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Improvement of *Parkia* Seedling Growth using Various Seed Dormancy Breaking Technologies in Different Soil Media

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ABSTRACT

Improvement of *Parkia* seedling growth on plant height (PH) using seed dormancy breaking technologies in different soil media was investigated at nursery unit of Department for Forestry and Wildlife Management, Federal University Dutsin-Ma. Completely Randomized Design (CRD) with four replicates was the design used. The data were analyzed using Analysis of Variance (ANOVA) while the means were separated using Fishers' Least Significant Difference (F-LSD; $P \leq 0.05$). Emergence of seeds was observed to commence four days after sowing (DAS) in mechanically scarified seeds (MS). The top soil added with mycorrhiza at 120 g (M_{120}^+) had significantly higher value (24.01) on PH at 10 weeks after sowing (WAS) in the main effect. In the interactive effect, seeds soaked in 98 % concentrated tetraoxosulphate (V1) (H_2SO_4) for 2 and 4 minutes (A_2 and A_4) and sowed in sterilized top soil (SS) and non-sterilized (NS) had significantly higher values (16.70 and 16.25) and (27.60 and 28.25) on PH at 4 and 12 WAS respectively. Seeds soaked in H_2SO_4 for 6 minutes (A_6) and sowed in M_{120}^+ had higher value (15.60) on PH at 4 WAS. MS in M_{60}^+ , hot water (HW) at 80 °C and 100 °C for 10 and 5 minutes had higher effect (16.52 and 16.48) on PH at 4 WAS. MS in HW at 60 °C for 15 minutes and HW 80 °C in M_{60}^+ was significant on PH (26.80, 27.85 and 29.00) at 12 WAS. HW 60 °C in SS had higher effect (15.95) on PH at 4 WAS. In conclusion, mechanically scarified seeds, seeds soaked in H_2SO_4 acid for 2-6 minutes and in hot water between 60 °C to 100 °C for at most 15 minutes break *Parkia* dormancy and grow rapidly in ectomycorrhiza soil.

Keywords: *Parkia biglobosa*, Seedling growth, dormancy breaking, technologies, *Parkia* seeds, soil media

1. INTRODUCTION

Parkia biglobosa (Jacq. Benth) is an important indigenous multipurpose fruit tree (Oyebamiji *et al.*, 2014; 2018). *Parkia* is popularly known as the African locust bean belonging to the family leguminosae-mimosoideae (MIM). It is known as dawadawa (Hausa), African locust beans (English), Igba/Iyere (Yoruba), Nere (Bambara) have been known to be a native of Africa and is an important multipurpose tree of West African Savannah land and one of the most common species of the parkland agro-forestry system (Sacande and Clethero, 2007).

Parkia biglobosa is a perennial deciduous tree with a height ranging from 7 to 20 m, although it can reach 30 m under exceptional conditions. Its crown is large, spreads wide with branches low down on a stout bole; amber gum exudes from wounds; bark dark grey brown, thick, fissured. Leaves alternate, dark green, bipinnate to 30 cm long, pinnae up to 17 pairs with 13-60 pairs of leaflets, 8-30 mm × 1.5-8 mm, of distinctive shape and venation. Leaflets held on a long rachis.

The fruit is a legume, slightly indented between the seeds at maturity. The seeds are embedded in a yellowish, mealy, sweet testing edible pulp (Aliero *et al.*, 2001).

Locust bean trees are the most prioritized woody component of the Nigeria Savanna parkland system because of their drought and fire resistance, and their culinary, therapeutic and industrial raw material values (Kio *et al.* 1989). In Nigeria, the tree is encountered in many savannah land uses, including improved fallow, silvopastoral system and homestead woodlots (Popoola and Tee, 2001).

The tree can also grow on rocky slopes, stony ridges or sandstone hills. It is a fire-resistant heliophyte. *P. biglobosa* occurs in a diversity of agroecological zones, ranging from tropical forests with high and well-distributed rainfall to arid zones where mean annual rainfall may be less than 400 mm. It has a capacity to withstand drought conditions because of its deep taproot system and an ability to restrict transpiration. Its seeds are rich in protein and usually fermented to a tasty food condiment called *dawadawa* which is used as a flavour intensifier for soups and stews and also adds protein to a protein-poor diet (Dike and Odunfa, 2003).

Since the tree is a leguminous, it has the tendency of improving soil nutrients when it leaves are decomposed and nutrients are released (Oyebamiji *et al.*, 2017). Farmers have always been involved in using fertilizer as a last resort but this has not been economically feasible because the nature of the soil in the tropics do not allow for maximum utilization of nutrients from chemical sources.

This is because they are characterized by the possession of low activity clay which is their parent rock materials. These soils with their fewer charged surfaces for exchanged of ions have low ion exchange capacity. Hence, research has shown that this problem could be solved through the incorporation of mycorrhizae into the savanna or tropical soils and other soil media before raising savanna seeds and seedlings in balancing of nutrient absorption with nutrient replenishment (Liasu, 2000).

Moreover, *Parkia* trees are also such vital components of the ecosystem that have productive, protective and recreational functions (Atiku *et al.*, 2013). They control soil erosion, stabilize regional and global climates; provide carbon sinks, and acts in pollution control. The extent to which this forest tree is being exploited calls for urgent attention and to resuscitate its biological diversity is the major focus of this study.

2. MATERIALS AND METHODS

2. 1. Study Area

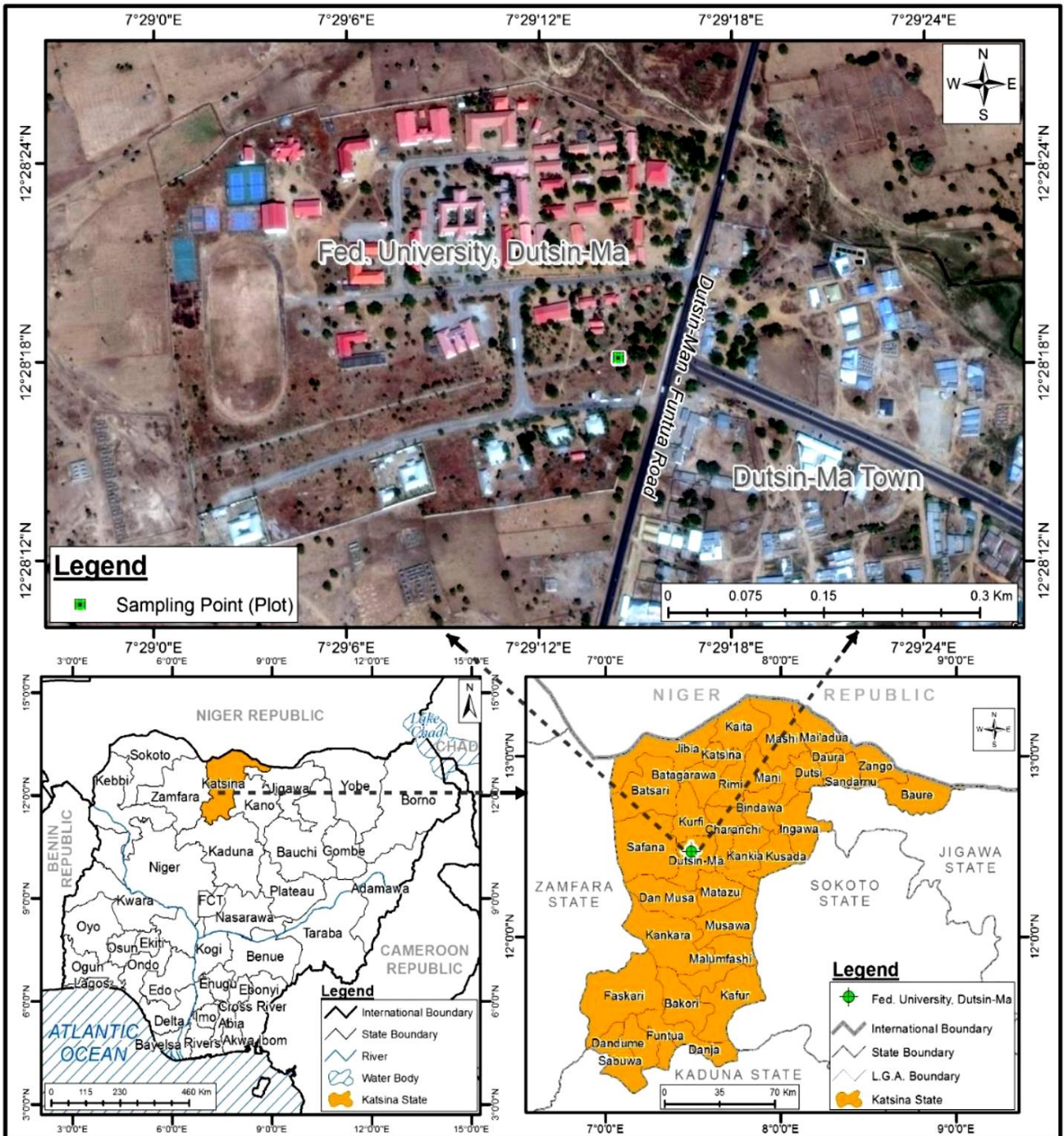


Figure 1. Federal University, Dutsin-Ma showing study area (plot).

Source: Map Gallery, Geography Department, ABU, Zaria.

The experiment was carried out in the nursery unit of the Department of Forestry and Wildlife Management, Federal University Dutsin-Ma, Katsina State, Nigeria. The area lies between latitude 12°28'18.3" N and longitude 07°29'15.4" E (Figure 1) with an annual rainfall of 700 mm, which is spread from May to September. The mean annual temperatures range from 29-31 °C, the high temperature normally occurs in April/May and the lowest in December through February. The vegetation of the area is the Sudan savanna sharing the characteristics and species of both Guinea and Sahel savanna (Tukur and Kan, 2013).

2. 2. Experimental Design

The experimental was laid out as 4×7 factorial in a Completely Randomized Design (CRD). The soil media factors represented were: M_{120}^+ = Top soil added with 120 g of mycorrhiza; M_{60}^+ = Top soil added with 60 g of mycorrhiza; SS = Sterilized top soil; NS = Non-sterilized top soil (control), while pre-germination treatments factors were: A_2 = seeds soaked in H_2SO_4 acid for 2 minutes; A_4 = seeds soaked in H_2SO_4 acid for 4 minutes; A_6 = seeds soaked in H_2SO_4 acid for 6 minutes; MS = Mechanical scarification; HW 60 °C = seeds soaked in hot water (wet heat treatment) at 60 °C at 15 minutes; HW80 °C = seeds soaked in hot water (wet heat treatment) at 80 °C at 10 minutes; HW 100 °C = seeds soaked in hot water (wet heat treatment) at 100 °C at 5 minutes.

2. 3. Seed Procurement, Soil Collection and Pot Filling

Parkia biglobosa seeds were procured from the Wednesday market in Dutsinma Local Government of Katsina State, Nigeria. The top soil used was collected from Department of Forestry Dutsin-Ma Local Government, Katsina State. Ectomycorrhiza soil was collected from pine plantation of Forestry Research Institute of Nigeria (FRIN) Jericho, Ibadan, Oyo State, Nigeria. One hundred and twelve (112) polythene bags of 30.5 cm \times 34.0 cm dimensions were used of which ectomycorrhiza soil collected from pine plantation at Forestry Research Institute of Nigeria (FRIN) Jericho, Ibadan, Oyo State, Nigeria, was added to the top soil at 60 grammes and 120 grammes respectively, while sterilized and non-sterilized top soils were also used to fill the polythene bags.

2. 4. Initial Germination Studies, Sowing Techniques and Soil Inoculation

One thousand, one hundred and twelve (1120) *Parkia* seeds were sterilized with 5 % sodium hypochlorite solution for 45 seconds in order to make the seeds free of contamination and make seeds healthy before sowing and then rinsed thoroughly in distilled water. 10 seeds each was sown per polythene bag in 28 treatments per replicate, that is $(10 \times 28) = 280$ and $280 \times 4 = 1120$ seeds for four replicates. A 120 g (M_{120}^+) and 60 g (M_{60}^+) of mycorrhiza were added into the potted top soil.

2. 5. Soil Sterilization, Seed Viability Test and Pre-Sowing Treatments

The soil sample was sterilized using the oven dry method at 75 °C for 3 hours before filling in the pot, while control for the experiment was not sterilized (non-sterilized top soil). The viability test was carried out using simple floating method. The seed lots (1120 seeds) were dropped in a beaker containing water. The seeds that float indicate that such seed is not viable, they were removed and replaced. The pre-sowing treatments were:

2. 5. 1. Hot Water (Wet Heat) Treatments

Parkia seeds of one hundred and sixty (160) each were subjected to wet heat treatments in hot water at 60 °C, 80 °C and 100 °C temperatures for 15 minutes, 10 minutes and 5 minutes respectively. The seeds were allowed to cool in each case before sowing.

2. 5. 2. Mechanical Treatments

Parkia seeds of one hundred and sixty (160) were mechanically scarified by testa abrasion at the micropyle with emery cloth for few minutes and then sowed for germination.

2. 5. 3. Chemical Scarification

Parkia seeds of one hundred and sixty (160) each were soaked for the periods of 2 minutes (A₂), 4 minutes (A₄) and 6 minutes (A₆) respectively in 98 % concentrated tetraoxosulphate (VI) acid (H₂SO₄) and was rinsed severally in distilled water to rinse off acid that may hamper the seeds from germination and then immediately sowed.

2. 5. 4. Data Collection and Analysis

Data were collected at 2 weeks interval for 12 weeks on plant height; in which five (5) tagged seedlings from each pot was measured from the root collar to the tip of the terminal shoot using ruler in centimetre (cm) to determine plant height of the seedlings and were recorded.

2. 5. 5. Statistical Data Analysis

Data were analysed using Analysis of Variance (ANOVA) with the Statistical Analysis System (SAS, 2003) computer package at 5 % level of significance to determine differences in the treatments effect, while the Fisher's Least Significant Difference (F-LSD; $P \leq 0.05$) was used to separate the means of differences among the treatments.

3. RESULTS

3. 1. Days of Emergence

Seeds of *Parkia* mechanically scarified (MS) and sowed in top soil added with 120 g of mycorrhiza (M₁₂₀⁺) germinated 4 DAS. Meanwhile, *Parkia* seeds soaked in hot water at 100 °C for 5 minutes (HW 100 °C) and sowed in top soil added with 120 g and 60 g of mycorrhiza (M₁₂₀⁺ and M₆₀⁺) and sterilized top soil germinated 13 DAS (Figure 2).

3. 2. Plant Height (cm)

There was no significant effect on plant height in various soil media across the weeks after sowing except at 10 WAS where seeds sowed in soil with mycorrhiza at 120 g (M₁₂₀⁺) was significant with higher value (24.01). However, seeds soaked in hot water at 60 °C for 15 minutes (HW 60 °C), 100 °C for 10 minutes (HW 100 °C) and 80 °C for 10 minutes (HW 80 °C) had significantly higher values (10.28, 15.29, 17.98) at 2-6 WAS respectively, while seeds soaked in H₂SO₄ acid for 4 minutes (A₄) had significantly lower value of 22.75 among others (Table 1).

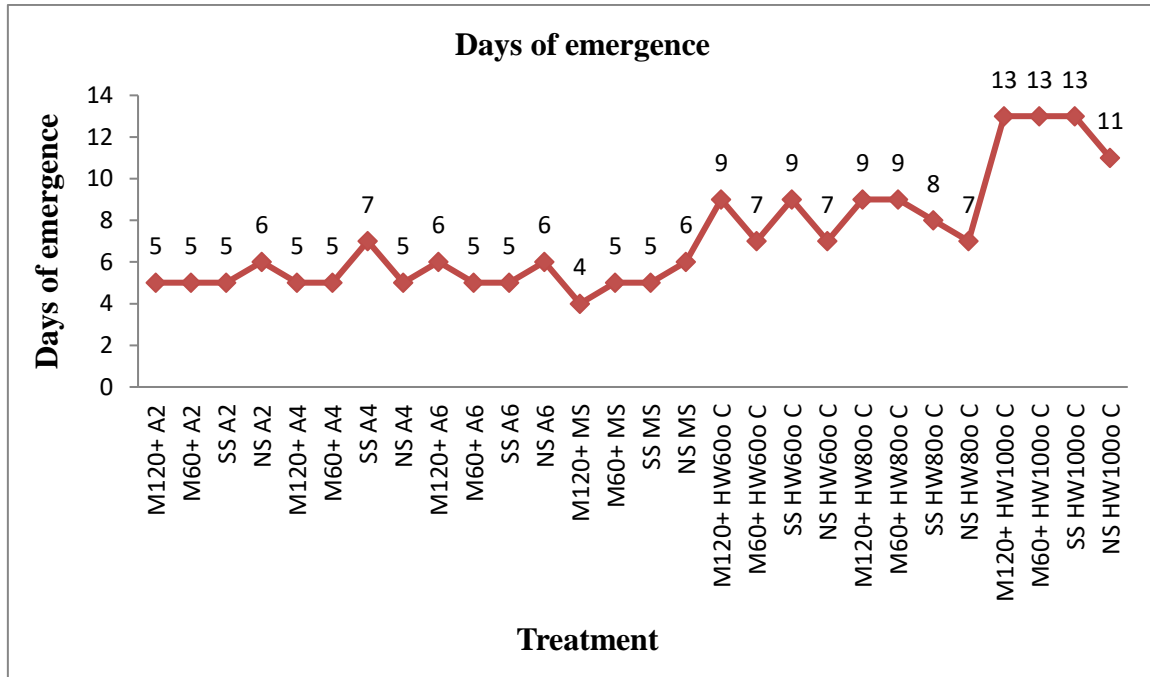


Figure 2. Effect of soil media and pre-germination treatments on days of emergence of *Parkia*.

Table 1. Effect of soil media and pre-germination treatments on plant height at interval of 2 weeks.

Plant height						
Treatment	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS	12 WAS
Soil media						
M ₁₂₀ ⁺	10.00	14.89	17.06	19.31	24.01 ^a	26.82
M ₆₀ ⁺	9.96	14.97	17.08	18.87	22.93 ^b	25.90
SS	9.93	14.35	16.78	18.66	22.87 ^b	26.16
NS	9.76	14.39	17.19	18.60	23.38 ^{ab}	25.99
SE±	0.203	0.406	0.398	0.359	0.382	0.477
Pre-Sowing Treatments						
A ₂	9.48 ^b	15.00 ^b	17.04 ^{ab}	19.31	23.33 ^{ab}	26.14
A ₄	9.86 ^{ab}	1388 ^{ab}	16.70 ^{ab}	18.08	22.75 ^b	25.89

A₆	9.87 ^{ab}	14.47 ^{ab}	16.70 ^{ab}	18.76	23.65 ^{ab}	26.46
MS	10.13 ^{ab}	14.90 ^{ab}	16.79 ^{ab}	19.07	22.90 ^{ab}	25.71
HW 60 °C	10.28 ^a	14.56 ^{ab}	16.55 ^b	19.00	23.94 ^{ab}	26,96
HW 80 °C	10.00 ^{ab}	14.48 ^{ab}	17.98 ^a	18.83	23.01 ^{ab}	25.83
HW 100 °C	9.76 ^{ab}	15.29 ^a	17.28 ^{ab}	19.08	23.53 ^{ab}	26.54
SE±	0.265	0.545	0.552	0.472	0.527	0.470
Interaction						
ST	S*	S*	S*	S*	S*	S*

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, ST: Interaction between soil and pre-germination treatments, S*: Significant, **M₁₂₀⁺**: Soil with mycorrhiza at 120 g, **M₆₀⁺**: Soil with mycorrhiza at 60 g, **SS**: Sterilized top soil, **NS**: Non-Sterilized top soil, **A₂**: Seeds soaked in H₂SO₄ acid for 2 minutes, **A₄**: Seeds soaked in H₂SO₄ acid for 4 minutes, **A₆**: Seeds soaked in H₂SO₄ acid for 6 minutes, **MS**: Mechanical scarification, **HW 60 °C**: Seeds soaked in hot water for 15 minutes, **HW 80 °C**: Seeds soaked in hot water for 10 minutes, **HW 100 °C** Seeds soaked in hot water for 10 minutes.

3. 3. Soil Media and Pre-Treatments Interaction at 4 WAS

Seeds of *Parkia* soaked in 98 % concentrated tetraoxosulphate(VI) (H₂SO₄) for 2 and 4 minutes (A₂ and A₄) and sowed in sterilized top soil (SS) and non-sterilized (NS) had significantly higher values (16.70 and 16.25) on plant height at 4 WAS. Seeds soaked in H₂SO₄ for 6 minutes (A₆) and sowed in top soil added with mycorrhiza at 120 g (M₁₂₀⁺) had significantly higher value (15.60) on plant height at 4 WAS. Mechanically sterilized seeds (MS) in top soil added with mycorrhiza at 60 g (M₆₀⁺), seeds soaked in hot water at both 80 °C and 100 °C for 10 and 5 minutes had significantly higher values (16.52 and 16.48) on plant height at 4 WAS. HW 60 °C in SS had significant effect (15.95) on plant height at 4 WAS (Table 2).

Table 2. Interaction between soil media and pre-germination treatment on plant height of *Parkia* at 4 WAS

Plant height (cm)							
Treatments	(A ₂)	(A ₄)	(A ₆)	(MS)	HW 60 °C	HW 80 °C	HW 100 °C
Soil media							
M₁₂₀⁺	15.87 ^{a-f}	14.80 ^{a-i}	15.60 ^{a-g}	12.48 ^{ij}	13.68 ^{e-j}	12.60 ^{hij}	13.18 ^{g-j}
M₆₀⁺	11.93 ^j	14.77 ^{a-i}	15.10 ^{a-i}	17.08 ^a	13.88 ^{c-j}	16.52 ^{abc}	16.48 ^{a-d}

SS	16.70 ^{ab}	15.80 ^{a-g}	13.60 ^{e-j}	15.53 ^{a-g}	15.95 ^{a-f}	15.25 ^{a-h}	15.27 ^{a-h}
NS	13.73 ^{e-j}	16.25 ^{a-e}	14.37 ^{b-j}	13.83 ^{d-j}	12.60 ^{hij}	13.88 ^{c-j}	13.47 ^{f-j}
SE±	0.744	1.359	0.573	0.505	0.519	0.970	0.977

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, **M₁₂₀⁺**: Soil with mycorrhiza at 120 g, **M₆₀⁺**: Soil with mycorrhiza at 60 g, **SS**: Sterilized top soil, **NS**: Non-Sterilized top soil, **A₂**: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 2 minutes, **A₄**: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 4 minutes, **A₆**: Seeds tetraoxosulphate (VI) acid (H₂SO₄) for 6 minutes, **MS**: Mechanical scarification, **HW 60°C**: Seeds soaked in hot water for 15 minutes, **HW 80°C**: Seeds soaked in hot water for 10 minutes, **HW 100°C** Seeds soaked in hot water for 10 minutes.

3. 4. Soil Media and Pre-Treatments Interaction at 8 WAS

Seeds of *Parkia* soaked in 98 % concentrated tetraoxosulphate(VI) (H₂SO₄) for 6 minutes (A₆) sowed in top soil added with mycorrhiza at 60 g (M₆₀⁺) had significantly lower value (17.55) at 8 WAS, while, seeds of *Parkia* soaked in hot water at 60 °C for 15 minutes (HW 60 °C) in non-sterilized (NS) also had significantly lower value (17.45) at 8 WAS, and even, *Parkia* seeds soaked in hot water at both 80°C and 100°C for 10 and 5 minutes (HW 80°C and HW100 °C) and sowed in top soil added with mycorrhiza at 120 g (M₁₂₀⁺) also had significantly lower value (15.58) on plant height at 8 WAS (Table 3).

Table 3. Interaction between soil media and pre-germination treatment on plant height of *Parkia* at 8 WAS

Plant height (cm)							
Treatments	(A ₂)	(A ₄)	(A ₆)	(MS)	HW 60 °C	HW 80 °C	HW 100 °C
Soil media							
M₁₂₀⁺	19.13	18.23 ^{ab}	19.18 ^{ab}	18.08 ^{abc}	18.42 ^{ab}	15.58 ^c	18.80
M₆₀⁺	18.60	18.88 ^{ab}	17.55 ^{bc}	18.88 ^{ab}	20.15 ^{ab}	19.95 ^{ab}	19.25
SS	19.75	20.50 ^a	18.13 ^{abc}	19.93 ^{ab}	18.38 ^{ab}	19.35 ^{ab}	20.05
NS	19.90	20.55 ^a	18.80 ^{ab}	18.13 ^{abc}	17.45 ^{bc}	18.20 ^{ab}	18.55
SE±	1.035	0.759	0.696	0.896	0.596	0.733	1.015

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, **M₁₂₀⁺**: Soil with mycorrhiza at 120 g, **M₆₀⁺**: Soil with mycorrhiza at 60 g, **SS**: Sterilized top soil, **NS**: Non-Sterilized top soil, **A₂**: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 2 minutes, **A₄**: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 4 minutes, **A₆**: Seeds tetraoxosulphate (VI) acid (H₂SO₄) for 6 minutes, **MS**: Mechanical scarification, **HW 60°C**: Seeds soaked in hot water for 15 minutes, **HW 80°C**: Seeds soaked in hot water for 10 minutes, **HW 100°C** Seeds soaked in hot water for 10 minutes.

3. 5. Soil Media and Pre-Treatments Interaction at 12 WAS

Seeds of *Parkia* soaked in 98 % concentrated tetraoxosulphate(VI) (H₂SO₄) for 2 and 4 minutes (A₂ and A₄) sowed in sterilized top soil (SS) and non-sterilized (NS) had significantly higher values (27.60 and 28.25) on plant height at 12 WAS.

Mechanically sterilized seeds (MS), seeds soaked in hot water at 60 °C and 80 °C for 15 and 10 minutes (HW 60 °C and HW80 °C) sowed in top soil added with mycorrhiza at 60 g (M₆₀⁺) was significant on plant height (26.80, 27.85 and 29.00) at 12 WAS. Seeds of *Parkia* soaked in 98 % concentrated tetraoxosulphate(VI) (H₂SO₄) for 6 minutes (A₆) in top soil added with mycorrhiza at 60 g (M₆₀⁺) had significantly lower value (25.70) at 12 WAS, also, seeds of *Parkia* soaked in hot water at 80 °C and 100 °C for 10 and 5 minutes (HW 80 °C and HW 100 °C) sowed in top soil added with mycorrhiza at 120 g (M₁₂₀⁺) (24.65) on plant height at 12 WAS respectively (Table 4).

Table 4. Interaction between soil media and pre-germination treatment on plant height of *Parkia* at 12 WAS

Plant height (cm)							
Treatments	(A ₂)	(A ₄)	(A ₆)	(MS)	HW 60 °C	HW 80 °C	HW 100 °C
Soil media							
M ₁₂₀ ⁺	27.25 ^{a-d}	25.10 ^{b-f}	27.50 ^{a-e}	24.90 ^{c-f}	25.85 ^{a-e}	22.50 ^f	24.65 ^{c-f}
M ₆₀ ⁺	25.70 ^{b-f}	26.70 ^{a-e}	25.70 ^{b-f}	26.80 ^{a-e}	27.85 ^{abc}	29.00 ^a	27.45 ^{a-d}
SS	27.60 ^{a-d}	27.20 ^{a-d}	25.85 ^{a-e}	25.65 ^{b-f}	26.20 ^{a-e}	27.90 ^{abc}	27.35 ^{a-d}
NS	24.55 ^{edf}	28.25 ^{ab}	26.10 ^{a-e}	25.75 ^{a-f}	23.85 ^{ef}	25.00 ^{b-f}	25.90 ^{a-e}
SE±	1.010	1.381	0.512	1.039	1.234	0.996	1.061

Means followed by the same letters within the same column and treatment are not significantly different at 5 % level of probability using Least Significant Difference (LSD). SE±: Standard Error, M₁₂₀⁺: Soil with mycorrhiza at 120 g, M₆₀⁺: Soil with mycorrhiza at 60 g, SS: Sterilized top soil, NS: Non-Sterilized top soil, A₂: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 2 minutes, A₄: Seeds soaked in tetraoxosulphate (VI) acid (H₂SO₄) for 4 minutes, A₆: Seeds tetraoxosulphate (VI) acid (H₂SO₄) for 6 minutes, MS: Mechanical scarification, HW 60 °C: Seeds soaked in hot water for 15 minutes, HW 80 °C: Seeds soaked in hot water for 10 minutes, HW 100 °C Seeds soaked in hot water for 10 minutes.

4. DISCUSSION

Parkia seeds mechanically scarified (MS) and sowed in top soil added with 120 g mycorrhiza (M₁₂₀⁺) germinated 4 days after sowing (DAS) due to removal of seed coat which has been eaten up by scarification through sand paper, meanwhile, seeds soaked in hot water at

100 °C for 5 minutes (HW 100 °C) and sowed in top soil added with both 120 g and 60 g mycorrhiza (M_{120}^+ and M_{60}^+) and sowed in sterilized top soil germinated 13 DAS (Figure 1).

Days of emergence was observed to commence on 4 DAS in mechanically scarified seeds due to the rasping of the seeds hard coat which has eaten deeper to the embryo or cotyledon, and this actually speed up the emergence or germination of the seeds as also confirmed by (Agboola 2002).

It was discovered from this study in spite of barely all the soil media examined were not significantly different from one another. All the same, the inclusion or addition of ectomycorrhiza in the top soil permit mobility of nitrogen for absorption and distribution of ions to the upper soil layers for plant uptake (Mukerji *et al.*, 1991). *Parkia biglobosa* seeds soaked in hot water also soften the seed coat and allowed water to penetrate into the seeds.

Though, care has to be taken because soaking seeds in hot water above boiling point could damage the seed embryo (cotyledon) as reported by Mwase and Mvula (2011), and this method is preferred to be one of the best in breaking the dormancy of hard coat seeds of *Parkia* (Azad *et al.*, 2010; Azad *et al.*, 2011).

This therefore informed that pre-sowing treatments is necessary in seeds germination for an improved growth (Zida *et al.*, 2005; Dayamba *et al.*, 2008, 2010 a, b, 2014). Several pre-sowing treatments such as hot water, sulphuric acid and mechanical scarification have been used and proven successful to overcome seed coat-imposed dormancy (Teketay 1996, Tigab and Oden 2001).

Likewise, Zida *et al.* (2005) reported that increased rate of germination increased soaking time in acid, and extended soaking time in acid may disintegrate embryo of the seed and inhibit germination (Baskin and Baskin 1998, Zida *et al.* 2005). However, the interaction between soil media and pre-germination treatments were comparable in that top soil added with ectomycorrhiza in which seeds mechanically scarified were sowed had higher and improved growth on plant height.

Hence, top soil that was sterilized (SS) and the one not sterilized (NS) in which *Parkia* seeds soaked in 98 % concentrated tetraoxosulphate (VI) acid (H_2SO_4) acid for 4 minutes and *Parkia* seeds soaked in hot water at 80 °C (HW80 °C) for 10 minutes were sowed, were also observed to improve seedling growth performance in the early growth in the nursery.

5. CONCLUSIONS

This study concluded that seeds of *P. biglobosa* mechanically scarified, seeds soaked H_2SO_4 acid for 4 minutes and seeds soaked in hot water at 80 °C for 10 minutes were the best technologies for breaking dormancy in *Parkia* and that inclusion of ectomycorrhiza soil improve the seedling growth during the early growth in the nursery.

Acknowledgement

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