Asian Journal of Research in Botany

7(2): 28-43, 2022; Article no.AJRIB.85825

Influence of Seed Priming Method on Seedling Growth of Some Sudan Savannah trees in Yobe Stsate, North-Eastern Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/85825

Original Research Article

Received 26 January 2022
Accepted 06 April 2022
Published 12 April 2022

ABSTRACT

This research work was carried out to evaluate the effect of different seed priming methods on germination percentage and seedling growth of *Prosopis africana* and *Pterocarpus erinaceus*. Nursery experiment was conducted at Biological Garden Yobe State University, Damaturu. The experiment was laid in completely randomized block design with 100 seeds were planted with Ten (10) seeds per treatment and each replicated three (3) times, treatment employed consist of sundrying and seeds soaking in cold water for 24 hours, seeds soaking in (H_2SO_4) for 5 minutes, seeds soaking in boiling water at 100^oC for 5 minutes and Control. Growth parameters assessed were Germination percentage, Plant height, Stem girth, Number of branches, Number of leaves and leaf area. The data collected was analyzed using analysis of variance (ANOVA). The results revealed that, *Prosopis africana*, had highest germination percentage of 42.5% in seeds immersed in 98% (H_2SO_4) for 5 minutes with Highest mean values of Plant height (9.90±0.89^a), Stem girth (1.23±0.05^a), Number of branches (10.19±0.67^a), Number of leaves (147.00±14.33^a) and Leaf area of (0.43±0.04^a). In *Pterocarpus erinaceus*, the highest germination percentage was 15% and recorded in seeds treated by Sundrying and immersing in cold water for 24 hours with highest mean values of Plant height (9.75±0.36^a), Stem girth (1.10±0.11^a) Number of branches (8.00±1.20^a), Number of leaves (12.50±2.79^a) and Leaf area (1.38±0.58^a). This study concluded that treatment of seeds with 98% (H_2SO_4) to be extended from 5 minutes to 35 - 40 minutes is the most effective method to improve percentage germination in *Prosopis africana* while treatment of seeds by sundrying and immersing in cold water for 24 hours to be extended from 24 - 72 hours is the most effective method to improve germination percentage of *Pterocarpus erinaceus*.

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Keywords: Seed priming; sudan savannah; Prosopis africana; Pterocarpus erinaceus.

1. INTRODUCTION

Forest degradation and deforestation and have been factors that threaten forest productivity and sustainability [1] coupled with impending and increasing demand for forest and forest resources as a result of increasing world population [2]. The rate at which forest is disappearing is such that it can no longer sustain the demand on it for timber, food and other forms of livelihood. The indigenous plants with high economic value are coming under intense exploitation pressure [3]. Sudan savannah plants are overexploited at a rate faster than reforestation which competes with other land uses such as food production, livestock grazing, and living space for further economic growth [4]. When humans alter the landscape, as they do through cropping, ranching or urbanization, the system become more vulnerable to climatic variability, particularly droughts [5].

The vegetation cover of the savanna is economically and medicinally important as a large number of Africans used medicinal and aromatic plants that are known to be reservoirs of curative elements in treatment of various diseases ranging from malaria, diabetes, mental disorders, cancer and hypertension [3]. According to the World Health Organization (WHO), more than 3.5 billion people in the developing world rely on medicinal plants as components of their healthcare needs [6].

Seed propagation is one of the most important stages in the life cycle of plants and it is initiated when the apparent metabolic dormancy of desiccated seeds is disrupted by imbibitions [7]. Seed is considered as the ripened ovule which comes out due to proper fertilization. A matured seed consists of seed coat and embryo which is the young plant enclosed within the seed coat. The major storage of food materials of seeds include carbohydrate, lipids, protein which provide energy and other nutritional requirements of the growing embryo [8]. Seeds require vital conditions for germination such as supply of oxygen, water and favorable temperature and light. Seed of many plant species cannot germinate despite favorable environmental conditions such as light, temperature, moisture and oxygen required for germination as a result of seed dormancy. Seed may also be dormant for a variety of reasons, including seed immaturity at fruit harvest, low seed coat permeability to water and or oxygen, seed coat resistance to embryo growth, presence of metabolic in embryo and various combination of the afore-mentioned [9]. Many seeds have difficulty in germination such that their propagation is adversely affected by seed coat dormancy leading to poor growth potential. One of such indigenous plants is *Pterocarpus erinaceus* seed which is being threatened of going into extinction because of its inability of not been able to germinate under natural condition.

Seed dormancy is a physiological phenomenon in wild and crop plants, and is more common in wild plants than the crop plants [10]. Dormancy can be causing keep some plant species in particular environmental conditions, and one of the most important survival mechanisms in plants, is their ability to delay seed germination until conditions of the location and time be suitable for germination. Dormancy breaking is very important when rapid germination is required after sowing [8].

Most species of the *Fabaceae* family, timing and extent of seed germination are primarily controlled by physical seed dormancy induced by the development of an impermeable testa or seed coat [7]. This type of dormancy can be overcome through treatments that weaken or rupture the seed coat, allowing water absorption and the onset of germination [10]. Immersion in hot water for a few minutes, mechanical scarification with sandpaper, and chemical scarification with sulphuric acid are methods successfully used to overcome seed dormancy in seeds of some tropical plant species. The degree of dormancy makes it difficult for seed to germinate evenly and adequately. Scarification in botany involves cutting the seed coat using abrasion, thermal stress or chemical to encourage germination. In mechanical scarification, the seed coat is physically opened to allow moisture and air to penetrate into the seed. Seed coat can be filed with metal file, rubbed with sand paper, nicked with a knife, cracked gently with a hammer or any possible form of physical abrasion to weaken and open the seed coat. Acid scarification involves the use of chemical such as H_2SO_4, HNO_3 and HCl. This is achieved by imbibing, soaking seeds in concentrated acid solution at appropriate concentration and duration of treatments. Treatments with Sulphuric acid were reported to have been used successfully to overcome

dormancy in forest seeds However, each species requires a specific seed scarification period (acid exposure time), resulting from differences in thickness and chemical composition of the seed coating [11].

However, Sudan Savannah plant species are overexploited at the rate faster than reforestation which competes with other land uses such as food production, livestock grazing, and living space for further economic growth. However, many seeds have difficulty in germination such that their propagation is adversely affected by one form of dormancy leading to poor growth potential. Therefore, to improve the germination properties of seeds, different treatments will be tested.

Therefore, the study was aimed at assess the effectiveness of pre-sowing treatments on the germination and early seedling growth of *Pterocarpus erinaceus and Prosopis africana.*

2. MATERIALS AND METHODS

2.1 Study Area

Yobe state is one of the six states that form the North East geopolitical zone. The state occupies a land mass of 47,153 square kilometers and a population of 2,757,322 people spread across 17 LGAs [12]. It shares borders with Borno State from the east, Gombe State from the south and Jigawa and Bauchi States to the west. Its northern border is shared with the Republic of Niger. Yobe is classified 6th out of the 36 states of Nigeria in terms of size [13]. The state is characterized by semi-arid savannah vegetation with considerable long period of hot season (maximum average temperature of 38 ºC to 42 ºC) with an apparent desertification, which makes most parts of the State sandy during the dry season and muddy in the rainy season as a result of which, the environment is mostly difficult and communities classified as “hard to reach” [13].

2.2 Sample Procurement and Authentication

The Seeds of *Pterocarpus erinaceus* (Rosewood) and *Prosopis africana* (Iron tree) plants were collected from Potiskum L.G.A of Yobe State, North-Eastern Nigeria. The seeds were identified and authenticated by a specialist in the Department of Biological Sciences, Yobe State University Damaturu. However, Nursery experiment was conducted at Biological Garden Yobe State University, Damaturu (Fig.1).

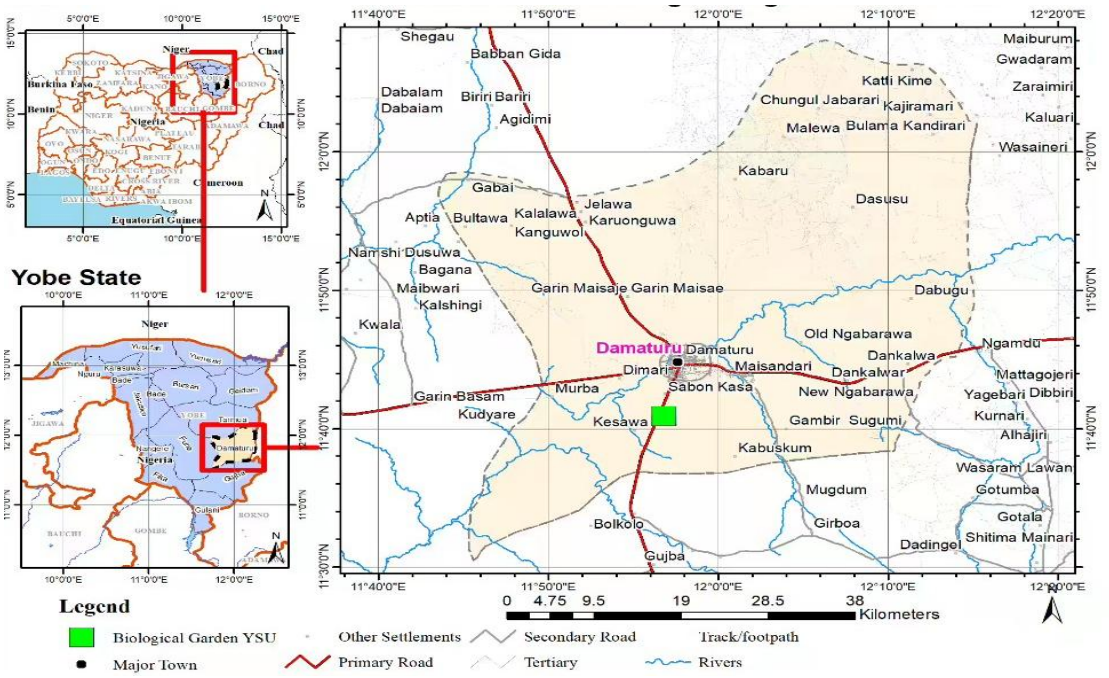

Fig. 1. Map of Yobe State indicating Study Site
Source: (Field work, 2021)

2.3 Seed Viability Test

The Seeds were subjected to a viability test using the *floating test method*.

2.4 Parameters Measured

The following are the parameters were measured: germination count, germination percentage, plant height, number of branches and leaf, stem girth and leaf breadth [7].

Germination count: - Number of seeds germinated were counted daily.
Germination percentage: - The germination percentage was derived as the ratio of number of seed germinated to the total number of seed planted multiply by 100. The formula shown below:

$$G\,\% = \frac{\text{Total number of seeds germinating}}{\text{Total number of seeds sowed}} \times 100$$

Plant height: - This parameter was measured with aid of graduated ruler.
Stem girth: - The diameter of each seedling was taken from the base of the first leave with aids of thread and graduated ruler.
Numbers of branches and leaves: - These were carried out by physical counting of the number of branches and leaves on each seedling.
Leaf breadth: - This was measured with the aid of graduated ruler.

2.5 Treatments (T1-T3)

1. **(T1)** The Seeds was sundried, then soaked in beaker containing cold water and left for 24 hours.
2. **(T2)** The Seeds was put in a beaker containing boiled water for 5 minutes before it was removed.
3. **(T3)** The seeds was placed in an empty beaker, then concentrated sulphuric acid was poured into the beaker. The seeds were fully immersed and left in the acid for 5 minutes after which they were removed and washed promptly and thoroughly in cool water for 3 to 5 minutes. This is to remove all traces of acid from the seed and were spread to dry.

2.6 Experimental Design

The experiment was laid out in a completely randomized block design involving four (4) treatments, replicated (3), Three methods of pre-sowing were applied, concentrated sulphuric acid (5 minutes) (T1), cold water (24 hours) (T2), hot water (100°C for 5 minutes) (T3) (4) control (no treatment). The total number of (200) seeds were used, one (1) seed was sown per pots. The seeds were sown in nursery polythene bags filled with a mixture of top soil and manure. Watering was done daily to maintain adequate moisture content in the soil medium. Seedlings were watered twice daily.

2.7 Data Collection and Analysis

Seed germinated were monitored and data collected. The measurements of parameters were conducted at interval of two weeks for a period of eight (8) weeks for *Pterocarpus erinaceus* and *Prosopis africana*. Straight rule was used to measure the seedling height, leaf length and leaf breadth whilst physical counting was used to count the number of leaves. Germination percentage was calculated as ratio of germinating seedling to number of seeds planted multiply by 100.

Data from seedling growth were analyzed using analysis of variance (ANOVA), the mean with significant difference were separated using Duncan multiple range test at 5% probability level (0.05).

3. RESULTS

3.1 Percentage of Germination

The result of this finding revealed that seeds soaked in Boiling water at 100^{o}C for 5 minutes enhanced the germination of *Prosopis africana* to 40.0% and Seeds Sundried and soaked in cold water for 24 hours enhanced the Germination of *Prosopis africana* to 25.0% while seeds treated with Concentrated Sulphuric acid (H_2SO_4) enhanced Germination of *Prosopis africana* to 42.5% where the Control gave 13.3%. In *Pterocarpus erinaceus* the seeds soaked in Boiling water at 100^{o}C for 5 minutes had 0.0% while the seeds Sundried and Soaked in Cold water for 24 hours enhanced the Germination of *Pterocarpus erinaceus* to 15% and the seed treated with Sulphuric acid (H_2SO_4) enhanced the Germination of *Pterocarpus erinaceus* to 10% while the Control (untreated seeds) also showed 0.0% Percentage Germination (Table 1).

Table 1. Effects of Different Seed Priming Method on Germination Percentage of Prosopis africana, and Pterocarpus erinaceus

S/N	Seed Treatments	*Prosopis africana*	*Pterocarpus erinaceus*
1	Boiling	40.0%	0.0%
2	CWT	25.0%	15.0%
3	H_2SO_4	42.5 %	10.0%
4	Control	13.3%	0.0%

Key: CWT= Cold Water Treatment, Source: Field Work, 2021

3.2 Plant Height

The effects of socking in concentrated sulphuric acid (H_2SO_4) for 5 minutes had the highest plant height of *Prosopis africana* from 2 WAP (4.56 ± 0.83^a) to 8 WAP (9.90 ± 0.89^a) but without significant difference compared to other treatments. The result of treatment with cold water for 24 hours had the Plant Height of *Prosopis africana* from 2 WAP (2.50 ± 0.82^a) to 8 WAP (8.24 ± 0.70^a) which was not significantly higher than in seedling derived from seed treated in concentrated sulphuric acid (H_2SO_4) for 5 minutes. The seeds soaked in boiling water at 100ºC for 5 minutes and control had the least plant height from 2 WAP (0.64 ± 0.29^a) to 8 WAP (8.23 ± 0.40^a) it was slightly less than those observed in the two treatments. The effects of soaking in cold water for 24 hours had the highest plant height of *Pterocarpus erinaceus* from 2 WAP (1.75 ± 1.18^a) to 8 WAP (12.33 ± 0.56^a) which was not significantly taller than seedlings from concentrated sulphuric acid for 5 minutes with values of (0.00 ± 0.00^a) and (8.30 ± 2.74^b) from 2 to 8 WAP. The Boiling water 100ºC treatment and control had no germination which both had (0.00 ± 0.00^b) as shown in Table 2 and 3.

3.3 Stem Girth

From the results of this work, the seeds in concentrated sulphuric acid (H_2SO_4) for 5 minutes had the highest stem girth of *Prosopis africana* from 2WAP (0.23 ± 0.13^a) to 8WAP (1.23 ± 0.05^a) which was not significantly higher than other treatments. Boiling water treatment for 5 minutes also slightly enhanced stem girth from 2 WAP (0.11 ± 0.03^a) to 8WAP (0.98 ± 0.02^a) while the cold water treatment had the least stem girth from 2WAP (0.21 ± 0.05^a) to 8WAP (0.90 ± 0.03^{ab}). For *Pterocarpus erinaceous,* soaking in cold water for 24 hours had the highest stem girth from 2 WAP (0.27 ± 0.17^a) to 8 WAP (1.48 ± 0.09^a) followed by soaking in concentrated sulphuric acid (H_2SO_4) for 5 minutes which had stem girth from 2 WAP (0.20 ± 0.07^b) to 8 WAP (1.05 ± 0.19^b). While, the control and boiling water treatment had lowest value of stem girth from 2 WAP to 8 WAP (0.00 ± 0.00^c) as shown in Table 4 and 5.

3.4 Number of Branches

The seeds soaked in concentrated sulphuric acid (H_2SO_4) for 5 minutes enhanced the highest number of branches of *Prosopis africana* from 2WAP (1.20 ± 0.51^a) to 8WAP (10.19 ± 0.67^a) followed by the boiling water at 100ºC treatment with number of branches from 2 WAP (1.20 ± 0.51^a) to 8 WAP (7.20 ± 0.66^a) while the control had the least number of branches from 2 WAP (0.50 ± 0.29^a) to WAP (5.25 ± 0.75^a). Also seeds sun drying and soaked in cold water for 24 hours enhanced the highest number of branches of *Pterocarpus erinaceus* from 2 WAP (1.75 ± 0.48^a) to 8 WAP (12.33 ± 2.28^a) while the control and boiling water treatments had lowest values of number of branches from 2 WAP to 8 WAP (0.00 ± 0.00^c) value as shown in (Table 6 and 7).

3.5 Number of Leaves

The results of the seeds soaking in concentrated sulphuric acid (H_2SO_4) for 5 enhanced the highest total number of leaves of *Prosopis africana* from 2WAP (35.25 ± 6.92^a) to 8WAP (147.00 ± 14.33^a) followed by the seeds soaked in boiling water at 100ºC for 5 minutes enhanced the total number of leaves from 2 WAP (15.10 ± 4.60^a) to 8 WAP (129.56 ± 16.93^a) which are not significantly different. The control had the least number of leaves from 2 WAP (1.00 ± 0.58^a) to 8 WAP (78.25 ± 21.88^a). In *Pterocarpus erinaceus*, the seeds soaked in cold water for 24 hours enhanced the highest total number of leaves from 2 WAP (3.50 ± 0.87^a) to 8WAP (15.83 ± 3.61^a) followed by the seeds soaked in concentrated sulphuric acid (H_2SO_4) for 5 minutes with values from 2 WAP (1.67 ± 1.09^b) to 8WAP (14.25 ± 1.38^a) which are also not significantly different. While, in seeds soaked in boiling water at 100ºC and control no germination was observed (0.00 ± 0.00^b) throughout the work as shown in (Table 8 and 9).

Table 2. Effects of Different Seed Priming Methods on Plant Height (cm) of *Prosopis africana, Pterocarpus erinaceus* and at Two (2) and Four (4) Weeks after Planting.

	2WAP				4WAP			
Plants	**Boiling**	**CWT**	**H $_2SO_4$**	**Control**	**Boiling**	**CWT**	**H $_2SO_4$**	**Control**
Prosopis africana	0.64±0.29^a	2.50±0.82^a	4.56±0.83^a	1.75±1.03^a	4.23±0.58^a	6.94±0.59^a	7.68±0.72^a	4.33±1.56^a
Pterocarpus erinaceus	0.00±0.00^b	1.75±1.18^a	0.00±0.00^b	0.00±0.00^b	0.00±0.00^c	5.93±0.76^a	4.63±0.83^b	0.00±0.00^c

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021

Table 3. Effects of Different Seed Priming Methods on Plant Height (cm) of *Prosopis africana* and *Pterocarpus erinaceus* at Six (6) and (8) Eight Weeks after Planting

	6 WAP				8 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H $_2SO_4$**	**Control**
Prosopis africana	7.72±0.42^a	8.13±0.70^a	9.70±0.88^a	7.25±1.11^a	8.23±0.40^a	8.24±0.70^a	9.90±0.89^a	8.43±0.50^a
Pterocarpus erinaceus	0.00±0.00^c	9.75±0.36^a	7.25±1.70^b	0.00±0.00^c	0.00±0.00^c	12.33±0.56^a	8.30±2.74^b	0.00±0.00^c

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021
Key: CWT = Cold Water Treatment, WAP = Weeks after Planting

Table 4. Effects of Different Seed Priming Methods on Stem Girth (cm^2) of *Prosopis africana* and *Pterocarpus erinaceus* at Two (2) and Four (4) Weeks after Planting

	2 WAP				4 WAP			
Plants	**Boiling**	**CWT**	**H $_2SO_4$**	**Control**	**Boiling**	**CWT**	**H $_2SO_4$**	**Control**
Prosopis africana	0.11±0.03^a	0.21±0.05^a	0.23±0.13^a	0.16±0.05^a	0.80±0.04^a	0.52±0.03^a	0.88±0.08^a	0.52±0.02^a
Pterocarpus erinaceus	0.00±0.00^c	0.27 ±0.17^a	0.20 ±0.07^b	0.00±0.00^c	0.00±0.00^c	0.88 ±0.10^a	0.55±0.12^b	0.00±0.00^c

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021

Table 5. Effects of Different Seed Priming Methods on Stem Girth (cm) of *Prosopis africana* and *Pterocarpus erinaceus* at Six (6) and (8) Eight Weeks after Planting

	6 WAP				8 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	0.89±0.02^{a}	0.80±0.03^{a}	1.10±0.06^{a}	0.74±0.04^{a}	0.98±0.02^{a}	0.90±0.03^{ab}	1.23±0.05^{a}	0.84±0.04^{b}
Pterocarpus erinaceus	0.00±0.00^{c}	0.85 ±0.18^{b}	1.10±0.11^{a}	0.00±0.00^{c}	0.00±0.00^{c}	1.48 ±0.09^{a}	1.05 ±0.19^{b}	0.00±0.00^{c}

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021
Key: CWT = Cold Water Treatment, WAP = Weeks after Planting

Table 6. Effects of Different Seed Priming Methods on Number of Branches of *Prosopis africana* and *Pterocarpus erinaceus* at Two (2) and Four (4) Weeks after Planting

	2 WAP				4 WAP			
Plants	Boiling	CWT	H_2SO_4	Control	Boiling	CWT	H_2SO_4	Control
Prosopis africana	0.50±0.29^{a}	0.50±0.39^{a}	1.20±0.51^{a}	0.50±0.29^{a}	2.25±0.48^{a}	5.00±0.68^{a}	7.63±0.67^{a}	1.75±0.36^{a}
Pterocarpus erinaceus	0.00±0.00^{b}	1.75±0.48^{a}	0.00±0.00^{b}	0.00±0.00^{b}	0.00±0.00^{c}	3.83±0.54^{a}	3.00±0.41^{b}	0.00±0.00^{c}

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021

Table 7. Effects of Different Seed Priming Methods on Number of Branches of *Prosopis africana* and *Pterocarpus erinaceus* at Six (6) and (8) Eight Weeks after Planting

	6 WAP				8 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	5.69±0.31^{a}	4.69±0.31^{a}	9.38±0.71^{a}	4.25±0.75^{a}	7.20±0.66^{a}	5.69±0.31^{a}	10.19±0.67^{a}	5.25±0.75^{a}
Pterocarpus erinaceus	0.00±0.00^{c}	4.50±0.65^{b}	8.00±1.20^{a}	0.00±0.00^{c}	0.00±0.00^{c}	12.33±2.28^{a}	6.00±1.08^{b}	0.00±0.00^{c}

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021
Key: CWT = Cold Water Treatment, WAP = Weeks after Planting

Table 8. Effects of Different Seed Priming Method on Number of Leaves of *Prosopis africana* and *Pterocarpus erinaceus* at Two (2) and Four (4) Weeks after Planting

	2 WAP				4 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	15.10±4.6[a]	2.31±1.85[a]	35.25±6.92[a]	1.00±0.58[a]	64.30±10.4[a]	46.50±14.7[a]	78.00±10.41[a]	27.69±5.50[a]
Pterocarpus erinaceus	0.00±0.00[c]	3.50±0.87[a]	1.67±1.09[b]	0.00±0.00[c]	0.00±0.00[b]	7.67± 1.61[a]	6.50±1.19[a]	0.00±0.00[b]

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021

Table 9. Effects of Different Seed Priming Methods on Number of Leaf of *Prosopis africana* and *Pterocarpus erinaceus* at Six (6) and (8) Eight Weeks after Planting

	6 WAP				8 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	66.69±9.2[a]	116.19±17.05[a]	133.70±15.90[a]	65.50±20.01[a]	86.56±9.56[a]	129.56±16.93[a]	147.00±14.33[a]	78.25±21.88[a]
Pterocarpus erinaceus	0.00±0.00[b]	12.50±2.79[a]	12.00±2.79[a]	0.00±0.00[b]	0.00±0.00[b]	15.83±3.61[a]	14.25±1.38[a]	0.00±0.00[b]

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021
Key: CWT = Cold Water Treatment
WAP = Weeks after Planting

Table 10. Effects of Different Seed Priming Methods on Leaf Area (cm^2) of *Prosopis africana* and *Pterocarpus erinaceus* at Two (2) and Four (4) Weeks after Planting

	2 WAP				4 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	0.14 ± 0.03^{a}	0.07 ± 0.02^{a}	0.23 ± 0.13^{a}	0.02 ± 0.01^{a}	0.20 ± 0.04^{c}	0.16 ± 0.02^{a}	0.25 ± 0.03^{b}	0.07 ± 0.01^{a}
Pterocarpus erinaceus	0.00 ± 0.00^{c}	1.38 ± 0.58^{a}	0.61 ± 0.27^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	3.07 ± 0.61^{a}	1.90 ± 0.35^{b}	0.00 ± 0.00^{c}

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021

Table 11. Effects of Different Seed Priming Methods on Leaf Area (cm^2) of *Prosopis africana* and *Pterocarpus erinaceus* at Six (6) and (8) Eight Weeks after Planting

	6 WAP				8 WAP			
Plants	**Boiling**	**CWT**	**H_2SO_4**	**Control**	**Boiling**	**CWT**	**H_2SO_4**	**Control**
Prosopis africana	0.23 ± 0.03^{a}	0.21 ± 0.02^{a}	0.32 ± 0.03^{a}	0.18 ± 0.03^{a}	0.33 ± 0.03^{a}	0.31 ± 0.03^{a}	0.43 ± 0.04^{a}	0.28 ± 0.03^{a}
Pterocarpus erinaceus	0.00 ± 0.00^{c}	4.64 ± 0.60^{a}	2.79 ± 0.37^{b}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}	5.21 ± 0.46^{a}	3.13 ± 0.46^{b}	0.00 ± 0.00^{c}

Means followed by same letter(s) in a row are not significantly different at P=0.05, Source: Field Work, 2021
Key: CWT = Cold Water Treatment, WAP = Weeks after Planting

3.6 Leaf Area

The result of soaking in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes gave the higher leaf Area of *Prosopis africana* from 2WAP (0.23 ± 0.13^a) to 8WAP (0.43 ± 0.04^a) which was significantly higher than other treatment. Soaking in boiling water at 100ºC for 5 minutes enhanced the total leaf area of *P. africana* from 2WAP (0.14 ± 0.03^a) to 8WAP (0.31 ± 0.03^a) while the control gave the least value of leaf area from 2WAP (0.02 ± 0.01^a) to 8WAP (0.28 ± 0.03^a). Also from this results, the seeds treated with cold water for 24 hours enhanced the total leaf area of *Pterocarpus erinaceus* from 2WAP (1.38 ± 0.58^a) to 8WAP (5.21 ± 0.46^a) and concentrated sulphuric acid (H_2SO_4) for 5 minutes gave the total leaf area of *Pterocarpus erinaceus* from 2WAP (0.61 ± 0.27^b) to 8WAP (3.13 ± 0.46^b) while boiling water treatment and control had (0.00 ± 0.00^c) from 2WAP to 8WAP (Table 10 and 11).

4. DISCUSSION

4.1 Germination Percentage

The results of this study on germination percentage shows a significant variation ($p = 0.05$) within seeds priming methods. Germination in *Prosopis africana* started on the eleventh (11^{th}) day after planting and lasted for 40 days in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with the germination percentage of 42.5%, while the seeds immersed in boiling water at 100ºC for 5-minutes germination started on the thirteenth (13^{th}) day after planting and lasted for 50 days with the germination percentage of 40%. In control germination started on the sixteenth (16^{th}) day after planting and lasted for 55 days with the germination percentage of 13.3%. The highest germination percentage was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) although the percentage was slightly moderate, this could be due to the time taken for the seeds exposed to the acid. This is consistent with the findings of [14] on *Prosopis africana* where they recorded highest germination percentage in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 30 minutes. Similarly, [15] who also worked on *Prosopis africana*, concluded that soaking seeds in 98% concentrated sulphuric acid (H_2SO_4) for 30 minutes was effective in seed dormancy breaking and also give highest germination percentage. In *Pterocarpus erinaceus*, Seeds treated by Sun drying and immersed in cold water for 24 hours, germination started on the Ninth (9^{th}) day after planting and lasted for thirty-five (35) days and had germination percentage of 15%, while the seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) germination started on the thirteenth (13^{th}) day after planting and lasted for 50 days with 10% germination percentage whereas the seeds immersed in boiling water at 100ºC for 5 minutes and control no germination was observed. The higher percentage recorded in seeds immersed in cold water for 24 hours was probably low because of the period employed for seeds exposure to cold water is limited to break the dormancy. This is consistent with works of [38] that worked on *P. erinaceus* and recorded 20% germination percentage in seeds immersed in cold water for 24 hours. The poor germination percentage recorded in seeds soaked in boiling water at 100ºC could be probably due to higher degrees of temperature used during the treatment. This is consistent with works of [17] on *P. erinaceus* who reported that the seeds of the species are very sensitive to heat. Indeed, no germination was observed in under pretreatment of light fire burning and soaking in boiling water at 100ºC.

4.2 Growth Parameters

4.2.1 Plant Height

The highest mean value of plant height in *P. africana* was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes at 8 WAP with mean value of (9.90 ± 0.89^a). The highest plant height recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes is attributed to the fact that sulphuric acid (H_2SO_4) stimulate prompt and uniform germination. This is consistent with the works of [14] who recorded highest plant height of *P. africana* in seeds immersed in concentrated sulphuric acid (H_2SO_4) for 30 minutes than those immersed in water. This is also consistent with the works of [18] who also recorded highest plant height of *P. africana* in seeds immersed in concentrated sulphuric acid (H_2SO_4). Similarly, [19] revealed that soaking of *P. juliflora* seeds in sulphuric acid (H_2SO_4) reduce the germination period considerable and concluded that it was the best and effective treatment to enhance seedling growth, though, dangerous to handling. The lowest plant height was recorded in seeds immersed in cold water for 24 hours and control at 2 WAP with mean values of (0.64 ± 0.29^a) and

(1.75±1.03[a]) respectively. The least values recorded in cold water treatment and control could be attributed to the fact that the seeds of *P. africana* have the hard seed coat (water impermeable) which are not easily germinate even there is a favorable condition for germination.

In *Pterocarpus erinaceus*, the highest mean value of plant height was recorded in seeds sun drying and immersed in cold water for 24 hours at 8 WAP with mean values of (12.33 ±0.56[a]) followed by the Seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with mean value of (8.30 ±2.74[b]) which are not significantly different at (P=0.05). The HIGHEST Plant height recorded in seed immersed in cold water for 24 hours could be attributed to the ability of cold water to hasten early germination. This is in agreement with the findings of [20] on *C. pentandra* where he reported that seed soaking in water at room temperature performed best with percentage germination of 100% and seedling growth. While, the lowest Plant height was recorded in seeds immersed in boiling water at 100^{o}C with mean values of (0.00±0.00[c]). This indicates that hot water had made contact with the embryo and this occurred because the seed coat has been damaged. This is consistent with the woks of [17] who worked on *Pterocarpus erinaceus* and reported that seeds of the species are very sensitive to heat. Indeed, no germination was observed in seeds immersed in boiling water at 100^{o}C. This study, furthermore, disagrees with the findings of [21] who reported that hot water treatment had the highest germination on *Acacia auriculiformis*.

4.3 Stem Girth

4.3.1 *Prosopis africana*

The highest mean value of stem girth was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes followed by the seeds treated with boiling water at 100^{o}C for 5 minutes at 8WAP with mean values of (1.23±0.05[a]) and (1.23±0.05[a]). The highest Stem girth recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4), this could be due to the fact that acid rapture the hard seed coat and break seed dormancy, improving coat impermeability and increased imbibition of seed. This is consistent with the finding of [22] on *Prosopis juliflora* who reported that Sulphuric acid create or enlarge pores in the seed, enabling water to enter the seed and directly contact the embryo and thus accelerate the germination processes. Also [23] on *Lupines varius* reported that scarifying the seed with Concentrated Sulphuric acid (H_2SO_4) increased imbibition and improved germination, seedling vigor and growth characteristic of *L. varius*. While, the lowest Stem girth was recorded in seeds immersed in cold water for 24 hours and control at 2 WAP with mean value of (0.21±0.05[a]) and (0.11±0.03[a]) which are not significance difference at (p = 0.05). This is probably because the cold water was less effective in breaking the hard seed coat possessed by the seed to enhance early germination and seedling establishment. This is in agreement with [24] who stated that germination is the most crucial stage that affect earlier seedling growth and establishment.

4.3.2 *Pterocarpus erinaceus*

The highest mean stem girth was recorded in seeds treated by sun drying and immersed in cold water for 24 hours at 8 WAP with value of (1.48 ±0.09[a]) followed by the Seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with mean values (1.05 ±0.19[b]) which are significantly different at (P=0.05) The moderately high stem girth recorded in Seeds immersed in cold water for 24 hours was probably because the seeds are water-impermeable. This is in agreement with the works of [11] who confirm that the majority of species from Fabaceae and Malvaceae have water-impermeable seeds and hence have physical dormancy. Also according to [25] one of the problem with this species is difficulty of raising seedling from seeds due to its hard impermeable seed coats restricting the entry of both water and oxygen that will aid its germination. The lowest mean stem girth was recorded in Seeds immersed in boiling water at 100^{o}C for 5 minutes and control with mean values of (0.00±0.00[c]) respectively. The least value recorded in seeds immersed in boiling water at 100^{o}C could be due to the fact that higher temperature and time for seeds immersion used during treatment may be injured the seed embryo. This is in agreement with the works of [26] who reported that high temperature with high acidity can kill the embryo. This is also in agreement with findings of [27] who reported that exposure of seed to 100ºC resulted in poor germination which could be attributed to detrimental effect on seeds due to long duration of exposure to high temperature.

4.4 Number of Branches

4.4.1 *Prosopis africana*

In *Prosopis africana*, the highest mean value of number of branches was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes followed by seeds treated in boiling water at 100^oC for 5 minutes with mean values of (10.19±0.67^a) and (7.20±0.66^a) at 8 WAP but are not significantly different at (P=0.05). The highest number of branches recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes could due to the ability of Acid to soften the seed coat and high temperature used to break the seed dormancy faster than other treatments. The results from this work supports the findings of [22] in their study on *P. africana* who noted that Sulphuric acid treatment is the most effective way of improving seed coat impermeability. The result of this study is consistent with the works of [8] on *Adansonia digitata* who revealed that at the end of eight weeks, H_2SO_4 at 98% for 1hr gave the best result in seed emergence, percentage germination, plant height, number of leaves and leaf length. A similar study by [28] where he also discovered that treatment of *Parkia biglobosa* with sulphuric acid induces germination and improves seedling growth. The least mean value was recorded in seeds immersed in cold water for 24 hours and Control at 2 WAP with mean value of (1.20±0.51^a) and (0.50±0.29^a). This could have been due to the water impermeable seed coat possessed by the seed and limited period of seed exposure to the cold water. This is in supports of [11] who worked on West African woody species and confirm that majority of tree species belong to the Fabaceae and Malvaceae are known to have many species with water-impermeable seeds.

4.4.2 *Pterocarpus erinaceus*

In *Pterocarpus erinaceus,* the highest mean values of number of branches was recorded in seeds treated by sun drying and immersed in cold water for 24 hours followed by seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with mean values of (12.33±2.28^a) and (6.00±1.08^b) at 8 WAP which are significantly different at (P=0.05). The highest branch number recorded in seeds soaked in cold water for 24 hours could be as a result of the influence of cold water to break seed dormancy earlier and faster compared to other methods employed. This is in agreement with the findings of [16] on *Pterocarpus osun* where he reported that seedling growth can be obtained in *P. osun* by de-coating the seed before sowing or soaking seeds in ordinary water over night and use of hot water should be avoided due to its detrimental effect on seedling emergence and growth. The least mean values of number of branches was recorded in seeds immersed in boiling water at 100^oC for 5 minutes and control from 2 to 8 WAP with mean values of (0.00±0.00^c). The least values recorded in seeds immersed in boiling water at 100^oC and control could be due to high temperature (100^oC) employed and hard seed-coat possessed by the seed. This is consistent with [29] who worked on *Prosopis juliflora* and *Delbergia sissoo* and reported that soaking of seed in hot water over-night proved to be harsh and resulted in the embryo death as there was no germination.

4.5 Number of Leaves

4.5.1 *Prosopis africana*

The results of *Prosopis africana*, the highest mean values of Leaves number was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes followed by seeds treated in boiling water at 100^oC for 5 minutes at 8 WAP with mean values of (147.00±14.33^a) and (129.56±16.93^a) but not significantly different at (P=0.05).The highest mean values of leaves number recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes followed by seeds treated in boiling water at 100^oC for 5 minutes could be as a result of the effect of acid and boiling water in breaking of seed dormancy. This is consistent with the works of [15] on *Prosopis africana* who concluded that soaking of *Prosopis africana* in 98% Sulphuric acid (H_2SO_4) for 30minutes was superior in breaking seed dormancy as it also gave the highest germination percentage and seedling growth performance. The result was also in agreement with the findings of [30] who reported that seed which gave pre-sowing treatment overcome seed dormancy and enhance germination and the performance of pre-sowing treatment depend on the nature of the dormancy present and also concluded that seed soaking in concentrated sulphuric acid is the most effective pre-sowing treatment. Similarly, [31] in his that seeds of *Acacia nilotica*

when treated with H_2SO_4 for 90 minutes produced vigorous seedling and higher percentage germination. While, the lowest mean values of number of leaves was recorded in seeds immersed in cold water for 24 hours and control at 2 WAP with mean value of (86.56 ± 9.56^a) and (78.25 ± 21.88^a). The reason behind this is that *Prosopis africana* like most leguminous plants possess hard seed coat which hamper water imbibition, gaseous exchange and/or harbors inhibitors to suppress seed germination. This is contrary with the findings of [32] who worked on *Detarium microcarpum* and recorded highest germination percentage and seedling vigor in seeds immersed in cold water.

4.5.2 *Pterocarpus erinaceus*

In *Pterocarpus erinaceus,* the highest mean value of leaves number was recorded in seeds treated by sun drying and immersed in cold water for 24 followed by seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with mean values of (15.83 ± 3.61^a) and (14.25 ± 1.38^a) at 8 WAP but are not significantly different at (P=0.05) The highest mean value of leaves number recorded in seeds treated by sun drying and immersed in cold water for 24 hours and in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes are still moderate and this could be due to climatic factor and soil type. This is in agreement with works of [33] on *Pterocarpus erinaceus* who showed that a stable greenhouse, healthy climate, rich soil and a humid tropical climate are essential for harmonious development of the plant height, diameter and number of leaves of *Pterocarpus erinaceus* seedling. The least mean value of leaves number was recorded in seeds immersed in boiling water for 5 minutes and control from 2 to 8 WAP with mean value of (0.00 ± 0.00^b). This could be as result of hard seed coat (water and oxygen impermeable seed) possessed by the species and higher water boiling point used during the treatment hence poor germination was observed. This is consistent with works of [17] on *P. erinaceus* who reported that the seeds of the species are very sensitive to heat. Indeed, no germination was observed in under pretreatment of light fire burning and soaking in boiling water at 100ºC. This is also consistent with the reports of [34] and [35] who reported that in other woody species high temperature and prolonged exposure of seed resulted in poor seed germination.

4.6 Leaf Area

4.6.1 *Prosopis africana*

The effect of different priming method revealed that in *P. africana*, the highest mean values of leaf area was recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes at 8 WAP with mean values of (0.43 ± 0.04^a) The highest mean values of Leaf Area recorded in seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes and seeds treated in boiling water at 100^oC for 5 minutes may be due to fast breaking of seeds dormancy which enabling the water to enter the seed and directly contact the embryo and thus enhance leaf area. The lowest mean value of leaf area was recorded in seeds immersed in cold water for 24 hours and control at 2 WAP with mean value of (0.07 ± 0.02^a) and (0.07 ± 0.01^a) at 2WAP. This is attributed to the fact that the treatment of the *Prosopis africana* seed with cold water is incapable of breaking seed coat rapidly to enhance fast germination and seedling growing as the seed coat is water impermeable. The result of this study is in line with the works of [36] on *P. compachiana* who reported that seeds treatment with cold water had a negative effect on the germination and seedling growth. This study was also in disagreement with the findings of [37] on *A. lebbeck* who reported that soaking of seeds in hot water and subsequent cooling at room temperature gave highest germination percentage and improve seedling growth.

4.6.2 *Pterocarpus erinaceus*

In *P. erinaceus,* the highest mean values of leaf area were recorded in seeds treated by sun drying and immersing in cold water for 24 hours followed by seeds immersed in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes with mean values of (5.21 ± 0.46^a) and (3.13 ± 0.46^b) at 8 WAP which are significantly different at (P=0.05). The highest mean of Leaf area recorded in seeds immersed in cold water could be as a result of the influence of water on de-coating seed which enable water uptake by the seed to enhance rapid germination and seedling growth. This is in agreement with the findings of [16] on *Pterocarpus osun* who reported that optimum seedling emergence can be obtained in *Pterocarpus osun* by de-coating the seeds before sowing or soaking seeds in ordinary water over-night. While, the least mean value of leaf area was recorded in seeds

immersed in boiling water at 100^{o}C for 5 minutes and control from 2 to 8 WAP with mean value of (0.00±0.00^{b}). Least leaf area recorded in seeds immersed in boiling water at 100^{o}C for 5 minutes could be as a result of sensitivity of seeds to high temperature. This is consistent with works of [17] on *P. erinaceus* who confirm that *P. erinaceus* seeds are sensitive to heat and 0% germination percentage was recorded in seeds soaked in boiling water treatment. However, [16] on *Pterocarpus osun* also reported that the use of boiling water as pre-sowing treatment should be avoided as much as possible due to its detrimental effect on seeds.

5. CONCLUSION

This study concluded that soaking seeds of *Prosopis africana* in 98% concentrated sulphuric acid (H_2SO_4) for 5 minutes was superior in breaking the seeds dormancy as it gave the highest germination percentage and seedling growth (plant height, stem girth, number of branches and number of leaves as well as leaf area). While, in *Pterocarpus erinaceous* the seeds treated by sun drying and soaked in cold water for 24 hours is the most effective priming method for breaking the seed dormancy where highest germination percentage and seedling growth were recorded compared to other method.

6. RECOMMENDATION

This study recommended that soaking of *Prosopis africana* in concentrated sulphuric acid (H_2SO_4) be extended from 5 minutes to 35 – 40 minutes to improve percentage germination while for *Pterocarpus erinaceous* soaking in cold water be extended from 24 – 72 hours to improve percentage germination.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Falemara BC, Chimini DC, Undekwere M. Pre-Germination and Dormancy Response of *Adansonia digitata* Seed to Pre-Treatment Techniques and Growth Media, European Journal of Botany Sciences Pathology. 2014; 2(1):13-23.
2. Owolabi D. Forest loss in Nigeria, The Impact on Climate and People from the Perspectives of Illegal Forest Activities and Government Negligence. 2019; 1-23.
3. Bello A, Jamaladdeen S, Elder MT, Yaradua SS, Kankara SS, Wagini NH. 'Threatened Medicinal and Economic Plants of the Sudan Savanna in Katsina State, Northwestern Nigeria', Bothalia. 2019; 49(1):7-15.
4. Azare IM, Abdullahi MS, Adebayo AA, Dantata JI, Duaia T. Deforestation, Desert Encroachment, Climate Change and Agricultural Production in the Sudano-Sahelian Region of Nigeria, Journal of Applied Science and Environmental Management. 2020; 24(1):127-132.
5. Sintayehu DW. Impact of Climate Change on Biodiversity and Associated Key Ecosystem Service in Africa: A Systematic Review, Ecosystem Health sustainability. 2018; 4(9):225-239.
6. Archer M, Agyeib TA, Mintahc SO, Atta-Adjei JP, Kumadohe D, Asiedu-Larbi J. (2019). Medicinal Uses of *Cassia sieberiana*; A Review, International Journal of Sciences Basic and Applied Research. 2019; 48(2):161-180.
7. Bareke T. (2018). Biology of Seed Development Germination Physiology, Advanced Plant Agric. 2018;8(4):336-346.
8. Usman IA, Asan TV. Influence of different pretreatments on seed germination and growth rate of *Adansonia digitata* seedlings, Journal of Research in Forestry, Wildlife & Environment. 2017; 9(2).
9. Niang M, Diouf M, Samba SAN, Ndoye O, Cisse N, Van Damme P. Differences in Germination Rate of Boabab (*Adansonia digitata*) Provenances construction in their Seed Morphology when Pre-treated with Concentrated Sulphuric Acid, African journal of Agricultural Research. 2015; 10(12):1412-1420.
10. Mousavi SR, Rezaei M, Mousavi A. A General Overview on Seed Dormancy and Methods of Breaking It. Advances in Environmental Biology. 2011; 5(10):3333-3337.
11. Milene N, Koutouan K, Shyam SP, Sergey R, Edouard, KK, Peter P. Seed Dormancy and Seed Dormancy Breaking Conditions to 12 West African Woody Species with Higher Reforestation Potential in Forest Savanna Ecotone Cote d'Ivore. Seed Science and Technology. 2020;48(1):101-116.
12. National Population Commission [NPC]. Official Result for 2006 House and

Population Census Figures. Bureau for National Statistics, Abuja, Nigeria. 2006.
13. Yobe State Ministry of Health [YSMoH]. Yobe State Government Strategic Health Development Plan (2010-2015). Damaturu: Yobe State Government of Nigeria; 2010.
14. Uleh M, Fegbemi T. Progeny trail of *Prosopis africana* in Benue State, Nigeria. Journal of Forestry, Wildlife and Environment. 2017;9(1):61-66.
15. Chukwu O, Anselm EE, Merypercious AU, Jacinta UE. Influence of Pre-Sowing Treatment on the Germination of *Prosopis africana* (Guill. and Perr.) Taub. Seeds, Asian Journal of Research in Agriculture and Forestry. 2020;5(4):20-25.
16. Peter IO, Uzokwe G. Comparative Evaluation of Different Pre-Sowing Seed Treatment and Potting Media on Seedling Emergence and Early Growth on *Pterocarpus osun* (Craib), International Research Journal of Plant Science. 2014;5(2):127–134.
17. N'golo B, Noufou DO, Djezou K, Adama B, Fezan H. Effect de cinq pretraitements sur la germination du vene (*Pterocarpus erinaceus* poir., Fabaceae) dans la Reserve du Haut Bandama (Cote d'Ivoire) European Scientific Journal. 2018;14(30):438-451.
18. Onyekachi C, Anselm E, Maryprecious AU, Jacinta UE. Influence of pre-sowing treatments on the germination of *Prosopis africana* Seed. Asian Journal of Research in Agriculture and Forestry. 2020;5(4): 20-25.
19. Agbojidi OM. Effects of acid pre-treatment on the germination and seedling growth of *Prosopis juliflora*, Int. J. Agric Res.2007;2:952–958.
20. Ojo MO. Impact of Selected Seed Pretreatments on Emergence and Early Growth of *Cieba pentandra* (L) Gertna, European Journal of Agriculture and Forestry Research. 2019;7(3):7-17.
21. Azad S, Manik, MR, Hassan S, Matin A. Effect of Different Pre-Sowing Treatments On Seed Germination and Growth Performance of *Acacia auriculiformis*, Journal of Forestry Research. 2011;22(2): 83-188.
22. Miranda RQ, Oliveira MTP, Correia RM, Almeida-Cortez JS, Prompelli MF. Germination of *Prosopis juliflora* DC Seeds after Scarification Treatment. Plant science biology. 2011;26:186-192.
23. Karaguzel O, Cakmakci S, Ortacesme V, Aydinoglu B. Influence of Seed Coat Treatments on Germination and Early Seedling Growth of *Lupinus varius* L. Pak. Journal of Botany. 2004; 36(1):65-74.
24. Tian Y,Guan B, Zhou J, Yu GL, Lou, Y. Responses of Seed Germination, Seedling Growth and Seed Yield Effect of Seed Size Trait to Seed Pre-Treatment in Maize (*Zea mays*), The Scientific World Journal. 2014;8.
25. Karsten JR, Meilby, H, Larsen BJ. Regeneration and Management of Lesser Known Timber Species in Peruvian Amazon Following Disturbance Logging Forest Ecology and Management. 2014; 327(1): 76-85.
26. Luna J, Kasten D. Bioclimatic Influence on Seed Germination and Seedling Morphology Parameters in *Pterocarpus erinaceus* Poir, (Fabaceae). International Journal of Environment, Agriculture and Biotechnology. 2014;6(3):001-015.
27. Amri S. The Effects of Seed Treatment on Germination of Snake Bean (*Swartzia madagascariensis*); A Reported Medicinal Plant, Research Journal of Agriculture and Biological Sciences. 2010;6(4):557-561.
28. Aliero BL. Effects of Sulphuric acid, mechanical scarification and wet heat treatments on germination of African Locust bean tree. *Parkia biglobosa*. African Journal of Biotechnology. 2004; 3:79-181.
29. Muhammad JA, Atif A, Muhammad ZM, Ayyoub T, Bilal Z, Iqra, A, Muhammad ZA, Muhammad SM. Effect of Different Pre-Treatment on Seed Germination of *Prosopis juliflora* and *Dalbergia sissoo*: A step Towards Mutation Breeding. Journal of Forest Science. 2020;66(2):80-87.
30. Varun A, Pant KS, Prabhat T. Effect of Seed Size and Pre-Sowing Treatment on Germination of Some Important Trees- A Review, Research Journal of Chemical and Environmental Sciences. 2018;6(1):104-113.
31. Goda SE. Effect of Pre-Sowing Treatment on Germination of *Acacia nilotica* Seeds, Indian Forester. 1987;113(17):443-445.
32. Bernard NB, Latif IN, Adnan S, Hamza I, William JA. Effect of Seed Pre-Treatment and its Duration on Germination of *Detarium microcarpum* (Guill. and Perr,), African journal of environmental science and technology. 2019;13(8):317-323.
33. Beda IA, Selastigue DA, Kaoudio HK, Yao PH, Jerome D. Bioclimatic Influence on

Seed Germination and Seedling Morphology Parameters in *Pterocarpus erinaceus* Poir, 1804 (Fabaceae). International Journal of Environment, Agriculture and Biotechnology. 2021;6(3): 001-015.

34. Qaderi MM, Cavers PB. Effect of Dry Heat on the Germinability and Viability of Scotch Thistle (*Onopordum acathium*) Cypselae: Interpopulation and interposition variation. Can. Journal of Botany. 2003;81:684-697.
35. Tilki F. Seed Germination of *C. creticus L. & C. laurifolius* L.as Influenced by Dry-Heat, Soaking in Distilled Water and Giberellic acid, Journal of Environmental Biology. 2008;29(2):193-195.
36. Amoakoh OA, Nortey DDN, Sagoe F, Amoako PK, Jallah CK. Effect of Pre-Sowing Treatment on The Germination and Early Growth Performance of *P. campachiana,* Journal of Forest Science and Technology. 2017;13(2): 83-86.
37. Kumar N, Handa AK, Dev I, Ram A, Uthappa AR, Shukla A. Effect of Pre-Sowing Treatment and Growing Media on Seed Germination and Seedling Growth of *Albazia lebbeck* (L) Benth Journal of Applied and Natural Science. 2018;10(3):860-863.
38. Peter MK, Agera SIN, Amonum JI. Effects of pre-sowing treatment on germination and early seedlings growth of *Pterocarpus erinaceus* Poir. Journal of Forestry, Wildlife and Environment. 2021;13(1):197-205.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/85825