days on African walnut who used a combination of cracking with GA3 (Gibberellic acid) by 750 ppm stratification for 30 days (Negi et al., 2017). Further, the result of this study showed that small seed had the least performance in both number of days to emergence of 19 days and germination rate in all media combination. This result emphasizes why planting large seeds should be preferred for seedling production than small seeds. Apart from seed size, the properties of the growing media may have also affected the germination of the seedling. Topsoil by its bulky nature cannot facilitate aeration and porosity, conditions that enhances seed germination. Invariably, this explains why seeds planted in topsoil emerged late. A similar report has been observed by other workers (Onwubiko et al., 2015).

Large seeds grown on topsoil mixed with sawdust (v/v 1:1) had the highest mean value on plant height of 23.56, 104.08 and 123.28 at 4, 8, and 12 WAP, respectively. In this result, the significant effect of large food reserve contained in large seed that can support early seedling growth was clearly observed. The result of this study is in agreement with the report from other workers (Souza and Fagundes, 2014; Thiyam et al., 2017; Farahani et al., 2011, Yusuf et al., 2014; Umeoka and Ogbonnaya, 2016; Jasim and Esho, 2022). Small seeds planted on topsoil mixed with sawdust gave the second-best result on plant height. This result has some implication on the property of the growing media since both large and small seeds grown on topsoil mixed with sawdust had better growth results than big seeds grown on other nursery media composition, especially those with poor physical and chemical composition. In other words, the effect of good nursery media that can support fast nutrient circulation may have positively affected the result on plant height.

The result obtained on the number of leaves was like that of plant height. Large seeds planted on topsoil mixed with sawdust (v/v 1:1) had the highest mean value of 5.6, 14.33, and 22.83 at 4, 8, and 12 WAP, respectively, while the least mean value of 4.00, 10.25, and 21.00 at 4, 8, and 12 WAP, respectively, was obtained for small seeds planted on topsoil. Significant effect on the number of leaves was observed based on seed size and not on growing media types. The large seeds, which contain higher food reserve that can support early growth of the seedlings, positively affected the number of leaves. Other studies have reported a similar result (Ambika et al., 2014; Shahi et al., 2015; Mohsen et al, 2011, Singh et al., 2012; Tumpa et al., 2021). Good nursery media may have also affected the number of leaves. Seeds

planted on topsoil mixed with sawdust, either large or small seeds, had better results on the number of leaves unlike those planted on other nursery media composition used in this study. Topsoil mixed with sawdust had low bulky density when compared with other nursery media. It made nutrients in the media readily available for the growing seedlings.

CONCLUSIONS

In this research work, the days to emergence, germination rate, and seedling growth of African walnut were mostly affected by seed size. The most appropriate seed size for growing African walnut seedlings was large seed. In addition, nursery media composition was also observed to have affected seed germination and seedling development.

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