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Research Article

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Evaluation of Different Pre-Germination Treatments and Growth Media on Seed Emergence and Early Seedling Growth of Gum Arabic (Acacia Senegal)

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Abstract

The study investigated the effects of three (3) pre-treatment techniques and growth media on seed germination and seedling growth of gum arabic (Acacia senegal). The study consists of two experiments: The germination experiment and the growth experiment. The seeds were subjected to different pre-germination treatments. The treated and the untreated seeds (control) were sown in bowls previously filled with topsoil and watered for germination. The number of seeds germinated per day was monitored and recorded until no further germination was observed. For the early growth experiment, seedlings with relatively uniform height were selected from all the treatments and transplanted into polythene pots filled with different growth media (topsoil, river sand and sawdust) and arranged in Complete Randomized Design (CRD). Data collected was computed and subjected to analysis of variance at p = 0.05 and the mean was separated using the Duncan Multiple Range Test (DMRT). The results showed that all treatments had the same days of emergence (3 days). The highest germination rate (90.5%), was recorded for seeds soaked for 3 minutes in 80% acid concentration, while other treatments have lower germination percentages ranging from 13% to 80%. Topsoil showed a significant effect in the early growth of seedlings followed by sawdust and river sand respectively. Thus, 80% acid concentration soaked for 3 mins was recommended for pre-treatment of Acacia senegal seeds to improve germination performance, while topsoil was recommended as the best growth media for Acacia senegal seedlings.

Keywords: Pre-Germination, Growth Media, Seed Emergence, Early Growth, Acacia Senegal.

Introduction

Throughout the humid tropics, numerous woody species have provided the indigenous people with food, medicine, construction wood and various other services [1]. Currently, the majority of these products particularly medicinal plants are exploited extensively from the wild. Despite their numerous roles (provision of employment, income, food and rural health) their natural population has been diminishing both in size and gravity due to natural and human-induced factors [2]. With the high value of these plants, their propagation was been inhibited.

However, for plants to efficiently propagate, germination is a requirement. Effective and sustainable germination of seeds is usually affected by seed structures and environmental factors, a condition referred to as seed dormancy [3]. Though seed dormancy is often considered an impeding factor, many plants use it as a survival mechanism that ensures that germination occurs only during favourable conditions. Many forms of seed dormancy have been identified with the degree of dormancy varying depending on the species, genome and type of dormancy these include: physical, chemical, physiological, photo- or thermo-dormancy [4, 5]. Seed germination and early seedling growth phases are considered critical for raising a successful crop as they directly determine the crop stand density and the yield of resultant crop. It is a known fact that seed germination, seedling growth, and seedling survival percentage, are governed

by internal and external factors and are species-specific [6]. Many trees have been identified as fast-growing and categorized as high biomass yielders, while many other trees have seeds that possess hard coats that are nearly impermeable to water; thus, they cannot germinate or have a delayed germination under normal conditions [7].

Germination can be defined as the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question are indicative of the ability to produce a normal plant under favorable conditions [8]. In germination, the seed's role is that of a reproductive unit; it is the thread of life that assures the survival of all plant species. Furthermore, seed germination remains a key to forestry development because of its role in stand establishment. Thus, in a world acutely aware of the delicate balance between deforestation and world population, a fundamental understanding of seed germination and seedling growth is essential for maximum tree production and forest conservation.

Some seeds germinate a few days after fertilization and some before their normal harvesting time. Others are dormant and require an extended rest period or additional development before germination occurs. Depending on the species, this period may last for only a few days or for as long as several years. Acacia is one of the plants with a dense seed coat that usually takes a long time to germinate without some attempt to break through its exterior. Once the shell has undergone treatments, the germination success and speed greatly increase. Though sowing acacia seed without pre-treatments may still result in seedlings but its time-consuming. Therefore, a study on pre-treatment techniques that affect germination and early seedling growth of this tree species is required.

The main objective of this study is to evaluate the effect of different pre-germination treatments and growth media on seed emergence and early seedling growth of Acacia senegal. A successful field emergence is vital for crop production from seeds and maximum yield is often very dependent on successful germination of seeds and early growth. Acacia senegal seeds are covered in hard coats which make them shallowly dormant, they germinate slowly and over a narrow range of conditions if planted without undergoing a pre-treatment method. Because of this, pre-treating Acacia senegal seeds would increase the rate of germination, which in return would maximize its yield. The distribution of Acacia senegal in Nigeria is peculiar to the northern region. This is due to the environmental factors which is one of the characteristics of the plant, survival under adverse environment. The comparison of different soil media was done to determine the performance of the plant outside the northern region of the country.

Materials and Methods

Study Area

The study was carried out at the nursery site of the Department of Forest Resources Management, University of Ilorin. The nursery is geographically located on latitude 38' 30" and longitude 29' 30". Ilorin lies within a region described as a tropical climate and is characterized by double rainfall maxima [9].

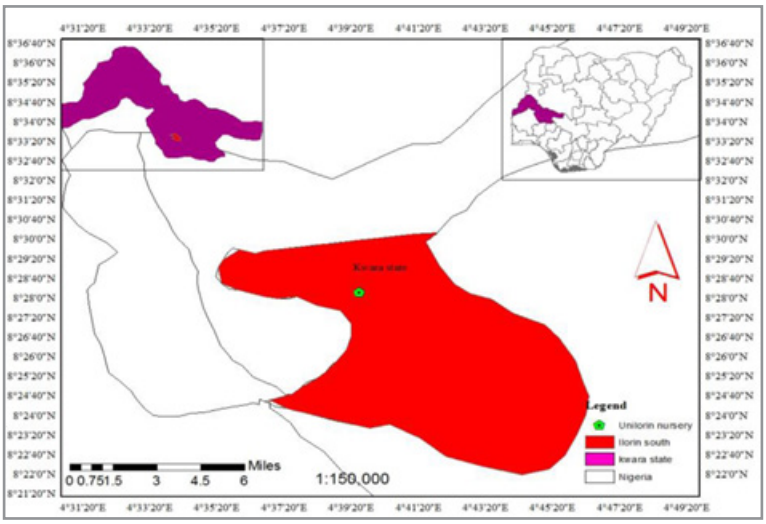

Plate 1: Map of the University of Ilorin Showing the Nursery Site

Seed Collection and Processing

Seed Procurement

The seeds were procured from Savanna Forestry Research Station, Forestry Research Institute of Nigeria, Zaria–Kaduna. The seeds were subjected to a seed viability test through the floatation method, the seeds that floated on the water were considered not viable while the ones that sank were collected and regarded as viable and further used in the study.

Experimental Procedure

Germination experiment

This consists of five (5) treatments; (tetraoxosulphate (vi) acid (80%) conc., tetraoxosulphate (vi) acid (60%) conc., hot water, cold water and control),

i. Cold Water Treatment: One hundred and twenty (120) seeds were put inside a container containing cold water at room tem-

perature. The seeds were soaked for 12 hours, then the seeds were drained and then sown into a perforated planting bowl containing topsoil.

ii. Hot Water Treatment: A hundred and twenty (120) seeds were placed in a container containing hot water heated to approximately 100° C and then left for 5 minutes. The seeds were drained and sown into a perforated planting bowl containing topsoil.

iii. Immersion in Concentrated Tetraoxosulphate (vi) acid (H2SO4): Two hundred and forty (240) seeds were used altogether for acid treatment. A hundred and twenty (120) seeds were first placed in a suitable container. Tetraoxosulphate (vi) acid (80% conc.) was poured on the seeds and allowed for 3 minutes, the seeds were then thoroughly rinsed under running water and sown into a perforated planting bowl containing topsoil. Another (120) seeds were placed in a suitable container. Tetraoxosulphate (iv) acid (60% conc.) was poured on the seeds and allowed for 5 minutes, the seeds were then thoroughly rinsed under running water and sown into a perforated planting bowl containing topsoil.

iv. Control: A total of one hundred and twenty (120) seeds without any treatment were sown into perforated planting bowls filled with topsoil. The number of seeds germinated per day was monitored and recorded for each treatment, till no further germination was observed. Once counted, the seedlings were tagged to avoid double counting.

Calculations

- Germination Percentage : $\frac{\text{Number of seeds germinated}}{\text{Total number of seeds planted}} \times 100$
- Mean germination time (MGT) = $\frac{\text{Number of seeds germinated per day X Day after planting}}{\text{Total number of seedlings germinated}}$
- First day of germination
- Last day of germination
- Time spread of germination = last day of germination – first day of germination

Growth Experiment

This consists of three treatments involving three (3) growth media (topsoil, river sand, and sawdust). Seedlings with relatively uniform height were selected from all the pre-germination treatments and were transplanted into polythene pots filled with different growth media (topsoil, river sand and sawdust). The treatments were replicated ten (10) times and arranged in a Complete Randomized Design (CRD). Growth parameters viz; (heights, stem diameter, number of leaves, and length of leaves,) were measured for eight (8) weeks.

Data Analysis

Data collected was computed and subjected to Analysis of variance {ANOVA} using Ms. Excel. at $p = 0.05$, to determine mean differences, while the mean was separated using Duncan Multiple Range Test (DMRT).

Results

Effects of Acid Pre-Treatments on Germination of Acacia Senegal Seed

The result in Table 1 shows that seeds treated with 80 % concentration of Tetraoxosulphate (vi) acid for 3 minutes had the lowest mean germination time (MGT) of 5.4 days, this was followed by seeds treated with 60 % concentration for 5 minutes (7.4 days). The seeds soaked in hot water had 7.9 days while seeds soaked in cold water had the highest MGT value (8.7 days). The result on the first day of germination (FDG) shows that all the seeds treated with acid and water germinated on the third day after sowing while the control treatment germinated on the fourth day.

The result shows that seeds soaked in hot water had the fastest germination completion on the twenty-third day after sowing, followed by seeds treated with 80 % and 60 % acid concentration on the twenty-fifth day. Seeds soaked in cold water had the longest LDG at 31 days, while the control treated had the shortest LDG at 7 days. Time spread of germination (TSG) shows that seeds under control treatment have the shortest germination circle of 3 days, while seeds soaking in cold water had the longest germination circle of 28 days.

Table 1: Effect of Different Pre-treatments on Germination of Acacia Senegal Seed.

Germination parameters	Hot Water	60% Acid Conc.	80% Acid Conc.	Cold Water	Control
MGT (days)	7.9	7.4	6.4	8.65	4.6
FDG (days)	3	3	3	3	4
LDG (days)	23	25	25	31	7
TSG (days)	20	22	22	28	3

MGT (Mean Germination Time); GP (Germination Time); FDG (First Day of Germination); LDG (Last Day of Germination) and TSG (Time Spread of Germination)

The result in Figure 1 shows that seeds treated with 80 % concentration for 3 minutes had the highest germination percentage (GP) of 90.5 %, this was followed by seeds soaked in cold water (80 %) and 60 % concentration for 5 minutes (74%), while the lowest GP was recorded for the control treatment (13%).

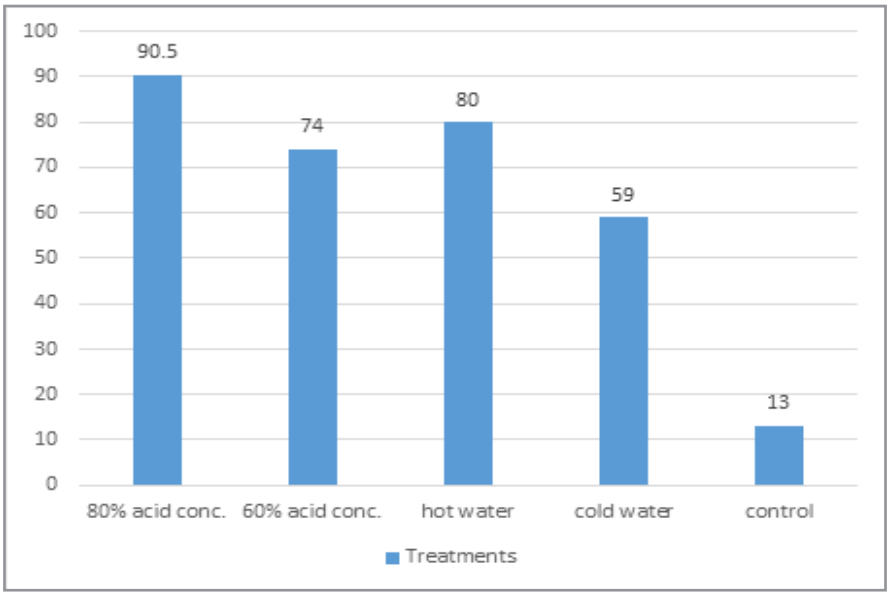

Figure 1: Percentage of Seed Germination of Acacia Senegal Seed

Effect of Different Growth Media on the Height of Acacia Senegal Seedling

Table 2 shows the results for seedlings' height under the different growth media. The result showed that seedlings grown on river sand had the highest height of 17.46cm at 4WAT. However, at 6 and 8WAT, the seedling height was significantly higher ($p<0.05$) with 27.20cm and 39.20cm respectively in seedlings grown on topsoil.

Table 2: Effect of Different Growth Media on the Height of Acacia Senegal Seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
TP	7.56±0.22b	11.70±1.09b	15.06±1.8b	27.20±1.94a	39.20±2.17a
SD	7.78 ±0.37b	9.74±0.59c	15.40±0.82b	22.42±0.61b	33.90± 0.82b
RS	8.26±0.59a	13.32± 0.78a	17.46± 0.75a	22.62±0.78b	27.06±1.81c

Key: TP = Topsoil, RS = River sand, SD = Sawdust

NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

Effect of Different Growth Media on the Stem Diameter of Acacia Senegal Seedling

Table 3 shows the result for seedling stem diameter of different growth media. The result shows that the collar diameter of seedlings grown on topsoil has the highest mean values throughout the growth period with 0.061cm at 8WAT. The collar diameter of seedlings grown on sawdust was significantly lower ($p<0.05$) with 0.045cm at 8WAT.

Table 3: Effect of Different Growth Media on the Stem Diameter of Acacia Senegal Seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
TP	0.04±0.00b	0.046±0.00a	0.052±0.00a	0.055±0.00a	0.061±0.00a
SD	0.04± 0.00a	0.042±0.00a	0.044±0.00b	0.044±0.00b	0.045±0.00b
RS	0.04± 0.00a	0.043±0.00a	0.049±0.00a	0.054±0.00a	0.059±0.00a

Key: TP = Topsoil, RS = River sand, SD = Sawdust

NB: Means with the same alphabets as superscript in the column are not significantly different (($p<0.05$).

Effect of Different Growth Media on the Number of Leaves of Acacia Senegal Seedling

Table 4 shows the number of leaves produced by seedlings under the different growth media. The result shows that seedlings grown on topsoil has the highest leaf number throughout the growth period. This was followed by seedlings grown on sawdust and river sand respectively. The result further shows that seedlings leaf number was not significantly different ($p<0.05$) at 2WAT for all the treatments. However, at 4, 6, 8WAT, seedlings leaf for river sand were significantly low ($p<0.05$).

Table 4: Effect of Different Growth Media on the Number of Leaves of Acacia Senegal Seedlings

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
TP	7.80 ±0.45a	11.20±1.30a	14.80±1.48a	20.60±1.82a	25.40±1.67a
SD	7.20±0.84a	10.80±1.30a	13.80±1.30a	16.60±1.67b	23.00±2.00 a
RS	7.20±0.84a	9.60±0.55a	10.60±1.14 b	11.00±2.55c	10.80±3.83 b

Key: TP = Topsoil, RS = River sand, SD = Sawdust

NB: Means with the Same Alphabets as Superscript in the Column are not Significantly Different ($p<0.05$)

Effect of Different Growth Media on the Leaf Area of Acacia Senegal Seedling

Table 5 shows the result for seedlings' leaf area under the different growth media. The result showed that leaf area was highest for seedlings grown on topsoil throughout the growth period. This was followed by sawdust and river sand. The result also showed that leaf area was not significantly different ($p<0.05$) for seedlings grown on sawdust and river sand throughout the growth period.

Table 5: Effect of Different Growth Media on the Leaf Area of Acacia Senegal Seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
TP	3.60±0.27b	6.88±0.99a	11.96±0.89 a	22.15±1.12 a	28.19±1.30 a
SD	2.63±0.54a	4.16±0.39b	7.06±1.66 b	11.02±2.94 b	12.50±2.93 b
RS	2.89±0.59a	4.67±0.67b	6.71±0.55b	8.62±0.60 b	11.69±1.35 b

Key: TP = Topsoil, RS = River sand, SD = Sawdust

NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

Discussion

The findings of this study showed that the seed germination of Acacia senegal improved when subjected to different pre-treatment methods. Seeds soaked in 80 % conc. of H_2SO_4 acid for 3 minutes gave the highest germination percentage (90%). This observation could be attributed to the highly desiccant effect of the acid on the seed coat which enhances the absorption of water by the embryo. This assertion further confirms the report of Olujobi et.al., [10] that acid pre-treatment is very effective in hastening germination by removing the waxy layer of the seed coat through a chemical reaction. The result further confirms that the more rapidly the seed coat ruptured the faster the seed germination [11]. The high percentage of germination obtained for acid-treated seeds in this study is similar to the findings of Azad et al., [12]. who reported early germination commencement day for Albizia lebbeck seeds?

This study also showed that the overall growth rate was best recorded under a topsoil growth medium. The observed better performance in all the growth parameters measured for the seedlings grown on topsoil over other growth medial could be attributed to the fact that topsoil is firm and well-structured and retains water better than sawdust and river sand. This observation had similarly been reported by Olujobi et.al., [10]. on the growth response of Albizia lebbeck seedlings in the topsoil. However, river sand and sawdust are not rich in plant nutrients like the topsoil thus, the seedlings could not derive nourishment for proper growth. This assertion agrees with the submission of [13]. who reported better growth in the seedlings of Afzelia africana grown on forest soil than river sand. The result is also in consonance with the findings of [14]. who related the positive effect of topsoil on seedlings' growth parameters to the high-water retention ability of the topsoil. Authors like [15-17]. similarly, attributed significant growth parameters of seedlings on topsoil to its high organic matter, better aeration and high-water retention capacity.

Conclusion and Recommendations

From the results of this study, it is evident that A. senegal seeds that were treated with 80 % conc. H_2SO_4 for 3 mins had the highest emergence percentage. This implies that using higher concentrations and reduced exposure time of seeds to acid treatment is effective in breaking the dormancy. The study has also revealed that Acacia senegal seedlings respond differently to the various growth media, however, topsoil and sawdust gave the best result for all measured growth parameters of the species. Based on the findings of the study, it is recommended that acid scarification with increasing concentration but minimal exposure should be adopted in pre-treating seeds of A. senegal to break seed dormancy for enhanced germination before planting. Also, topsoil should be used as appropriate growth media for raising A. senegal seedlings in the nursery for plantation establishment.

Reference

1. Adebooye OC, Ajayi SA, Baidu-Forson JJ, Opabode JT (2005) Seed constraint to cultivation and productivity of African indigenous leaf vegetables. African Journal of Biotechnology 4: 1480-1484.
2. Odetola, T, Etumnu C (2013) Contributions of Agriculture to Economic Growth in Nigeria. International Food Policy Research Institute (IFPRI), Abuja, Nigeria.
3. Chahooki Z, Ali M (2010) The effect of different treatment on improving seed germination characteristics in medicinal species of Descurainia sophia. African Journal of Biotechnology 9: 6588-6593.
4. Zoghi Z, Azadfar D, Kooch Y (2011) The effect of different treatment on seeds dormancy breaking and germination of Caspian locust (Gledistschia capsica) tree. Ann Biol. Res 2: 400-406.
5. Mwase WF, Mvula T (2011) Effect of seed size and pre-treatment methods of Bauhinia thonningii schum on

germination and seedling growth. African journal of Biotechnol 10: 5143-5148.
6. Hossain MA, Aref MK, Khan BM, Rahman MA (2005) effects of seed treatments on germination and seedling growth attributes of Horitika (Terminalia chebula Retz.) in the nursery,"Research Journal of Agriculture and Biological Sciences 1: 135-141.
7. Satya Narayan Hota1, Ajay Kumar Karna, Bharat Kumar Dakhad, Jain PK (2005) Influenced by selected nursery growth media. International Journal of Agriculture and Rural Development 19: 2506-2510.
8. Gunaga RP, Doddabasava D, Vasudeva R (2011) Influence of seed size on germination and seedling growth in Mammea suriga. Karnataka Journal of Agriculture and Science 24: 415-416.
9. AOSA (2000) Association of Official Seed Analysts. Jack Peter (Eds). Tetrazolium testing handbook 29: 32.
10. Olanrewaju RM (2009) Climate and Growth Circle of Yam Plant in the Guinea Savanna Ecological Zone of Kwara State. Journal of Meteorology and Science 7: 43-48.
11. Olujobi OJ, Thompson ZO, Faniseyi AS (2022) Effect of acid pre-treatment and potting media on seed germination and early seedling growth of Albizia Lebbek. GSC Biological and Pharmaceutical Sciences 20: 293-298.
12. Olujobi OJ, Olayode OO, Dahunsi OM (2010) Breaking seed dormancy in Afzelia africana (Sm.ex Pers) toward plantation establishment for sustainable production. Proceedings of 33rd Annual Conference of the Forestry Association of Nigeria held in Benin City, Edo State Nigeria 205-212.
13. Azad MS, Islam MW, Matin MA, Barl MA (2006) Effect of pre-sowing treatment on seed germination of Albizia lebbeck(L) Bench. South Asian Journal of Agriculture 1: 32-34.
14. Olujobi OJ, Dahunsi OM (2010) Comparative effect of potting soils from different sources on early growth of Afzelia africana seedlings. Journal of Researches in Agricultural Sciences 2: 82-86.
15. Okunomo K, Ogisi DO, Bosah BO (2009) Effect of growth media on germination and seedling growth of Persea americana (mill.). Journal of Food Agriculture & Environment 7: 111-113.
16. Ngwuta AA, Peter-Onoh CA, Obiefuna JC, Chigbundu NI, Nwokeji EM, et al. (2016) Juvenile phenology of Jatropha curcas as
17. Agbogidi OM, Eruotor PG, Akparobi SO (2007) Effects of Time Application of Crude Oil to Soil on the growth of Maize. Res. J. Environ. Toxicol 1: 116-123.