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Comparative Seed Germination and Early growth Assessment of Indigenous and Exotic Tree species in Nigeria†

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Abstract: This study assessed the germination and early growth of selected indigenous tree crops (*Khaya grandifoliola, Khaya senegalensis, Terminalia superba, Terminalia ivorensis, Mansonia altissima*) and exotic tree species (Tectona grandis). Seeds of the tree species were collected, treated, and raised in the departmental nursery of Forest Production and Products, University of Ibadan. The replicate for the seed germination experiment varied based on seed availability. A total of 45 and 42 Khaya grandifoliola and Khaya senegalensis seeds, 8390 Tectona grandis, 295 seed of Terminalia superba, and 2725 Terminalia ivorensis seed was planted respectively. Upon germination, seedlings were pricked-out into the polythene pots while the change in growth variables which are leaf length, number of leaves, leaf width, and height was assessed for three weeks using a total of 10 replicates per each tree species. Data obtained were subjected to descriptive statistics and ANOVA using IBM Statistics 27 and the experimental design employed is the completely randomized design (CRD). The best germination (100%) was recorded for two of the indigenous tree crops (Khaya senegalensis and Khaya grandifoliola) 21 days after planting. Plant height increased from Mansonia altissima (2.17 cm) to T. superba (26.05 cm). All the growth variables assessed were significantly different among the tree species. This study revealed that the indigenous tree species are better germinated and grew more appreciably than the exotic species, however, there is a need for a more extended study to confirm the claim.

Keywords: Germination**;** Indigenous; Exotic; tree seedlings, Growth Variables

1. Introduction

Seed germination is the beginning of the life cycle of a plant, after which the seedling grows [1]. A seed germinates in response to favorable environmental conditions, such as light, temperature, and soil components [1, 3]. The process is complex and it involves the ignition of growth by the mature seed, a shift from the maturation phase to a germination-driven sequence of development, and the growth of the seedling [3]. By definition, germination begins with the uptake of water by the seed and is complete when the radicle (root) emerges from the seed coat [1,2]. The successful establishment and management of indigenous and exotic tree species for forest plantation is hinged on the germination pattern and early growth of the tree species [4,5]. Although, it is popularly believed that the exotic species perform better than most indigenous species even though there is limited scientific research to attest to this. Due to this belief, the supply chain and fast growth of these species has made them favored compared to most indigenous species. Based on our

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knowledge, out of the few studies that have examined the early growth of indigenous and exotic tree species in Nigeria, none has considered the comparative germination of these species. For instance, [7] investigated the early growth assessment of *Tectona grandis, Khaya senegalensis, Khaya grandifoliola,* and *Gmelina arborea* using the monthly data collection of the growth variables height, collar diameter and number of leaves for a period of 6 months to deduce the growth rate of both the indigenous and exotic tree species. It was discovered that; the indigenous tree seedlings had faster growth than the exotic tree seedlings.

More so, there is little information available on the germination and early growth of some indigenous tree species such as *Mansonia altissima, Terminalia superba, Terminalia ivorensis* amongst many others which makes it a bit difficult to make informed decisions in determining their potential use for plantation establishment, agroforestry activities amongst others. Additionally, researches on the early growth of seedlings are majorly focused on the height, and collar diameter of the seedlings as well as the collection of the data monthly. This begs the discuss "is the other growth variables such as Leaf length, Leaf width" for a number of days impossible to determine the early growth rate of the seedlings?
Hence, this research aims to add to the body of knowledge by including other indigenous tree species as well as considering their germination potential and making use of the other growth variables in terms of, Leaf length, Leaf width (seldomly used), in conjunction with the number of leaves and height to determine the early growth of the selected tree species for a period of three weeks (21 days).

2. Materials and Methods

Study Area

This study was conducted at the departmental Nursery, University of Ibadan. The departmental nursery is situated behind the department of Forest Production and Products in the university of Ibadan. It has a latitude of 7°26'N and longitude 3°54'E at a mean altitude of 227m above the sea level. The annual rainfall is 1258mm-1437mm and a mean daily temperature of 22°C-31°C. The soil present in the departmental nursery is ferric luvisol [7] nursery has a screen house, a workshop and a permanent water supply.

Method of Data Collection

The seeds of *Tectona grandis*, *Terminalia superba*, *Terminalia ivorensis*, *Khaya grandifoliola*, *Khaya senegalensis* and *Mansonia altissima* were collected from the mother trees growing in University of Ibadan environment. The seeds picked were treated using different pretreatment method. The number of seeds used for germination experiment varied based on availability. Therefore, a total of 8390 teak seeds was picked, divided into 1477, 3974 and 2940 respectively. The seeds were treated using the hot water, cold water and alternate pretreatment method respectively. Likewise, 295 Terminalia superba seeds were soaked in water at room temperature for 24 hrs before planting on the seed bed. Also, a total of 850, 935 and 940 *Terminalia ivorensis* seeds were soaked for 24 hrs, 48 hrs and 72 hrs respectively prior to the planting. A total of 45 *Khaya grandifoliola* seeds and 42 *Khaya senegalensis* seeds were handpicked and planted directly.
Three seedbeds were constructed to accommodate all the seeds collected, processed and treated at the departmental nursery. The three seedbeds were thoroughly watered properly. The seeds were broadcast on the seedbed according to. A total of 295 *Terminalia superba* seeds was broadcast, a total of 1,875 seeds of *Terminalia ivorensis* seeds were broadcast although it was divided into 850 for the 24hrs pretreatment, 935 seeds for the 48hrs pretreatment and 940 seeds for the 72hrs pretreatment. Likewise, a total of 8,414 *Tectona grandis* pretreated seeds were broadcast although it was divided into 2970 seeds for the cold-water pretreatment, 1470 for the soaking and air-drying alternate pretreatment, and 3,974 teak seed for the hot water pretreatment.

After the seed broadcast, the seeds were covered lightly with top soil to aid faster germination. However, on the seedbed containing the pretreated teak seed with hot water, after covering the seeds with topsoil, the seedbed was covered with palm fronds. This is to generate heat for faster germination and also prevent rapid evaporation of water. Also, the *Khaya grandifoliola* and *Khaya senegalensis* seeds were planted directly into the poly pots. A total of 45 *Khaya grandifoliola* seeds was planted directly into the poly pots while 42 *Khaya senegalensis* seeds was planted directly into the poly pots as well. Additionally, a total of 140 *Mansonia altissima* seeds was planted directly into a bowl. The bowl was perforated to allow passage of air, and was filled with top soil which was watered. Afterwards, the *Mansonia* seeds were planted while covering lightly with top soil. Upon germination and emergence of the radicle, it was pricked into the poly pot filled with top soil and organic manure. The seedlings were nurtured and raised in the poly pot and the early growth variables in terms of the number of leaves, height, leaf length and leaf width were assessed for a period of 21 days. Cumulative germination percentage was estimated, pulled for each species and presented on a chart.

Statistical analysis was carried out using a one-way analysis of variance (ANOVA) to know the significant difference in the growth variables among the species. Duncan Multiple range test was used for post hoc analysis. This was carried out with the SPSS version 27.

3. Result and Discussion

Cumulative germination of the tree seeds is shown in Figure 1. Among all the tree species, *Khaya senegalensis* and *Khaya grandifoliola* were the first to commence germination at approximately 8 days after planting and had 100% germination at 21st day of planting. *Tectona grandis* being the only exotic species commenced germination on the same day with the mahoganies with just 0.4 % germination success. However, only 10.2% germinated at the end of the assessment. *Terminalia superba's* germination was first observed at 10th day of planting with only 0.7% germination success and had a peak germination of 28.1% at the 20th day of planting. *Terminalia ivorensis* was the last to commence germination of about 0.4% of the total seed sown at exactly 12 days after planting. The peak germination was 20.1% as at the time there was no further germination record. The fast germination rate of the mahoganies might be attributed to their seed coat permeability. The structure and thickness of seed coats dictates the rate of water absorption and gas exchange. However, Khaya species seed have thinner seed coats which facilitates faster water uptake and oxygen exchange compared to Terminalia ivorensis, Terminalia superba and Mansonia altissima. The Terminalia species possesses a thicker seed coat compared to the mahoganies, which causes for the species to be pretreated prior to planting in order to hasten up the germination process even though the overall germination rate was low [13]. This findings corroborate the findings done by [11], who stated that Khaya senegalensis and Khaya grandifoliola has a fast germination rate.

Similarly, different tree species have varying compounds present in their seeds that influence the rate of germination. These compounds serves as either promoters or inhibitors. Khaya species seeds have a high concentration of gibberellic acid that aids the breaking of dormancy in order to promote germination. In contrast, Teak seeds possesses growth inhibitors, one of which is identified as "teakin". This is a chemical compound that inhibits germination and root growth which contributes to the dormancy of the teak seeds and hinders sprouting. Hence, teak seeds are subjected to specific pretreatment [12]. Furthermore, the quality and viability of seeds is an important factor in aiding fast germination growth. Khaya spps seeds possess higher viability naturally which allows them to grow faster than seeds from other species [10].

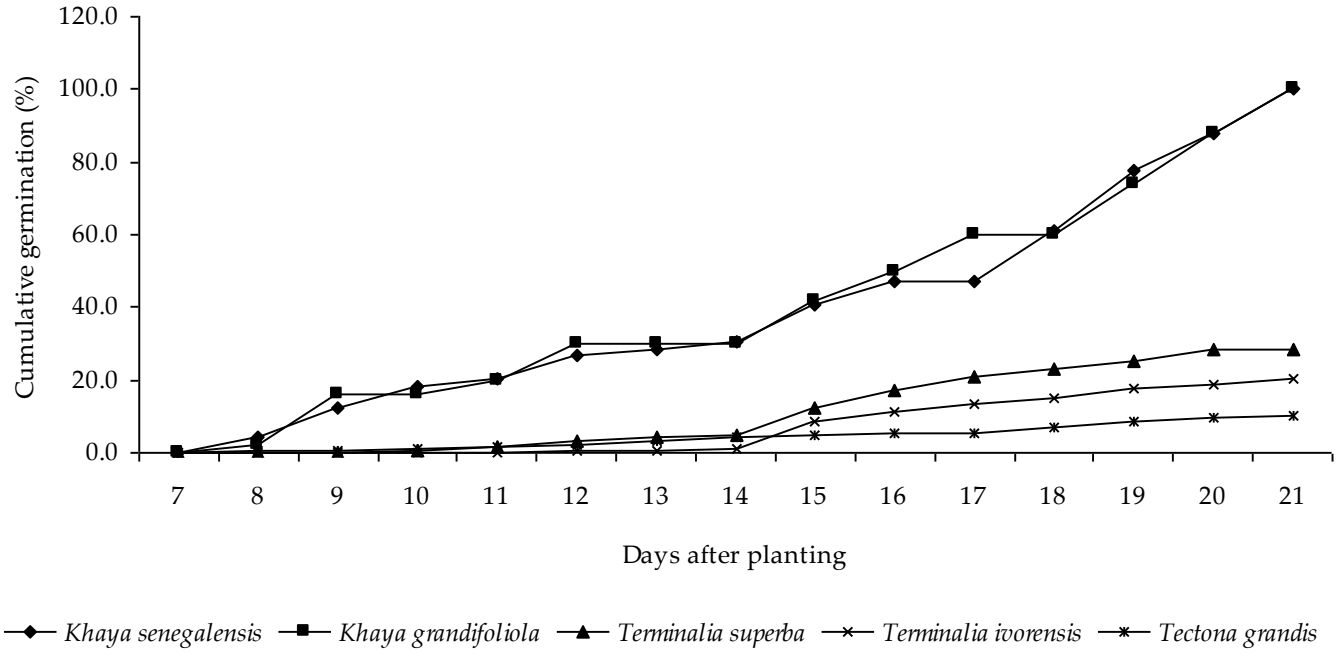

Figure 1. Cumulative germination percentage of the tree species

The periodic change in number of leaves, leaf length, leaf width and plant height from the first week to the third week is shown in Table 1. Highest number of leaves was found in *T. ivorensis* (7.0), while the lowest value was observed on both *Mansonia altissima* and *Tectona grandis* having an average additional single leaf after 3 weeks of assessment. Similarly, leaf length was highest in *T. ivorensis* with an average value of 6.02cm but *T. superba* had the least leaf length (0.92 cm). Meanwhile, leaf width varied from *Khaya grandifoliola* (0.25 cm) to *Tectona grandis* (2.93 cm). Plant height increased from *Mansonia altissima* (2.17 cm) to *T. superba* (26.05 cm). Hence the statistical growth variation shown among all the species showed a significant difference ($p < 0.05$). The significant difference observed in the assessed growth variables of the five tree species implies that their level of adaptation to similar environmental conditions differs. This can be as a result of the intrinsic characteristics of the trees and the combined environmental effect which dictates their physiognomy. Broadly, the selected exotic species which is *Tectona grandis* in this study was observed to have grown more rapidly at the initial stage of assessment than the indigenous species. This finding is in tandem with the result of [8], which was reported that exotic species are more favored to be used for plantation establishment rather than indigenous species due to their faster growth rate. However, this study shows that the indigenous species have the highest number of leaves, and height as shown in Figure 1 and Figure 3 than the exotic species. This finding negates the findings of [9] who stated that exotic species records better growth performance than indigenous tree species. Regardless, the findings of our study corroborate with the result of [7] on how indigenous species recorded a faster growth than the indigenous tree species with respect to their height and collar diameter.

Table 1. Number of leaves, Leaf length, Height and Leaf width of the indigenous and exotic tree species after three weeks of assessment

Tree species	Number of leaves	Leaf length	Plant height	Leaf width	p-value
Khaya grandifoliola	4.0c	3.36b	4.67c	0.25c	0.000*
Terminalia superba	5.0b	0.92b	26.05a	0.26c	0.000*
Tectona grandis	1.0d	0.99b	16.36b	2.93a	0.000*
Terminalia ivorensis	7.0a	6.02a	22.8a	0.57bc	0.000*
Mansonia altissima	1.0d	1.9b	2.17c	1.14b	0.000*

Means with similar superscript within the same column of any set of species are not significantly different at p=0.05

*=significant (p<0.05)

Conclusions

In conclusion, the findings of this study revealed that *Khaya grandifoliola* and *Khaya senegalensis* have the fast germination rate which might be due to the structure of their seed coat or the presence of germination promoters compared to the late germination of *Terminalia superba, Terminalia ivorensis, and Mansonia altissima*. Likewise, this study shows that germination can be hastened through pretreatment of the seeds prior to planting. This statement holds true for *Tectona grandis* which had a fast germination rate as that of the mahoganies. Furthermore, based on the result derived from the early growth assessment of the tree species, it is safe to say that indigenous tree species are suitable for plantation establishment due to their fast growth as opposed to the belief that exotic tree species grows faster than the indigenous tree species.

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