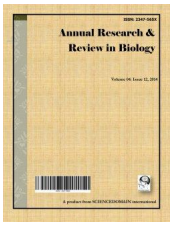

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Effects of Growth Media on Germination and Early Growth of *Afzelia africana sm ex pers*

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Authors' contributions

This work was carried out in collaboration between all authors. Author ETI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JIA and IAU managed the analyses of the study and proof read the draft manuscript. Authors EAA and KA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study investigated the effects of growth media on germination and early growth of *A. africana* in order to enhance its plantation development. The experiment was divided into two; experiment 1 and 2. Experiment 1 investigates the germination response while experiment 2 investigates the early growth response of *Afzelia africana* to different growth media. Both experiments were arranged in a completely Randomized Design (CRD). The growth media used for the study were Topsoil (control), sawdust, fine sand, riversand and the mixture. Fifty seeds were sown into each growing medium and experiment was monitored for 8 weeks. Data were collected on germination and early seedling growth parameters. Analysis of variance was used to analyze the data collected. Means separation were carried out using the Duncan's Multiple Range Test. The result revealed that germination percentage was significant at 5% level of probability. The highest germination percentage was recorded in topsoil (68%) while the least was recorded in sawdust (40%). There was significant difference at 5% level of probability on seedling performance. The highest mean height was recorded in mixture (14.71 cm) and fine sand recording the lowest (9.53 cm). The highest collar

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diameter growth was recorded in sawdust (0.63 cm) and the least (0.42 cm) was in fine sand. The highest stem diameter was recorded for sawdust (0.49 cm), and the mixture recording the lowest (0.35 cm). The highest mean for leaf length was recorded in river sand which had 6.93cm, while topsoil and sawdust recorded the least mean (5.40 cm.). Leaf production in *A. africana* was not significant between the treatments. The study has shown that the germination percentage of *A. africana* improved significantly with growing media especially topsoil. The use of sawdust and topsoil as growing media for small and large scale propagation of the species can be adopted.

Keywords: Afzelia Africana; germination; growing media; seedling performance plantation.

1. INTRODUCTION

Growth media play vital role for seed germination and are the materials that physically support plant growth [1]. The component of media used for propagation influence the quality of seedlings. Germination is a process by which the dormant embryo of the seed resumes active growth and forms a seedling. Seed germination of many indigenous tree species is difficult as a result lack of suitable growth media and their mode of propagation. Propagation procedure is critical and central to sustainable producion. Nowadays efforts are directed towards planting multipurpose indigenous tree species that can cope with harsh environment prevalent in arid and semi-arid areas [2].

Afzelia africana sm ex pers (Family Caesalpinaceae) is an endangered species. It is a medium to large spreading deciduous tree attaining 24–35 m height and 1−1.6 m diameter breast height [3-4]. It is a valuable multipurpose African tree species. It produces quality valuable timber [5]. Leaves are cooked together with potash and eaten with other vegetables [4] and its various parts such as roots, leaves and bark are used in traditional medicine to treat different ailments [4-7]. The foliage is browsed by livestock, mainly towards the end of the dry season when little fodder is available [4]. The wood is characterized by excellent stability with little susceptibility to variations in humidity, small shrinkage rates during drying and good natural durability [4]. However, its valuable wood makes it economically interesting and warrants its propagation and introduction in plantation and agroforestry systems the tree fixes atmospheric nitrogen and is known to improve soil fertility in many African countries and hence used in agroforestry practices.

Afzelia africana is widespread, but recent studies have shown that it is locally threatened by the high rate of exploitation or valuable timber [4-5], wildfires, habitat degradations and factors related to climate change [8]. The low growth rates of the tree limits its prospects as a commercial plantation timber species [4].

The challenge in propagating seedlings of indigenous tree species in arid and semi-arid areas is poor germination related to seed dormancy [8-9] and poor potting media. Knowing the nursery requirements of *Afzelia africana* is important in producing quality seedlings that are capable of surviving harsh conditions when planted out in the field. Due to increasing rate of afforestation programme and high level of utilization of this species, there is need to adopt the in-situ-conservation method for future use. Therefore the study becomes necessary to identify the best growing medium in order to promote plantation development of the A. *africana* seedlings.

2. MATERIALS AND METHODS

2.1 Study Site

The study was conducted at the University of Agriculture Makurdi forestry nursery, located adjacent to the university water works, south core, Makurdi Benue state which lies on longitude 8°35' and 8°41'E and latitude 7°45' and 7°52'N. It lies within the southern guinea savanna zone. The climate is characterized by wet and dry seasons. The annual rainfall is between 100 and 150 cm. The mean annual temperature is 25-37°C and relative humidity lies between 65-96%. This originally consists of open forest dominated by tall forest trees, understorey of shrubs interspersed with tall grasses.

2.2 Seed Collection and Procedure

The seeds were bought from North bank market in Makurdi local government area of Benue state. Seeds were kept under normal room temperature for a period of 3 weeks. A total of 300 *Afzelia africana* seeds were tested for viability using

floatation method [10]. Seeds that sank were regarded viable while the floated ones were discarded. Only 250 seeds were viable for sowing. Seeds were dried under shade at normal room temperature.

2.3 Growth Media

Germination trays and polypots were filled with different growth media namely sawdust which was collected from sawmill, topsoil (control) collected at the depth of 0-15 cm and sieved using a 2 mm sieve to remove stones, roots and other materials that may hinder seed germination, riversand collected from Forestry nursery, fine sand was obtained in front of the new Department of Agricultural Business building North core, University of Agriculture Makurdi and mixture of topsoil, river sand, fine sand, and sawdust in the ratio of 2:1:1:1.

2.3.1 Experiment 1

Two hundred and fifty (250) viable seeds obtained by floatation test were pretreated using 98% sulphuric acid (H_2SO_4) for 10 minutes to break the dormancy as stated by (11). Fifty (50) seeds were then randomly selected and sown into different germination trays of 21 × 8 cm size filled with different growth media. The growth media were namely; Topsoil, river sand, sawdust, fine sand and the mixture. Seeds were sown 25 polypots at the rate of two seeds per poly pot. Each treatment (medium) received 50 seeds and was replicated 5 times giving a total of 125 polythene pots. The experiment was laid in completely randomized design (CRD). Watering was done twice a day. The seeds were considered germinated when the cotyledons become exposed or the seedlings grew to about 1cm above the growth medium. The experiment was terminated at the fourth week after noticing no new germination.

2.3.2 Experiment 2

Ten (10) Seedlings of relatively even growth from the first experiment (Experiment 1) were transplanted into polypots of equal dimension filled with different growth media namely; sawdust, fine sand, mixture and topsoil (control) only and replicated three (3) times making thirty (30) seedlings for each treatment. This makes the total number of seedlings to be one hundred and twenty (120). Watering was done once in a day during the duration of the experiment. The experimental design was laid out in completely randomized design (CRD) having four (4) treatments and replicated three (3) times. The experiment was conducted under a green shade to minimize loss of water. Seedlings were watered twice a day, in the morning and in the evening throughout the duration of the experiment. Weeds were removed manually by hands whenever they occurred. No fertilizer was applied to the seedlings.

2.4 Data Collection and Analysis

The emergence of seedlings and number of leaves were counted physically, seedling height was measured with a meter rule, stem and collar diameter (at the base of the stem) were determined with the aid of a veneer caliper.

2.5 Germination Parameters

- Germination percentage of seedlings $= \frac{\text{Number of seeds germinated}}{\text{Total number of seeds planted}} \times \frac{100}{1}$
- Emergence index = $\frac{\text{Number of seedling germinated per day} \times \text{Day after planting}}{\text{Total number of seedling germinated}}$
- Emergence rate index = $\frac{\text{Emergence index}}{\text{Germination percentage}}$
- Increment = highest value(week 8) − lowest value(week 5)

The data collected were computed and subjected to analysis of variance (ANOVA) by adopting the completely randomized design (CRD) using SPSS 16.0.The observed means were subjected to Duncan's multiple range for mean separation to determine the more suitable sowing medium on the germination and early growth performance of *Afzelia africana* seedlings.

3. RESULTS

3.1 Germination Indices of *Afzelia africana*

The result indicates that the first germination occurred on the 14th day after sowing, except for control which was on the 15th day of sowing (Table 1). The highest germination percentage was recorded in control (topsoil) (68%), this was followed by fine sand (56%) and the least was recorded in sawdust (40%). The highest emergence index was recorded in topsoil (9.38) while river sand had the least (2.58). For emergence rate index, sawdust was highest with (14.5) while the least was recorded in river sand with (5.38) (Table 1).

3.2 Growth Parameters

The results revealed that growth performance responded greatly to growth media. The highest seedling height (14.71 cm) was recorded in the mixture, followed by sawdust (14.28 cm), topsoil (control) (13.96 cm). The least was observed in fine sand (9.53 cm). The highest collar diameter was obtained in sawdust (0.63 cm), followed by topsoil (control) (0.45 cm) and mixture (0.44 cm). Fine sand recorded the least (0.42 cm).

The result indicates that the highest stem diameter was 0.49 cm in sawdust followed by fine sand (0.38 cm) and topsoil (control) (0.36 cm). The least was observed in the mixture (0.35 cm).The result shows that the effect of growth media was significant. The result also indicates that the highest leaf length (5.97 cm) was obtained in fine sand followed by the mixture (5.56 cm) and sawdust and topsoil (5.40 cm) (Table 3).

The statistical analysis indicates that there was no significant difference in the number of leaves recorded in each growth medium at 5% level of significance The result shows that the highest mean number of leaves was recorded in the topsoil (88), followed by the mixture (81) and fine sand (73). Sawdust had the least (49) (Table 3).

4. DISCUSSION

4.1 Germination Indices of *Afzelia africana*

The time taken for the first germination to occur is an indication that *A. africana* seeds exhibit some forms of dormancy which pre-treatment and suitable growing media was able to reduce the germination time. This agrees with the work of McDonald and Omoruyi [12] that pre-treatment increases and accelerates germination in seeds that exhibit dormancy. The number of days taken from the first germination in *A.africana* in this study is higher than the mean days recorded by Amusa [11] under different pre-treatments. However, the period is lower than the 21days taken by *Persea americana* as reported by Okunomo et al. [13]. The lowest germination percentage recorded in sawdust is similar to the work of Okunomo [14] with seeds of *Parkia bicolor.* This can be due to the fact that sawdust could contain poisonous compounds emanating from different species used [15].

4.2 Seedling Height

The highest seedling height in the mixture could be attributed to the high nutrient content of the treatment. The finding collaborates with the work of [16] who reported highest plant height of *Jatropha curcas* and [17] of *Adansonia digitata*

Table 1. Germination indices of *Afzelia africana* as influenced by different growing media

Treatments	Number of days taken for first emergence	Number of seeds germinated	Germination percentage (G %)	Emergence index (EI)	Emergence rate index (ERI)
Sawdust	14	20	40	5.8	14.5
River sand	14	24	48	2.58	5.38
Fine sand	14	28	56	4.32	7.71
Mixture medium	14	24	48	4.79	9.98
Control (topsoil	15	34	68	9.38	13.8

Table 2. Seedling perfomance of *Afzelia africana* as influenced by different growing media

Growth media	Seedling height	Stem diameter	Collar diameter
Sawdust	14.28 [a]	0.49 [a]	0.68 [a]
Fine sand	9.53 [b]	0.38 [b]	0.42 [a]
Mixture	14.71 [a]	0.35 [b]	0.44 [a]
Topsoil(control)	13.96 [a]	0.36 [b]	0.45 [a]

Means with different letters in column are significantly different (p≤0.05) using Duncan's multiple range test.

Table 3. Leaf length and number of leaves of *Afzelia africana* as influenced by different growing media

Growth media	Leaf length	Number of leaves
Sawdust	5.40[a]	49[a]
Finesand	5.97[a]	74[b]
Mixture	5.56[a]	81[b]
Topsoil(control	5.40 [a]	88[b]

Means with different letters in colum are significantly different (p≤0.05) using Duncan's multiple range test.

in the mixture. The result disagrees with Okunomo et al. [13] who recorded better increment in topsoil of *Persea americana*. This also contradicts the work of Dickens [18] who recorded better performance in river sand.

4.3 Collar and Stem Diameter

Studies have shown that growth media affect plant growth characteristics [17]. *A. africana* collar and stem diameters were significantly affected by the growing media. This is due to nutrient variation in the growing media. The diameters were higher in sawdust which shows an enhanced nutrient supply as decomposition increases [17]. These findings agree with the work of Omokhua et al. [19] who recorded least diameter in fine sand. The finding disagrees with the report of Mathowa et al. [20] who observed highest stem diameter of *Corchorus olitorius* in clay soil. The highest collar diameter observed in sawdust does not agree with the findings of Mathowa et al. [17] who obtained highest diameter of *Adansonia digitata* in the mixture and the work of Agbogidi et al. [21] of *Dacroydes edulis* in topsoil. The work contradicts the work of Mathowa et al. [22] who observed collar diameter of *Afzelia quanzensis* in top forest garden. This variation can also be attributed to species, involved.

4.4 Seedlings Leaf Length and Number of Leaves

The result of the study has shown that there was no significant difference in leaf length by the growing media. The high leaf length recorded in topsoil could be attributed to the presence of organic matter. The result of this study agrees with other findings [23-24]. This is because organic matter in growing media regulates water and nutrient availability which enhance seedlings production [25]. The high number of leaves recorded in topsoil is similar with the findings of Okunomo et al. [13] who relate it to the high water retention ability of the topsoil; this may be a possible reason for the result in this study. The result is in conformity with the work of Ngwuta et al. [16]. The finding agrees with the report of Agbogidi et al. [21] who reported number of leaves of *Dacryodes edulis* in topsoil. The work disagrees with [20] of *Corchorus olitorius* in the mixture. The result also contradict the work of Ndor et al. [26] who obtained higher number of leaves of *Telferia occidentalis* in sawdust.

5. CONCLUSION

The study has demonstrated that *Afzelia africana* seedlings responded differently to the various growth media, however topsoil and sawdust gave the best result with respect to all measured growth parameters of the species. It is recommended that mixture of topsoil + sawdust + river sand + fine sand could also be adopted by farmers for its domestication.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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