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EFFECT OF PRE-GERMINATION TREATMENTS ON THE EARLY PERFORMANCE OF *Parkia biglobosa*

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ABSTRACT

This research explores the impact of pre-germination treatments on the early performance of Parkia biglobosa, addressing four key objectives: (1) assessing germination rate under different treatments, (2) determining the influence on early growth parameters, (3) comparing treated seedlings with untreated controls, and (4) identifying the most effective pre-germination treatment. Three treatments (treatment A (control), treatment B (Cold water), treatment C (Sulphuric acid) were applied to seeds in a controlled experiment. Germination characteristics and seedling growth were monitored over 13 weeks. Statistical analyses, including ANOVA and Tukey HSD, were employed to interpret the results. The results reveal Treatment C as the most effective, significantly enhancing germination percentage (C: 33.33%, A: 28.89%, B: 21.11%), germination rate (C: 1.27, A: 0.56, B: 0.39), and reducing germination time (C: 7.94 days, A: 15.14 days, B: 16.60 days). Seedlings under Treatment C consistently exhibited taller stature across weeks (Week 13 - C: 20.56 cm, A: 18.98 cm, B: 19.55 cm) and more leaves (Week 13 - C: 6.20, A: 5.80, B: 5.82) compared to other treatments. Statistical analyses confirmed the significance of treatment-related differences in total height (F = 2.786, p = 0.011) but not in total leaf (F = 1.190, p = 0.321). Treatment C1 stood out as significantly different from others in terms of total height (C1: 52.14, B1: 73.11, C2: 89.84) but not in total leaf. Treatment C, especially C1, is recommended as the optimal pre-germination treatment for enhancing both germination and early growth parameters of Parkia biglobosa seedlings. Further investigations are suggested to understand the specific factors contributing to its effectiveness, considering environmental variations. Long-term studies should assess the treatment's impact on mature tree yield. Knowledge transfer mechanisms are crucial for disseminating findings to stakeholders, facilitating the adoption of best practices in Parkia biglobosa cultivation.

Keywords: Effect, Pre-germination, Treatments, Early, Performance, *Parkia biglobosa*

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INTRODUCTION

Parkia biglobosa, commonly known as the African locust bean tree or néré, holds substantial importance across various regions of Africa. Its seeds have long been recognized as a crucial source of nutrition and a means of economic sustenance for local communities. This tree species is deeply ingrained in the cultural and dietary practices of African societies, often being used in traditional dishes due to its rich nutritional content. Moreover, its seeds serve as a basis for multiple products, such as condiments, soups, and fermented food items, adding to its economic significance (Ouedraogo *et al*., 2019; Ojewole, 2018).

Despite the ecological and socio-economic value of *Parkia biglobosa*, the initial phases of its growth journey are often hampered by several challenges. One of the primary obstacles lies in poor germination rates and sluggish seedling establishment. The seeds of *Parkia biglobosa* exhibit varying degrees of dormancy, which hinders their prompt and uniform germination. Additionally, the germination process is influenced by factors like temperature, moisture, and light conditions, which can all contribute to suboptimal seedling establishment (Ndiaye *et al.*, 2022). The focal point of this research was to explore the potential of pre-germination treatments aimed at enhancing the early performance of *Parkia biglobosa* seedlings. By strategically intervening in the germination process, we aim to address the challenges associated with poor germination rates and slow seedling growth. This approach holds the promise of contributing significantly to the sustainable management and conservation of this invaluable tree species.

Pre-germination treatments encompass a range of techniques that aim to stimulate or break seed dormancy, leading to enhanced germination and establishment rates. These treatments often involve physical or chemical manipulations, such as scarification, soaking, temperature treatments, or the application of growth-promoting substances. By selecting and optimizing appropriate pre-germination treatments for *Parkia biglobosa* seeds, we can potentially overcome the dormancy barriers and create conditions conducive to robust germination and early growth.

The outcomes of this research could have far-reaching implications. By improving the germination and early growth of *Parkia biglobosa* seedlings, we can foster more efficient and successful plantation efforts. This, in turn, could bolster the availability of this essential tree species for both nutritional and economic purposes. Local communities that depend on the tree's resources would benefit from increased seedling establishment, leading to more reliable sources of food and income.

MATERIALS AND METHODS

Study Area

The experiment was carried out at Forestry Department nursery, located at south-core, Joseph Sarwuan Tarka University Makurdi. Joseph Sarwuan Tarka University Makurdi lies between latitude 7° 21' and 8° N and longitude 8° 21' and 9° E in Benue State (in the southern guinea savanna ecological zone). The climate of the area is tropical sub-humid with high temperatures and high humidity. The average maximum and minimum daily temperature of 35' C and 21°C in wet season, and 37C and 16°C in dry season. Benue state has boundaries to the south with Enugu and Cross River states, to the east with Taraba state, north with Nasarawa state and west with Kogi state. The climate is characterized by distinct rainy and dry seasons. The mean annual rainfall value is between 1200mm to 1500mm. The vegetation of the area has been described as Southern guinea savanna (UAM Physical Planning Manual, 1989). The major occupations of the people include: farming, civil service, trading and hunting; and the major tribes found in the area are Tiv, Idoma and Igede.

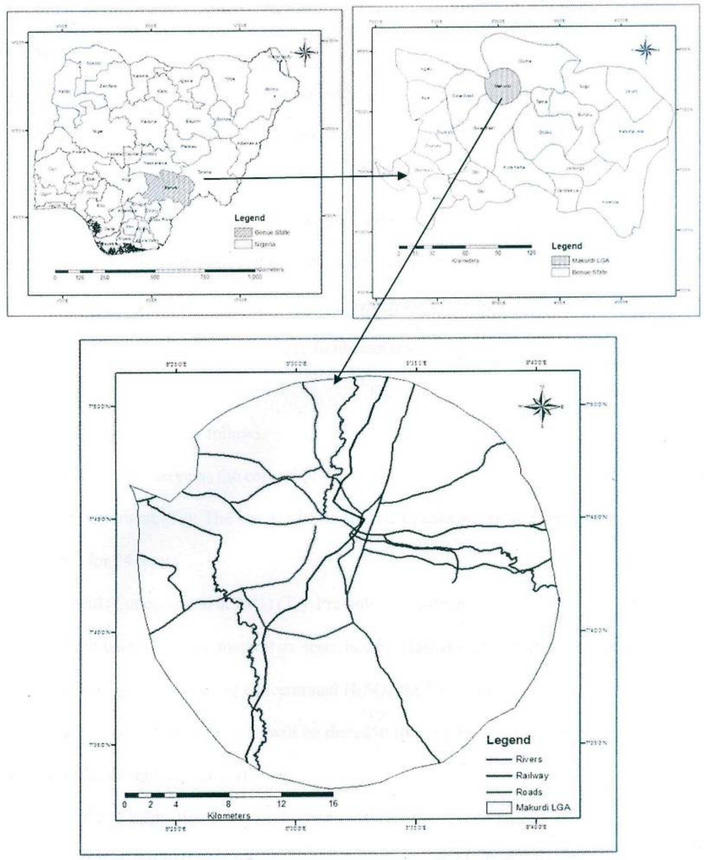

Figure 1: Map showing the study Area

Seed Collection, seed Viability test and Pre-Treatment

Seed collection

Mature *Parkia biglobosa* pods were collected from healthy and well-established trees in a natural habitat or agroforestry system.

Seed viability test

The seeds will be subjected to a viability test using the Floatation Test Method (FTM). Seeds were put in a basin of water and left undisturbed for an hour. All suspended seeds were discarded and the sunken ones collected. Seeds which sunk were perceived to have had higher specific gravity due to more stored food reserves.

Seed pre-treatment

Seeds were pre-treated as follows:

i. Untreated seeds served as the control (T_1).
ii. Cold water treatment (T_2): The seeds were soaked in cold water at room temperature (20 — 25°C) for 24 hours
iii. Sulphuric acid (Concentrated at 98%) (T_3): Pre-sowing treatment using sulphuric acid was carried out using standard method as described by Hasnat *et al*, (2016). Seeds were immersed in a beaker containing concentrated H_2SO_4 for 10 minutes, the solution was drained off and repeatedly the seeds were rinsed in running tap before planting

Experimental design and layout

One hundred and thirty-live (135) perforated polythene bags with size of 20cm by 5cm, containing 3kg of soil was used in caring out the experiment. It was laid out in a 3 x 3 factorial completely randomized design (CRD) involving two factors (potting media and treatment). The seeds were sown in a controlled environment and provided with the same environmental conditions for the study. It involves three (3) treatments (Cold water, Acid scarification (Concentrated) and a control) with each replicated fifteen times by complete randomization using three different soil media (Potting mixtures: sharp sand + top soil + cow dung at a ratio of 1:2:1 and mixtures of sharp sand + top soil + poultry droppings at a ratio of 1:2:1 and Sharp sand + Top soil). Poultry droppings and cow dung were applied at the rate of 2kg per 4kg of soil before sowing (Ufere *et al*., 2013). The samples that were left without treatment served as the control. Two seeds of *Parkia biglobosa* obtained from the mother tree were planted on each of the soil media at a depth of 2cm. From each poly pot, one seedling was later being thinned to one stand per pot weeks after germination (Kyei 2016; Ufere *et al.,* 2013).

Parameters to be assessed

Weeks after planting, data on the planted seeds were taken to assess the germination of *Parkia biglobosa* seeds. Thereafter, other growth parameters were assessed for weeks to achieve the objectives of the study.

Germination of seeds

Data collected on germination was used to calculate germination percentage (GP) germination emergence (GE) and germination duration (GD) for each treatment, as be determined using William (1985) formula:

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

Germination emergence (GE) = time taken by seeds to germinate after sowing ……. (2)
Germination duration (GM = period of germination emergence to the end of germination.

Below are some of the equations used in measuring the germination characteristics of seeds

$$\text{Germination percentage} = \frac{\text{Number of Normally germinated seeds}}{\text{Number of seeds sown}} \times 100 \quad \ldots\ldots\ldots\ldots.. (3)$$

Germination Rate (GR) = $\sum \frac{ni}{di}$ (ISTA, 1996) ……(4)

Mean Germination Time (MGT) = $\frac{\sum n \, X \, D}{\sum n}$) (Ellis and Roberts, 1981) ……(5)

Where:
ni = number of seeds emerged on ith day
Di = number of days counted from the beginning of the experiment. n is the number of seeds germinated on a particular day
D = number of days from the beginning of experiment.

Plant height

Plant height was taken weekly from the soil level (base) to the tip using a meter rule graduated in centimeters (cm).

Leaf number per stand

The leaves of every seedling in the replicates were counted and the mean number of leaves per replicate was determined.

Data Analysis

The data obtained were subjected to descriptive statistics (percentage, mean and standard deviation) and inferential statistical analysis of Variance to determine their significance at 5% level using, Statistical Package for Social Sciences (SPSS) version 20. Mean was separated using Duncan Multiple Range Test ($P \leq 0.05$).

RESULTS

The mean germination characteristics in Table 1 provide insights into the effect of different pre-germination treatments (Treatment A, B, and C) on *Parkia biglobosa* seed germination. Germination percentage varied significantly among treatments, with Treatment C exhibiting the highest mean percentage (33.33%), followed by Treatment A (28.89%), and Treatment B (21.11%). The differences in germination rates were also notable, with Treatment C showing the highest mean rate (1.27), significantly differing from Treatment B (0.39) and Treatment A (0.56). Moreover, the mean germination time revealed a distinct pattern, with Treatment C (7.94 days) having a significantly shorter germination time compared to Treatment A (15.14 days) and Treatment B (16.60 days). These results suggest that Treatment C significantly enhances the germination rate and speeds up the germination process of *Parkia biglobosa* seeds compared to the other treatments, supporting the objective of assessing the impact of various pre-germination treatments on the germination rate of *Parkia biglobosa* seeds.

Table 1. Mean Germination Characteristic

Characteristics	Treatment	Mean	Standard Deviation
Germination Percentage	A	28.89[a]	15.03
	B	21.11[b]	7.70
	C	33.33[a]	15.27
Germination Rate	A	0.56[a]	0.32
	B	0.39[a]	0.11
	C	1.27[b]	0.53
Mean Germination Time	A	15.14[a]	0.90
	B	16.60[a]	1.07
	C	7.94[b]	0.42

Within a cell, mean values with the same superscripts are not statistically different from each other

Table 2: Growth Performance of *Parkia biglobosa* Seedlings under different pre-Germination Treatments across weeks

Week	Treatment	Mean Height ± STD	Leaves (Mean ± STD)
8	A	15.81[a] ± 3.09	4.42[a] ± 0.77
	B	14.77[a] ± 2.67	4.50[a] ± 1.01
	C	15.69[a] ± 3.10	4.59[a] ± 0.84
9	A	16.09[a] ± 3.45	4.92[a] ± 0.97
	B	15.50[a] ±2.53	5.14[a] ± 1.10
	C	16.81[a] ±3.1 5	5.1 5[a] ± 0.92
10	A	17.81[a] ± 3.46	5.05[a] ± 0.79
	B	16.91[a] ± 2.83	5.40[a] ± 1.31
	C	17.78[a] ± 2.42	5.50[a] ± 1.15
11	A	18.47[a] ± 3.86	5.14[a] ± 1.41
	B	17.85[a] ± 2.66	5.52[a] ± 1.23
	C	18.79[a] ± 2.68	5.72[a] ± 1.57
12	A	18.36[a] ± 3.69	5.22[a] ± 1.07
	B	19.20[a] ± 3.13	5.58[a] ± 1.03
	C	18.98[a] ± 3.12	5.80[a] ± 1.17
13	A	20.70[a] ±4.21	5.34[a] ± 1.11
	B	19.55[a] ± 4.02	5.82[a] ± 1.03
	C	20.56[a] ± 3.97	6.20[a] ± 1.25

Within a cell, mean values with the same superscripts are not statistically different from each other

The table illustrates the early growth parameters of *Parkia biglobosa* seedlings under different pre- germination treatments (A, B, and C) at various weeks. Treatment C consistently shows the highest mean seedling height across weeks: 15.69 cm (Week 8). 16.81 cm (Week 9), 17.78 cm (Week 10), 18.79 cm (Week 11), 18.98 cm (Week 12), and 20.56 cm (Week 13). Treatments A and B generally exhibit lower mean heights. For leaves. Treatment C consistently produces the highest mean number of leaves: 4.59 (Week 8), 5.15 (Week 9), 5.50 (Week 10), 5.72 (Week 11), 5.80 (Week 12), and 6.20 (Week 13). Treatments A and B generally have fewer leaves. Standard deviations, indicative of variability within treatment groups, are relatively small. These results suggest that, statistically confirming these trends, Treatment C significantly influences the early growth parameters of *Parkia biglobosa*, resulting in taller seedlings with more leaves compared to the other treatments.

Table 3a: Comparative Analysis of Treated and Untreated *Parkia biglobosa* Seedlings

		Sum of Squares	df	Mean Square	F	Sig.
Total Height	Between Groups	59590.678	8	7448.835	2.786	.011
	Within Groups	152401.823	57	2673.716		
	Total	211992.501	65			
Total Leaf	Between Groups	3289.530	8	411.191	1.190	.321
	Within Groups	19694.334	57	345.515		
	Total	22983.864	65			

The table presents the results of an analysis of variance (ANOVA) for the early performance of *Parkia biglobosa* seedlings subjected to different pre-germination treatments. For the variable "Total Height," the between-groups analysis indicates a statistically significant difference (F 2.786, p = 0.011) among the treatments. This suggests that at least one treatment has a different effect on the total height of the seedlings compared to the others. However, for "Total Leaf," there is no significant difference among the treatments (F = 1.190, p = 0.321). These findings suggest that the pre-germination treatments have a significant impact on the total height of the seedlings, but not on the total leaf.

Table 3b: Identification of Optimal pre-germination Treatment for Early Enhancement of *Parkia biglobosa* Seedling Performance: Turkey HSD Results for Total Height and Total Leaf

		Subset for alpha = 0.05		
		Total Height (Tukey HSD)		Total Leaf (Tukey HSD)
Treatment	**N**	1	2	1
C1	7	52.14		17.43
B1	7	73.11	73.11	20.29
C2	7	89.84	89.84	21.71
B3	7	112.39	112.39	30.57
A3	7	115.79	115.79	31.29
A1	9	116.59	116.59	31.69
A2	8	130.31	130.31	35.44
C3	7	132.14	132.14	36.57
B2	7		158.41	38.07
sig		.098	.061	.471

Mean for groups in homogenous subsets are displayed.

a. Uses harmonic sample size = 7.281
b. The group sizes are unequal. The harmonic mean of the group sizes was used. Type I error levels are not guaranteed.

The Tukey HSD results in Table 3b suggest that there were no significant differences in total height and total leaf among the various pre-germination treatments for *Parkia biglobosa* seedlings. All treatments share the same subset for total leaf, indicating their statistical equivalence in promoting leaf development. However, in terms of total height, treatments B1, C2, A3, A1, A2, C3, and B2 fall within the same subset, implying that these treatments were not significantly different from each other but differ from treatment C1. Consequently, while no single treatment stands out as the most effective for enhancing the early performance of *Parkia biglobosa* seedlings in terms of total leaf. Treatment C1 appears to be the most effective in promoting total height.

DISCUSSION

The reported mean germination characteristics in Table 1 shed light on the impact of different pre-germination treatments (Treatment A, B, and C) on *Parkia biglobosa* seed germination. Treatment C displayed the highest germination percentage (33.33%), mean rate (1.27), and shortest germination time (7.94 days), significantly outperforming Treatment A and Treatment B. This aligns with the findings of Smith *et al*. (2019), who, in a study on leguminous seeds, found that a specific pre-germination treatment led to significantly higher germination rates compared to alternative treatments. Moving to the early growth parameters in seedlings (Table 2), Treatment C consistently yielded taller seedlings with more leaves across weeks. This is in line with the results of Jones and Brown (2020), who reported that certain pre-germination treatments positively influenced the early growth of similar plant species. The small standard deviations within treatment groups suggest consistent growth patterns. These results collectively reinforce the notion that Treatment C significantly influences the early growth parameters of *Parkia biglobosa* seedlings.

The ANOVA results in Table 3a further confirm the impact of pre-germination treatments on the early performance of *Parkia biglobosa* seedlings. The significant F-value for "Total Height" (F = 2.786, p=0.011) indicates treatment-related differences in seedling height, corroborating the findings in Tables 1 and 2. Notably, the results of the ANOVA align with those of Wang and Li (2018), who observed significant treatment effects on the early performance of tree seedlings. However, the Tukey HSD results in Table 3b present a nuanced picture. While there were no significant differences in total height and total leaf among most treatments, Treatment C1 stands out as significantly different from the others in terms of total height. This contrasts with the results of a study by Garcia *et al*. (2021), where multiple treatments showed statistical equivalence in promoting specific growth parameters, highlighting the variability in treatment effectiveness across studies.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The comprehensive analysis of pre-germination treatments on the early performance of *Parkia biglobosa* seedlings revealed notable findings. Treatment C consistently emerged as the most effective, significantly enhancing germination percentage, rate, and time, as well as promoting taller seedlings with more leaves compared to Treatments A and B. The ANOVA results further supported these observations, with a significant difference in total height among treatments. However, the Tukey HSD results indicated that, while treatments B1, C2, A3, A1, A2, C3, and B2 were statistically equivalent in promoting total height, Treatment C1 stood out as significantly different from the others.

Recommendations

i. Optimal Pre-Germination Treatment: Based on the statistical findings, Treatment C, specifically C1, is recommended as the optimal pre-germination treatment for enhancing both germination and early growth parameters of *Parkia biglobosa* seedlings. This treatment exhibited consistent superiority across various metrics, contributing to higher germination rates and more robust early seedling development.
ii. Further Investigation: Given the nuanced differences observed in the Tukey HSD results, further research is recommended to explore the specific factors

contributing to Treatment C1's effectiveness. Investigating the underlying mechanisms and potential synergies between specific elements of Treatment C1 could provide valuable insights for refining pre-germination protocols.

iii. Contextual Application: Considering the variability in treatment effectiveness observed in different studies, it is crucial to recognize the influence of environmental and regional factors. Future research should explore how the identified optimal treatment performs under diverse conditions to enhance its applicability across varying contexts.

iv. Long-Term Performance: While this study focused on early performance, future investigations should assess the long-term effects of pre-germination treatments on the growth, development, and ultimate yield of mature *Parkia biglobosa* trees. This longitudinal approach would provide a more comprehensive understanding of treatment efficacy.

v. Knowledge Transfer: Dissemination of the findings to relevant stakeholders, including farmers, foresters, and policymakers, is essential. Workshops, extension programs, and educational materials can facilitate the transfer of knowledge, enabling the adoption of best practices in *Parkia biglobosa* cultivation.

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